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EDITORIAL

International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE) is an open access international peer-reviewed, open-access journal, which provides a platform for highlighting and discussing various cognitive science issues dealing with the problems of cognition (and its evolution) within some specific subject field - philosophical, psychological, linguistic, mathematical, psychogenetic, pedagogical, ergonomic. Editorial Board strives to provide a possibility for the scientists of different fields to publish the results of their research, technical and theoretical studies. IJCRSEE is multidisciplinary in approach, and will publish a great range of papers: reports of qualitative case studies, quantitative experiments and surveys, mixed method studies, action researches, meta-analyses, discussions of conceptual and methodological issues, etc. IJCRSEE publisher is The Association for the Development of Science, Engineering and Education, Vranje, co-publisher is Don State Technical University, Russian Federation..

IJCRSEE particularly welcomes articles on the results of scientific research in various fields of cognitive science (psychology, artificial intelligence, linguistics, philosophy and neuroscience) catering for international and multidisciplinary audience. Readers include those in cognitive psychology, special education, education, adult education, educational psychology, school psychology, speech and language, and public policy. IJCRSEE has regular sections: Original Research, Review Articles, Studies and articles, Book Reviews, Case Studies, and is published three times a year. This journal provides an immediate open access to its contents, which makes research results available to the public based on the global exchange of knowledge. The journal also offers access to uncorrected and corrected proofs of articles before they are published.

The main aim of the Journal is to discuss global prospects and innovations concerning major issues of cognitive science, to publish new scientific results of cognitive science research, including the studies of cognitive processes, emotions, perception, memory, thinking, problem solving, planning, education and teaching, language and consciousness study, the results of studying man's cognitive development and the formation of basic cognitive skills in everyday life. The Journal seeks to stimulate the initiation of new research and ideas in cognitive science for the purpose of integration and interaction of international specialists in the development of cognitive science as interdisciplinary knowledge.

All articles are published in English and undergo a peer-review process.

The scope of IJCRSEE is focused on cognitive research both in topics covered as well as disciplinary perspective:

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- Psycholinguistics
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- Text Processing and Cognitive Technologies
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IJCREE has an international editorial board of eminent experts in their field from Russia, USA, Republic of Macedonia, Germany, Hong Kong, Greece, Serbia, Australia, United Kingdom, USA, Turkey, Nigeria, Bulgaria, Romania, Spain, Italy, Republic of Srpska, Croatia, Kingdom of Saudi Arabia (KSA), India, China, Thailand, Israel, Malaysia, Morocco, Jordan,, Iran... We are confident that IJCREE will attract a great number of editors, eminent scientists in the field. The selection will be based on the activities of the editors and their desire to contribute to the development of the journal.

IJCREE provides a platform for academics and scientists professionals to refer and discuss recent progress in the fields of their interests. Authors are encouraged to contribute articles which are not published or not under review in any other journal.

Each submitted manuscript is evaluated on the following basis: the originality of its contribution to the field of scholarly publishing, the soundness of its theory and methodology, the coherence of its analysis, its availability to readers (grammar and style). Normal turn-around time for the evaluation of manuscripts is one to two months from the date of receipt.

Submission of an original manuscript to the journal will be taken to mean that it represents original work not previously published, that is not being considered elsewhere for publication; that the author is willing to assign the copyright to the journal as per a contract that will be sent to the author just prior to the publication and, if accepted, it will be published in print and online and it will not be published elsewhere in the same form, for commercial purposes, in any language, without the consent of the publisher.

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The requirement for the submission of a paper implies that it has not been published before; that it is not under consideration for publication anywhere else; that its publication has been approved by all co-authors.

When considering submitting an article, the Editors have provided the following criteria to assist authors with preparing their submissions:

Originality – The author should ensure that the manuscript has not been previously published nor is being considered by another journal.

Plagiarism - Content should be properly referenced. Be sure to check the paper for possible accidental plagiarism. Some plagiarism checker websites include: <http://www.ithenticate.com/>, www.antiplagiat.ru, www.grammarly.com, www.plagtracker.com or www.duplichecker.com

Writing – Please write in good English (American or British usage is accepted, but not a mixture of these). For non-native English speakers, and perhaps even for some native English speakers, grammar, spelling, usage, and punctuation of the texts are very important for an effective presentation. Hence, manuscripts are expected to be written in a clear, cogent, and readily understandable by an international readership.

Manuscripts must be submitted online. Electronic submission reduces the editorial processing and reviewing time. As part of the submission process, authors are required to check off their submission compliance with all of the following items, and submissions may be returned to authors who do not adhere to the following guidelines:

The submission has not been previously published or presented to another journal for consideration (or an explanation has been provided in Comments to the Editor).

The submission file is in OpenOffice, Microsoft Word, RTF, or WordPerfect document file format.

Where available, DOIs and URLs for the references have been provided.

The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.

The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines.

If submitting to a peer-reviewed section of the journal, the instructions in Ensuring a Double Blind Review have been followed.

A manuscript goes through the peer review process. Authors submit manuscripts to Editorial office via the online system. The acknowledgement letter should be sent to the author to confirm the receipt of the manuscript. The Chief Editor first reviews manuscripts. Chief Editor is assisted by Section Editors (could also be Co- or Associated Editors). The Editor assigns a Section Editor to see the manuscript through the complete review process and return it with a recommendation or decision. The manuscript is checked to see if it meets the scope of the Journal and its formal requirements. If it is incorrect or unsuitable, the author should be informed and the manuscript filed (or returned if requested) – direct rejection. Manuscripts that are not suitable for publication in the Journal are rejected. A Rejection letter is sent to the author stating the reason for rejection. If the manuscript conforms to the aims and scope of the Journal, and formally abides by the Instructions to Authors it is sent out for review. Depending on the type of paper, it could be accepted immediately for publication (invited Editorial, Book review etc) by the Chief Editor.

Check that the manuscript has been written and styled in accordance with the Journal style; that it carries an abstract (if applicable), keywords, correct reference system etc. and check that the correct blinding system has been used. If anything is missing ask the author to complete it before the manuscript is sent out for review.

The manuscript is sent out for review. The reviewer reads and evaluates the manuscript and eventually sends a review report to the Chief Editor. The time for review can be set to 2-6 weeks depending on the discipline (more time is usually given to papers in the humanities and social sciences). Make sure to provide the reviewer with clear instructions for the work, e.g. outlined in the form of a Review report or a number of questions to be considered.

Based on the reviewers' comments the Chief Editor makes a decision to:

- Accept the manuscript without further revision
- Accept after revision
- Ask authors to resubmit
- Reject

An acceptance letter is sent to the author and the final manuscript is forwarded to production. Sometimes, the authors are requested to revise in accordance with reviewers' comments and submit the updated version or their manuscript to the Chief Editor. The time for review can be set to 2-6 weeks depending on the discipline and type of additional data, information or argument required. The authors are requested to make substantial revisions to their manuscripts and resubmit for a new evaluation. A rejection letter is sent to the author and the manuscript is archived. Reviewers might be informed about the decision.

After review a manuscript goes to the Copy Editor who will correct the manuscript concerning the correct referencing system, confirmation with the journal style and layout. When Copy Editor finishes his/her work they send manuscripts to the Layout editor.

Layout Editor is responsible for structuring the original manuscript, including figures and tables, into an article, activating necessary links and preparing the manuscript in the various formats, in our case PDF and HTML format. When Layout Editor finishes his/her job they send manuscripts to Proof Editor.

Proof Editor confirms that the manuscript has gone through all the stages and can be published.

This issue has 13 articles (10 Original researches and 3 Review articles). Our future plan is to increase the number of quality research papers from all fields of science, engineering and education. The editors seek to publish articles from a wide variety of academic disciplines and substantive fields; they are looking forward to substantial improvement of educational processes and outcomes.

Editor in Chief
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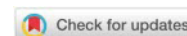
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Self-Confidence in Metacognitive Processes in L2 Learning

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Abstract: The study aims to identify the role of self-confidence, meta-cognition, personality traits, and motivation (predictive variables) as factors of success in second language (L2) learning. It is assumed that there is a high correlation between the observed variables in the meta-cognitive process, which distinguishes academically gifted students from regular students, and that self-confidence is an autonomous factor of success and has a significant role in the self-regulated motivation of gifted students. The results on the Language Proficiency Test are a criterion variable, while gender, residence in the country of the native speaker, duration of L2 learning, and average grade in studies are moderator variables. The sample is convenient, and consists of 460 students from the University of Novi Sad and the University of Belgrade. The research was carried out using a quantitative approach and a method of systematic non-experimental observation. The following instruments are used: the Big Five Personality Traits Questionnaire, the Meta-cognitive Awareness Inventory, the Memory and Reasoning Competence Inventory, the English Language Motivation Questionnaire, the Rosenberg Self-esteem Scale, and the L2 Proficiency Test. The main findings confirmed the hypothesis of a high correlation between the observed variables in the meta-cognitive process that distinguishes academically gifted students from regular students, as well as that self-confidence is an autonomous factor of success and plays an important role in the self-regulated motivation of the gifted. This confirms the significance of self-confidence in self-regulation and provides an indirect role in L2 learning achievements. Students should be aware of meta-cognitive processes and try to self-regulate their knowledge and learning strategies.

Keywords: gifted, self-confidence, meta-cognition, self-regulated motivation, L2 language.

Introduction

The research is focused on the importance of self-confidence in the self-regulated motivation of the gifted for L2 learning. The theoretical context for exploring this phenomenon consists of Sternberg's (2020) Triarchic Theory of Intelligence and the Theory of Self-Determination (Ryan and Deci, 2000). What makes this question interesting? Understanding motivation for L2 learning and its relationship with intelligence and other important cognitive and non-cognitive constructs is still insufficient for what L2 pedagogy would need to effectively teach and direct students to self-regulated learning (SRL), i.e., learning autonomy. However, self-confidence increasingly attracts the attention of researchers in this field of study.

In the last few decades, self-confidence has been an important notion in cognitive psychology, general didactics, and L2 pedagogy. Thus, the "self-confidence movement" (Singal, 2017) considers the lack of self-confidence as one of the factors of mental or emotional difficulties, and in the field of learning, it is believed that improving self-confidence can result in better performances (Zimmerman et al., 1997).

The results of studies on the complexity of the phenomenon of self-confidence indicate differences between the overlapping concepts of self-efficacy, self-confidence, and self-esteem (Oney and Oksuzoglu-Guven, 2015). Self-efficacy is defined as the individual's belief in their own ability to influence events in their life and resolve future situations (Bandura, 1990), while self-esteem is based on ideas about the value or dignity of the individual. Therefore, it is concluded that self-esteem is more present-oriented, while self-efficacy is a more future-oriented belief. The third related term is self-confidence, which is defined as an individual's expectations for performances and self-evaluation of abilities and previous performances (Lenney, 1977; 1981; Lenney, Gold and Browning, 1983). The main idea in this concept is

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the individuals' confidence in their own abilities, capacities, and assessments, or confidence that they can succeed in facing everyday challenges and demands (Colman, 2008). Self-confidence has been related to self-belief, satisfaction with one's abilities and successes, and also to the energy and motivation to take action and achieve goals. Thus, self-confidence is similar to self-efficacy in that it tends to focus on an individual's future performances. However, it is considered to be based on previous performances, and thus, it is focused on the past as well. Many scholars refer to self-efficacy when looking at individuals' beliefs in their abilities in relation to a particular task, while self-confidence is more often seen as a broader and more stable trait relating to individuals' perception of overall ability.

Through the mediating function of motivation, studies have also established interrelationships between the aforementioned success factors as well as their individual relationship with L2 knowledge (Noels and Giles, 2009). The findings of several studies that consider the meaning and definition of this term will be mentioned further in the discussion. The findings of Stankov (2013) and Stankov and Lee (2014) refer to the statement that the success of individuals with high self-confidence lies in the following properties: a higher sense of self-worth; higher enjoyment in activities and life in general; lack of self-doubt and apprehension; social anxiety and stress reduction; more energy and motivation to act; enjoyment of interacting with other people at social gatherings; relaxation; and confidence that others feel at ease in our presence.

In addition to previous findings that are related to self-confidence and support its significance for a wide range of aspects of an individual's life, studies also provide opposite findings. It has been noted that increasing trust does not always lead to improved positive outcomes (Brinkman et al., 2015; Forsyth et al., 2007), and there are also negative correlations with self-confidence. Kremer and his associates (2013) conclude that self-confidence has been constantly increasing during the last decades, leading to increasing narcissism and unrealistic expectations. It is thought that more caution is needed while encouraging self-confidence in children and youth (Singal, 2017). Thus, the belief that a positive self-image is essential for a happy and successful life focuses solely on its positive attributes and creates an age of self-confidence in which children of these generations are taught in schools and at home to view themselves as special. Children are praised for modest accomplishments, but recent research indicates that this practise and these beliefs may contribute to low motivation and a decrease in goal-directed behaviour rather than protecting individuals from depression (Dweck, 1999; Blackwell, Trzesniewski and Dweck, 2007). It is even believed that strengthening self-confidence leads more effectively to an increase in narcissism and a decrease in ambition than to achievement and success. Therefore, the question is whether the idea of improving self-confidence should be rejected. Some researchers (Baumeister et al., 2003) noted that there are certain contexts in which strengthening self-confidence can improve performances, and that these opportunities should be supported. The same authors advocate strengthening self-confidence, but in a more moderate and cautious way (Baumeister et al., 2003), providing support for self-confidence with praise, and increasing self-confidence as a reward for socially desirable behaviour. Accordingly, it encourages the development of healthy self-confidence and avoids the risk that children become convinced of their own competence without investing any effort. In addition, children and young people should be allowed to experience failure and cope with consequences and disappointment, which will probably help them to develop resilience and success in coping skills (Pajares, 1996; Kudinov et al., 2020).

Accordingly, the scholars agree with the opinion of Seligman (1998), who argues that a positive image of oneself does not produce anything. A sustainable sense of self-confidence stems from positive and productive behaviour. Therefore, developing self-confidence means that it should be practiced, because progress toward personally significant goals is considered to be the foundation on which healthy self-confidence is built (Seligman, 1998). The path towards self-regulation implies being aware of the fact that failure is inherent to achievements, and in order to pursue their goals, individuals need to work hard and face their weaknesses (Altaras, 2006; Letić, 2015). Even those who are exceptional in particular areas of life perform less well in other areas. That is why the view that success does not come by chance but should be achieved and comes from giving our best has been increasingly accepted (Csikszentmihályi, 1988; Stankov and Crawford, 1997).

In contemporary conceptions of giftedness, there are differences starting with the personality profile, the ability to tolerate solitude, motivation, and intellectual-moral independence in the sense of autonomous, non-conformist thinking and behaviour of the gifted. There are disagreements in the research findings related to high self-confidence and hypersensitivity (Lee and Olszewski-Kubilius, 2006).

Subotnikova and Džarvinova (Subotnik and Jarvin, 2005) emphasise the importance of self-confidence in the musical development of the gifted, which goes beyond the level of technical skill. There are also well-known studies regarding the predictive value of self-efficacy in gifted individuals (McCormick, 2003).

According to the research findings, self-esteem, a construct developed by the Self-Esteem Movement (Singal, 2017) could not explain poor performance and emotional problems in gifted students in the field of learning (Zimmerman et al., 1997). The new wave of research into the significance of non-cognitive factors for the achievements of gifted students also included research into the overlapping concepts of gifted and regular students' self-efficacy, self-confidence, and self-esteem (Oney and Oksuzoglu-Guven, 2015). According to the research findings, self-efficacy is more pronounced in the gifted and can be considered a significant factor of good self-assessment and belief on the part of the gifted individuals in their own ability to influence events and is linked to their success in solving challenges and life problems (Benabou and Tirole, 2002). The findings also indicate that the individual's expectations of performance and self-evaluation of abilities and previous performance are more pronounced in gifted individuals (Lenney, 1981; Lenney, Gold and Browning, 1983), as is the individual's confidence in their own abilities, capacities, and assessments, or their belief that they can successfully face daily challenges and demands (Colman, 2008). Researchers refer to self-efficacy when observing an individual's beliefs about their abilities in relation to a specific task, whereas self-confidence of the gifted appears more frequently as a broader and more stable trait concerning the perception of their overall abilities (Kleitman and Stankov, 2007). Research has also determined mutual connections between self-confidence and the success of the gifted, as well as with L2 knowledge through the mediating function of motivation (Noels, Pelletier and Vallerand, 2000).

This research is exploratory, based on a quantitative approach and systematic non-experimental observation. The aim of the research is to identify relationships and the role of self-confidence, meta-cognition, personality traits, and motivation (predictive variables) in L2 learning, i.e., to examine these factors within the taxonomy of cognitive and meta-cognitive processes.

The assumption is that there is a high correlation between the observed variables in the meta-cognitive process, which distinguishes academically gifted students from other students, as well as that self-confidence has an autonomous and significant role in the self-regulated motivation of the gifted. In addition to the above predictor variables, the research takes success on the Proficiency Test as a criterion variable. Gender, residence in the country of the native speaker, years of learning L2 language, and average grade in studies were taken as moderator variables.

Materials and Methods

The sample is convenient and consists of students from the University of Belgrade and the University of Novi Sad. Four hundred and sixty respondents participated in the research, of which 345 (75%) were female participants. Of the total number of respondents, 105 stated that they resided in the country of the native speaker, and the length of residing time ranged from one week (7 days) to 17 years. The sample consisted of 205 academically gifted students (with an average grade above 9) and 255 regular students.

Instruments

The Big Five Personality Traits Questionnaire (Goldberg, 2001) The questionnaire was intended to assess the "big five" personality traits, where each trait was measured through 10 items on a five-point Likert scale (1 = completely disagree, 5 = completely agree). The reliability of the scales measured by Cronbach's alpha were: extraversion = 0.78, emotional stability = 0.83, openness to experience = 0.63, agreeableness = 0.67, and conscientiousness = 0.61. Thus, the reliability values of the scales ranged from acceptable to good.

The Meta-cognitive Awareness Inventory (Schraw and Dennison, 1994) consists of 52 items with a binary response format (True or False). It consists of two scales: knowledge of cognition and regulation of cognition. The reliability of the scales measured by Cronbach's alpha was: knowledge about cognition = 0.62 and regulation of cognition = 0.76, indicating acceptable reliability.

English Language Motivation Questionnaire (LLOS-IEA; Noels, Pelletier and Vallerand, 2000). The questionnaire consists of 21 items on a five-point Likert scale that measure seven types of motivation for L2 learning: amotivation, external regulation, introjected regulation, identified regulation, knowledge, achievement, and stimulation. Cronbach's alpha reliability values were as follows: Motivation = 0.82; external regulation = 0.61; introjected regulation = 0.71; identified regulation = 0.83; knowledge = 0.84; achievement = 0.88; stimulation = 0.93, indicating acceptable reliability.

The Memory and Reasoning Competence Inventory (Stankov and Crawford, 1997) is a scale consisting of 16 items measured on a six-point Likert scale. The instrument is divided into two subscales intended to measure memory competence and reasoning competence. The reliability of the scales

measured by Cronbach's alpha was: memory competence = 0.85 and reasoning competence = 0.81, indicating acceptable reliability.

The Rosenberg Self-esteem Scale (Rosenberg, 1965; Rosenberg, Schooler and Schoenbach, 1989), which was partially adjusted for self-confidence in this study, is a 10-item scale measured on a four-point Likert scale and measures the overall level of self-esteem and self-confidence by assessing the person's positive and negative feelings about themselves. Cronbach's alpha calculated the scale's reliability to be 0.87, indicating excellent reliability.

Data analysis

The average summation scores were calculated for all instruments in order to reduce them to the scale for the answers of each particular instrument for easier interpretation and comparison. Relationships between self-confidence, meta-cognition, personality traits, motivation, and success on the L2 proficiency test were determined by calculating Pearson's correlation coefficient. In order to examine the influence of self-esteem and self-confidence, meta-cognition, personality traits, and motivation more systematically (with mutual control of predictors) on success in L2 learning, a hierarchical regression analysis was conducted. In the first step of the analysis, personality traits (extraversion, emotional stability, openness to experience, agreeableness, and conscientiousness) were introduced as predictors, while in the second step, types of motivation, self-confidence, meta-cognition scales, and memory and reasoning competences were introduced, with success in the L2 language proficiency test as the criterion variable.

The t-test for independent samples was used to test the idea that gifted (average grade above 9) and regular students are different in meta-cognitive processes and self-confidence.

In the PROCESS macro for SPSS, the moderator role of specific variables between meta-cognitive processes, self-confidence, and L2 proficiency test success was investigated using moderator analyses. Here, the moderator variables were gender, residence in the country of a native speaker, years of L2 learning, and average grade in studies. The PROCESS macro moderation examined the relationship between one predictor, one moderator, and one dependent variable per analysis.

Results

Descriptive statistics

The basic descriptive indicators for the variables in the study are shown in Table 1. For all variables, skewness and kurtosis values are in the recommended range of ± 2 (George and Mallery, 2010) indicating that the variables do not deviate significantly from the univariate normal distribution. It is important to note that the higher scores on the scales of the questionnaire on meta-cognition were closer to 1, because the number 1 indicated agreement with the item and 0 indicated disagreement. The average grade in L2 was measured in the range of 6 to 10, and it was 8.55, indicating a good performance of the sample in L2 learning.

Table 1
Descriptive indicators of research variables

| | Minimum | Maximum | Arithmetic mean | Standard deviation | Skewness | Kurtosis |
|------------------------|---------|---------|-----------------|--------------------|----------|----------|
| Extraversion | 1.50 | 4.90 | 3.26 | 0.70 | 0.02 | -0.56 |
| Emotional stability | 1.00 | 4.80 | 3.19 | 0.77 | -0.23 | -0.55 |
| Openness to experience | 2.20 | 5.00 | 3.64 | 0.49 | 0.09 | -0.41 |
| Agreeableness | 2.30 | 5.00 | 3.88 | 0.54 | -0.61 | 0.36 |
| Conscientiousness | 2.20 | 5.00 | 3.75 | 0.53 | -0.19 | -0.16 |
| Knowledge (MTK) | 0.31 | 1.00 | 0.77 | 0.19 | -0.68 | -0.21 |
| Regulation (MTK) | 0.34 | 1.00 | 0.75 | 0.14 | -0.33 | -0.33 |
| Amotivation | 1.00 | 3.67 | 1.45 | 0.76 | 1.58 | 1.42 |
| External regulation | 1.00 | 5.00 | 3.04 | 1.06 | -0.29 | -0.39 |
| Introjected regulation | 1.00 | 5.00 | 2.57 | 1.06 | 0.25 | -0.71 |
| Identified regulation | 1.00 | 5.00 | 3.82 | 1.12 | -0.60 | -0.68 |
| Knowledge | 1.00 | 5.00 | 3.37 | 1.13 | -0.31 | -1.00 |
| Achievement | 1.00 | 5.00 | 3.33 | 1.18 | -0.18 | -1.10 |
| Stimulation | 1.00 | 5.00 | 3.27 | 1.21 | -0.20 | -1.09 |
| Memory | 1.00 | 6.00 | 3.98 | 0.93 | -0.43 | -0.07 |
| Reasoning | 1.63 | 6.00 | 4.13 | 0.78 | -0.26 | 0.35 |
| RSA | 1.00 | 4.00 | 1.99 | 0.66 | 0.75 | 0.16 |
| Grade | 6.00 | 10.00 | 8.55 | 1.31 | -0.51 | -0.82 |

Correlation of variables

Pearson's correlation coefficient between the research variables is shown in Table 2. The grade on the L2 proficiency test shows a significant correlation with most scales, although these correlations are of low intensity. The highest correlation with the grade is stimulation ($r = 0.34$) and knowledge ($r = 0.33$). Knowledge, achievement, and stimulation are highly correlated, with coefficients close to $r = 0.70$. Among personality traits, the highest correlation is between openness to experience and conscientiousness ($r = 0.32$), but all correlations are of low to moderate intensity. A high correlation ($r = 0.70$) also existed between the scales of the Memory and Reasoning Competence Inventory.

Hierarchical regression, influence on the grade in L2

Since some of the correlations between the variables were high, the VIF criterion was used to find problems with multicollinearity. Since none of the predictors in the analysis had a VIF criterion higher than 4, all of the predictors were kept in the model.

In the first step of the hierarchical regression analysis (Table 3), personality traits were introduced as predictors, and they explain a significant part of the criterion variance, $F(5, 453) = 14.61$, $p < 0.001$, $R^2 = 0.14$, about 14% of the variance. In the first step of the analysis, extraversion appears as a positive predictor, and conscientiousness and emotional stability appear as negative significant predictors. Upon the introduction of other predictors, the model significantly improves, $F_c(12, 441) = 9.22$, $p < 0.001$, $R^2_c = 0.17$, and about 17% of the additional variance has been explained, for a total of about 31% ($R^2 = 0.31$, $R^2_{adjusted} = 0.28$). After the introduction of additional predictors, extraversion, emotional stability, and conscientiousness remain important predictors, while identified regulation, stimulation, and self-esteem (Rosenberg self-esteem and self-confidence scale) appear as additional important predictors, with all new predictors being positive. An increase in the average score on the L2 proficiency test is associated with an increase in the scales of these predictors.

Table 2
Correlation of research variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | |
|----------------------------|---|------|-------|-------|-------|-------|-------|--------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|
| Extraversion (1) | 1 | -.07 | .26** | .29** | .05 | .25** | .06 | -.12** | -.02 | -.08 | -.02 | .15** | .15** | .04 | .09* | .11* | -.07 | .27** | |
| Emotional stability (2) | | 1 | -.10* | .02 | .21** | 0.00 | .16** | -.02 | .08 | -.07 | -.00 | -.14** | -.22** | -.13** | .13** | .16** | -.23** | -.22** | |
| Openness to experience (3) | | | 1 | .19** | .32** | .31** | .22** | -.25** | .03 | .13** | .19** | .18** | .12** | .12** | .40** | .46** | -.16** | .11* | |
| Agreeableness (4) | | | | 1 | .19** | .24** | .33** | -.08 | -.08 | -.01 | .12** | .17** | .16** | .19** | .01 | .00 | -.13** | .09* | |
| Conscientiousness (5) | | | | | 1 | .32** | .22** | -.18** | -.00 | -.19** | .02 | .05 | .07 | .03 | .37** | .27** | -.26** | -.14** | |
| Knowledge (MTK) (6) | | | | | | 1 | .47** | -.22** | -.05 | .02 | .06 | .21** | .21** | .24** | .43** | .38** | -.17** | .09* | |
| Regulation (MTK) (7) | | | | | | | 1 | -.06 | .07 | .02 | .23** | .13** | .13** | .14** | .14** | .30** | -.12** | .10* | |
| Amotivation (8) | | | | | | | | 1 | .00 | .26** | -.37** | -.26** | -.20** | -.26** | -.42** | -.19** | 0.04 | -.14** | |
| External reg. (9) | | | | | | | | | 1 | .21** | .25** | -.22** | -.11* | -.18** | .06 | -.00 | -.18** | .06 | |
| Introjected reg. (10) | | | | | | | | | | 1 | .05 | .20** | .18** | .21** | -.07 | -0.02 | .10* | .13** | |
| Identified reg. (11) | | | | | | | | | | | 1 | .32** | .38** | .35** | .19** | .22** | -.11* | .29** | |
| Knowledge (12) | | | | | | | | | | | | 1 | .72** | .71** | .10* | .15** | .22** | .31** | |
| Achievement(13) | | | | | | | | | | | | | 1 | .69** | .09* | .15** | .21** | .33** | |
| Stimulation (14) | | | | | | | | | | | | | | 1 | .09* | .18** | .34** | .34** | |
| Memory (15) | | | | | | | | | | | | | | | 1 | .70** | -.27** | -.05 | |
| Reasoning(16) | | | | | | | | | | | | | | | | 1 | -.20** | .00 | |
| RSA (17) | | | | | | | | | | | | | | | | | 1 | .21** | |
| Grade (18) | | | | | | | | | | | | | | | | | | | 1 |

Note: RA – Rosenberg self-esteem scale; MTK – Meta-cognition questionnaire; * - $p < 0.05$; ** - $p < 0.01$.

Table 3
Partial contribution of predictors in the hierarchical regression model

| | Beta (model 1) | p (model 1) | Beta (model 2) | p (model 1) | VIF |
|---------------------------|-------------------|----------------|-------------------|----------------|------|
| Extraversion | 0.24 | 0.000 | 0.27 | 0.000 | 1.31 |
| Emotional stability | -0.17 | 0.000 | -0.11 | 0.012 | 1.30 |
| Openness to experience | 0.08 | 0.120 | 0.04 | 0.401 | 1.65 |
| Agreeableness | 0.05 | 0.288 | -0.04 | 0.430 | 1.42 |
| Conscientiousness | -0.16 | 0.001 | -0.11 | 0.027 | 1.47 |
| Knowledge (MTK) | | | 0.03 | 0.610 | 1.95 |
| Regulation (MTK) | | | 0.08 | 0.143 | 1.73 |
| Amotivation | | | -0.04 | 0.412 | 1.77 |
| External reg. | | | 0.08 | 0.105 | 1.42 |
| Introjected reg. | | | 0.04 | 0.350 | 1.44 |
| Identified reg. | | | 0.22 | 0.000 | 1.81 |
| Knowledge | | | 0.02 | 0.764 | 2.84 |
| Achievement | | | 0.02 | 0.753 | 2.72 |
| Stimulation | | | 0.15 | 0.025 | 3.03 |
| Memory | | | -0.07 | 0.293 | 3.05 |
| Reasoning | | | -0.04 | 0.551 | 2.80 |
| RSA | | | 0.14 | 0.003 | 1.53 |

Differences between the academically gifted and other students

Results of the t-test for independent samples are shown in Table 4. These indicate differences across the three scales in the expected direction. On the scales of knowledge and regulation of cognition (meta-cognition), the academically gifted students scored higher, indicating higher levels of these meta-cognitive traits as well as higher self-confidence.

Table 4
Differences between academically gifted and regular students

| | AS (gifted) | AS (others) | t | df | p |
|------------------------------|----------------|----------------|-------|-----|-------|
| Meta-cognition knowledge | 0.82 | 0.73 | -4.72 | 458 | 0.000 |
| Meta-cognition regulation | 0.7 | 0.73 | -3.29 | 458 | 0.001 |
| Self-confidence | 1.85 | 2.15 | -4.96 | 458 | 0.000 |

Moderation analyses Gender as moderator

All moderations were examined by introducing a moderator into the model in addition to only one main predictor and criterion. Gender is not a significant moderator in the case of the influence of knowledge of cognition (meta-cognitive process) on success in L2 learning, $F(1, 456) = 0.09, p > 0.05$; and the interaction of gender and knowledge of cognition does not improve the model. Gender is a significant moderator in the influence of regulation of cognition (meta-cognitive process) on L2 learning success ($F(1, 456) = 4.01, p = 0.046$), as well as the influence of self-confidence on L2 learning success ($F(1, 456) = 4.92, p = 0.027$). In order to better interpret the moderation effect, the significant interaction effects are presented in Chart 1, which shows moderation between regulation of cognition and gender. Here, the largest difference is in the grade among respondents with higher levels of regulation of cognition. In this case, females have significantly higher grades than males, while these differences are negligible at lower levels of regulation of cognition. Moderation of self-confidence and gender show that at lower levels of self-confidence, both males and females have nearly identical grades in L2, whereas increasing self-confidence improves grades for females but not for males.

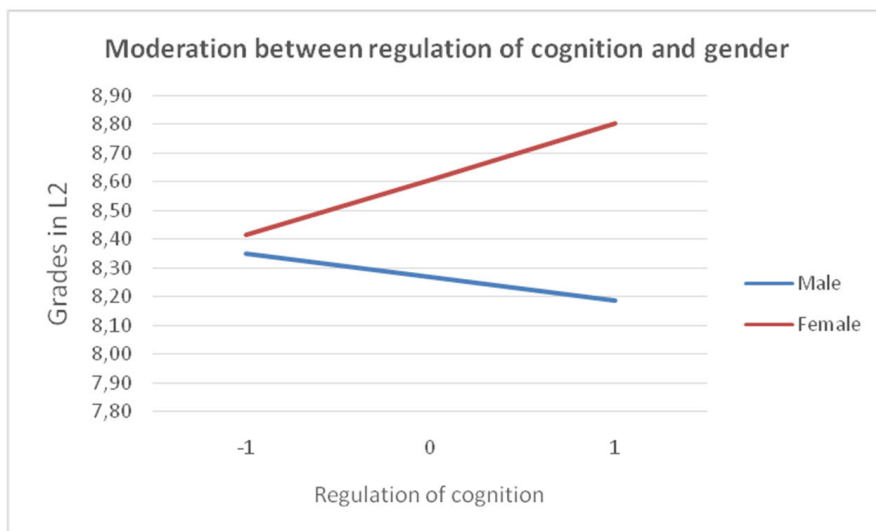


Chart 1. Moderation between regulation of cognition and gender based on the grade in L2



Chart 2. Moderation between self-confidence and gender based on the grade in L2

Residing in the country of native speaker as moderator

In the case of scales of meta-cognitive processes, knowledge, and regulation, residing in the country of a native speaker did not prove to be a significant moderator, $F(1, 456) = 0.61, p > 0.05$ and $F(1, 456) = 0.10, p > 0.05$, and the introduction of interaction does not improve the model. In the case of self-confidence, a significant interaction can be seen $F(1, 456) = 13.16, p < 0.001$, and the introduction of the interaction of self-confidence and residing in the country of a native speaker significantly improves the model. The interaction is shown in Chart 3. For the success in L2 of students' with low levels of self-confidence, it is more important whether they resided in the country of the native speaker or not, while this factor is insignificant for students with high levels of self-confidence, whose success does not depend on whether they resided in the country of the native speaker or not.

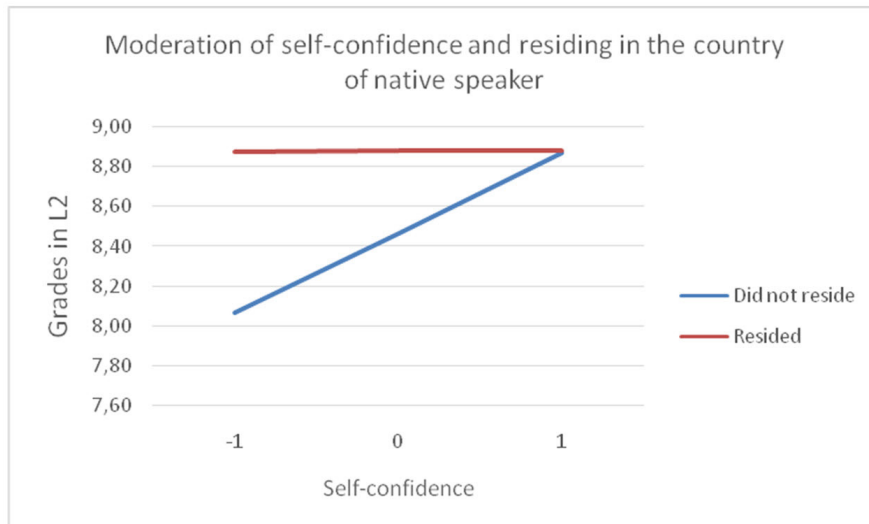


Chart 3. Moderation between self-confidence and residing in the country of native speaker based on the grade in L2

Length of residing in the country of native speaker

Moderation analysis in the case of the length of residing in the country of the native speaker was conducted on a subsample of students who stated that they resided in the country of the native speaker ($n = 104$). They were divided into two categories: students residing for less than a month ($n = 44$) and those residing for a month or longer ($n = 66$). The length of residence did not prove to be a significant moderator in any of the models: $F(1, 100) = 2.29, p > 0.05$, $F(1, 100) = 2.82, p > 0.05$ and $F(1, 100) = 0.28, p > 0.05$

Average grade in studies

The average grade in the studies does not prove to be a significant moderator in the case of meta-cognitive processes, $F(1, 456) = 1.77, p > 0.05$ and $F(1, 456) = 0.97, p > 0.05$, and self-confidence, $F(1, 456) = 2.51, p > 0.05$.

Length of L2 learning

The length of L2 learning proves to be a significant moderator in all models. Improvement of all three models, knowledge of cognition, $F(1, 456) = 8.12, p = 0.005$, regulation of cognition, $F(1, 456) = 11.23, p = 0.001$, and self-confidence, $F(1, 456) = 14.14, p < 0.001$, is statistically significant when introducing the interaction with the length of L2 learning. These moderation effects are shown in Charts 4, 5, and 6. In all charts, the different colours indicate different lengths of L2 learning (in standard deviations). Those who have been learning the language longer have the highest scores in cases of high knowledge of cognition, while their scores are the lowest in cases of low knowledge of cognition. This pattern is reversed in the case of those who have been learning L2 for a shorter period of time. In the case of moderation of regulation of cognition and length of L2 learning, for those with low regulation, the grade is lower and the same regardless of the length of L2 learning, while for those with high regulation, the grade is better for those who have been learning L2 for a longer period of time. A high level of self-confidence has been shown to be more important than the length of L2 learning for those with high levels of self-confidence, and they have high grades regardless of the length of learning. On the other hand, at lower levels of self-confidence, the length of L2 learning is more crucial for achieving a better result on the L2 proficiency test.

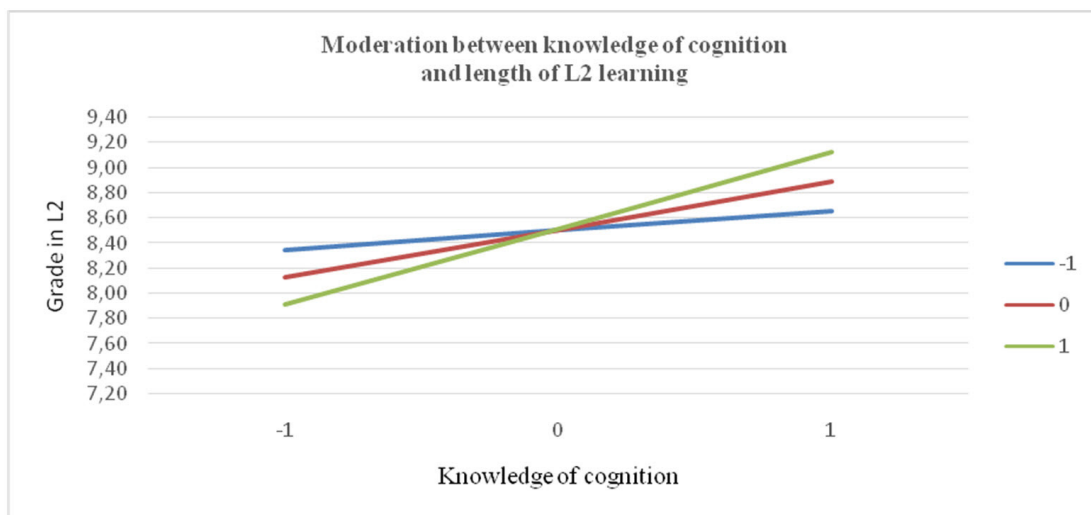


Chart 4. Moderation between knowledge of cognition and length of L2 learning based on the grade in L2

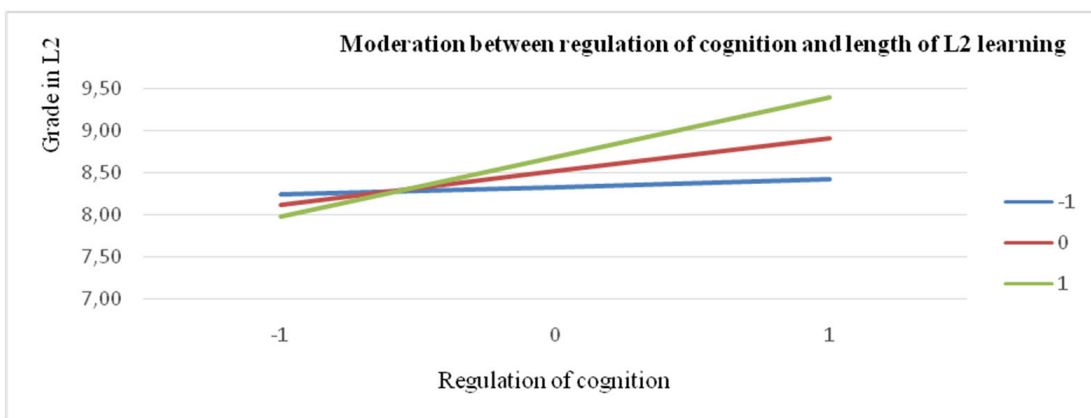


Chart 5. Moderation between regulation of cognition and length of L2 learning based on the grade in L2

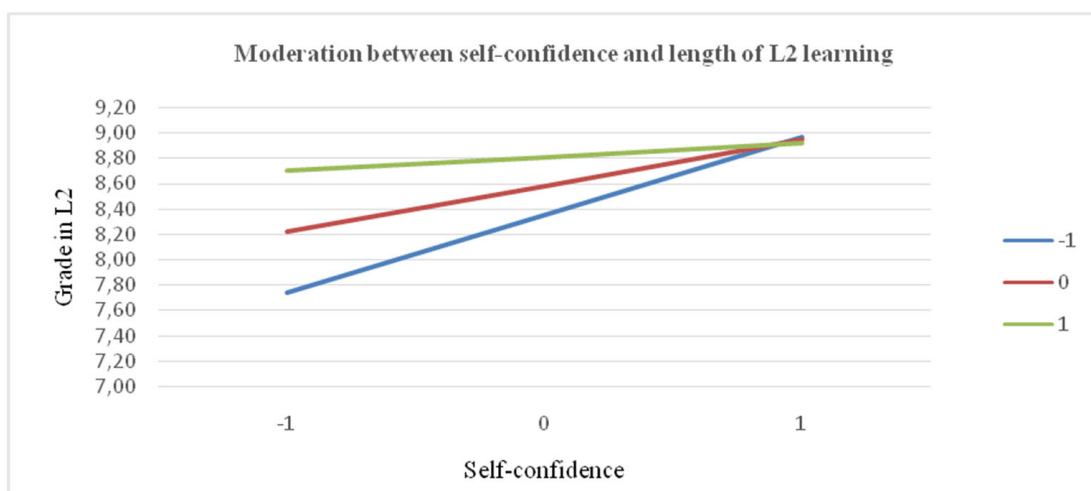


Chart 6. Moderation between self-confidence and length of L2 learning based on the grade in L2

Discussion

The result of a close relationship between knowledge (MTK), achievement, and regulation (MTK with coefficients of correlation close to $r = 0.70$) and success L2 knowledge, referring to students from the category of academically gifted (with an average grade above 9.00), emphasises the close relation of intellectual potentials, i.e., academic giftedness, with cognitive and meta-cognitive variables, which, in synergy, each in its own way, contribute to self-regulation shown in the realisation of academic giftedness. From a theoretical point of view, the previous statements fit into the notions of the influence of contextual approaches and modern conceptions of intelligence, which emphasise the importance of social context for determining behaviour that will be considered a reflection of intelligence, and directly into Sternberg's concept of intelligence (2009) in which meta-cognition is seen as the regulation of intellectual functioning. So, it could be noted that the findings discussed here confirm the importance of this understanding, as well as the components by which Sternberg (2009) defined this concept (meta-cognition as a cognitive phenomenon of higher order - cognition about cognition, i.e., intellectualization of various cognitive functions, including the intellect itself - about the characteristics, powers and limitations of cognitive functioning; regulatory role in relation to cognition-strategies of monitoring and managing one's own cognition and behaviour (meta-cognitive decisions about what to look out for, what to check well, in which direction to search for a solution, etc.). The previous findings indicate that gifted individuals are using strategies and meta-cognitive abilities, especially for resolving complex and demanding tasks. Thus, it seems that efforts to improve the application of strategies and meta-memories of academically gifted individuals, in this case in the field of L2 learning, have shown significant effects, which is in line with previous studies (Gojkov Rajić et al., 2021; Šafranji and Gojkov Rajić, 2019), and it could be concluded that this direction is worth following.

The findings of this study are consistent with other researchers' findings on the importance of meta-cognition (Kleitman and Stankov, 2007). Trying to clarify self-confidence within the framework of a taxonomy of cognitive and meta-cognitive processes, they found that these phenomena are crucial in identifying factors that facilitate intelligent behaviour and that they cross the limited scope of traditional notions of intelligence. The same authors also accept the assumption that meta-cognitive knowledge and skills are essential components of successful learning because they can lead to the choice of strategies and, where necessary, anticipate their adaptation, which is emphasised by Sternberg (1997) as well. The results that confirm the importance of knowledge (MTK), meta-cognition, and the importance of assessing awareness of one's own cognitive weaknesses and strengths (Kleitman and Stankov, 2007) are in line with the findings discussed here. From the point of view of didactic implications, the findings of this research can help students work on developing an adequate level of success as well as confidence in their cognitive performance and self-help in the effective use of their own cognitive abilities and strategies in L2 learning.

The high correlation ($r = 0.70$) between memory and reasoning scales and self-confidence indicates the importance of another construct (self-confidence) for the prediction of success in L2 learning. The following were included in the composite of significant predictors of achievement in L2 learning: extraversion, emotional stability, conscientiousness, identified regulation, stimulation, and self-confidence. Furthermore, it could be concluded that there are several cognitive and non-cognitive components important for the self-regulation of gifted students in the field of L2 learning. The complexity of the phenomenon of self-regulation is also revealed in this finding.

The findings related to self-confidence, which Kleitman and Stankov (Kleitman and Stankov, 2007; Stankov, 2013) characterise as a broad psychological trait that intersects different cognitive domains, are pointed out for comparison. It was significant to include self-confidence in the variables that seek to answer the question of what their relationship is and how much individual contribution there is to achievement in L2. It helps teachers and students build meta-cognitive strategies for L2 learning. The findings of this research are in line with the above-mentioned in terms of their close relation to intellectual and meta-cognitive potentials. Thus, the correlation between self-confidence and meta-cognitive abilities of academically gifted students in their achievements in L2 places self-confidence in the meta-cognitive field of the cognitive/meta-cognitive taxonomy (Kleitman and Stankov, 2007). Moreover, when investigating the importance of self-confidence, which is shown to be more important for achievement than other moderator variables (length of L2 learning and residing in the country of a native speaker), the obtained results are in line with the findings confirming the specific place of self-confidence in the taxonomy of cognitive and meta-cognitive processes. It confirms the findings of other researchers (Teovanović, Knežević and Stankov, 2015) on self-confidence as a significant factor, but is also independent of other cognitive and non-cognitive factors in L2 learning. It functions independently in its contribution to the self-realization of

intellectual potentials for mastering foreign languages.

This finding is another confirmation of the opinion (Seligman, 1998) that a positive self-image is insufficient for a sense of security and self-realization and that supporting the development of self-confidence implies the need for practice, because self-confidence is based on making progress towards personally important goals. Thus, self-regulation entails being aware that failure is inherent in accomplishments, and achieving self-realization and self-confidence necessitates exerting effort as well as confronting our own weaknesses. Gifted students have weaknesses as well; in some areas, they are stronger than others. Based on self-regulation, they accept the fact that success does not come by chance but rather stems from dedication and self-correction (Csikszentmihályi, 1988), which certainly has significant implications for L2 pedagogy. Therefore, it could be concluded that the findings of the studies on negative correlates with self-confidence cannot be accepted (Brinkman et al., 2015; Kremer, Brannen and Glennerster, 2013), but the agreement remains regarding the need to promote self-confidence in children and youth in order to prevent narcissism and an unrealistic sense of self-confidence, an illusion that in L2 knowledge is usually quickly shattered.

Conclusion

The main findings confirmed the hypothesis of a high correlation between the observed variables in the meta-cognitive process that distinguishes academically gifted students from regular students, as well as that self-confidence is an autonomous factor of success and has a significant role in the self-regulated motivation of the gifted. This further confirms the significance of self-confidence in self-regulation and, as can be seen from the results, provides an indirect role in L2 learning achievements. Thus, students and L2 teachers should be aware of meta-cognitive processes and try to self-regulate their knowledge and learning strategies so that they are consistent with other cognitive and non-cognitive factors, such as personality traits and types of motivation.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, A.G.R., J.Š. and D.G.; methodology, A.G.R.; software, J.Š.; formal analysis, D.G. and J.Š.; writing—original draft preparation, A.G.R. and D.G.; writing—review and editing, J.Š. and A.G.R. All authors have read and agreed to the published version of the manuscript.

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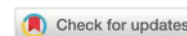
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Students' Perceptions of Teacher Support, and Their School and Life Satisfaction Before and After The COVID-19 Pandemic

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Abstract: In an attempt to examine the extent to which the COVID-19 pandemic affected the lives of primary school students, a longitudinal study was conducted focused on students' school satisfaction and life satisfaction, and their perception of the support provided by their teachers. The study was conducted in two waves, within the period of two years – the first one before the pandemic, and the second one upon its end, that is, when the students returned to classes in school. The study encompassed 548 students in total, attending third to eighth grades of primary school in the Republic of Croatia. 267 students participated in both waves of the study. The quantitative approach was applied. The results revealed statistically significant differences in students' perception of teacher support, and the level of their school satisfaction and life satisfaction. Students seem to have been more satisfied with school, life and teacher support before the pandemic. An additional analysis of the differences between generations of students (2019 and 2021) was conducted. Although the younger generation seem to give a lower rating to all the examined variables, in comparison to the generation of 2019, the results reveal statistically significant differences only in life satisfaction (grades 4, 5 and 7) and teacher support (grades 5 and 6). The limitations of the study, as well as implications for future research and educational practice are discussed.

Keywords: COVID-19; life satisfaction; school satisfaction; teacher support.

Introduction

The world is currently witnessing a great scientific and technological revolution. Its influence has reflected on various aspects of human life and can be particularly felt in the time of the COVID-19 pandemic. The changes brought about by the pandemic in the area of education were sudden and unexpected. The COVID-19 pandemic led to the closing of schools all around the world and transformed the existing ways of learning and teaching. Suddenly, distance learning was introduced. The pandemic emphasized the importance of online learning, which became an acceptable solution to a problem created when face-to-face teaching was brought to a halt. There had been no time to prepare for such a change. The learning and teaching environment underwent fundamental changes and had an impact on all stakeholders in the education process. [Pokhrel and Chhetri \(2021\)](#) point out that it was the biggest disturbance in the history of education. A great number of the main stakeholders in the education process, students and teachers, found themselves involved in online learning for the first time. In normal circumstances, such sudden and massive changes would call for additional resources, training, planned strategies and adaptability of all stakeholders. However, as it was impossible to provide them, both students and teachers were forced to cope with the new situation as best they could. Also, they came across various challenges and obstacles in the process ([Salihagic and Akay, 2022](#)). According to [Blahušiaková, Mokošová, and Šoltés \(2021\)](#) the primary goal of teachers was to ensure quality teaching at the same level as during the traditional attendance form of teaching. Teachers had to overcome the obstacles relating to technology, find new ways to design and adjust their teaching activities, combine pedagogy and technology, etc. ([Son, 2018](#)).

The transition from traditional teaching to virtual teaching for all students, at all education levels, is a phenomenon which had never been seen before. That is why it was important to examine students' perceptions of the changes in education introduced due to safety measures in order to minimize the

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negative effects of the pandemic. Students pointed out that negative characteristics of online learning for them included a lack of personal communication and self-confidence for asking questions when they did not understand something and when they needed clarification. Furthermore, they also mentioned difficulties in focusing on studying, lack of motivation for studying, technical problems, not understanding the tasks they were supposed to do, and writing exams. In general, students did not have a positive attitude to online teaching and were dissatisfied with it because they were faced with numerous challenges. The only positive thing they mentioned was being at home and feeling safe from catching a virus (Salihagic and Akay, 2022). Although the pandemic has not officially ended yet, its end is near (World Health Organization [WHO], 2021) and we are going back to the new normal, so we are using the phrase after the pandemic in the title of this paper as well.

During the pandemic in Croatia, the teaching process was conducted by applying one of the three possible models, depending on the epidemiological situation: A model – the teaching process was conducted in school; B model – a combination of in-school and online teaching, and C model – online teaching. Due to these three models, students in Croatia were able to have online lessons less frequently. The Croatian model, as an example of good practice, was presented at the WHO meeting on education in the time of the pandemic (WHO, 2021). In March 2020, the teaching process in Croatia was being conducted online, at all levels of education. Over time, the teaching process was slowly going back to its traditional form – face-to-face. At first, the youngest students in primary schools went back to face-to-face teaching, followed by older students. Occasionally, in case there were students who had been infected by the corona virus, or those who had been in close contact with the infected people, whole classes would go back to the virtual teaching environment for a certain period of time. In September 2021, the COVID-19 measures were relaxed and only individual students were required to self-isolate, instead of entire classes (Hrvatski zavod za javno zdravstvo [HZJZ], 2021).

Teacher support

Teacher support may be defined as a student's perception of care, help, feedback and advice provided by the teacher (Guess and McCane-Bowling, 2016). Alder (2002) lists teachers' characteristics that students perceive as caring and supportive. These teachers know their students well, provide personalized leadership for their students, teach them to understand the content, are academically helpful, and hold high expectations for behaviour and achievement. According to Skinner et al. (2008), teacher support includes three dimensions: autonomy support, structure and involvement. Autonomy support is teacher's provision of choice, relevance, or respect to students. Structure implies clear expectations, while involvement encompasses warmth, affection and understanding. Teacher support is positively related to a sense of belonging (Wang and Eccles, 2012), satisfaction with school (Buehler et al., 2015; Danielsen et al., 2009), and engagement in school (Buehler et al., 2015; Reyes et al., 2012). Supportive teachers create opportunities in the classroom which enable students' holistic growth and development, and help them experience the learning process in a positive way. Such experiences and encouraging feedback provided by teachers motivate students to be more engaged in work in school (Buehler et al., 2015). Wang et al. (2010) point out that students who feel teacher support tend to exhibit problem behaviour less frequently.

Students' School Satisfaction

Students' first associations with school include mainly studying, teaching, learning outcomes, and marks. However, school is much more than that. It is a place where students (and teachers) live and it should, besides providing students with opportunities to gain new knowledge and skills and enabling their personal growth and development, also provide them with a feeling of satisfaction and success. School satisfaction is a very important, but insufficiently researched phenomenon, which is related to students' well-being in school (Epstein and McPartland, 1976). Nowadays, school satisfaction is considered the fundamental area for understanding the quality of students' lives (Suldo, Bateman and Gelley, 2014).

Baker (1998) defines school satisfaction as a student's subjective cognitive evaluation of the quality of school life. Since it is a subjective construct, school satisfaction accounts for the individual differences in students' perceptions (Huebner, 1991a). Baker (1998) states that school satisfaction is influenced by numerous factors from students' environment and individual factors. The former include ethical and caring school environment, stress and family environment. It is expected that children's perception of caring and supportive school environment, including good and quality interpersonal relationships, will have a positive impact on children's school satisfaction. If children evaluate school as stressful environment, it will have a negative impact on their school satisfaction. The sources of stress most frequently associated with school are: academic requirements, interaction with teachers and interaction with peers (Carson and

Bittner, 1994). The quality of a child's family life is the most important environment factor that will probably influence school satisfaction. The most frequent individual factors that have an impact on children's school satisfaction are psychological distress and academic self-perception (Baker, 1998).

A high level of school satisfaction influences a student's acceptance of educational values and his/her motivation, and it is related to academic success as well (Danielsen et al., 2011; Goodenow and Grady, 1993). On the other hand, it has been proved that a low level of school satisfaction is related to students' risky behaviour and substance abuse (Vogel et al., 2015).

Life satisfaction

The experiences that children and young people have in school, be they positive or negative, will have an impact on the quality of their lives and their psychological well-being (Hui and Sun, 2010). One of the components of subjective well-being is life satisfaction, that is, an individual's evaluation of how satisfied he or she is with the quality of their own life (Pavot et al., 1991). Life satisfaction can be studied in terms of evaluation of life as a whole and/or in terms of evaluation of specific life domains (e.g. family, school) (Seligson, Huebner and Valois, 2003). Park, Peterson and Seligman (2004) point out that hope, as a character strength, is related to life satisfaction in adults, while Gilman and Huebner (2006) claim it is related to life satisfaction in young people as well.

Studies on life satisfaction in children and young people have been conducted recently, taking into consideration the introduction of measures intended to prevent the spread of SARS-CoV-2 virus. Magson et al. (2021) detected a significant decrease in the life satisfaction level in adolescents, following the introduction of safety measures at the national level due to the COVID-19 pandemic. They also determined differences in terms of gender and explained that girls exhibited a greater decrease in life satisfaction level than boys. Furthermore, according to the findings of a longitudinal study conducted by Steinmayr, Paschke and Wirthwein (2022) on a sample of 425 primary school students during the COVID-19 pandemic, there was a decrease in positive behaviour exhibited by children, as well as lower levels of family life satisfaction, general life satisfaction and satisfaction with peers.

The aim of the research

The aim of this study was to examine how primary school students perceive teacher support and how satisfied they are with school and their life. As the first wave of the study was carried out in 2019 (before the COVID-19 pandemic), and the second wave was conducted when students returned to schools in 2021 (after the COVID-19 pandemic), the first task in the study was to check if there were any changes in students' perceptions of teacher support, school satisfaction and life satisfaction. Between these two points in time the teaching process was sometimes conducted online, while before the beginning of the pandemic and after the study had been carried out the teaching process was conducted in the face-to-face format. An additional analysis was carried out to determine if there were differences in the perceptions of the examined variables in terms of the generation of students. It was assumed that, due to online teaching, students perceived a lower level of teacher support. It was also assumed that online teaching and lockdown had left their marks on students' school and life satisfaction.

This study aims to answer the following three questions:

1. Are there differences in students' perceptions of teacher support, school satisfaction and life satisfaction before and after the COVID-19 pandemic in the entire sample of the respondents?
2. Are there differences at a class level in students' perceptions of teacher support, school satisfaction and life satisfaction before and after the COVID-19 pandemic in the respondents who participated in both waves of the study?
3. Are there differences in students' perceptions of teacher support, school satisfaction and life satisfaction before and after the COVID-19 pandemic in terms of the generation to which students belong?

Materials and Methods

Participants and procedures

The sample comprised primary school students in Zagreb, the Republic of Croatia. Five hundred and forty eight students attending grades 3 – 8 of primary school participated in the study. Since primary school in the Croatian education system includes students from first (aged 6-7 years) to eighth grade (aged 13-14 years), the second wave of the study could not include the students who had attended grades 7 and 8 during the first wave of the study. Two hundred and sixty seven respondents in total took part in both waves of the study, 146 respondents took part only in the first wave (grades 7 and 8), while

135 respondents took part only in the second wave (grades 3 and 4). In relation to the total number of students in the school, the first wave included 82.6% (n1 = 413), and the second wave 77.75% (n2 = 402) of students. The total number of the respondents included 47.7% of male and 52.3% of female participants. A detailed analysis of the sample is shown in Table 1.

Table 1
The sample

| Grade | 3 rd | 4 th | 5 th | 6 th | 7 th | 8 th | Total | M _{age} (SD _{age}) |
|--------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-------|---------------------------------------|
| T1 | 64* | 74* | 66* | 63* | 70 | 76 | 413 | 11.74 (1.76) |
| T2 | 65 | 70 | 64* | 74* | 66* | 63* | 402 | 11.70 (1.74) |
| Total number of students | 129 | 144 | 131 | 137 | 136 | 140 | 548 | |

Note: * respondents who took part in both waves

The study was conducted in line with the provisions of the Ethical Code for Research with Children. Prior to the study, a written parental consent for children's participation in the study had been obtained. As the participants are children attending lower grades of primary school, and in order to secure their anonymity and the protection of their data, the data in the first wave of the study were completely anonymous and did not involve any personal information based on which students could be identified. The only data that were collected were those on students' gender, age and grade. The first point of measurement was in 2019, before the pandemic broke out. Although the study was conducted anonymously, it was known who the participants were, as the written parental consent had been obtained prior to the study. However, the analyses were conducted only at the individual class level. In 2021 it was decided to repeat the measurement to examine the differences in students' school satisfaction and life satisfaction levels and the received teacher support, regarding the changes caused by the COVID-19 pandemic and the changes in students' lives and organization of the teaching process. In the second wave, written parental consent for participation of third- and fourth-grade students in the study was required again. For students attending grades 5, 6, 7 and 8, written parental consent was required only from those parents whose children had participated in the first wave of the study.

Measurements

Teacher support – to measure teacher support, one dimension of The Child and Adolescent Social Support Scale (CASSS; [Malecki and Demaray, 2002](#); [Malecki, Demaray and Elliott, 2014](#)) was used. The Teacher Support Dimension originally contained 12 items. However, in this study, 5 items were used (e.g. My teachers tells me I did a good job when I've done something well). The calculated reliability coefficients were $\alpha = .832$ (Time 1) and $\alpha = .830$ (Time 2).

School satisfaction – to measure students' school satisfaction, one dimension of The Multidimensional Students' Life Satisfaction Scale (MSLSS; [Huebner, 2011](#)) was used, containing eight items (e.g. I like being in school). The calculated reliability coefficients were $\alpha = .841$ (Time 1) and $\alpha = .838$ (Time 2).

Life satisfaction – to measure students' life satisfaction, a one-dimensional Student's Life Satisfaction Scale (SLSS; [Huebner, 1991b](#)) was used. It contains nine items (e.g. I like the way things are going for me). The calculated reliability coefficients were $\alpha = .849$ (Time 1) and $\alpha = .850$ (Time 2).

Students evaluated all items on a 5-point scale (1 – Strongly disagree; 2 – Disagree; 3 – Neither agree nor disagree; 4 – Agree; 5 –Strongly agree).

Results

In order to provide answers to the questions posed in the study, the mean values and standard deviations were calculated for each of the examined variables in the first ($n_1 = 413$) and the second wave ($n_2 = 402$) of the study. The obtained results are presented in Table 2.

Table 2
Descriptive statistic for variables at Time 1 and Time 2

| Variable | Time 1 | | Time 2 | |
|---------------------|----------|-----------|----------|-----------|
| | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> |
| Teacher support | 4.38 | 0.31 | 3.73 | 0.44 |
| School satisfaction | 3.83 | 0.36 | 3.22 | 0.36 |
| Life satisfaction | 4.22 | 0.35 | 3.69 | 0.27 |

Note: $n_1 = 413$; $n_2 = 402$

The results indicate that students were more satisfied with school and life and felt more teacher support before the pandemic. It should be pointed out that these data present the results obtained for the entire study sample.

In order to determine if there are differences in the perceptions before and after the COVID-19 pandemic, a t-test for dependent samples was performed on the data of those respondents who took part in both waves of the study. Since the data on students had not been matched, the t-test was performed at a class level ($n = 15$). Before the t-test, the normality of distributions was tested, indicating that the distributions for school satisfaction ($z = .131$; $p > .01$), life satisfaction ($z = .186$; $p > .01$) and teacher support ($z = .173$; $p > .01$) in 15 classes were not statistically significantly different from the normal distribution, so the application of t-test for dependent samples was justified. The results obtained by t-test are shown in Table 3.

Table 3
Differences in students' perception of teacher support, school satisfaction and life satisfaction before and after the COVID-19 pandemic

| | T1 | | T2 | | <i>t-test</i> | <i>p</i> | <i>Cohen d</i> |
|---------------------|----------|-----------|----------|-----------|---------------|----------|----------------|
| | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | | | |
| Teacher support | 4.38 | 0.31 | 3.73 | 0.44 | 5.444 | .001* | 1.71 |
| School satisfaction | 3.83 | 0.36 | 3.22 | 0.36 | 5.944 | .001* | 1.69 |
| Life satisfaction | 4.22 | 0.35 | 3.69 | 0.27 | 8.173 | .001* | 1.68 |

Note: T1 – time of the first measurement; T2 – time of the second measurement, $N = 267$; 15 classes

The results confirm statistically significant differences in the perceptions of teacher support, school satisfaction and life satisfaction. The obtained effect size, Cohen *d*, points to a great difference in perceptions, with all values significantly higher before the outbreak of the COVID-19 pandemic.

An additional analysis was carried out to detect possible differences in students' perceptions relating to the generation they belong to. In order to determine if there are differences between generations, the sets of data were compared – for example the data of third-grade students in 2019 with the results of other third-grade students in 2021. The t-test was performed for each grade respectively. Prior to that, the normalities of distributions ($N = 792$) were tested and it was revealed that distributions for school satisfaction ($z = .046$; $p < .01$), life satisfaction ($z = .126$; $p < .01$) and teacher support ($z = .133$; $p < .01$) showed statistically significant differences in comparison with the normal distribution. Still, since indices of skewness (.295 – .956) and kurtosis (.028 – .359) were small, and the number of the respondents was large enough, it was justified to use the parametric data analysis (Hair et al., 2010). The results of the t-test are shown in Table 4.

Table 4
Differences in students' perceptions of teacher support, school satisfaction and life satisfaction in terms of the generation students belong to

| | T1 | | T2 | | t-test | p | Cohen d |
|---|------|------|------|------|--------|-------|---------|
| | M | SD | M | SD | | | |
| 3rd grade ($n_1 = 62$; $n_2 = 65$) | | | | | | | |
| Teacher support | 4.59 | 0.59 | 4.62 | 0.46 | -0.282 | .778 | 0.05 |
| School satisfaction | 4.10 | 0.78 | 3.90 | 0.85 | 1.395 | .166 | -0.25 |
| Life satisfaction | 4.30 | 0.74 | 4.27 | 0.60 | 0.200 | .842 | -0.04 |
| 4th grade ($n_1 = 77$; $n_2 = 70$) | | | | | | | |
| Teacher support | 4.56 | 0.70 | 4.46 | 0.58 | 0.945 | .346 | -0.16 |
| School satisfaction | 4.08 | 0.71 | 4.07 | 0.71 | 0.080 | .936 | -0.01 |
| Life satisfaction | 4.45 | 0.71 | 4.06 | 0.87 | 2.969 | .003* | -0.49 |
| 5th grade ($n_1 = 64$; $n_2 = 64$) | | | | | | | |
| Teacher support | 4.19 | 0.58 | 3.91 | 0.81 | 2.292 | .024* | -0.41 |
| School satisfaction | 3.57 | 0.60 | 3.42 | 0.78 | 1.245 | .215 | -0.22 |
| Life satisfaction | 4.13 | 0.82 | 3.82 | 0.81 | 2.172 | .032* | -0.38 |
| 6th grade ($n_1 = 52$; $n_2 = 72$) | | | | | | | |
| Teacher support | 4.08 | 0.74 | 3.67 | 0.98 | 2.572 | .011* | -0.48 |
| School satisfaction | 3.45 | 0.68 | 3.19 | 0.91 | 1.755 | .082 | -0.33 |
| Life satisfaction | 3.96 | 0.90 | 3.74 | 0.96 | 1.296 | .197 | -0.24 |
| 7th grade ($n_1 = 66$; $n_2 = 66$) | | | | | | | |
| Teacher support | 3.90 | 0.81 | 3.83 | 0.76 | 0.580 | .563 | -0.10 |
| School satisfaction | 3.20 | 0.57 | 3.29 | 0.68 | -0.798 | .426 | 0.14 |
| Life satisfaction | 4.00 | 0.83 | 3.51 | 1.01 | 3.043 | .003* | -0.53 |
| 8th grade ($n_1 = 69$; $n_2 = 64$) | | | | | | | |
| Teacher support | 3.36 | 0.72 | 3.41 | 0.97 | -0.350 | .727 | 0.06 |
| School satisfaction | 3.08 | 0.70 | 2.92 | 0.79 | 1.208 | .229 | -0.21 |
| Life satisfaction | 3.86 | 0.78 | 3.65 | 1.02 | 1.364 | .175 | -0.24 |

Note: T1 – time of the first measurement; T2 – time of the second measurement

The differences in generations have shown that there were no statistically significant differences in the third and eighth grade in 2019 and 2021. In the group of students attending the fourth, fifth and seventh grade, the life satisfaction level was lower in 2021 in comparison with 2019. Also, students in the fifth and sixth grade perceived a lower level of teacher support in comparison with the year 2019. Still, all the identified differences have a moderate effect (Cohen $d < 0.5$).

Discussions

The aim of the present study was to investigate how primary school students perceive teacher support and how satisfied they are with their school and lives before and after the COVID-19 pandemic.

The current data have shown that students feel that teacher support was greater before than after the pandemic. Among all three examined variables, at both time points, the teacher support variable was ranked highest, but at the same time, the difference in the perceived teacher support before and after the pandemic was the biggest. The analysis of students' results at a grade level has shown that students felt teacher support was statistically significantly lower two years later.

A possible explanation for such results could be found in the fact that, since students are at a relatively young age (8-9 and 13-14 years old), the help they expected to get from their teacher during the pandemic and occasional online lessons was not sufficient. The majority of students probably did not have the necessary knowledge and sufficiently developed skills, especially the digital skills, which were of utmost importance for participation in online classes and for independent work. That is why they expected more care, attention, time and understanding from their teachers, which they, according to their

own assessment, did not receive.

Examining the differences by generations, it is evident that students in fifth and sixth grade perceived lower teacher support after the pandemic, while these differences were not evident in other generations. This might be due to the fact that students in Croatia have a classroom teacher in the first four grades of primary school, who spends several hours with them every day. In fifth grade, the classroom teacher is replaced by subject teachers. The transition to a new and different form of teaching in which subject teachers do not spend so much time with their students, do not know them well, and have not established a good rapport with them could have resulted in the fact that students perceived a lower level of teacher support. Furthermore, the teaching process during the pandemic was occasionally conducted via ICT tools, which might have made interaction and communication more difficult.

The importance of teacher support for students is great. Klem and Connell (2004) state that both students and teachers believe that teacher support is important for student engagement. Havik and Westergård (2020) point out that when students have caring teachers who encourage their development, they are more likely to work harder in class and be more engaged in work. Mali and Lin (2021) carried out research on the sample of undergraduate students in the UK, at two time points, during the second wave of the pandemic. The results revealed that students felt that teacher support was greater when lessons were conducted face-to-face (Mali and Lim, 2021). Examining students' perceptions of online learning before and after transition to online lessons due to the COVID-19 pandemic, Lemay, Bazelais and Doleck (2021) found that teachers should not only take into consideration the technical aspects, but also social and affective dimensions of support for students.

Although the use of computers or other artefacts in education is not a new issue, teaching in a virtual environment posed a problem for some teachers. Due to difficulties they had in mastering the usage of digital technology and tools, and transition to online teaching, some teachers might have provided less support for their students. These teachers were probably more focused on developing their own competencies, so they found it difficult to provide support to their students. It is very likely, as this study includes the initial stage of the pandemic, when the entire teaching process was transferred into a virtual environment in an extremely short time period. There was no time for teachers to prepare well for achieving the outcomes set in the curricula. Numerous studies point out that teachers experienced a great time pressure and increased volume of workload during the pandemic (van der Spoel et al., 2020), exhaustion (Sokal, Trudel and Babb, 2020) and stress (Klapproth et al., 2020). In order to use distance learning as a normal way of work, teachers should be provided with training and guidelines for development of their expertise in using the learning and teaching technology (Spiteri and Chang Rundgren, 2020), as well as sufficient resources, time and support (Stone and Springer, 2019).

According to the obtained results, among all the examined variables, students seem to be least satisfied with school, both before and after the pandemic. Furthermore, their school satisfaction decreased during the pandemic, making a statistically significant difference. Teacher support is one of the significant predictors of general school satisfaction (Bubić and Goreta, 2015). Since students perceive a lower level of teacher support over time, it is not surprising that school satisfaction is also lower. Baker et al. (2003) also point out that low school satisfaction can be a result of students' perception of insufficient social support from classmates and teachers.

Differences between generations of students in school satisfaction were not found, as students were moderately satisfied with schools during measurements at both time points. Still, it is evident that there is a decreasing level of school satisfaction as students get older. Older students seem to be less satisfied with school, which is in line with other studies carried out in primary schools in Croatia (Perić, 2010; Koludrović and Radnić, 2013; Nikčević-Milković, Jerković and Biljan, 2014). During the course of education, requirements from students become more complex and demanding, and expectations become higher. Therefore, it is possible that older students tend to exhibit greater dissatisfaction.

Kuo et al. (2014) point out that interaction is a critical factor of student satisfaction. During the pandemic and online teaching, the interaction between teachers and students, and among students themselves, was reduced and made difficult, which affected the results we obtained in our study through reduced school satisfaction.

Glazier and Harris (2021) examined the similarities and differences in the perceived face-to-face and online teaching among graduate and undergraduate students at the University of Arkansas, USA (N = 2,007). They collected qualitative and quantitative data via surveys. American students' perceptions of online teaching were lower than their perceptions of face-to-face teaching. Although this study involved university students, not primary school students like our study, it is significant that they mention the possibility of establishing personal relationships. Apart from the importance of quality interaction between students and teachers, Alqurashi (2019) points out the importance of interaction between students and

the content, which proved to be the strongest and most significant predictor of student satisfaction in online learning environment. [Baber \(2020\)](#) claims that student school satisfaction is a key component of education and that it should be kept in mind during transition from offline to online teaching.

Our findings showed that students perceived a higher level of life satisfaction before the pandemic in contrast to the period after the pandemic, and this difference is statistically significant. It should be mentioned that students perceived a higher level of life satisfaction than school satisfaction, at both time points. A possible explanation is that factors outside school have an important impact on life satisfaction in general. [Achkar et al. \(2019\)](#) carried out research with primary school students in Brazil (N = 400; age = 11-17 years) and found that the adolescents who perceived a higher level of support provided by family and community seemed to exhibit a higher level of life satisfaction.

School takes an important place in the lives of children and adolescents. [Huebner, Ash and Laughlin \(2001\)](#) state that school satisfaction has a key role in defining the level of students' quality of life. The study carried out by [Gempp and González-Carrasco \(2021\)](#) confirmed a significant reciprocal effect between school satisfaction and overall life satisfaction. Examining the perceptions of sixth grade students in Germany on an individual level, it was determined that life satisfaction is positively related to teachers' care and monitoring and autonomy, whereas school-related demands were related to lower life satisfaction ([Rathmann et al., 2018](#)).

Since, in our study, we found a difference at a grade level (within generations), that is, we found that the same students perceived lower values after the period of two years, it can be assumed that one of the factors accountable for this difference is the COVID-19 pandemic. Also, these differences might depend on the students' age, that is, there are differences between lower and higher grades of primary school. Taking into consideration the data of those participants who took part in both waves of the study, the students who participated in the second wave were approximately two years older than the participants in the first wave. It is precisely why it was examined if there were differences in generations; that is, if there were some differences in different generations in 2019 and 2021. Most differences were found in life satisfaction, so students in fourth, fifth and seventh grade in 2019 perceived a lower level of life satisfaction than students in the same grades in 2021.

A longitudinal study, similar to ours, was conducted by [Magson et al. \(2021\)](#) on a sample of adolescents (N = 248) in Australia (M_{age} = 14.4), a year before the pandemic and two months after restrictive measures had been introduced by the government due to the pandemic. Among other symptoms, the authors examined general life satisfaction and determined a significant reduction in the level of life satisfaction between the first and the second measurement.

Conclusions

In this study, primary school students' perceptions of teacher support, school satisfaction and life satisfaction were examined. Student perceptions are influenced by school environment and a broader context (family, peers, society). The study was longitudinal, and the measurements were taken at two time points – before the pandemic and after the pandemic, when students returned to school.

The results confirm the assumption that students were more satisfied with school, life and teacher support before the outbreak of the pandemic. In the analysis of the obtained data, the values measured in two waves, in a two-year time interval, were compared. Since the COVID-19 pandemic broke out in the period between the two measurements and the teaching process and life in general were organized in a different way, an explanation can be found in the changed circumstances.

Still, school satisfaction and life satisfaction are frequently related to students' age. It is a well-known fact that younger students tend to exhibit a higher level of school satisfaction than older students, so the results obtained in this study can be viewed within this context as well. Students included in the study are in the period of late childhood and early adolescence, in terms of their developmental characteristics. In this period of life, socializing with peers is of utmost importance. However, throughout the period of online teaching during the pandemic, they were deprived of physical contacts, which might have influenced their perception of a lower level of life satisfaction.

Since all students seem to be generally dissatisfied with school, it poses a great pedagogical challenge which should be addressed in the future. School is a considerably inert system and it seems that, to a certain extent, it does not suit the needs and expectations of all students. The time after the pandemic is a period in which teachers, scientists and educational experts have no time to remain passive; they are expected to take immediate action instead.

However, the study has certain limitations. First of all, the sample was appropriate, and the data

were collected only in one primary school. Students in other schools might have had different perceptions, although all schools in the Republic of Croatia were following the guidelines by the Ministry of Science and Education and conducted the teaching process in the same way (face-to-face or online). Furthermore, it should be pointed out that two measurements at two time points did not involve the same students. Students who had finished school during the time period of two years (that is how long the study lasted) did not participate in the second wave of the study, and students attending third and fourth grade were included, although they did not participate in the first wave of the study.

The value of the study certainly lies in the selection of the participants, as a relatively small number of studies have been conducted involving primary education. Most of studies have been conducted in the area of higher education, involving undergraduate and graduate students, although online teaching had been introduced at all levels of education. Moreover, younger students must have been put in a more difficult position due to developmental characteristics, insufficiently developed digital competencies and lack of independence in work. Therefore, it was by no means harder for them to get involved in and participate in a new form of teaching and learning. As far as we are aware, this is the first study conducted in Croatia that examined these variables, before and after the COVID-19 pandemic, in primary school students.

Regardless of the fact that this was a longitudinal study, the changes in students' perceptions cannot be ascribed solely to the effects of the COVID-19 pandemic. Numerous other factors (for example, family situation, gender, exposure to media content during the pandemic) might have had a direct or indirect influence on students' perceptions. On the other hand, we cannot ignore the pandemic or marginalize its impact. That is why this study could inspire other studies. Besides, since online teaching will certainly be conducted in the future, the obtained results might help direct attention to the efforts that teachers might make in order to raise the level of online teaching quality and students' satisfaction.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

All persons who meet authorship criteria T.V., M.Đ., I.K. are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept T.V., M.Đ., I.K., design T.V., M.Đ., I.K., formal analysis T.V., M.Đ., I.K., investigation T.V., methodology T.V., visualization T.V., writing M.Đ., I.K., and revision of the manuscript T.V., M.Đ., I.K.. All authors have read and agreed to the published version of the manuscript.

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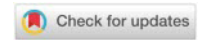
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Psychological Portrait of the Modern Mentor of Students' Group Projects

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Abstract: The aim of the research is studying the individual psychological characteristics of teachers included in project activities as student teams mentors. The purpose of the work was to identify influence degree of individual psychological characteristics of mentors to the success level in the implementation activities of project student groups. The work presents the results of the empirical study based on the educational intensive SfeduNet, which was implemented and hosted by the Southern Federal University in cooperation with the NTI University 20.35. The object of the empirical study was 84 SfeduNet intensive mentors, aged 26 to 55 years ($M=40.70$; $SD=7.36$), 20,20% of respondents are men and 79,80% are women. Methodological tools are represented by psychological questionnaires: "Methodology for diagnosing general communicative tolerance" (V.V. Boyko), "Motivation for success and fear of failure" (A.A. Rean), "Communicative and organizational skills (COI-2 emotional intelligence questionnaire by D.V. Lyusin. The individual psychological characteristics of project mentors were identified, as well as the features which determine the mentor's effectiveness activity for project team support. They were identified as: tolerance, the ability to understand and accept other people's individuality, their specificity, manipulative orientation in communication, invaluable attitude towards people, the ability not to accept herself or himself as a reference person, beyond comparison with themselves and their value preferences. Collected data are of practical importance and are significant and widely used in project activities implementation at the stage of selection, training and mentors' support.

Keywords: project activity, project mentor, tutor, emotional intelligence, communication skills, organizational skills.

Introduction

At present, serious changes are taking place in our country in the system of Russian education and the socio-cultural life of society. These transformations were the result of transfigurations in the goals and objectives of teaching the younger generation, taking into account the requirements of modern society, restructuring students' way of thinking, transformation in the economic and social spheres of society.

The necessity and relevance of a systemic change in these areas is clearly reflected in the national project "Education", where two extremely important goals for all educational organizations are set: ensuring the competitiveness of Russian education in the global labor market and educating socially responsible and harmoniously developed personality based on spiritual and moral values and the Russian Federation cultural traditions.

The widest opportunities for various kinds of competencies development and competitive graduate preparation are provided by a project-oriented approach to learning.

In this context, we will adhere to the interpretation of "project-oriented learning within the framework of higher education educational programs as a way of the educational process organization involving students in active project activities to solve real problems and tasks, ensuring the formation of the necessary competencies" (Turlo, 2013, p. 28). It is important to note that in modern pedagogical practice, the project method, which is gaining more and more popularity, often represents a substitution of concepts when the word "project" is used to describe methods that have developed over decades. In this regard, we denote that the word "project" describes "a product (material or intellectual) which is developed and

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manufactured by students independently from an idea to its implementation, possessing subjective or objective novelty, created under teacher's consultation and supervision" (Sharipov, 2012, p. 90). Not without reason, 2023 was declared the year of the Teacher and Mentor by the President of the Russian Federation Decree No. 401, June 27, 2022.

According to the authors, project activity as a form of educational process organizing provides a wide range of didactic opportunities for students to acquire competencies "in the direction of research activities, product development, team interaction in the area of solving actual production and entrepreneurial problems" (Bakaeva et al., 2020, p. 29). At the same time, according to Trishchenko D.A., using the project method, follows an essential requirement: "a significant problem presence that requires a creative solution based on integrated knowledge and analysis research" (Trishchenko, 2018, p. 136).

The specificity of project-oriented learning is the changing interactive structure between the teacher and the student. The teacher's position "from above" (as in traditional teaching), and "outside" position (as in independent work) is changed. The main teacher's task is to support students' activities, which is understood by the psychological and pedagogical community as "a system of the teacher's professional activities aimed to create conditions for successful learning and development of student's personality in various learning situations." (Bakaeva et al., 2020, p. 29). Consideration of the teacher's activities is fixed in the role position of the mentor. "In his activity, the mentor combines the work of a moderator, a coach, a tutor, a teacher, an expert, a researcher, an engineer, an entrepreneur, but his activity is not reducible to any of them" (Nikolsky and Neslukhovskaya, 2020, p. 138). Seisenbayeva and her colleagues characterize the position of the project team mentor as an enthusiast, a specialist, a consultant, a leader, a coordinator, an expert which is asking questions, while it should be hidden, providing space for students' independence (Seisenbayeva et al., 2018).

The authors make mentors responsible for such process areas as team group dynamics, team psychological support during the work, assistance in reflection (assessment of their competencies), assistance in the self-realization of each participant in the project, development of participants' competencies, both hard and soft skills, organization of team business communication, assistance in project team product presentation.

Project method application must be accompanied by teachers special pre-training, because formal characteristics of the project method emphasize more often than on the essential characteristics (Dreher, 2013; Turlo, 2013); it is also noted that effectiveness decrease in the project method implementation is largely associated with insufficient qualified teachers (Kazun and Pastukhova, 2018; Hattum-Janssen, 2012; Kołodziejcki and Przybysz-Zaremba, 2017). Likely, the specifics of mentoring in project activities and the requirements for the level of competencies of a mentor also determine the psychological portrait of a person whose individual typological characteristic will allow to manage with the mentor functions as efficiently as possible.

For example, Kobernyk and colleagues note that motivational sphere features and the teacher's orientation towards cooperation with students determine the effectiveness of the project method implementation (Kobernyk et al., 2022), and Telnova S.V. and Pozynich K.P. describe not only the basic competencies, but also highlight the personal qualities which are necessary for a mentor: "communicative and organizational competencies, acceptance of your own role, focus on working with people, self-development, responsibility, adaptability, openness to new ideas" (Tel'nova and Pozynich, 2021, p. 44), studying mentor's necessary qualities, along with professional competence, it is noted "willingness to share experience, willingness to spend time with mentored, emotional balance and the ability of self-organization and as well as others." (Ignat'eva and Ryabkova, 2018, p. 48). Wiewiora A., Chang A., Smidt M., based on project participants feedback, emphasize the importance of the mentor figure as the person helping to cope with emotions, providing support and quality feedback (Wiewiora, Chang and Smidt, 2020, p. 31). Floris & Cuganesan mark cognitive and emotional complexity as a necessary property for the project mentor (Floris and Cuganesan, 2019), and Malik and colleagues point out that communication features within the team and its autonomy, which is one of the mentor's responsibility areas, influence the level of project team members motivation (Malik, Sarwar and Orr, 2021). According to Krasilo D.A., the mentor becomes a significant adult for boys and girls and acts as a "guide to adulthood", assisting in self-determination (Krasilo, 2006).

Hence, the purpose of this research is to study communicative and motivational sphere of teachers' characteristic who are included into project activities as student teams mentors, and to high-light the degree of their influence on success level of this activity implementation.

As an empirical basis for the research, project mentors of the SfeduNet project-educational intensive course, implemented on the basis of the Southern Federal University in cooperation with the NTI University 20.35, were chosen. This program has been implemented by the Southern Federal University

since 2019, five design and educational intensives were held, in which more than 2,000 students took part.

As a part of the program, students are selected. As a result, teams of 4-10 people are formed who will be working on the projects for 3-6 months. In addition to the task of project creation, participants are trained to study design basics, market analysis, target audience needs, product creation and its presentation. Each team is assigned by a mentor who performs the functions of motivation, consultation, facilitation of team members. The features of interaction between the mentor and the team, as well as the team inside, are reflected in the success of the project and the uniqueness of the product result.

Materials and Methods

To achieve this goal, an empirical study was organized. Based on the feedback from the students participating in the intensive, project mentors and expert supervisors, as well as the organizations requirements for the mentor by realizing project activities, a list of more than 50 personal qualities, which are necessary for the successful mentoring, was obtained. The identified qualities were grouped into logical blocks (communicative skills and communicative orientation, self-regulation, emotional intelligence). Based on the resulting list, approved valid test methods were selected as methodological tools that define the level of expression significant for the mentor qualities.

Methods which were used:

1. Methodology for diagnosing general communicative tolerance (V.V. Boyko);
2. Motivation for success and fear of failure (A.A. Rean);
3. Test questionnaire "Communicative and organizational inclinations (COI-2)";
4. Emotional Intelligence Questionnaire D.V. Lucina;

The methods of mathematical statistics were used to obtain the results: descriptive statistics, one-sample Kolmogorov-Smirnov test, one-way analysis of variance ANOVA with Bonferroni correction, Student's t-test for two independent samples (calculations were carried out using SPSS 26.0).

The following hypotheses were tested:

- (1) mentors with different levels of success have different degrees of expression of communicative and motivational personality features;
- (2) successful in project activities mentors have high levels of communicative tolerance, established success and achievement of results, a highly developed emotional intelligence in general and the components that form its structure;
- (3) unsuccessful mentors may show excessive criticality, exactingness, motivation in communicating with themselves and a high level of using themselves as a standard when evaluating others, low indicators of emotional intelligence and communicative tolerance.

The object of the empirical study was 84 SfeduNet intensive mentors, aged 26 to 55 years ($M=40.70$; $SD=7.36$), of which 20.20% were men and 79.80% were women. The sample size of 84 people is caused by the generally limited number of project mentors of project student teams.

Based on the organizers' expert assessment of the project intensive; assessment of the quality of activities performed by students; places occupied by teams under project mentors' guidance in various project intensives and personal rating among mentors within the intensive, the average rank of each particular mentor was calculated. Based on these ranks, three study groups were formed demonstrating project mentors' level of success: with a high level of success (Group 1), with an average level of success (Group 2) and with a low level of success (Group 3). At the same time, the volume of group 1 was 26 people, group 2 included 33 mentors, and group 3 consisted of 25 people.

Results

Results are the third section of an IMRAD paper. Its purpose is to present the new information gained in the study being reported. It should be clear and concise. The Results are core of the paper. You shouldn't start the Results section by describing methods that you inadvertently omitted from the Materials and Methods section. The Results must be writing in past tense.

To verify the first assumption about different severity of the leading individual mentors' psychological qualities with different levels of success, a one-way analysis of variance (ANOVA) was chosen to determine the significance of differences between the three groups of mentors.

It was found that in all aspects of relationships, mentors with different levels of success showed a fairly high level of communicative tolerance, which indicates a low tendency of all respondents to

conflicts, to inadequate behavioral reactions in various situations of interpersonal interaction. In general, we can say that mentors are able to build the process of communication in general, and communication in particular, due to which its effectiveness increases, they demonstrate a highly developed ability to create a comfortable psychological climate in the process of interpersonal interaction and joint activities (Table 1).

Table 1
Indicators of communicative tolerance of mentors with different levels of success (N = 84)

| Scale | Group 1 (M (SD)) | Group 2 (M (SD)) | Group 3 (M (SD)) | F | p |
|--|---------------------|---------------------|---------------------|--------------|--------------|
| Rejection or misunderstanding another person individuality | 4,46 (2,37) | 5,12 (2,51) | 3,48 (2,36) | 3,262 | 0,043 |
| Using yourself as a reference for judging others | 2,42 (2,30) | 3,12 (2,39) | 4,60 (2,71) | 5,198 | 0,008 |

To verify the first assumption about the different severity of individual psychological qualities among mentors with different levels of success, a one-way analysis of variance was chosen to determine the significance of differences between the three groups of mentors. It should be noted that statistically significant differences were found only in the degree of severity of two components of communicative tolerance: "rejection or misunderstanding of another person's individuality" and "using herself or himself as a reference in behavior evaluation and way of thinking of other people". In this regard, in order to obtain more differentiated data, the results were subjected to a comparative analysis in pairs, using Student's t-test for independent samples (Table 2-3).

Comparative analysis of the severity of some aspects of mentors' communicative tolerance with a high and medium level of success did not reveal statistically significant differences in any of the indicators, which allows us to talk about high efficiency in interpersonal communication and interaction, the ability to establish high-quality interpersonal relationships between group members, find the correct communication way to each of them and create a positive psychological climate within the group.

Comparative analysis of the severity of some aspects of mentors' communicative tolerance with an average and low level of success revealed that mentors of both groups demonstrate low categoricalness in assessing others, the ability not to show a negative attitude towards people, a low desire to re-educate or adjust communication subjects to suit themselves, their standards, and know how to adapt to others, tolerant of mistakes and well-being and negative states of group members, understand and accept their individual psychological and personal characteristics. However, it was found that mentors with an average success level demonstrate more obvious dislike, insufficient understanding and acceptance of some features of other people individuality, but mentors with a low success level tend to evaluate others based on their ideas of good and bad, considering themselves a model, a standard, the measure of the ideal personality.

Table 2
Indicators of communicative tolerance of mentors with medium and low levels of success

| Scale | Group 2 (M (SD)) | Group 3 (M (SD)) | t | p |
|--|---------------------|---------------------|--------------|--------------|
| Rejection or misunderstanding another person individuality | 5,12 (2,51) | 3,48 (2,36) | 2,528 | 0,014 |
| Using yourself as a reference for judging others | 3,12 (2,39) | 4,60 (2,71) | 2,201 | 0,032 |

Comparative analysis of the severity of some aspects of mentors' communicative tolerance with high and low success levels also revealed a high level of mentors' communicative tolerance of both groups, a highly developed ability to accept other people in all variety of their individual demonstrations, flexibility in assessing personal characteristics, the ability to recognize the right to make mistakes, to negative psycho-emotional states.

At the same time, mentors with a high success level are distinguished by a less detected desire

to consider themselves a reference personality and compare other people's qualities and characteristics with their own personal characteristics.

Table 3
Indicators of communicative tolerance of mentors with high and low levels of success

| Scale | Group 1 (M (SD)) | Group 3 (M (SD)) | t | p |
|--|---------------------|---------------------|--------------|--------------|
| Using yourself as a reference for judging others | 2,42 (2,30) | 4,60 (2,71) | 3,098 | 0,003 |

Thus, it was proved that despite the high communicative tolerance of mentors with different levels of success, mentors with high and medium levels of success have more expressed tolerance, the ability to understand and accept other people's individuality, and their peculiarity. Mentors with a low level of success are distinguished by a more detected desire to evaluate the actions, behavior, thoughts, actions and activities of other people, focusing on themselves as standards.

Results analysis of motivation diagnosing for success and fear of mentors' failure with different levels of success revealed the orientation of mentors with a high level of success towards success, while the motivation of the mentors of the other two groups does not have obvious orientation (Table 4).

Table 4
Indicators of motivation for success and fear of failure of mentors with different levels of success (N = 84)

| Scale | Group 1 (M (SD)) | Group 2 (M (SD)) | Group 3 (M (SD)) | F | p |
|------------|---------------------|---------------------|---------------------|--------------|--------------|
| Motivation | 13,08 (2,87) | 11,06 (3,49) | 11,32 (3,26) | 3,144 | 0,048 |

In order to obtain more differentiated data, we compared the results of the study in groups of mentors with different levels of success in pairs and used Student's t-test for independent samples (Table 5).

Comparative analysis of the severity of the motivation to achieve success and avoid failures proved the orientation of the mentors of the first group towards success, which indicates positive motivation, a detected desire to get a positive result, to find a constructive approach to solving a problem that will lead to victory, triumph.

Table 5
Indicators of motivation for success and fear of failure of mentors with high, medium and low levels of success

| Scale | Group 1 (M (SD)) | Group 2 (M (SD)) | t | p |
|------------|---------------------|---------------------|--------------|--------------|
| Motivation | 13,08 (2,87) | 11,06 (3,49) | 2,378 | 0,021 |
| | Group 2 (M (SD)) | Group 3 (M (SD)) | t | p |
| Motivation | 11,06 (3,49) | 11,32 (3,26) | 0,288 | 0,744 |
| | Group 1 (M (SD)) | Group 3 (M (SD)) | t | p |
| Motivation | 13,08 (2,87) | 11,32 (3,26) | 2,044 | 0,046 |

We also found no differences in the communicative and organizational inclinations of mentors with different levels of success (Table 6). All respondents are characterized by an average level of both communicative and organizational inclinations, which, on the one hand, indicates sufficiently developed skills in establishing contacts with strangers, easy orientation in unfamiliar and typical situations, a tendency to help and support other people, take initiative, perseverance in decision making. On the other hand, these abilities are quite unstable, their potential may not be fully revealed or not revealed at all in a given situation or in interaction with some people.

Table 6
Indicators of communicative and organizational inclinations of mentors with different levels of success (N = 84)

| Scale | Group 1 (M (SD)) | Group 2 (M (SD)) | Group 3 (M (SD)) | F | p |
|-----------------------------|---------------------|---------------------|---------------------|-------|-------|
| Communicative tendencies | 10,57 (1,90) | 10,39 (2,74) | 9,60 (2,53) | 1,164 | 0,317 |
| Organizational inclinations | 9,81 (2,29) | 10,18 (1,84) | 10,36 (3,05) | 0,357 | 0,701 |

Differences were also found in the development of interpersonal emotional intelligence among mentors with different levels of success (Table 7). In general, all mentors are characterized by well-developed intrapersonal emotional intelligence and, as a result, the general level of emotional intelligence. Those mentors have well-developed abilities to understand and manage their emotions. They perfectly determine the state of another person on the basis of non-verbal expressions, are able to suppress their unwanted emotions, manage the manifestation of their emotions well and control their emotional states.

Table 7
Indicators of emotional intelligence of mentors with different levels of success (N = 84)

| Scale | Group 1 (M (SD)) | Group 2 (M (SD)) | Group 3 (M (SD)) | F | p |
|--------------------------------------|---------------------|---------------------|---------------------|--------------|--------------|
| Interpersonal emotional intelligence | 37,73 (8,49) | 37,21 (5,46) | 32,96 (7,70) | 3,454 | 0,036 |

For more differentiated data, obtained results were subjected to a comparative analysis in pairs, using Student's t-test for independent samples (Table 8-9).

Comparative analysis of emotional intelligence level and its components, mentors included in its structure with high and average levels of success did not reveal statistically significant differences in any of the indicators, which allows us to speak about the well-developed mentors' emotional intelligence of both groups, their ability to understand and manage with mentors' and other persons' emotions.

Comparative analysis of the emotional intelligence level and its components, mentors included in its structure with an average and low level of success has shown that mentors with an average level of success have more developed emotional intelligence due to highly developed ability to control other people emotions, to evoke emotions which are necessary at present and stop unwanted or excessively intense emotions.

Table 8
Indicators of emotional intelligence of mentors with average and low levels of success

| Scale | Group 2 (M (SD)) | Group 3 (M (SD)) | t | p |
|---|---------------------|---------------------|--------------|--------------|
| Managing other people's emotions | 17,33 (2,84) | 15,40 (3,34) | 2,381 | 0,021 |
| Interpersonal emotional intelligence | 37,21 (5,46) | 32,96 (7,70) | 2,462 | 0,017 |
| General level of emotional intelligence | 77,55 (9,57) | 71,56 (12,49) | 2,065 | 0,044 |

Comparative analysis of emotional intelligence level and its components, mentors included in its structure with a high and low level of success proved that mentors with a high level of success have more developed interpersonal emotional intelligence due to a well-developed ability to understand other people emotions, highly developed empathy, and the ability to differentiate emotions and emotional states of other people based on the interpretation of non-verbal expressions.

Table 9
Indicators of emotional intelligence of mentors with average and low levels of success

| Scale | Group 1 (M (SD)) | Group 3 (M (SD)) | t | p |
|---------------------------------------|---------------------|---------------------|--------------|--------------|
| Understanding other people's emotions | 20,56 (5,05) | 17,58 (5,65) | 2,063 | 0,044 |
| Interpersonal emotional intelligence | 37,73 (8,49) | 32,96 (7,70) | 2,099 | 0,041 |

Based on average values, we were able to compile a personality profile of the most successful project mentor. Features in motivational, communicative and emotional spheres were found. Thus, the most successful mentors are characterized by increased success motivation.

It is also registered by Kobernyk and colleagues, who note that positive motivation is the most important characteristic of a teacher who implements the project method. Communicative sphere of successful mentors is characterized by the following features: a low desire to make a partner comfortable for them to communicate, they have more intense tolerance, ability to understand and accept other people's individuality or their specificity.

Successful mentors show the orientation towards other people's emotions: they have higher rates of understanding and another's emotions managing, along with a high level of interpersonal emotional intelligence; at the same time, indicators of understanding and managing their own emotions and expression are lower than those of other mentors (Table 8).

Discussions

According to the results of the empirical research, all the hypotheses which had been put forward by us were confirmed. Summarizing the above, we can say that all mentors, regardless of their success degree, have high communicative tolerance, well-developed emotional intelligence, understand their activities motives, they are motivated to achieve success and positive results in their activities. Blinov V.I., Yesenina E.Yu., Sergeev I.S. spoke about the importance of these properties and competencies in their work, who noted the importance of developing emotional and communicative intelligence (Blinov, Yesenina and Sergeev, 2019).

Motivation for achieving success, emotional and volitional stability, adaptive potential, empathy, social sensitivity as professionally important qualities of a mentor were also highlighted by Kolesnichenko K.V. in her work. According to her, the professionally important qualities of a teacher include "figurative thinking, speech features, selectivity of attention, switching of attention, distribution of attention, short-term and random access memory, verballogical memory, storage in long-term memory, cognitive control flexibility, interferability, non-conformism" (Kolesnichenko, 2012), which confirms the point of view that mentor functions performance requires the teacher to have specific competencies and the presence of certain personal characteristics.

Also, some features were identified unique only to mentors with a particular level of success. Thus, mentors with a high level of success are distinguished by a highly developed success orientation and achieving results.

Thus, mentors with a high and average level of success have more a highly developed ability to understand and accept other people's individuality, their specificity, a high level of interpersonal emotional intelligence, the ability to respond adequately and easily adapt to new and changing activity conditions.

But mentors with a low level of success are distinguished by more detected desire to evaluate the actions, behavior, thoughts, actions and activities of other people, focusing on themselves as a standard. At the same time, mentors with a low level of success are distinguished by less developed inter-personal emotional intelligence, which manifests itself in a poorly developed ability to both understand and manage the emotions of other people.

At the same time, low flexibility, low level of communicative competence and communicative tolerance, inability to see the specifics of others and using himself as a standard in general demonstrate the authoritarian leadership style of a mentor, which is typical for mentors from an unsuccessful type of group. Thus, we can conclude that in mentoring student projects, psychological maturity and communicative flexibility are much more important than an expert and rigidly regulated position.

Probably, identified features determine the pedagogical and moderator-facilitator position according to Glazunova O.V. (Glazunova, 2020), the most relevant for the participants of the project-educational intensive SfeduNet, which defines the development of the project, hard and soft skills of students as the main goals, and not just the creation of a product as a result of the project. Perhaps a different goal of the intensive as a whole would require different mentor positions (expert, methodological, product) and, as a result, a different personal profile and competencies.

Conclusions

Project students' activity is one of the most important tools for the future professional competence formation, "which guarantees successful adaptation and professionalization of a person on a career path." (Turlo, 2013). The most important role in accompanying students in project activities realization is played by the mentor - the teacher who acts as a tutor, a coach, an expert, performing functions of motivation, facilitation and organization. Also, creating conditions for effective communication between project team members. Wide mentor's functionality imposes special requirements for the level of development of his or her competencies and personal qualities, the study of which was the goal of this research, realized on the basis of the project-educational intensive of the Southern Federal University SfeduNet 4.0.

During the empirical study, the individual typological characteristics of project mentors were studied. Thus, a project mentor has the following characteristics: a high degree of communicative tolerance; motivation for success; general level of emotional intelligence, including the ability to manage and understand one's own and others' emotions. In addition, the properties that determine the effectiveness of the mentor's activities accompanied by the project team were identified, namely: tolerance, the ability to understand and accept the individuality of other people, their specificity, orientation towards achieving success, an invaluable attitude towards people, beyond comparison with oneself and one's own values. preferences, high level of interpersonal emotional intelligence.

Obtained data have practical significance and are widely used in project activities implementation at the stage of selection, training and support of mentors. So, at the selection stage, diagnostic methods can be used to select candidates which determine the level of expression of mentors' key characteristics: communicative tolerance, emotional intelligence, motivation to achieve success. According to obtained during the selection results, a program of mentors' training and educating can be formed, which helps to master not only project activities basics and the intensive organizational side, but also to develop necessary for the mentor universal and meta-competences, which are necessary for effective communication with the team. Also, obtained results can help in preparation of additional materials and methodological

recommendations that increase communicative mentors' competence.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, G.E.D., S.E.G. and T.E.C.; methodology, G.E.D.; software, S.E.G.; formal analysis, G.E.D. and S.E.G.; writing—original draft preparation, G.E.D. and S.E.G.; writing—review and editing, T.E.C. and S.E.G. All authors have read and agreed to the published version of the manuscript.

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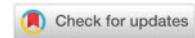
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Preschool Teachers' Professional Training in the Field of Inclusive Education in The North of Kosovo and Metohija

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Abstract: The issue of inclusive education is focused on providing the high quality education for all learners through the process of introducing the changes concerning the educational approach and the modification of educational content depending on the learners' individual needs for additional support. The analyses of inclusive policies and inclusive practice in Europe indicate that the characteristics of social context significantly impact the development of inclusive practice. Self-assessment for professional training is a vital condition for enhancing competences through continuous learning and reflexive practice with the aim of achieving the final learning outcomes of all pupils. The aim of the research was also to determine the dominance of certain ways of training within the regular professional training, in regard to the quality and availability of education and support for work that can be provided by the preschool institution where these teachers are employed. The sample comprises of 130 preschool teachers of the following preschool institutions in the north of Kosovo and Metohija. Taking into account the results of the conducted research, the respondents outlined as the most useful findings and skills that are necessary for working with children with disabilities the following ones: the identification of characteristics of certain difficulties among children, the adjustment of methods, ways of teaching, materials and space to working with children who need additional educational support, the creation of individual educational plan for a child who needs additional educational support and communication skills for working with parents.

Keywords: inclusive education, professional training, preschool institution, competences.

Introduction

The issue of inclusive education is focused on providing the high quality education for all learners through the process of introducing the changes concerning the educational approach and the modification of educational content depending on the learners' individual needs for additional support. In order to realize the inclusive education, the employees in the educational system must be ready to enable themselves for supporting the children and the learners they work with.

Although the inclusive educational approach has been promoted for the last several decades and it was established as a norm in 2006 (Krischler et al., 2019), the change of the educational paradigm in educational institutions in Serbia from medical model to the pedagogic one started through legal reforms in 2009. After all employees in educational institutions were obliged to the umbrella law on education (Zakon o osnovama sistema obrazovanja i vaspitanja, 2009), its realization was regulated through the following rulebooks: the Rulebook on additional education, healthcare and social support of the child, a pupil and adult (Pravilnik o dodatnoj obrazovnoj, zdravstvenoj i socijalnoj podršci detetu, učeniku i odraslom, 2018) and the Rulebook on closer instructions for determining the right to an individual education plan, its implementation and evaluation (Pravilnik o bližim uputstvima za utvrđivanje prava na individualni obrazovni plan, njegovu primenu i vrednovanje, 2018) ("Sl. glasnik RS", No 74/2018). However, the process from the legal regulations to the practical implementation has not been easy (Krstić,

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2017), therefore the development of the inclusive education is supported through organizing lectures, debates, trainings for planning, its implementation and evaluation, the Individual Education Plan (IEO), availability of appropriate references, through establishing Interdepartmental Commissions at the local level as well as the Inclusive Education Unit at the republic level (Maksimović and Stamatović, 2021).

In terms of the absence of this field in initial education, the inclusive approach has frequently been criticized with pessimistic attitude, hence the realization of children's/pupils' rights who need additional support is doubted. The research on teachers' attitudes in Serbia (Macura-Milovanović and Vujsić-Živković 2011) indicate that students start their professional practice with negative attitudes towards inclusive education, moreover that pupils who need additional support should be educated in specialized schools. Kostović and associates also wrote about the willingness of schools for inclusion (Kostović, Zuković and Borovica, 2011). In addition, some research among teachers (Popović et al., 2020) point out that they do not evaluate themselves as competent enough for inclusive education. A competent teacher is the one who is able to identify educational values within transaction with all pupils (Radulović et al., 2010). The main indicators that refer to the competent teacher for working in the inclusive practice are the acceptance and understanding of the diversity among children and the difference concerning the satisfaction of their needs, as well as the readiness for finding strategies (for cooperation with parents and other individuals) for improving their development and learning. The benefit of such an approach toward a child is reflected in the maximum development of potentials that he/she has.

The analyses of inclusive policies and inclusive practice in Europe indicate that the characteristics of social context significantly impact the development of inclusive practice (Ainscow and César, 2006; Krstić, 2017; Ratković, Hebib and Šaljić, 2017). Previously mentioned findings imply the need for creating consciousness concerning the relevance of applying resources that can be used for professional trainings and at the same time enhance the social commitment to this issue. One more important aspect of the support to the children who need additional educational support is also the parents' awareness and commitment, whereas employees in educational institutions also have a significant role (Zuković and Popović 2011). Self-assessment for professional training is a vital condition for enhancing competences through continuous learning and reflexive practice with the aim of achieving the final learning outcomes of all pupils (Jerotijević and Mrše 2010). There are only few research on the competences of preschool teachers for working in inclusive practice in our region. Their authors agree with the fact that conceptual changes in the preschool teachers' initial education are necessary because preschool teachers are not sufficiently prepared for working in the inclusive practice from the professional point of view (Milenković and Nikolić, 2015; Nikolić, Korać and Lazarević, 2020). Furthermore, enhancing the mechanism of cooperation among experts from the institutions of education, healthcare and social protection is needed (Zlatarović and Mihajlović, 2013). The results also point that the support of inclusive education through professional training and horizontal connecting is rare, as well as that the plans of educational institutions predict trainings for developing competences for working with children who need additional educational support, but not different ways of learning through horizontal exchange and team work (Radivojević et al., 2007: 55).

The importance and need for professional training of preschool teachers for working with children who need additional support are based on the results of some earlier research (Jordan, Schwartz and McGhie-Richmond, 2009; Seçer, 2010), which show that most professional training within this field implies more preschool teachers' positive attitudes concerning the inclusive process in the preschool institution. Thus, the crucial significance of the development of inclusive policy and practice, focusing on the problem and raising the interest of preschool teachers about personal roles and the possibilities of applying certain strategies in practice, is reflected in the participation of as many various models and programs of preschool teachers' professional training as possible (Corbett, 2002). The ways of approach toward dealing with these issues are different and depend largely on the social context.

Taking into account the European Framework for Inclusive Education, legal regulations, but the current national support of the development of the inclusive practice too, and the contextual framework of the region where the research was conducted, the paper points out the research findings that are the result of preschool teachers' self-assessment concerning the necessary assistance through professional training for understanding children who need additional support, in order to provide them with adequate and timely support of their development and learning.

Materials and Methods

The subject matter of this research was to examine how preschool teachers assess the possibilities of professional training in the field of inclusive education. The authors' primary idea was to use the final results for professional engagement, support and creating adequate and various ways for training the preschool teachers for working with children with disabilities, who need additional educational support. In other words, this research highlights the need for considering the preschool teachers' attitudes towards the factors of inclusion that impact its quality since the preschool teachers are bearers of educational activities while working with children who need additional educational support. The appreciation of their perceptions can reveal significant preconditions of good inclusive practice.

The aim of the research was also to determine the dominance of certain ways of training within the regular professional training, in regard to the quality and availability of education and support for work that can be provided by the preschool institution where these teachers are employed. The aim itself was achieved through several tasks such as: to determine how preschool teachers assess the availability and quality of education concerning the children who need additional educational support within regular professional training; to map preschool teachers' attitudes towards the availability and quality of support in the institution; to examine which knowledge and skills, according to preschool teachers, would contribute to their competences and self-confidence while working with children who need additional educational support; to determine which way of professional training preschool teachers find the most useful one.

For the requirements of the research the following scales were applied: The scale of basic socio-demographic characteristics (which was constructed for the purposes of the research and the consideration of socio-demographic variables) and the Scale of self-assessment of competences and the quality of training for working in the inclusive kindergarten which was constructed by Mamić (2012) but it was modified for the purposes of this research. This scale consists of the following segments, sub-scales:

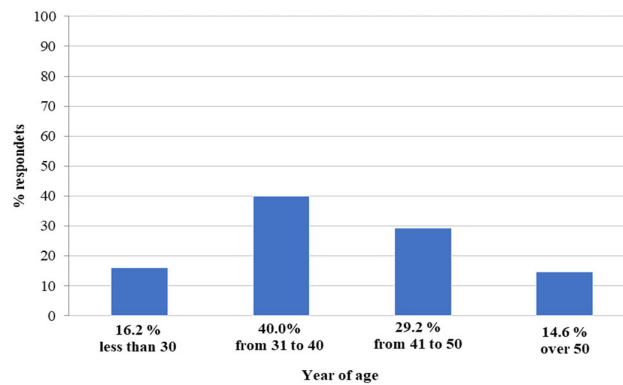
1. *The scale of availability and quality of trainings within regular professional training* that contains 6 items (Cronbach's Alpha 0,931- It is widely known that the values of Cronbach's α that are above 0,70 are acceptable (Pallant, 2009, according to Kompirović, 2021: 96).) by means of which the preschool teachers were examined how they assess the availability and quality of trainings concerning the children who need additional educational support on the scale from 1 to 5, 1 refers to the lowest, while 5 refers to the highest level of availability and quality of trainings. The following variables were considered: availability of trainings, the amount of new information, the quality of new information, applicability of gained knowledge, the contribution of training to the competence for working with children and the contribution of training to the self-confidence for working with children who need additional educational support.

2. *The scale of availability and quality of support in the preschool institution* that contains 17 items (Cronbach's Alpha 0,972) by means of which the preschool teachers were examined how they assess the availability and quality of support that they get in the institution where they work, on the scale from 1 to 5, 1 refers to the lowest, while 5 refers to the highest level of availability and quality of support. The following variables were considered: the availability of the experts' support, the amount of the gained information, the quality of the gained information, the applicability of suggestions, the contribution of cooperation to competences and self-confidence, the availability of didactic tools, the amount and quality of didactic tools, the applicability of available didactic tools, teachers' effort for creating didactic tools, the contribution of didactic tools to self-confidence, the possibility of engaging the personal assistant, the contribution of personal assistant, appropriate number of children in a group, the contribution of appropriate number of children to the quality of work and physical adaptation of the space.

3. *The list of knowledge and skills of preschool teachers for inclusive approach in education* that was used for ranking the most important knowledge and skills of preschool teachers while working with children who need additional educational support. The respondents were ranked by means of the scale from 6 which refers to the highest level to 1 which refers to the lowest one.

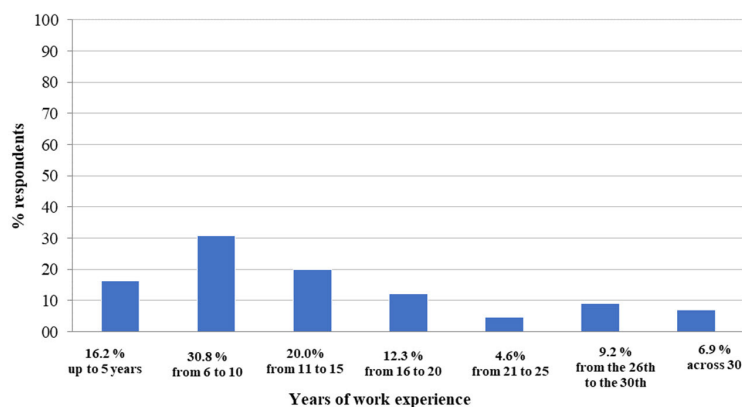
4. *The list of the most useful forms of preschool teachers' professional training* that contains 4 possible answers, where the preschool teachers could choose two of them that describe best which forms of trainings they find the most useful ones.

The research was conducted in September, 2021, in all preschool institutions in the north of Kosovo and Metohija. The sample comprises of 130 preschool teachers of the following preschool institutions: *Naše dete* in Zubin Potok, *Lane* in Zvečan, *Danica Jaramaz* in Kosovska Mitrovica, *Bambi* in Sočanica, *Naša radost* in Leposavić and *Veselo detinjstvo* in Lešak.



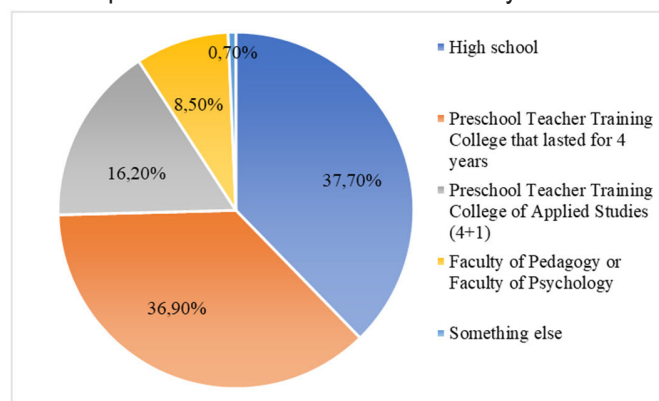
Graph 1. Sample structure in regard to the respondents' age

Considering the structure of the sample in terms of the respondents' age, most of them belong to the middle age from 31 to 40 that is from 41 to 50.



Graph 2. Sample structure in regard to the respondents' working experience in the preschool institution

For the purposes of the analysis but due to insufficient presence of certain categories that are grouped according to the variable of working experience, the respondents were divided into two groups: the first one contains the respondents who have less than 10 years of working experience (47%) while the second one contains the respondents who have more than 10 years of working experience (53%).



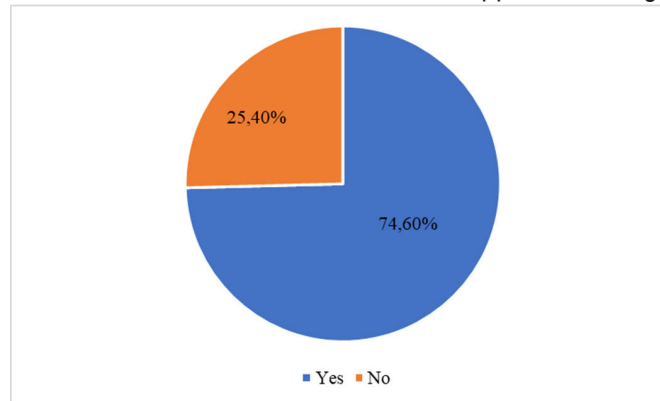
Graph 3. Sample structure in regard to professional qualifications

Taking into account respondents professional qualifications, approximately the same percentage of respondents (more than the third) graduated from high school (37,7%) or the Preschool Teacher Training College that lasted for 4 years (36,9%). 16,2% of respondents graduated from the Preschool Teacher Training College of Applied Studies (4+1), whereas 8,5% of them graduated from the Faculty of Pedagogy or Faculty of Psychology. In terms of gender, there were more female respondents, more precisely 127 (97,7%) of them, in comparison with the male ones, only 3 (2,3%) of them, which is not surprising at all considering the fact that mostly women are interested in this profession. Consequently, the variable of gender is not taken into account within further analysis and discussion of results.

The data were analyzed by means of the following procedures of the statistical program for data analysis SPSS 21: descriptive analysis, t-test and one-way analysis of variance.

Results and Discussion

The assessment of the availability and quality of trainings within regular professional training. These lines of the paper present the way preschool teachers assess the availability and quality of trainings concerning children who need additional educational support within regular professional training.



Graph 4. Attending training related to working with children who need additional educational support

According to the gained results, every fourth respondent (25,4%) attended some training related to working with children who need additional educational support, while 74,6% of them haven't had such an experience yet. This fact is humiliating because only the fourth of the whole sample attended some form of professional training. However, this finding is similar to the ones of the earlier research which indicate that barely 28 preschool teachers (approximately 21%) attended some of the professional trainings that are concerned with the issues of working with children with disabilities (Stančić and Stanisavljević Petrović, 2013).

What is more important is illustrated within the fact that less than half of preschool teachers who attended some form of additional training (44,8%) had only three trainings, while the third of them (34,5%) attended only one training, and every tenth respondent attended two trainings related to the previously mentioned issue. The data that refer to professional trainings of preschool teachers for working with children who need additional educational support at the preschool age seem very modest. If the final goal is more appropriate relationship to the children who need additional educational support as well as their education and the complete inclusion in the educational system even at the initial, preschool level, then the data indicate that it is necessary to consider the issue of high quality preparation and preschool teachers' training for identification of such children and further work with them.

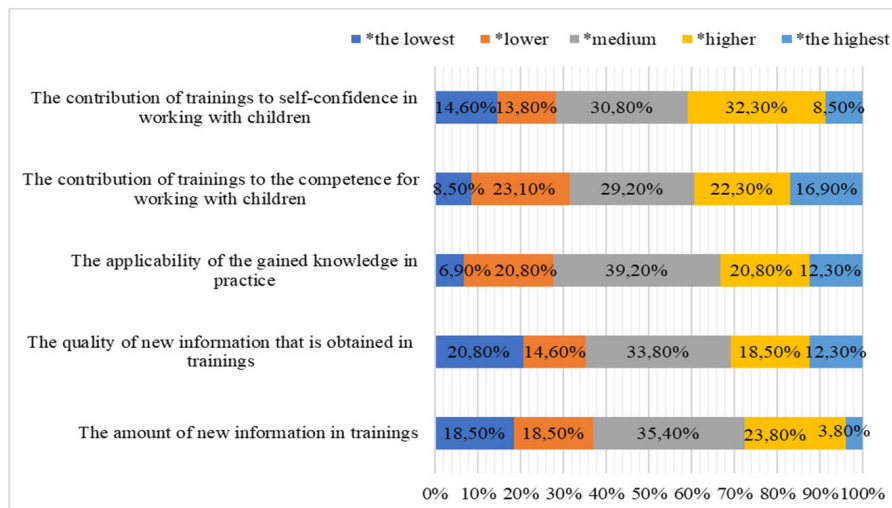
Table 1 presents the main statistical data of the preschool teachers' assessment in terms of the availability and quality of trainings within regular professional training that refer to working with children who need additional educational support.

Table 1

Descriptive statistical indicators of the availability and quality of trainings within regular professional training

| | N | Min | Max | AC | SD |
|--|-----|-----|-----|-------|-------|
| The assessment of availability and quality of trainings that refer to working with children who need additional educational support within regular professional training | 130 | 6 | 30 | 17,73 | 6,078 |

As can be seen from the Table 1, data range from 6 to 30, as well as the total achieved results, which indicates that the respondents assessed the availability and quality of trainings concerning children who need additional educational support within regular professional training with all values of the scale, from the lowest to highest ones. Considering the average result, it can be concluded that approximately one third of the preschool teachers, as for the investigated sample, assessed this item with the average result (AM=17,73, SD=6,078).



Graph 5. Distribution of results within the items of the scale Availability and quality of trainings for working with children who need additional educational support within regular professional training

Taking into account the average result from the scale, it can be concluded that most respondents (39,2%) assessed the level of applicability of the gained knowledge in practice with the medium grade. The similar result of preschool teachers' answers can be noticed in terms of the amount (35,4%) and the quality (33,8%) of new information which is obtained in the trainings that they attended. Although they assessed the contribution of trainings to the self-confidence with medium grade (30,08%), the fact that they also consider trainings as the factor that could help and enhance their self-confidence for work is the promising one (higher 32,3% and the highest 8,5%). The distribution of results in the Graph 5 also indisputably indicates the fact that preschool teachers are not satisfied with the availability and quality of trainings within regular professional training in terms of working with children who need additional educational support. This implies the finding that most preschool teachers' assessments are focused on the range of answers from the lowest to the medium level (the lowest 11,5%, lower 36,2% and the medium level 25,4%), which entails more than two thirds of the sample. Such outcome indicates the conclusion that preschool teachers think that the trainings where they could professionally train themselves and improve their competences are not available to them. On the other hand, preschool teachers are pretty much aware of the fact that such trainings would contribute to their competences for working with children who need additional educational support (higher 22,3% and the highest level 16,9%). If the context of the sample is considered, the answers of the insufficient presence and availability of the trainings could be the consequence of the peculiar isolation of the region of the northern part of Kosovo and Metohija, to which the sample belongs. Namely, this is an area of the difficult and prolonged social crisis (Stanojević, Krstić and Jaredić, 2013), bad security situation which both impact badly on the functioning of the complete social context and system. In such social circumstances, there is the lack of offers of professional trainings which could help the preschool teachers to improve their professional and educational capacities for working with children through various seminars, workshops, conferences etc.

In order to determine the differences concerning the respondents' answers in regard to working experience, t-test was applied. By means of the independent sample t-test it is concluded that there are statistically significant differences between the two previously mentioned groups of respondents which indicate that the respondents with less working experience show more positive attitude in terms of the availability and quality of trainings related to children who need additional educational support. These differences are found within the following items: *the availability of trainings* (group of respondents with less than 10 years of working experience - AM=3,18, SD=1,133, group of respondents with more than 10 years of working experience - AM=2,41, SD=1,048, $t(128)=4,049$, $p=0,000$); *the amount of new information in trainings that you attended* (group of respondents with less than 10 years of working experience - AM=3,07, SD=1,014, group of respondents with more than 10 years of working experience - AM=2,49, SD=1,158, $t(128)=3,006$, $p=0,003$); *the quality of new information obtained in trainings that you attended* (group of respondents with less than 10 years of working experience - AM=3,21, SD=1,127, group of respondents with more than 10 years of working experience - AM=2,57, SD=1,345, $t(128)=2,987$, $p=0,003$); *the applicability of the gained knowledge in practice* (group of respondents with less than 10 years of working experience - AM=3,34, SD=1,031, group of respondents with more than 10 years of working experience - AM=2,90, SD=1,100, $t(128)=2,374$, $p=0,019$) and *the contribution of trainings to your self-confidence*

for working with children who need additional educational support (group of respondents with less than 10 years of working experience -AS=3,38, SD=0,934, group of respondents with more than 10 years of working experience -AM=2,78, SD=1,305, $t(128)=3,011$, $p=0,003$). There aren't significant statistical differences between these two groups of respondents considering the other items.

One-way analysis of variance for the variable age of respondents pointed out that there are statistically significant differences among four groups of respondents in terms of *the availability of trainings through which preschool teachers professionally improve themselves for working with children who need additional educational support*. Subsequent tests determined that respondents who are less than 30 years old (AM=3,52, SD=0,750) assessed the availability and quality of trainings more positively than their older colleagues who are 41 to 50 years old (AM=2,39, SD=0,974) and more than 50 years old (AM=2,16, SD=0,898), $t(130)=7,633$, $p=0,000$. Moreover, respondents who are 31 to 40 years old (AM=2,96, SD=1,283) assessed this aspect of professional training more positively than their colleagues who are more than 50 years old. Statistically significant differences were also found in terms of the aspect of *the assessing the amount of new information* so that respondents who are less than 30 years old (AM=3,19, SD=0,928) and the ones who are 31 to 40 years old (AM=2,94, SD=1,162) assessed more positively the amount of new information in comparison with the colleagues who are more than 50 years old (AM=2,16, SD=1,214), $t(130)=3,855$, $p=0,011$.

Furthermore, there are also differences in regard to the *applicability of the gained knowledge in practice*, which means that the respondents who are less than 30 years old (AM=3,62, SD=0,865) assessed this aspect more positively than their colleagues who are more than 50 years old (AM=2,53, SD=0,964), $t(130)=3,560$, $p=0,016$. Preschool teachers who are less than 30 years old (AM=3,52, SD=1,078) have statistically significant more affirmative attitude in terms of *the contribution of trainings to self-confidence for working with children who need additional educational support* in comparison with the respondents who are more than 50 years old (AM=2,32, SD=1,376), $t(130)=4,256$, $p=0,007$.

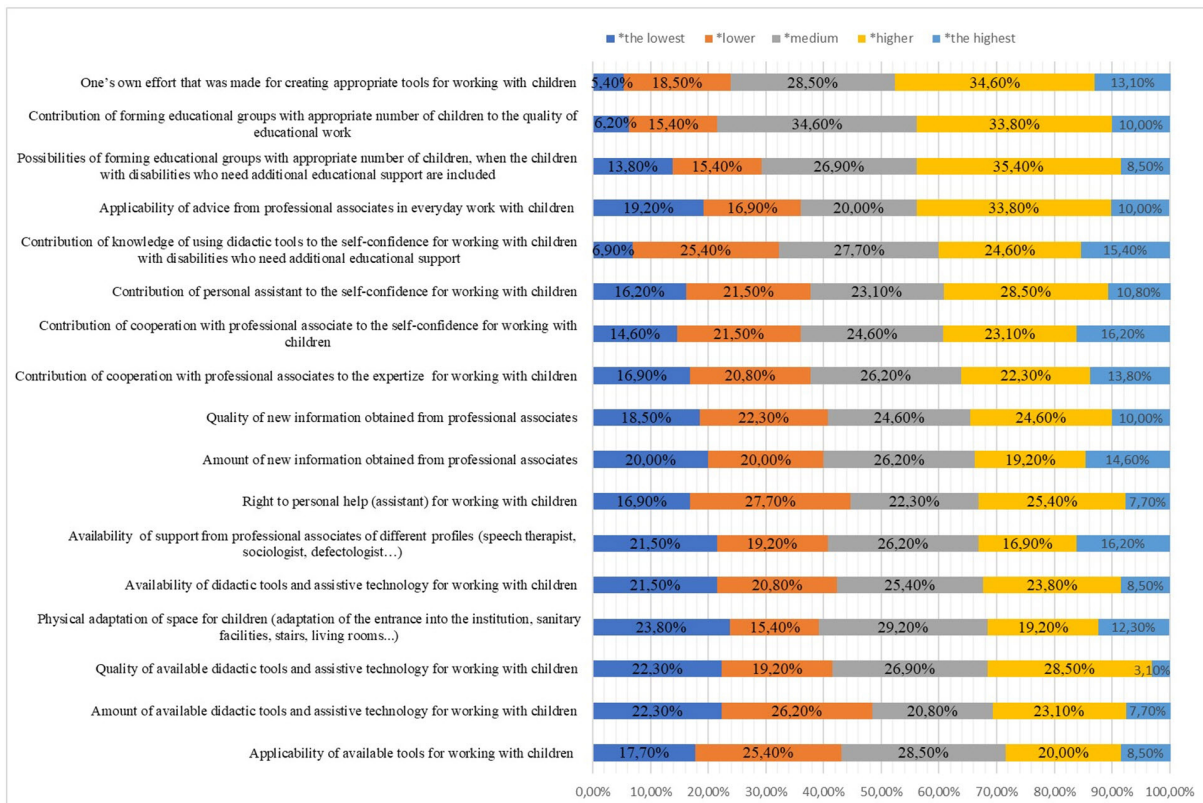
Taking into account the education of preschool teachers, there is a statistically significant difference between the respondents who graduated from high school (AM=3,57, SD=1,190) and the ones who graduated from the Preschool Teacher Training College that lasted for 4 years (AM=2,90, SD=1,276), $F(130)=3,365$, $p=0,021$, which implies the fact that respondents of lower level of education assessed *the contribution of trainings to their competence for working with children who need additional educational support* more positively and that could be regarded as the contribution of the length of the preschool teachers' initial education.

The assessment of the availability and quality of support in the preschool institution. Table 2 contains the main statistical parameters of the preschool teachers' assessment in regard to the availability and quality of support that they get in the preschool institution.

Table 2
Descriptive statistical indicators of the availability and quality of support within the institution

| | N | Min | Max | AM | SD |
|--|-----|-----|-----|------|--------|
| The assessment of the availability and quality of support that you get in the institution where you are employed | 130 | 17 | 80 | 49,0 | 17,573 |

As can be seen from the Table 2, taking into account the average result of the previously mentioned scale (AM=49,0, SD=17,573), it can be concluded that the results related to the items of the availability and quality are mainly distributed within average grades, which indicates that approximately every fourth of preschool teachers assessed this aspect as the medium one (on the scale from the lowest to the highest level).



Graph 6. Distribution of results concerning the items of the scale Availability and quality of support in the preschool institution

The Graph 6 provides insight into results according to which preschool teachers' attitudes concerning the quality of support that they get in the preschool institution is at medium level which implies the average level, while in terms of certain segments it even implies the serious deficiency and the lack of support that is necessary for appropriate work with children.

Considering these results, the assessments that are below the average, which contribute to the fact that material-organizational-technical facilities for working in the institution and adequate support by professional associates of different profiles lack and that they are not included to the appropriate extent, refer to the following items: quality (the lowest level 18,5% and lower level 22,3%) and amount of new information obtained from professional associates (the lowest level 18,5% and lower level 22,3%), right to the personal help (assistant) for working with children (the lowest level 16,9% and lower level 27,7%), availability of support from professional associates of different profiles (speech therapist, sociologist, defectologist...) (the lowest level 21,5% and lower level 19,2%), availability (the lowest level 21,5% and lower level 20,8%), amount (the lowest level 22,3% and lower level 26,2%) and quality of didactic tools and assistive technology for working with children who need additional educational support (the lowest level 22,3% and lower level 19,2%), physical adaptation of space (adaptation of the entrance into the institution, sanitary facilities, stairs, living rooms...) (the lowest level 23,8% and lower level 15,4%) and applicability of available tools for working with children (the lowest level 17,7% and lower level 25,4%). These research results differ from the Rulebook on continuous professional training and promotion to the titles of teachers, preschool teachers and professional associates (Pravilnik o stalnom stručnom usavršavanju i napredovanju u zvanja nastavnika, vaspitača i stručnih saradnika, 2021), where the focus is on planning the professional training at the level of preschool institution. Inconvenient attitudes towards the support for implementing inclusion are emphasized in some earlier research with preschool teachers, primary school teachers and secondary school teachers (Dulčić and Bakota, 2008; Kranjčec Mlinarić, Žic Ralić and Lisak, 2016; Stančić, Kiš-Glavaš and Nikolić, 2015). According this research results, it is surprising that the assessment of support from specialist services is very low, although all preschool institutions in the north of Kosovo and Metohija have at least one engaged associate.

In view of the analyzed results, it can be concluded that preschool teachers highly assess their own effort for creating appropriate tools for working with children (higher level 34,6% and the highest level 13,1%) and the possibility of forming educational groups with appropriate number of children (higher

level 35,4% and the highest level 8,5%). Moreover, preschool teachers highly assessed *advice from professional associates in everyday work with children* (higher level 33,8% and the highest level 10,0%), in spite of the fact that they are not satisfied with their support. In addition, they think that *knowledge for applying didactic tools and assistive technology highly contribute to their self-confidence for working with children who need additional educational support* (higher level 24,6% and the highest level 15,4%), as well as *the engagement of the personal assistant* (higher level 28,5% and the highest level 10,8%).

In order to determine the differences within the respondents' answers in terms of the working experience, t-test was applied. By means of the independent sample t-test it was determined that there are statistically significant differences between the two groups of respondents (the group with less than 10 years of working experience and the group with more than 10 years of working experience), which in terms of the availability and the quality of support in the institution point out more positive attitude of respondents with less working experience. These differences can be noticed within the following items: *availability of support by professional associates of different profiles (speech therapist, sociologist, defectologist...)* (the group with less than 10 years of working experience - AM=3,21, SD=1,343, the group with more than 10 years of working experience - AM=2,57, SD=1,323, $t(128)=2,767$, $p=0,006$; *amount of new information obtained from professional associates* (the group with less than 10 years of working experience - AM=3,21, SD=1,318, the group with more than 10 years of working experience - AM=2,59, SD=1,287, $t(128)=2,706$, $p=0,008$; *quality of new information obtained from professional associates* (the group with less than 10 years of working experience - AM=3,15, SD=1,236, the group with more than 10 years of working experience - AM=2,59, SD=1,240, $t(128)=2,542$, $p=0,012$; *contribution of cooperation to the professional expertise of preschool teachers for working with children* (the group with less than 10 years of working experience - AM=3,31, SD=1,162, the group with more than 10 years of working experience - AM=2,64, SD=1,328, $t(128)=3,059$, $p=0,003$; *contribution of cooperation with professional associates to the self-confidence of preschool teachers for working with children* (the group with less than 10 years of working experience - AM=3,31, SD=1,104, the group with more than 10 years of working experience - AM=2,81, SD=1,417, $t(128)=2,257$, $p=0,026$; *availability of didactic tools and assistive technology* (the group with less than 10 years of working experience - AM=3,08, SD=1,320, the group with more than 10 years of working experience - AM=2,49, SD=1,158, $t(128)=2,710$, $p=0,008$; *amount of available didactic tools and assistive technology for working with children* (the group with less than 10 years of working experience - AM=2,97, SD=1,251, the group with more than 10 years of working experience - AM=2,42, SD=1,230, $t(128)=2,510$, $p=0,013$; *the quality of available didactic tools and assistive technology for working with children* (the group with less than 10 years of working experience - AM=2,98, SD=1,133, the group with more than 10 years of working experience - AM=2,46, SD=1,195, $t(128)=2,536$, $p=0,012$ and *the applicability of available tools for work* (the group with less than 10 years of working experience - AM=3,05, SD=1,231, the group with more than 10 years of working experience - AM=2,51, SD=1,133, $t(128)=2,614$, $p=0,010$). Statistically significant differences for the rest of items between these two groups of respondents are not determined. The more positive attitude the respondents expressed, the less working experience they had which is not unexpected nor surprising because some earlier research showed that the age and working experience of preschool teachers, primary school teachers and secondary school teachers can impact the attitudes towards inclusive education (Vlah, Međimorec Grgurić and Bafiri, 2017; Skočić Mihić, Gabrić and Bošković, 2016). Such results can be explained by the fact that preschool teachers with less than 10 years of working experience had an opportunity to educate themselves through different levels of education, to educate themselves in classes in which children who need additional educational support were included too, or they had more opportunities to listen and learn about inclusive education within their university education.

By means of one-way analysis of variance it was also determined that there are statistically significant differences among preschool teachers of different age. The ones with less than 30 years of working experience (AM=3,57, SD=1,248) have statistically significant more affirmative attitude in terms of the *contribution of support by professional associates of different profiles (speech therapist, sociologist, defectologist...)* in comparison with the ones who are between 41 and 50 years old (AM=2,50, SD=1,268) and the ones who are more than 50 years old (AM=2,47, SD=1,219), $t(130)=3,680$, $p=0,014$. These results indicate that younger preschool teachers are probably more willing to ask for help in case they need any, thus they improve themselves regarding this matter more, since they have less working experience.

Moreover, their attitude is more affirmative in terms of *the amount of new information obtained from professional associates, the quality of new information obtained from professional associates, the contribution of cooperation with professional associates to their own expertise, the availability and amount of didactic tools and assistive technology for working with children*. They also assessed more positively *the quality of available didactic tools and assistive technology for working with children, the applicability*

of available tools, the aspect of support from professional associates, one's own effort for creating appropriate tools for working with children, the contribution of knowledge of using didactic tools and assistive technology to the self-confidence for working with children, the right to personal help (assistant) for working with children, the contribution of the assistant to one's own self-confidence for working with children.

Considering the professional qualifications, there is a statistically significant difference between the respondents who graduated from high school (AM=3,29, SD=1,369) and the ones who graduated from the Preschool Teacher Training College of Applied Studies – 4+1 (AM=2,29, SD=1,189), $F(130)=3,202$, $p=0,026$, which means that the respondents of lower level of education assessed more positively *the availability of support from professional associates of different profiles (speech therapist, sociologist, defectologist...)*, as well as *the amount* (AM=2,29, SD=1,189), $F(130)=3,525$, $p=0,017$ and *the quality of new information obtained from professional associates* (AM=2,24, SD=0,995), $F(130)=4,061$, $p=0,009$. In addition, there are also statistically significant differences between the preschool teachers who graduated from high school (AM=3,41, SD=1,257) and the ones who graduated from the Faculty of Pedagogy or Psychology (AM=2,55, SD=1,293), $F(130)=3,029$, $p=0,032$. These obvious differences outline the fact that respondents of lower level of education have more affirmative attitude towards the aspect of support which refers to *the applicability of advice of professional associates in everyday work, that is in terms of the contribution of cooperation with professional associates to their expertise for working with children who need additional educational support* (AM=2,36, SD=1,206), $F(130)=3,154$, $p=0,027$. Furthermore, there are statistically significant differences among the preschool teachers who graduated from high school (AM=3,49, SD=1,244), on the one hand, and the ones who graduated from the Preschool Teacher Training College of Applied Studies – 4+1 (AM=2,57, SD=1,165) and from the Faculty of Pedagogy or Psychology, on the other hand (AM=2,36, SD=1,120), $F(130)=4,170$, $p=0,007$. Such differences indicate that the lower the level of education is, the more affirmative attitude they have towards the aspect of support that refers to *the contribution of cooperation with the professional associates to the self-confidence for working with children who need additional educational support*. More convenient attitudes of preschool teachers who graduated from high school could be explained as the result of educational and professional deficiency in regard to the inclusion. Due to the lack of practical and educational experience concerning the knowledge about children who need additional educational support, preschool teachers of this level of education consider every way of support, help and cooperation with professional associates and the rest of participants of the educational process as the valuable benefit to developing and improving ones' own competences for working with children. On the other hand, it is possible that preschool teachers who graduated from Preschool Training College of Applied Studies and the ones who obtained a master's degree, as well as the ones who graduated from the Faculty of Pedagogy and Psychology, have more strict criteria when it comes to the evaluation of necessary knowledge and competences and the help they need from professional associates.

The analysis of variance showed that there is a statistically significant difference between the respondents who graduated from high school (AM=3,12, SD=1,201) and the ones who graduated from the Preschool Teacher Training College of Applied Studies - 4+1 (AM=2,33, SD=0,913), $F(130)=3,028$, $p=0,032$, to the effect that the respondents who graduated from high school assessed more positively *the applicability of available tools for working with children who need additional educational support*.

Furthermore, there is a statistically significant difference between the respondents who graduated from high school (AM=3,43, SD=1,137) and the ones who graduated from the Faculty of Pedagogy and the Faculty of Psychology (AM=2,64, SD=1,286). Consequently, the respondents of lower level of education more positively assessed the aspect of support that refers to *the contribution of knowledge for using didactic tools and assistive technology for self-confidence for working* $F(130)=2,990$, $p=0,034$, as well as for *the right to personal help (assistant) for working with children with disabilities for additional educational support* $F(130)=4,253$, $p=0,007$.

Likewise, there is a statistically significant difference between various groups of respondents in the sense that the respondents of lower level of education assessed more positively *the contribution of personal assistant to the self-confidence for working with children who need additional educational support* $F(130)=9,287$, $p=0,000$ and *the contribution to forming educational groups with appropriate number of children concerning the quality of educational work* $F(130)=3,426$, $p=0,019$, as well as *physical adaptations of space (adaptation of the entrance into the institution, sanitary facilities, stairs, living rooms...)* $F(130)=3,760$, $p=0,013$.

The assessment of knowledge and skills of preschool teachers for inclusive approach to education. The Table 7 shows the distribution of answers related to the most important knowledge and skills of preschool teachers for working with children who need additional educational support.

Table 7

The distribution of the respondents' answers about the most important skills and knowledge for working with children who need additional educational support

| Knowledge and skills | Importance | | | | | |
|--|--------------|---------|--------------|---------|--------|------------|
| | *the highest | *enough | *little less | *medium | *less | *the least |
| Identification of characteristics of various difficulties among children | 34,60% | 16,20% | 8,50% | 17,70% | 19,20% | 3,80% |
| Adjustment of the method, the form of teaching, materials and space for working with children who need additional educational support | 28,50% | 16,90% | 23,10% | 16,20% | 10,00% | 5,30% |
| Strategy of including children who need additional educational support in activities and encouraging the interaction with peers in the group | 33,80% | 24,60% | 12,30% | 18,60% | 3,80% | 6,90% |
| Creating the individual educational plan for the child who need additional educational support | 26,90% | 19,20% | 19,20% | 25,40% | 6,20% | 3,10% |
| Strategy of solving the problem of unwilling behavior of children who need additional educational support | 31,50% | 26,20% | 16,10% | 13,10% | 8,50% | 4,60% |
| Communication skills for working with parents | 39,20% | 13,80% | 18,60% | 23,80% | 0,00% | 4,60% |

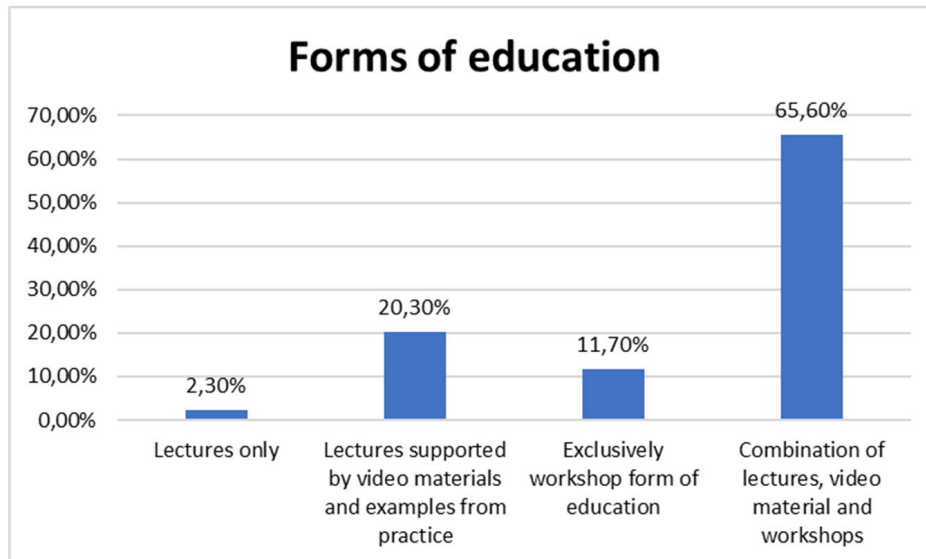
The respondents had the opportunity to rank in regard to their knowledge and skills that is to assess what could contribute most or least to the development of their competences and self-confidence for working with children who need additional educational support.

The respondents ranked as the most important thing *the identification of characteristics of various difficulties among children*. Apart from that, more than half of respondents consider the two categories in terms of the most significant (much and enough) for the following items: *the adjustment of methods, forms of teaching, materials and space for working with children who need additional educational support, the creation of individual educational plan for the child who need additional educational support and communication skills for working with parents*.

On the other hand, more than 30% of respondents consider the two categories in terms of the least significant (less and the least) for the following items: *the strategy of including children who need additional educational support in the activities and encouraging interaction with peers in the group, the strategy of solving the problem of unwilling behaviour among children who need additional educational support and communication skills for working with parents*.

The assessment of the most useful forms of professional training of preschool teachers.

Professional training of preschool teachers in preschool institutions and teachers in regular schools in Serbia is regulated by the Rulebook on continuous professional training and promotion to the titles of teachers, preschool teachers and professional associates ([Pravilnik o stalnom stručnom usavršavanju i sticanju zvanja nastavnika, vaspitača i stručnih saradnika, "Sl. glasnik RS", 109 19/2021](#)). *The Law on the Foundations of the Education System ("Sl. glasnik RS", br. 88/2017, 27/2018 - dr. zakon, 10/2019, 27/2018 - dr. zakon, 6/2020 i 129/2021)* prescribes that primary and secondary school teachers as well as preschool teachers must improve themselves permanently in order to advance their educational work more successfully. Therefore, preschool teachers' attitudes concerning the most useful forms of professional training were mapped.



Graph 7. The most useful forms of trainings for preschool teachers' competence for the inclusive approach in education

Taking into account the Graph 7, the fact that combining the lectures, material and workshops could be the most useful form of training dominates (65,6% agreed with it), whereas the other forms are less significant. This result points out the invaluable significance of pictures, sounds and words for teaching even the adult learners and it reminds of the well-known quote of the Chinese philosopher Confucius "tell me and I will forget, show me and I may remember, involve me and I will understand." This is very important because it can be used as a direction for the organization of trainings.

Conclusion

The preschool institution is the first educational institution in the whole education system of children. In the earliest age of development, the child gets different ways of support in the very group that is coordinated by the preschool teacher. However, the preschool institution should provide the possibility for developmental competences of the children with typical development, as well as of the children who need additional help and support in the development. Additional ways of support demand certain conditions for work, then preparation and planning, and the preschool teachers' competence too. On the other hand, firstly preschool teacher' positive attitudes towards the inclusive works, then motivation for work, characteristics of their personalities, as well as the need for permanent development and improvement for different forms of competence, contribute to better understanding of the issue and preschool teachers' professional work. The imperative of preschool teachers' inclusive work within the preschool institution implies the correct assessment and pedagogical tact of preschool teachers to create the socio-emotional atmosphere in the group where the feeling of satisfaction, while being a part of it, is equally present among all children.

According to the results of the conducted research, as for the investigated sample, it is determined that considering the availability and the quality of training concerning children, who need additional educational support, the respondents with less working experience have more positive attitudes than the respondents with more working experience, as well as that the respondents of lower level of education have more affirmative attitudes in comparison with the preschool teachers of higher level of education. The availability of high quality trainings that could help the preschool teachers through professional improvement with working with children who need additional educational support is at the medium level. The presence of medium assessments indicates that it is necessary to deal more with these issues, whereas the research findings emphasize that it is necessary to ensure more trainings, increase their number and the quality of information that is offered to preschool teachers within them. The percentage of preschool teachers who attended no training at all for the last three years is really high (74,6%), which is very bad and opposite to the policy of inclusion and that is the lifelong learning and improvement. There are doubts concerning the availability and the quality of support that preschool teachers get in the institution where they work because the assessments of average and below average level of support

imply that preschool teachers are not so much satisfied.

The ones with less working experience and who are less than 30 years old showed more positive attitudes towards the availability and the quality of support that they get in the institution where they work. Taking into account the results of the conducted research, the respondents from the northern part of Kosovo and Metohija outlined as the most useful findings and skills that are necessary for working with children, who need additional support, the following ones: *the identification of characteristics of certain difficulties among children, the adjustment of methods, ways of teaching, materials and space to working with children who need additional educational support, the creation of individual educational plan for a child who needs additional educational support and communication skills for working with parents*. Furthermore, they considered the combination of lectures, video materials and workshops as the most useful form of the preschool teachers' professional training. The research findings are valuable because they are first-hand, namely from the main representatives of the inclusive process, therefore it is necessary to focus on them and use them as directions that should be worked on in order to improve the quality of the inclusive practice in preschool institutions, because according to the results, there are still some lacks the preschool teachers are faced with.

In view of all that has been mentioned so far, it can be concluded that in order to develop and enhance the good inclusive practice in the region of the northern part of Kosovo and Metohija, it is necessary to provide permanent preschool teachers' improvement during their studies and after they graduate, i.e. preschool institutions should be the unique resource support in terms of facilitating various trainings concerning inclusion that are recommended by the very laws of the Republic of Serbia that regulate the system of education. Moreover, the internal structure of the preschool institution in terms of organization, material and technical facilities of the institution for working in the inclusive environment, as well as the willingness of the professional associates of different profiles should be the support, assistance and partners to the preschool teachers' who work with children who need additional educational support. In other words, they are regarded as the highly positioned preconditions for the successful realization of the preschool inclusive practice.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, D.R.P and T.P.K.; methodology, T.P.K. and A.M.B; software, A.M.B. and T. S. R.; formal analysis, T.P.K.,D.R.P., A. M.B., and T. S. R. ; writing—original draft preparation, T.P.K.,D.R.P., A. M.B., and T. S. R. ; writing—review and editing, T.P.K. and D.R.P., All authors have read and agreed to the published version of the manuscript.

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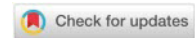
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Mental Representations as The Students' Academic Success Predictor

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Abstract: The analysis is aimed at defining peculiarities of mental representations in homogeneous cluster groups, represented by the students characterized by different (high, average or low) academic progress levels. Deductive and correlation design of the research is defined here as a general method. Statistic design: the research is held taking into account a mixed method, including several qualitative and quantitative techniques of data processing and interpreting; more specifically cluster analysis (used for relatively homogeneous groups defining), multiple regression analysis (used to determine the impact of mental representations characteristics on academic success) as well as Kruskal-Wallis rank sum test. The average value of the regression model significance reflects the veracity of the research results. The attained statistic results prove that mental representations have peculiar impact on students' academic success and there is an effect of the students' academic activity progress splitting. On the one hand, the research helps to identify cluster groups of students characterized by success exteriorization indices growth and academic success indices reduction. On the other hand, non-linear impact of mental representations characteristics on students' academic success was identified (the effect of inversion); i.e. some mental representations indices are highly developed, but the quality of education is low and individual resource is hard to implement in everyday life. Academic progress index, high level of studying and professional competences acquirement orientation as well as the activity factor are defined as measures of academic success mental representations splitting in groups. These results and conclusions prove the scientific fact that mental representations have an influence on the students' academic success. This influence is multidimensional and vague. These facts offer a challenge of the research in considering highly-effective psychotechnologies for developing mental representations in general and students' academic success in particular.

Keywords: predictors, mental representations, academic success, academic progress, implicit theories.

Introduction

Modern society requires competitive erudite persons, aimed at developing and able to adapt to changes; this request helps to form such social value as success. That is why the problem of modern young people being successful becomes extremely topical nowadays. Success conditions systematizing helps to assume that there is a stable structure of intellectual and personal variables, acting as a so-called "skeleton", providing real and potential success. Mental representations of success may be considered as crystallizing bases of this stable structure. Person's potential, but first and foremost actual success in different spheres of activity depends on mental representations, notions and images formed on success (Romero-Galisteo et al., 2022; Welsch and Zimmer, 2018). Success actualization in educational and professional activities becomes one of the most important indices for employers: they prefer hiring those students who were successful in educational activities and had advanced academic achievements. (Goegan and Daniels, 2021). That is why the basic variables in this research are the students' academic success and its predictors, represented by mental representations.

Academic success has been a relevant problem for many decades (Ishkov, 2019; Lewis and Yates, 2019). Theoretic analysis of modern researches showed that the academic success can be expressed through a great variety of criteria/indices. These criteria include academic progress (Fréchette-Simard et al., 2022); average mark, knowledge and skills achieved and overall satisfaction (Goegan and Daniels, 2021); completion of education and positive experience in professional algorithms, practical evaluation of schemes and models (Roshchevskaya, 2013); being ready to defend own point of view, active and

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positive attitude to studying/working; being adaptive (being ready to confront challenges) (Nadtochyy, 2017); effective record-keeping and time-management (Gaponova and Popova, 2016; Lewis and Yates, 2019); academic stress resistance (Martin et al., 2022); time for answering questions, answer correctness coefficient and decision-making confidence coefficient (Bakanov and Zelenova, 2015), etc.

However, the question of which variables are predictors of academic success is still topical. Analysis of different researches in this sphere showed that the academic success predictors can be conditionally subdivided into intellectual/cognitive, personal/non-cognitive and situational (connected with tasks, their complexity, strategy of studying, etc.). The last group of variables is large enough and is studied in various pedagogic and psychological researches. It includes the model of education (e.g., the model of flipped classroom, which helps to reduce stress and to increase academic progress) (Aydin and Demirer, 2022) and strategies of education (Freiberg-Hoffmann et al., 2022) using modern humanitarian technologies (dialogic, critical thinking development, projecting, self-presentation) (Sokolova and Khudoteplova, 2017) and such methods of education as experimental learning (Li and Li, 2021), frequency of students interacting with teachers as well as an academic validity (as a stimulation and support of students achievements) (Li and Li, 2021), etc.

The level of an intellectual activity efficiency is, in many respects, a defining factor for academic success. There are many researches proving these stable links. General (i.e. intelligence, creativity) (Bezerra, Alves and Azoni, 2022) and specific (speed of information processing, memory, thinking, attention, imagination and speech) cognitive predictors determine academic success at the beginning of studying as well as at other stages of getting education. These predictors define abilities to establish logical connections and to identify what is critically important and what is merely a detail (Larkina, 2021; Postavnev et al., 2020). For example, in a situation of solving averagely complex school tasks, a high level of cognitive development and a high need for cognition contribute to internal motivation and involvement in studying, helps educating process to be successful (Lavrijsen et al., 2021). Critical thinking correlates with academic self-esteem (average or moderate level of critical thinking is connected with adequately high academic self-concept) (Dehghani et al., 2011; Mafarja and Zulnadi, 2022). Intelligence and person implicit theories acceptance is a determining cognitive factor of academic efficiency and success (Dweck, 2015).

Intellectual flexibility/humility as well as fluid intelligence are one of the most important cognitive predictors of academic success. Intellectual humility determines the efficiency of fulfilling tasks of different complexity degrees and efficiency of coping with problems in future life (Ratu, Rai and Savitri, 2021). Flexible intelligence (including non-verbal one) has an impact on creation in case of indirect influence of field independence (acting as cognitive style), which can determine academic success (Bouchebra et al., 2022; Giancola, Palmiero and D'Amico, 2022). Intellectual activity (as the sign of involvement and intellectual activity satisfaction) is one more intellectual predictor. The higher the intellectual activity is, the higher academic success in humanitarian and linguistic (not mathematical or standardized tests) disciplines is (Hülür et al., 2018).

Intellectual peculiarities being predictors of academic progress are the most important prognostic indices; they help to make increasingly more accurate prognoses of academic success as students grow older. At the same time, it is difficult enough and not justified in all cases to rely just on the levels of intellect, creativity and other cognitive processes development (Dvojnjin and Trockaya, 2022).

The more person is oriented on achieving the goal, the higher personal achieving motivation is, the better educational, cognitive, professional and self-actualization motivation is developed, the higher students' success self-esteem is. The success self-esteem is studied as one of the mental representations of academic success (Eksakusto, Kibalchenko and Duganova, 2022; Karlen, Hirt and Stebner, 2021; Kornilova, Kornilov and Chumakova, 2009).

The range of non-cognitive (personal) variables is wide enough. Senior high school students' academic success was found out to be connected with such regulative universal academic activities as targeting, situation analysis, planning, self-control, correcting and volitional efforts (Dracheva, 2015). Moreover, there is a consistent positive correlation of educational motivation, scrupulosity and the so-called "Big five" factors (extraversion, agreeableness, conscientiousness, emotional stability and openness) with academic progress (Albar et al., 2022; Busato et al., 2000).

Self-esteem as well as significantly positive possible "Self" (including time spent for thinking process, current achievement strategies, etc.) may be potential predictors of academic success (Tommasi et al., 2022); possible "Self" is connected with self-development motivation and is the basis for high motivation for achieving goals in educational sphere (Vasilevskaya and Molchanova, 2021). The level of anxiety (personal and situational ones) (Bagandova et al., 2018), hardiness (Legostaeva, 2019), learning and cognitive motivation (Fréchette-Simard et al., 2022), self-efficiency and self-direction (Koh et al., 2022),

etc., are also rated as personal predictors of academic success.

If summarizing the results of the academic success intellectual and personal predictors studying, we may suppose that the method based on integration of these variables is the most advanced and prospective one. The complex of intellectual and personal features/resources (experience, targeting and correcting of goals based on this experience, own abilities) but not just separately defined variables determine the quality of academic progress and success in general. The data achieved during separate (single) studies support this approach (Smirnov, 2014; von Keyserlingk et al., 2022; Zirenko, 2018). Mental representations and human ideas are core/basic factors in this approach. Mental representations (connected with human intellectual and personal peculiarities) are the most important prognostic indices of potential and current success; they are being set up in a process of life and reflect the view of the world, society and self, formed in a process of life (Kholodnaya, 2019). Thus, mental representations can define the efficiency of success (in different activity types) actualization (Sipovskaya, 2015; Smirnov, 2014).

Being an operating form of mental experience, refracting through the identity of the subject, mental representations are characterized by individual resource value and guide a person to achievements, intentions and correct behavior. If speaking about the system of academic success predictors data, mental representations influence on academic success (including its being non-linear) is still insufficiently studied (Kholodnaya, 2020). There are few researches studying metacognitive skills and metacognitive experience from the point of view of their ability to effect positively on person choosing this or that cognitive strategy while solving problems and meeting wide range of educational challenges (Savin, 2004; Schuster et al., 2020; Sipovskaya, 2016; Trifonova, 2021; Volkova and Kholodnaya, 2018).

Such aspects of mental representations as intelligence and personal implicit theories acceptance, success achievement motivation, "Self" perception, metacognitive knowledge and personal success self-esteem are of great interest nowadays. Thus, the present research is aimed at studying mental representations as a subjective form of ongoing processes vision and the students' academic success predictors.

The study is based on content analysis, which helped to suggest that a multidimensional effect of mental representations on the students' academic success would be found.

So, the core objectives of the study were as follows: to identify cluster groups in accordance with the indices of mental representations and academic success of students; to determine the influence of mental representations characteristics on the students' academic success and correlations of these characteristics with the help of regression analysis and to analyze the features of mental representations of students' (included into different cluster groups) academic success.

Materials and Methods

Two hundred and twelve students 1st-year students aged 18 and 19 years of Southern Federal University took part in the research (62% - male students, 38% - female ones). The participants of the research were chosen from 587 students enrolled in the Basics of Project Management course. Taking part in the research was of their own volition (they could have withdrawn from participation at any step of the research; no one decided to recuse) and non-reimbursable.

Empiric research was held in two steps. Deductive and correlative design of the research is defined here as a general method. It includes the following qualitative and quantitative techniques of the results processing and interpreting: typing or classification typing method (cluster analysis) was used to organize students into relatively homogeneous groups pursuant to indices of mental representations and academic success; multivariate regression analysis was used to analyze mental representations impact on academic success; comparative analysis ("cross-sectional method") and statistic criteria were aimed at determining differences between the groups.

Several methods and techniques were used to define academic success and mental representations indices. Students' questionnaires with the academic progress data was aimed at biographic data acquisition and students' educational progress self-report. Implicit theories questionnaire (IT) (Dweck, Smirnov's variation) was used to study the indices of such scales as "Stackable" intelligence theory acceptance", "Enriched" personality theory acceptance", "The aims of education acceptance" and "Education self-estimation". Students' success achievement motivation questionnaire (Pakulina) helped to study such indices as "Success exteriorization" and "Success interiorization". Personal differential ("My own self" variant) (Bazhin & Etkind) aimed at getting results for "Assessment" factor (My own self)", "Strength" factor (My own self)" and "Activity" factor (My own self)" scales. The scale of success and satisfaction with life self-esteem (Dembo-Rubinstein variation) helped to study Current, Perfect and

Potential subjective success self-assessment indices. Metacognitive knowledge and metacognitive action self-esteem methods (Poshekhonova & Kashapov) were aimed at analyzing "Metacognitive knowledge" and "metacognitive activity" scales. Ranking indices (as academic success complex assessment) were used as students' academic success markers. Rating system is used in the University where the research was held. This system is accessible for students as well as for the University management and allows to control students' academic progress (0 to 100 credits) in all subjects during each term. Thus, each student has an own average academic progress rating.

Results

Cluster analysis was used at the first step of the research to define groups homogeneous in levels of mental representations academic progress variables formation (table 1).

Table 1
Students' mental representations and academic progress characteristics

| Independent variables | | Independent variables | |
|-----------------------|--|-----------------------|--|
| 1. | Metacognitive knowledge | 9. | Current subjective success self-assessment index |
| 2. | Metacognitive experience | 10. | Perfect subjective success self-assessment index |
| 3. | "Stackable" intelligence theory acceptance | 11. | Potential subjective success self-assessment index in case of personal abilities subjective assessment |
| 4. | "Enriched" personality theory acceptance | 12. | "Assessment" factor (My own self)" |
| 5. | The aims of education acceptance | 13. | "Strength" factor (My own self)" |
| 6. | Education self-estimation | 14. | "Activity" factor (My own self)" |
| 7. | Success exteriorization | 15. | Progress (rating index) |
| 8. | Success interiorization | | |

Three groups were defined while analyzing dendrogram resulting from clusterization; this fact is the indicative of tendency to normal distribution with 3.44 % deviation from standard distribution.

First group includes 26 students (12.26 % of the total number) – students with academic progress average index (67 points); this index shows satisfactory level according to a point rating system (100 % of students included in this group are characterized by low progress indices). This group can be notionally called "Average progress" according to criterion of academic progress.

Second group consists of 152 persons (71.7 %) – students with average rating of 85 points, i.e. excellent level in accordance with the point rating system. This group is characterized by high progress indices and can be called "High progress: current and potential". The name of the group detailing is connected with the fact that 42.1 % of students here are characterized by average progress index, 50 % – by high academic progress index and 7.9 % of them have satisfactory progress. The number of students with satisfactory progress index is significantly smaller that the number of students with average ($\varphi^*_{emp} = 10.82, p=0.01$) and high ($\varphi^*_{emp} = 9.16, p=0.01$) ones. Thus, the average and high academic progress indices significantly prevail in this group.

Thirty-four students (16.04 %) form a third group; these students are exemplified by average academic progress indices: 73 points – a good progress level. This group is notionally called "Conditionally average progress". The members of this group are ranged wider that the members of the previous one. It includes students with non-satisfactory progress – 17.6 %, satisfactory one – 14.7 % (33.1 % in sum), average (good) progress – 35.3 % and high one – 32.4 %. This group is characterized by academic progress complete splitting.

It should be also emphasized that the respondents included into second and third groups differ in academic progress levels. Clusterization procedure shows that these groups include students similar in mental representations indices variety. The level of students' mental representations formedness hypothetically serves as the academic progress indices splitting criterion.

Results analysis showed correlation according to the degree of success mental representations indices expression described in table 2.

Table 2
The levels of expressiveness of the success mental representations (SMR) indices

| | The levels of indices manifestation in "n" variables in groups (per cent) | | | | | | The number of dominating indices (per cent) |
|--|---|------|-----------------------|------|-----------------------|------|---|
| | High (B) | | Average (C) | | Low (H) | | |
| | n | % | n | % | n | % | |
| "Average progress" (1) | 4 | 26.7 | 2 | 13.3 | 9 | 60 | 60 per cent – low with the elements of high manifestation level (26.7 per cent) |
| "High progress: current and potential" (2) | 6 | 39.9 | 7 | 46.7 | 2 | 13.4 | 13.4 per cent – average with the tendency to high level (39.9 per cent) |
| "Conditionally Average progress" (3) | 3 | 20.0 | 5 | 33.3 | 7 | 46.7 | 46.7 per cent – low tended to the average manifestation level (33.3 per cent) |
| Dominant | 2 nd group | 39.9 | 2 nd group | 46.7 | 1 st group | 60.0 | |

The first group (so called "Average progress") is characterized by low academic progress as well as by ill-defined mental representations predictors predominance. However, the students included in this group show better results and higher indices in such characteristics as "Enriched" personality theory acceptance", "Stackable" intelligence theory acceptance", "The aims of education acceptance" as well as "Success exteriorization" than the students of the other ones. If comparing to other groups, this one is close to "Conditionally average progress" in mental representations indices.

The second group ("High progress: current and potential") differs from other ones; the students in this group are characterized by average and high academic progress; at the same time, averagely expressed mental representations tending to high expression prevail here. Two variables ("The aims of education acceptance" and "Perfect subjective success self-assessment index") are poorly defined here, if comparing to other groups.

The third group of students ("Conditionally average progress") is notable for different levels of academic progress and poorly expressed mental representations indices. This group's results in such variables as "Current subjective success self-assessment index", "Strength" factor (My own self)", "Assessment" factor (My own self)" are higher than the results of students in other groups.

Thus, "High progress: current and potential" group significantly differs from the other ones in dominating of averagely and positively expressed mental representations indices. The "Average progress" group, on the contrary, is characterized by poor expression of these indices. The "Conditionally average progress" group is in a middle position with average mental representations indices expression.

Coefficients (the sum equals one) of mental representations characteristics predominating in splitting equations (Rn) in the levels of expression (H, C, B) were defined while converting percent into nonintegrals:

$$1^{\text{st}} \text{ group } R1 = 0,6H + 0,27B + 0,13C$$

$$2^{\text{nd}} \text{ group } R2 = 0,5C + 0,40B + 0,10H$$

$$3^{\text{rd}} \text{ group } R3 = 0,5H + 0,30C + 0,20B$$

These results show the success mental representations indices being non-linearly distributed; this fact may be proved by regression analysis. These results can be determined by the progress and its predictor's correlation being multidimensional and complex.

The second step of the empiric research and a process of different levels of academic progress definition (regression analysis) helped to determine consistency of regressions and report for models (see Tables 3-5).

All the used variables are defined as academic progress predictors; they are used in different hierarchic order; the use of Kruskal-Wallis's H criterion proves this difference. The defined cluster groups differ in such indices as "academic progress" (H=55.51, p=0.00); "Education self-estimation" (acting as an academic success predictor and intellectual success self-presentation) (H=9.51, p=0.01); and "Enriched" personality theory acceptance" (H=6.95, p=0.01). If analyzing regression models content, note that the "Activity" factor (My own self)" predictor is the first one in all groups with averagely equal values (1st group – 26.6; 2nd group – 25.8; 3rd group – 25.8). This predictor is included into a pleiad with different hierarchically dominating variables and is safe to be the core sign of young people being active, engrossed with a life processes (which is typical of this age).

The first group: "Activity" factor (My own self)" (VAR 14) forms hierarchically significant complex of

the following predictors: "Strength" factor (My own self)" (VAR 13) (28.15), "Perfect subjective success self-assessment index" (VAR 10) (9.19) – highest rate in all groups; "Metacognitive activity" (VAR 2) (8.88) (see Table 3).

Table 3
Regression indices in "Average progress" cluster group

| ANOVA | | | | |
|---|----------------|--------------------|------|---------|
| Model | Sum of squares | Degrees of freedom | F | P-Value |
| Regression | 12.82 | 14 | 3.96 | 0.01 |
| a. Dependent variable: 15 | | | | |
| b. Predictors: constant = 31.84; characteristics and β -coefficients of each variable: VAR14 ($\beta=0.67$), VAR13 ($\beta=0.66$), VAR10 ($\beta=0.64$), VAR2 ($\beta=0.63$), VAR 8 ($\beta=-0.88$), VAR 3 ($\beta=0.60$), VAR 6 ($\beta=0.53$), VAR 12 ($\beta=0.51$), VAR 11($\beta=0.50$), VAR 1($\beta=0.47$), VAR 5($\beta=0.45$), VAR 9 ($\beta=-0.52$), VAR 4($\beta=0.33$), VAR 7($\beta=0.30$) | | | | |

These predictors influence an academic success no matter the education self-estimation index is expressed in a significantly weaker way here comparing to two other groups. Such characteristics as "The aims of education acceptance" (VAR 5) (the highest rate among groups); "Current subjective success self-assessment index" (VAR 9); "Enriched" personality theory acceptance" (VAR 4) (also the highest rate among groups); "Success exteriorization" (VAR 7) (the highest rate among groups, significant differences with the 3rd group: $U_{emp} = 534.5$; $U_{cr} = 620$, $p = 0.01$) have the least impact on the academic progress of this group participants. The students related to this group are much more stable and show more academic, cognitive and professional motivation than the students included into the second one. This group is characterized by the higher expression of the "Stackable" intelligence theory acceptance" index than in other groups no matter the students included into it are insufficiently targeted at studying and learning skills ($U_{emp} = 533$, $U_{cr} = 604$, $p = 0.05$).

If speaking about the second group, the "Activity" factor (My own self)" (VAR 14) forms hierarchically significant complex linked with such predictors as "Success interiorization" (VAR 8), "Current subjective success self-assessment index" (VAR 9) and the "Stackable" intelligence theory acceptance" (VAR 3) (see Table 4).

Table 4
Regression indices in "High progress: current and potential" cluster group

| ANOVA | | | | |
|---|----------------|--------------------|------|---------|
| Model | Sum of squares | Degrees of freedom | F | P-Value |
| Regression | 1870.12 | 14 | 2.49 | 0.00 |
| a. Dependent variable: 15 | | | | |
| b. Predictors: constant = 33.48; characteristics and β -coefficients of each variable: VAR 14 ($\beta=0.72$), VAR 8 ($\beta=0.70$), VAR 9 ($\beta=0.67$), VAR 3 ($\beta=0.65$), VAR 2 ($\beta=0.62$), VAR 12 ($\beta=0.60$), VAR 13 ($\beta=0.56$), VAR 10 ($\beta=0.55$), VAR 6 ($\beta=0.55$), VAR 7 ($\beta=0.52$), VAR 5 ($\beta=0.50$), VAR 11 ($\beta=-0.48$), VAR 4 ($\beta=0.45$), VAR 1 ($\beta=0.41$) | | | | |

Specific character of the students' knowledge structures and personal experience has an impact on their academic success. The students included into this group are active in studying (VAR 14) but are afraid of challenges, consider them as condition to further intellectual growth as well as the reason of this growth rate reduction. Such characteristics as "The aims of education acceptance" (VAR 5), "Potential subjective success self-assessment index" (VAR 9) (in case of own abilities subjective assessment), "Enriched" personality theory acceptance" (VAR 4) and "Metacognitive knowledge" (VAR 1) have the least effect on this group students' progress. It is noteworthy that the "Success interiorization" holds more expression ($U_{emp} = 534.5$; $U_{cr} = 620$, $p = 0.01$) in this group than in a third one.

The third cluster group is specific for the "Activity" factor (My own self)" (VAR 14) forming hierarchically significant complex with "Metacognitive knowledge" (VAR 1), "Enriched" personality theory acceptance" (VAR 4) and "Current subjective success self-assessment index" (VAR 9) (see Table 5).

Table 5
Regression indices in “Conditionally Average progress” cluster group

| ANOVA | | | | |
|---|----------------|--------------------|------|---------|
| Model | Sum of squares | Degrees of freedom | F | P-Value |
| Regression | 10507.99 | 14 | 2.53 | 0.03 |
| a. Dependent variable: 15 | | | | |
| b. Predictors: constant = 0; characteristics and β -coefficients of each variable: VAR 14 ($\beta=0.94$), VAR 1 ($\beta=0.93$), VAR 4 ($\beta=0.89$), VAR 9 ($\beta=0.87$), VAR 13 ($\beta=0.86$), VAR 10 ($\beta=0.77$), VAR 6 ($\beta=0.59$), VAR 8 ($\beta=0.57$), VAR 12 ($\beta=0.55$), VAR 2 ($\beta=0.55$), VAR 11 ($\beta=0.53$), VAR 5 ($\beta=0.51$), VAR 7 ($\beta=0.49$), VAR 3 ($\beta=-0.49$) | | | | |

Moreover, “Metacognitive knowledge” and “Enriched” personality theory acceptance” indices are the academic progress hierarchically valuable predictors. They are much poorly expressed here than in two previous groups. Such characteristics as “The aims of education acceptance” (VAR 5), “Success exteriorization” (VAR 7) and “Stackable” intelligence theory acceptance” (VAR 3) are formed better than in the second group, but have little effect on academic progress of students. Significantly higher “Ego self” index ($U_{emp} = 330.5$; $U_{cr} = 331$, $p = 0.01$) is specific of the students of this group.

Discussions

According to the results of the first stage of the study, one can conclude that the second group (“High progress: current and potential”) and the third one (“Conditionally Average progress”) are characterized by high mental representations indices; on the other side, academic progress quantitative indices are splitting and dividing into opposite sub-fields. That is, in case of sufficiently high quantitative indices of mental representations characteristics, opposite academic progress indices are observed. If speaking about the first group “Average progress” there is a reverse effect. Low academic success index became a measure of mental representations indices splitting; mental representations indices are expressed at low, average and high levels here. According to modern researches (Kholodnaya, 2020), intelligence (namely, mental representations) indices, no matter they are of high, average or low levels, can be associated with both high and low academic progress of students. Consequently, success indices of high, average and low levels as well as success mental representations “split” into different areas depending on the underlying productive or non-productive components. This fact is proved by some modern researches as well (Dyupina, 2021; Kibalchenko, Eksakusto and Chegodaeva, 2021).

The complex of predictors of the first “Average progress” group were analyzed at the second stage of the research. The resource link of the students included into this group is strong; i.e. they are able to focus on the process of teaching and getting skills; to assess intelligence objectively and to change internal mental action into an external one. However, they scarcely use this resource strong link in an educational activity.

Moreover, there is a contradiction: on the one hand, students demonstrate greater (comparing to others) stability and belief in their development and the achievement motivation expressiveness; on the other hand, they tend to consider themselves (situationally) unsuccessful; to be unstable in choosing and using effective metastrategies of learning, self-regulation skills and irrational in using school time (Volkova and Kholodnaya, 2018). They have problems with realizing correct means of information obtaining and processing, strategies and requirements for problems solving, etc. In other words, there is a contradiction between the implicit nature of evaluating one’s efforts and the existing metacognitive resource. It is fair to assume that the correlation of low-level metaknowledge and implicit aspirations for one’s personality “enrichment” make it difficult to change one’s own action from internal to external one. In other words, there is an inversion phenomenon in this group, i.e. these students have high cognitive performance, but other (non-cognitive) indices are low, i.e. the index of knowledge is highly developed, but the procedural side of the activity is underused (Cheng and Cheung, 2005).

Differences in the success interiorization index expression intensity detected in the second group (students with high progress) are expressed in the following understanding of success: the success is personal, depends on personal achievements; it is perceived as a result of personal activity, as a specific mental state as well as difficulties overcoming and vocational aptitude. The students of this group (opposed to the students of other ones) consider success as a positive result in studying and working. Meanwhile, the indices of “The aims of education acceptance”, “Enriched” personality theory acceptance”

and "Metacognitive knowledge" are of lower level than in two other groups. That is why the students of this group use these indices in an educational activity less frequently. Thus, according to metacognitive theory, there is a difference between person's metacognitive knowledge (understood as the vision of own thinking process) and the strategies being factors of metacognitive activity. This activity tend to increase. That is why the students with high progress can change the ways of information processing from peculiar focus (result) to metacognitive one; this fact helps to develop their cognitive processes perception (Moritz and Woodward, 2007).

The students of "Conditionally average progress" group show the lowest level of the implicit theory acceptance index expression. This fact characterizes these students as those who find it difficult to assess their learning efforts; have weak achieving motivation, insufficiently developed educational and cognitive motives and motives of creative self-actualization. Arguably, they do not work enough on themselves and on changing their personal characteristics. They differ from the other groups of students by lower potential success self-assessment index and subjective assessment of their abilities; i.e. they underestimate their capabilities because their abilities metacognitive awareness is poorly formed.

The results of the research let us conclude that the students of all three groups are situationally (inconsistently) oriented on the "Enriched" personality implicit theory acceptance". They find it difficult to assess their learning efforts; do not work enough on themselves and on changing their "enriched" personality characteristics. The motives of creative self-actualization are underdeveloped in all three groups; but the level of this development differs (1st group – 5.35; 2nd group – 2.18, 3rd group – 1.94). There is an interesting tendency if speaking about the "Stackable" intelligence theory acceptance": the students of all three groups are highly oriented on studying and getting professional skills (1st group – 9.38; 2nd group – 7.38, 3rd group – 8.2). The students are not afraid of challenges and consider difficulties as conditions of further intellectual growth. There is some ambivalence: on the one hand, students do not work enough on themselves and their personal qualities, they do not believe that there are no limits for personal development; on the other hand, they believe in intellectual development and the intelligence "growth" during the process of studying. This conclusion aligns with modern studies of mental abilities and their non-linear connection with academic and life success (Kholodnaya and Sipovskaya, 2023; Ushakov, 2011).

One more tendency was found out during the study: the lower the level of academic success index is, the higher the index of the success exteriorization is. Such external characteristics of success as high financial level of life and high social status (honours, power, etc.) become much more important for students. The result is specific because the students participated in the research are the future IT-specialists; they are interested in being employed as early as it is possible (most of them get jobs while being the first- or second-year students of Universities). The quality of their educational activity runs low and educational self-esteem decreases (the average point rating also reduces); but their financial well-being (helping to focus on success internal attributes) increases.

The lack of significant differences of such characteristics as "Self" assessment", "Self" activity", "Metacognitive knowledge" and "Metacognitive activity" indicates the fact that despite the differences between success and progress mental representations, the students of all groups have almost the same educational experience and level of knowledge; act almost identically in social and educational spheres. The students of all groups tend to value their current success at a quite low rate (5 points out of 10) regardless of their academic success. This is an indirect sign of the fact that modern young people (including future IT-specialists) do not consider getting education at the higher professional education establishment and average mark as being the bases of success (successful studying and professional success do not correlate with each other in their opinions). Nevertheless, the average assessment of perfect success in all groups equals 9 points (of 10), while potential success assessment (taking into account all the abilities) is at the rate of 8 points (out of 10); i.e. almost all young people are skeptic about their abilities and future achievements.

Thus, this research identifies the impact of mental representations characteristics on the students' academic success. This fact confirms the hypothesis of the study. Furthermore, the content of mental representations has rather a complex and ambiguous impact on students' academic success, which is more characteristic of students with low academic progress level. The phenomenon, when some separate indices of mental representations ("Enriched" personality and intelligence theory acceptance, "The aims of education acceptance" and "Belief in personal potential success acceptance) are highly-developed but the quality of education is low and students find it difficult to use their resources, is called an inversion effect. This effect reflects a multidimensionality of mental representations impact on academic success. As a result, it is necessary to carry out an additional research (factor analysis in particular) to study variability of mental representations as academic success predictors.

Conclusions

This research shows that studying mental representations (being success predictors) as well as their impact on the students' academic success is topical nowadays. Three groups of students were defined in a process of diagnostic results clustering: "High progress: current and potential", "Conditionally average progress" and "Average progress".

The students with low academic progress accept more personal and intelligence implicit theories and have low education self-assessment. This fact shows discrepancy between implicit character of personal efforts assessment and current metacognitive resource. Therefore, those mental representations characteristics, which are formed and developed better, have a minimal impact on academic success in accordance with the regression model. Low level of academic progress becomes the measure of mental representations characteristics splitting in this group. Mental representations indices, connected with low academic progress, are expressed on low, average and high levels.

A full picture of educational indices (high, average, satisfactory and unsatisfactory) splitting is found in a group of students with "conditionally average progress". The "Self" power" index is maximally expressed here and its impact becomes one of the peculiarities of the indices splitting. The students of this group are supposed to be more self-confident and tenacious (they choose this variable more often than the students in other groups do) because they have to be more impregnable during an educational process and to put up a good show in conditions of average cognitive abilities. The index of "Enriched" personality theory acceptance is poorly expressed in this group. Therefore, these students find it difficult to assess their own abilities and to change their personal characteristics while studying. Their achievement motivation and self-improvement are underdeveloped.

The students of "High progress: current and potential" group are characterized by having high mental representations characteristics indices; nevertheless, academic progress quantitative indices are splitting and dividing into opposite sub-fields. One of the basic predictors in this group is internal structures forming by the way of auditory material retention, life experience gaining and general development of a person. The effect of metacognitive theory may be observed here; i.e. the better the metacognitive strategies comparing to metacognitive knowledge are formed, the better the conditions for cognitive processes, new knowledge developing, own academic and general success recognizing are.

Mental representations impact on the students' academic success was indicated in general. This impact is multidimensional, ambiguous and worth further studying. It may help to create highly effective psychological technologies for mental representations of general and academic success development.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, I. A. K., T. V. E.; Investigation, I. A. K., T. V. E.; Data curation, I. A. K.; Methodology, I. A. K.; Writing – original draft, T. V. E.; Writing – review & editing, T. V. E.. All authors have read and agreed to the published version of the manuscript.

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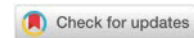
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Personal Predictors of Online Teaching - Experiences of The Teachers in Serbia in The Covid Regime

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Abstract: The pandemic of the COVID-19 virus initiated a rapid organizational transformation of teaching at all levels of education and its implementation in a virtual environment. In this context, teachers' perceptions of the predictors of online teaching largely determined the quality of its current implementation, but also the character of its further application in the future. Using the survey method, research was carried out with the aim of examining the attitudes of teachers in Serbia about personal predictors of online teaching and their determinants, in the past two school years. Personal predictors of online teaching are operationalized through the cognitive and affective competence of the teachers, as well as through organizational and technical support. Six hundred and seven teachers, who teach in the first three cycles of education, from all districts of the Republic of Serbia, participated in the research. Regarding all personal predictors considered, teachers evaluate cognitive competence as the most important predictor of the implementation of online teaching, then affective competence and finally, organizational and technical support. As the results of the research suggest, a significant influence of the dominant online experience, of the applied online platform, work experience and educational cycle on teachers' perceptions of affective competence as a predictor of online teaching were determined, while the perceptions of organizational and technical support were significantly influenced by the place where the school was located and the applied online platforms. The obtained results may have implications for pedagogical practice and professional development of teachers in terms of consideration and awareness of the role of various personal predictors required for the successful use of modern educational technology.

Keywords: online teaching, Covid-19; cognitive competence, affective competence, organizational and technical support.

Introduction

The pandemic of the COVID-19 virus initiated a rapid organizational transformation of the usual teaching and its implementation in a virtual environment. The forced closure of schools confronted teachers, students and parents with a completely new situation (Huber and Helm, 2020), which required an immediate transition to learning at home. The success and efficiency of external-factors-forced online teaching, largely depended on the technical and technological conditions of the school, the ICT and IPK competencies of teachers, the availability of ICT tools, and the possibility of teacher training in the domain of digital competencies. In most cases, the problem of lack of appropriate technical and pedagogical skills of teachers, key to the integration of teaching in a digital online environment, was identified (Schleicher, 2020). Hence, a need arose to review the roles of teachers and students, by observing the potential of the technological environment for online learning and teaching, both on the scientific- professional and on the application plan (Tsai et al., 2013).

Although digitization as a key issue of modern school was in the scientific and professional focus even before the pandemic of the COVID-19 virus, the transformation of ICT technologies was a surprise (did not live up to expectations) even in some developed countries, such as France and Italy (Frailon et al., 2019; GEW, 2020). Hence, there was a need to examine competence predictors of online teaching, both in the developed and in the less developed countries of the world.

Generic models of teacher competencies can be viewed through a cognitive and affective motivational context (Blömeke, 2017). When it comes to the cognitive context, starting from Shulman's

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classification of teacher knowledge (Shulman, 1987), today we distinguish teachers' content knowledge (CK), pedagogical content knowledge (PCK) and general pedagogical knowledge (GPK) (Guerriero, 2017). However, a TPACK-model based on the intersections of their combinations was also developed (Mishra and Koehler, 2006). For example, the intersection of TK with CK and GPK results in technological pedagogical knowledge (TPK), which implies knowledge about technologies for the application in teaching practice, which are not related to a specific subject. So, it is about the general ability to apply technology in different situations of teaching and learning. Technological-pedagogical content knowledge or TPACK arises as a total cross-section of all categories of teacher knowledge (CK, GPK, TK and PCK). Starting from this corpus of professional knowledge, skills and abilities, the teacher can respond to today's challenges, including those caused by the COVID-19 virus. The experiences of teachers in this regard have been the subject of numerous research in the world in the past two years.

A particularly interesting research was conducted in Germany based on a survey of young primary and secondary school teachers of various profiles. The researchers (König, Jäger-Biela and Glutsch, 2020) chose a population of teachers with initial work experience, students who had just graduated - the generation of "digital natives" (Prensky, 2001) considering them relatively competent in using online teaching applications. One part of the research was related to the examination of the contribution of potential factors such as school computer technology, teacher competences in terms of technological-pedagogical knowledge, as well as learning opportunities for teacher education related to digital teaching and learning to the effectiveness of online learning. The information and communication technology (ICT) tools, especially digital competences of teachers, as well as the opportunities for teacher education for learning in the domain of digital competences, shown to be of critical importance for the adaptation of regular teaching in an online environment during school closures due to COVID-19.

Especially valuable is the research related to the pedagogical competences of teachers in the online environment. It has shown how important the creative synthesis of the online technology and pedagogical teaching technology is: without their good integration we cannot talk about the effectiveness of the teaching process. Even before the emergence of the COVID-19 virus pandemic, the necessity of integrating pedagogical principles of teaching and learning and the ICT environment was pointed out (Baker et. al, 2018). In this context, the findings of a German study show that the educators of initial education (teachers) in most cases indicate the importance of topics oriented to information and research, followed by "operation and application", "production and presentation", while "problem solving and modeling" based on the use of the algorithm, were at the bottom of the list of choices (Jäger-Biela, Kaspar and König, 2020). This raises the question of their competence.

In the domain of the affective-motivational area, an important predictor of effective online teaching is teachers' self-confidence, which has been shown to be one of the most important constructs of teachers' competence (Lauermann and König, 2016). Their readiness and perseverance in facing professional challenges also depends on the degree of self-confidence and trust in their own abilities. Teachers' self-efficacy is a decisive factor in the adaptation of teachers to the new situation caused by the virus (König, Jäger-Biela and Glutsch, 2020). A self-determined teacher strives for competence, for autonomy (which is a consequence of internal motivation) expressed by the need to build emotional relationships with all actors of the educational process (Tan and Hsu, 2017). The similar thing appears in the findings related to students' learning in the online context, where the importance of self-regulation, motivation and positive dispositions of students for learning is particularly emphasized (Chiu and Hev, 2018). However, when it comes to motivation, there remains a wide field of unexplored possibilities of applying various motivational theories such as self-determination theory (SDT) (Rian and Deci, 2020), expectancy-value theory (Wigfield and Eccles, 2000), achievement goal theory (Senko, Hulleman and Harackiewicz, 2011) and control-value theory (Pekrun et al., 2017) in the field of online education, teaching and learning. The situation caused by the COVID-19 virus significantly contributes to the affirmation of research in this area. For example, a Taiwanese study, based on the application of three theories of motivation, aimed at examining students (before and after the pandemic) in relation to self-regulated learning, showed that the pandemic affected how students valued personal relevance and future expected feedback of online learning adoption; it has been shown that the gap between ideal and actual motivation must be overcome before implementing online learning. However, a research conducted in China, surveying 527 students of the OAS University of Teacher Education, showed that teachers could encourage self-regulated online learning by building a learning community and by designing collaborative learning activities (according to Chiu, Lin, and Lonka, 2021). Also, the nature of incentives, the convenience of learning, the quality of service, usefulness, the ease of use, teacher's attitude towards teaching, application of technology, usage habits, etc., proved to be relevant motivational factors (according to Chiu, Lin, and Lonka, 2021). The association of motivational profiles with online learners' self-regulation, and with affective learning

outcomes, was in the focus of an American study involving 556 online teachers. It was shown that in students with a high profile of motivation, self-regulation between students and content, and between students and teachers, was closely related to their affective learning outcomes, while self-regulation between students and teachers was in correlation with affective learning outcomes only in students with an average and low profile motivation (Cho, Cheon and Lim, 2021).

The experiences of Indonesian primary school teachers during the COVID-19 pandemic have shown that teacher support and motivation are indispensable topics of modern online teaching. In this sense, the establishment of online cooperation between the key bearers of the educational process (teachers, parents, school) is of particular importance for student achievement (Rachmadtullah et al., 2020).

How motivation and stress are closely related is also illustrated by an Italian study based on a survey of 688 teachers of all cycles of education, which showed that the influence of educational technologies negatively correlates with stress and motivation (Toto and Limone, 2021). That was the reason to additionally deal with the subject of teacher stress, as one of the key predictors of the quality of online teaching.

The fact that teaching is at the top of the list of the most stressful professions (Johnson et al., 2005), unfortunately is not denied even in the conditions of the COVID regime. On the contrary, the list of stressors has been significantly expanded. Common stressors, even before the pandemic included: pressure caused by heavy workload, time constraints, unbalanced integration of work and private life, limited autonomy, excessive administrative duties, complicated and strained relationships with colleagues and school management, role conflict/ambiguity, innovation management and changes, emotional exhaustion, fear of losing control over the class, fear of evaluation and low professional self-esteem (Mercer and Gregersen, 2020). That teaching in an online environment did not contribute to the improvement of the situation was supported by numerous contemporary observations. An international online survey of 600 language teachers found that the teachers reported significant level of stress. Positive psychological outcomes (well-being, health, happiness, resilience and professional improvement during trauma) were positively correlated with coping and negatively correlated with avoiding coping. A link was established between confrontational avoidance with negative outcomes (stress, sadness, anger, loneliness). As stress increases, confrontational avoidance also increases, although a confronting approach was used in stress groups (MacIntyre, Gregersen and Mercer, 2020). After the pandemic, the teachers in India also report stress as a result of online teaching, (13% high degree and 66% moderate degree), emotional exhaustion (11% high degree and 25% moderate degree) and a moderate level of depersonalization. Interestingly, almost all surveyed teachers or 99% of them, report a high level of personal achievement (Kumawat, 2020). Surveying online language teachers of various colleges based in the USA, from the aspect of the perceptual value of online language teaching, there were findings indicating that, in terms of adoption, teachers evaluate online teaching positively after the pandemic, although many prefer the hybrid model (Jin, Deifell and Angus, 2021). A group of scientists from Italy surveyed 107 teachers from Lombardy (an area that was among the first in Europe to be particularly affected by COVID-19), with the aim of examining the experience of teachers in online teaching, especially regarding the level of risk factors, protective factors and their impact on satisfaction levels during social distancing caused by the pandemic. It has been shown that stress and depression are the main predictors of the level of satisfaction with online teaching; that facing with, locus of control and self-efficacy are also relevant research factors. In that sense, the authors suggest the necessity of educational support and crisis-psychologically oriented services and assistance with the aim of maintaining psychological well-being (Truzoli, Pirola and Conte, 2021). The importance of the mediating role in terms of professional support in relation to stressors and the resistance mechanism, was also confirmed by a Romanian study based on a survey of 400 Romanian teachers (Obrad, 2020). In case of the absence of professional support and the absence of strengthening the teachers' capacity, their work engagement and performance, and thus the sustainability of the education system as a whole, can be questioned.

Materials and Methods

The changed conditions of life and work in Serbia, caused by the pandemic of the COVID 19 virus, required the Ministry of Education, Science and Technological Development to come up with an operational plan for continuing the work of schools in difficult conditions. To that end, on March 15, 2020, the Government of the Republic of Serbia, in accordance with the Decision on Proclamation of the State of Emergency ("Official Gazette of the RS", No. 29/2020, dated March 15, 2020) and the Decree on Measures During the State of Emergency ("Official Gazette of the RS", No. 31/2020, dated 16/03/2020),

passed the Decision on the Suspension of Teaching in Higher Education Institutions, Secondary and Primary Schools and the Regular Work of Preschool Education Institutions (“[Official Gazette of the RS](#)”, No. 30/2020 of March 15, 2020). In accordance with the adopted Decisions, the educational and direct teaching work was temporarily suspended in all primary, secondary and higher education institutions, and in order to ensure their realization in the new, changed conditions, remote television teaching was designed and implemented. In cooperation with Radio Television of Serbia, recording and broadcasting of educational content for distance learning was organized through channels RTS 2, RTS 3 and the RTS Planet platform. The broadcasting of educational programs began on March 17, 2020, only two days after the declaration of the state of emergency in Serbia.

However, it soon became clear that it was necessary to do an internal systemic institutional implementation of online teaching at all levels of education. In addition to the health situation in the country, region, and municipality where the school was located, the nature and the extent of implementation was also determined by the education cycle. In such chaotic circumstances, often without prior training and preparation, education hastily moved on to different types of internal organization of online classes, which, with the loosening of the measures, would be further realized most often in combination with direct classes. These circumstances, precisely, encouraged us to base the research subject on the examination of personal professional predictors of successful online teaching.

The goal and tasks of the research. The perception of predictors of online teaching largely determines the quality of the actual implementation, and also the character of its operationalization in perspective. With the expectation that the teacher must be open to changes in the educational paradigm, including the goals, forms, contents and methods of teaching and learning ([Villegas-Reimers, 2003](#)), we, at the same time, try to find the answers to the question of how teachers manage in the new situation, which is often conditioned by the experience of one’s own competence on the cognitive, affective and conative level, but also by the organizational and technical support of the work environment. Therefore, the goal of the research is focused on examining teachers’ attitudes about personal predictors of online teaching. The perception of predictors of online teaching of teachers with different “COVID” professional experience, achieved in the past two school years in the Republic of Serbia, was examined. The goal of the research was operationalized through four scientific research tasks related to the examination: a) the perception of teachers’ cognitive competence; b) teachers’ affective competences; c) organizational and technical support essential for the effective implementation of the online teaching model established in the COVID regime of the organization of educational work; d) the influence of independent variables on the final results of the research.

Sample of the research. The research sample consists of 607 teachers from the Republic of Serbia who teach in the first three cycles of education. The quantitative case study approach was applied, with practical sampling. In order to be more representative, respondents from all districts of the Republic of Serbia were included, i.e. rural, urban and suburban schools, teachers of different ages, work experience, class teachers, but also teachers who teach in higher grades of primary school, secondary school teachers, users of different online platforms of different professional readiness (courses and training) and different organizational online experience (classical teaching, combined model, online teaching).

Table 1
Sample structure

| Independent variables | Modalities | f | % |
|--------------------------------|--|-----|------|
| School/ Educational cycle | Lower classes of primary school | 204 | 33.8 |
| | Higher classes of primary school | 250 | 41.4 |
| | Secondary school | 150 | 24.8 |
| School/ locality | Rural | 154 | 25.5 |
| | Suburban | 76 | 12.6 |
| | Urban | 374 | 61.9 |
| Age | up to 30 years. | 21 | 3.5 |
| | from 31 to 40 | 134 | 22.2 |
| | from 41 to 50 | 256 | 42.4 |
| | over 50 | 193 | 32 |
| Work experience | up to 5 years. | 48 | 7.9 |
| | from 6 to 10 | 69 | 11.4 |
| | from 11 to 20 | 213 | 35.3 |
| | from 21 to 30 | 181 | 30 |
| | over 30 years. | 93 | 15.4 |
| Online platform | Google classrooms | 411 | 68 |
| | Teams Microsoft | 70 | 11.6 |
| | Moodle | 7 | 1.2 |
| | Social networks | 82 | 13.6 |
| | Other | 34 | 5.7 |
| Online courses/ attendance | Yes | 466 | 77.1 |
| | No | 138 | 22.9 |
| Dominant COVID work experience | Classical teaching | 48 | 8 |
| | Classical teaching dominant | | |
| | Online at times | 149 | 24.7 |
| | Online teaching, at times in combination with classical teaching | | |
| | | 347 | 57.5 |
| | Online teaching | 71 | 11.8 |

Methods, techniques and instruments. A survey research method and two research techniques: survey and scaling were applied. The theoretical-empirical starting points of various studies, as well as the current situation in Serbia, were the basis for designing an online questionnaire, which, in addition to independent variables, considered topics related to teachers' experiences of personal predictors of online teaching, selected in three thematic units: 1) cognitive competencies of teachers; 2) teachers' affective competences 3) organizational and technical support (personal equipment and technical support of students and teachers). The research is an integral part of a more extensive research conducted in 2022 in the Republic of Serbia, which refers to the examination of teachers about the effectiveness of online teaching in the COVID regime.

Data processing and analysis. In order to identify the capabilities of the platforms and reveal the potential relationship between the different research variables the descriptive analysis and quantitative analysis of the responses were applied. The obtained data were analyzed using the IBM SPSS 24.0 software package by calculating the Chi square, the contingency coefficient, and expressing the results as a percentage. Statistical significance was tested at the level of $p < .01$, $p < .05$ and $p < .001$.

Results and Discussions

Teachers' views about cognitive predictors of online teaching in the COVID regime

When it comes to the cognitive competencies of teachers, it is interesting to note that slightly less than four fifths of the respondents or 77.2% report that they attended some of the online courses. However, a serious majority of respondents (95.9%) declare that they are familiar with forms of distance education and that almost all of them, or 99.2%, are familiar with the possibilities of online classes. The percentage of teachers who were somewhat more critical in their assessment of their own ICT competencies in this matter is almost negligible. The distribution of teachers' responses is somewhat different regarding the assessment of PCT competencies. The ability to implement and organize online classes is positively evaluated by nearly two fifths of teachers (32.3% take a mostly positive and 11.1% an extremely positive attitude). Slightly less than two fifths or 36.8% of teachers are undecided on this issue, while one fifth evaluates PCT competencies negatively (2.6% strongly and 17.2% mostly).

It is particularly interesting that, in regard of the assessment of personal achievement and competences related to the adoption of online teaching, we obtained findings almost identical to the findings of the research conducted in India (Kumawat, 2020), and also in the other parts of the world (Jin, Deifell, and Angus, 2021). which points to the fact that teachers perceive their own competence indirectly through additional engagement and dedication to work and work duties. It is possible to interpret the results in the following way - teachers adopted what was expected of them by making maximum efforts in accordance with the sudden COVID situation. However, it is also evident that they are aware of the fact that the use of ICT technology a priori does not guarantee effective online teaching, and that PCT competencies play an important role, especially in the comparative situation of the effectiveness of the teaching process: online - classically organized teaching. The obtained findings of our diagnostic study can be the starting point for further comprehensive research of all the competencies of the TRCK model, and especially the PCT competencies of teachers of all three cycles of education.

Teachers' views on affective predictors of online teaching in the COVID regime

Based on the specific conditions in which online teaching was implemented in the past period, the data on teachers' affective competences were obtained by looking at the self-assessment of motivation, stress and satisfaction - readiness to implement online teaching even after the end of the COVID-19 virus pandemic.

The complexity of motivation of both students and teachers is further deepened in specific circumstances, i.e. when the situation changes for any reason, which results in completely different conditions for work and learning, the way in which the intended teaching content is presented to students and completely changed mutual relationships of the actors of the educational process (Brophy, 2015; Mercer and Gregersen, 2020). It is obvious that the new circumstances also affected the final results of the research in the domain of this research task.

Slightly less than half of the surveyed teachers or 46.5% were not motivated to actively participate in the organization of online classes even after the end of the pandemic (19.1% strongly and 27.4% mostly); one third did not express themselves on this issue (33.2%), while one fifth or 20.3% showed more enthusiasm on this issue.

Statistical significance was also observed showing that there were differences in the answers of teachers with different online experience in the past period in terms of motivation for the implementation of online teaching. It is interesting that teachers who occasionally and sporadically implemented online teaching during the pandemic were the least motivated for its implementation, followed by the teachers who exclusively realised teaching in classic, usual conditions (Table 2).

Table 2
Motivation of teachers for the implementation of online teaching of different online experiences

| Online experience | Negative attitude | | Undecided attitude | | Positive attitude | | Total |
|---------------------|-------------------|-------|--------------------|-------|-------------------|-------|-------|
| | f | % | f | % | f | % | f |
| Most part | 42 | 28.5 | 15 | 21.13 | 14 | 19.72 | 71 |
| Occasionally | 236 | 68.4 | 53 | 15.36 | 56 | 16.24 | 345 |
| At times | 90 | 62.93 | 27 | 18.88 | 26 | 18.19 | 143 |
| Without application | 26 | 54.16 | 10 | 20.83 | 12 | 25 | 48 |
| Total: | 394 | 64.91 | 105 | 17.3 | 108 | 17.79 | 607 |

$$\chi^2 = 22.435; df = 12; p = .033$$

The reasons for such attitudes can be found in the fact that teachers with occasional and sporadic online experience were the most burdened with professional obligations, given that they implemented a mostly combined teaching model.

And the independent variable – the applied online platforms, had an impact on this segment of the research. Teachers who use the Moodle platform (which is the most suitable for online teaching and learning) show the greatest motivation for using online teaching, followed by Teams and Google Classroom users (Table 3).

Table 3
Teachers' motivation for the implementation of online teaching / implemented online platforms

| Online platforms | Negative attitude | | Undecided attitude | | Positive attitude | | Total |
|------------------|-------------------|-------|--------------------|-------|-------------------|-------|-------|
| | f | % | f | % | f | % | f |
| Google | 68 | 16.47 | 62 | 15.01 | 283 | 68.52 | 413 |
| Teams | 13 | 18.31 | 15 | 21.13 | 43 | 60.56 | 71 |
| Social networks | 11 | 13.93 | 22 | 27.85 | 46 | 58.22 | 79 |
| Moodle | 0 | 0 | 2 | 28.57 | 5 | 71.43 | 7 |
| TV platform | 7 | 26.93 | 5 | 19.23 | 14 | 53.85 | 26 |
| Other | 8 | 72.72 | 1 | 9.09 | 2 | 18.18 | 11 |
| Total: | 107 | 17.62 | 107 | 17.63 | 393 | 64.74 | 607 |

Users of social networks and television programs are the least motivated. There were also those who did not use any platform and they took a dominantly negative attitude on this issue ($\chi^2 = 56.317$; $df = 24$, $p = .000$). We are talking about teachers employed in rural areas whose work has a primarily individual character. Similar parameters were obtained when it comes to assessing students' motivation for active participation in online classes. Namely, the calculated Chi-square ($\chi^2 = 26.538$; $df = 16$, $p < .05$) clearly indicates that the difference in the frequency of responses is statistically significant between teachers with different lengths of work experience (Table 4).

Table 4
The views of teachers with different work experience on students' motivation for active participation in online classes

| Work experience | Negative attitude | | Neutral attitude | | Positive attitude | | Total |
|-----------------|-------------------|-------|------------------|-------|-------------------|------|-------|
| | f | % | f | % | f | % | f |
| Up to 5 year | 19 | 3.13 | 11 | 1.81 | 16 | 2.63 | 46 |
| From 6 to 10 | 29 | 4.78 | 18 | 2.96 | 20 | 3.29 | 67 |
| From 11 to 20 | 106 | 17.46 | 78 | 12.85 | 32 | 5.27 | 216 |
| From 21 to 30 | 88 | 14.49 | 66 | 10.87 | 28 | 4.61 | 182 |
| Over 30 | 41 | 6.75 | 28 | 4.61 | 28 | 4.61 | 97 |
| Total: | 283 | 46.62 | 212 | 34.92 | 139 | 22.9 | 607 |

The obtained findings can be interpreted in the context of the teacher's perception of student motivation in the distance teaching education system. Namely, more than two-thirds of teachers or 68.3% assess that students in the online teaching system are not motivated to actively participate in educational work (29.7% significantly and 38.3% mostly), one fifth of teachers or 20.5 % did not define their views, and only a tenth of the respondents or 11.2% positively evaluated the engagement of their students. Also, the assessment of slightly less than half of the teachers or 49.1% (24.8% strongly and 24.3% mainly) is that online teaching did not motivate students to further research and to acquire new knowledge (one third are undecided or 30.4%); one fifth does not agree with the stated statement - 20.5%). The most critical in the assessment are teachers who have 11 to 20 years of work experience, followed by teachers with experience ranging from 21 to 30 years.

The perception of students' stress, caused by the obligations imposed by the organization of online classes, is conditioned by the cycle of education in which teachers implement classes. Everyone generally agrees that online teaching is very stressful for students. Nevertheless, the Chi-square parameters indicate a high statistical significance in terms of the determined difference in the responses of teachers (lower primary school age), teachers of upper grades of primary school and secondary school teachers (Table 5). The obtained Chi-square ($\chi^2 = 21.124$; $df = 6$; $p = .002$) shows that lower primary school teachers more than other respondents predict stress as a negative predictor of the implementation of online classes (51.20%), followed by teachers of upper grades of primary school (43.2%), and finally secondary school teachers (30%).

Table 5
Teachers' views on online teaching as a predictor of student stress

| School age | No | | Yes | | Undecided | | Total |
|---------------------------------|-----|-------|-----|-------|-----------|-------|-------|
| | f | % | f | % | f | % | |
| Lower classes of primary school | 41 | 19.80 | 106 | 51.20 | 60 | 28.98 | 207 |
| Upper classes of primary school | 41 | 19.80 | 108 | 43.2 | 101 | 40.4 | 250 |
| Secondary school | 37 | 24.66 | 45 | 30 | 68 | 45.33 | 150 |
| Total | 119 | 19.60 | 259 | 42.67 | 229 | 37.73 | 607 |

It is certain that the teacher's perception of student motivation defines attitudes about their own motivation to work in an online environment. Other researchers also observe teachers' dissatisfaction caused by insufficient student interaction (Nambair, 2020) as well as by lack of motivation to cooperate (Nikolić and Milivojević, 2020).

Teachers' stress caused by a different organization of the teaching process produced by the COVID-19 virus pandemic, proved to be an important competence predictor. Only 6.8% of teachers do not report stress as a relevant factor, while slightly under three fifths or 73.1% perceive the organization of online teaching as stressful.

Almost identical results were obtained in the aforementioned study conducted in India (Kumawat, 2020). It is evident that the majority of teachers find it difficult to bear the significant increase in the scope of professional obligations reported by as many as 93.8% of the surveyed teachers. It is no coincidence that the same percentage of teachers report being under stress and strongly agree with the statement related to the increase in professional obligations (73.1%), and that there is an almost identical percentage of respondents who were undecided about stress, and who also mostly report increasing of their professional obligations. These findings are also in agreement with foreign studies (Mercer and Gregersen, 2020). Our research also confirmed that motivation and stress are closely related, and that in this context, the influence of educational technologies is not affirmative (Toto and Limone, 2021).

Considering that stress is one of the key predictors of the level of satisfaction with online teaching (Truzoli, Pirola and Conte, 2021), it is clear that the personal experience of online teaching is crucial for teachers' commitment to its implementation in the future. When it comes to teachers' assessment of the implementation of online teaching in perspective, it is interesting that about half of the teachers show their willingness to organize online teaching even after the end of the measures. A little over one third or 36.75% do not show interest, while 11.3% are undecided on this issue. However, only 20.53% of teachers showed readiness to self-initiatively organize online classes, slightly more are undecided (27.81%), while half of the teachers (51.66%) clearly show that after the end of the COVID measures,

they will apply only classical classes. Although at first glance the findings seem contradictory, it is possible that their attitude towards the inclusion of online classes is conditioned by external factors (if the school management, parents, children... require it). The perspective of distance learning is completely certain and the respondents are fully aware of this fact, but with the view that in extraordinary circumstances online teaching can be an alternative to regular teaching, while in real circumstances it can only serve as an aid in regular teaching (Nikolić and Milojević 2020; Sutiah et al., 2020; Terenko and Ogjenko 2020).

Teachers' views on organizational-technological predictors of online teaching in the COVID regime

Personal equipment and technical equipment are an important predictor of effective online teaching. We were interested in the personal, material and technical conditions of online work of teachers and students at home. Slightly less than half of teachers (48.3%) report that they do not have the appropriate equipment for work, slightly less than one third or 29.9% did not say anything about this issue and approximately as many (31.8%) positively evaluate this type of online teaching support.

According to the assessment of city school teachers, two fifths of students (37.6%) have appropriate equipment for online teaching, while the attitude of their colleagues working in suburban and rural schools is somewhat different: about one fifth of students (26.1%) have appropriate equipment.

The non-uniformity of teacher's responses is visible through the indicators of statistical significance of the Chi-square, where high significance is identified at the 0.01 level. The Chi square value ($\chi^2 = 25.995$; $df = 8$; $p = .001$) clearly indicates the existence of statistically significant differences in the answers of teachers employed in rural and urban areas (Table 6). On the whole, which was to be expected, teachers employed in city schools are more satisfied with the material and technical conditions of the school; followed by those employed in suburban areas.

Table 6

Teachers' views on the material and technical conditions of students for active participation in online classes

| School location | Negative attitude | | Undecided attitude | | Positive attitude | | Total |
|-----------------|-------------------|-------|--------------------|-------|-------------------|-------|-------|
| | f | % | f | % | f | % | |
| Rural | 78 | 50.32 | 47 | 30.32 | 30 | 19.36 | 155 |
| Suburban | 37 | 45.12 | 26 | 31.71 | 19 | 23.17 | 82 |
| Urban | 115 | 31.08 | 146 | 39.46 | 109 | 29.46 | 370 |
| Total: | 230 | 37.89 | 219 | 36.08 | 160 | 26.36 | 607 |

We should have in mind the fact that internet signal coverage is not the same in every geographical area, which certainly had an impact on the satisfaction with school equipment for those employed in rural areas. Differentiation of answers also appeared in terms of the material and technical personal equipment of the students, considering the place where the school is located. It was to be expected that the teachers of rural schools rated the material and technical equipment of students for the realization of online classes the worst (50.32%), followed by teachers of suburban schools (45.12%), while the teachers employed in city schools rated somewhat more favourably this significant predictor of effectiveness of online teaching. The findings indicate the necessity of improving the material and technical equipment of school institutions in order to equalize the efficiency and effectiveness of educational systems, regardless of the place where the school is located and the type of school (OECD, 2016, 12).

It was also shown that the teachers who taught mainly through television transmission (RTS2, RTS3, RTS Planeta) rated the material and technical equipment of the students the best, which was to be expected (Table 7). The most skeptical in this regard were teachers whose students worked on the Moodle platform ($\chi^2 = 45,851$, $df = 24$, $p = .005$).

Table 7
Teachers' views on material and technical equipment of students / applied online platforms

| Applied online platforms | I do not agree | | Undecided | | I agree | | Total |
|--------------------------|----------------|-------|-----------|-------|---------|-------|-------|
| | f | % | f | % | f | % | |
| Google | 149 | 36.17 | 165 | 40.05 | 98 | 23.79 | 412 |
| Teams | 26 | 35.62 | 19 | 26.03 | 28 | 38.39 | 73 |
| Social networks | 40 | 59.64 | 23 | 29.11 | 16 | 20.25 | 79 |
| Moodle | 2 | 25 | 3 | 37.5 | 3 | 37.5 | 8 |
| TV platform | 9 | 37,5 | 4 | 16,66 | 11 | 45,83 | 24 |
| Other | 5 | 45,45 | 4 | 36,36 | 2 | 18,18 | 11 |
| Total: | 231 | 37,73 | 218 | 35,91 | 158 | 26,03 | 607 |

Given that the technical equipment of key actors is a basic assumption of the effectiveness of online teaching, the obtained findings cannot be considered affirmative. However, it should be kept in mind that the sample of teachers surveyed, is stratified in terms of the implementation of teaching in the first three cycles of education, as well as the experiences related to the application of the hybrid and complete online teaching model. The students of the first cycle were involved in the virtual teaching system for the shortest period of time and compared to others, they used complex platforms for distance learning the least, so it was not even expected that they would have appropriate ICT support. On the other hand, the devastating fact that teachers do not have adequate equipment for work can be partially explained by the fact that a number of teachers used the available material and technical resources of the school.

Conclusions

The general and personal readiness of the key actors of the educational process immediately before the pandemic of the COVID-19 virus largely determined the character and success of online teaching (Bozkurt et al., 2020). Competence predictors of online teaching influenced the speed and degree of adaptation of teachers to external factors caused by the situation. Nevertheless, in addition to different previous experiences, the findings of our research are in agreement with similar foreign studies, which leads to the conclusion that teachers around the world faced similar challenges during the COVID-19 pandemic.

It has been shown that during the virus pandemic, teachers mostly completed some of the online training courses at a distance, that they rate their own knowledge of the forms of distance training very highly, as well as the possibilities of online teaching (the results should be taken with a grain of salt due to potential subjective introspective evaluation). Almost half of the teachers declare that they are not motivated for active participation in online classes, two-thirds rate the students as unmotivated, and one half of the teachers believe that the students are not motivated for additional activities and research. Teachers generally perceive the organization of online classes as stressful, and almost all of them are unanimous in their assessment of the increase in their own professional obligations. The willingness to organize online classes even after the end of the measures (if necessary) was expressed only by about half of the respondents, while a fifth of the teachers opted for self-initiative organization. When it comes to material and technical equipment, it turned out that neither teachers nor students have adequate personal resources.

The general conclusion is that there is a need to encourage the development of teachers' competencies in teaching, especially with regard to the acquisition of PCK competencies, that continuous systemic support and incentives for teachers to create a comfortable environment for efficient work are necessary, that it is necessary to reduce the scope of unnecessary professional obligations of teachers, especially to look at stressors and workload of teachers who work according to the hybrid model, to indicate the role and importance of personal material and technical support for modern teaching. The general statement mentioned, is in accordance with the [Action Plan on Digital Education of the European Commission \(2018, 5-6\)](#), which insists on: 1. better utilisation of digital technology for learning and

teaching, 2. development of digital competencies and skills needed for life and work in the age of digital transformation and 3. providing support to schools in the form of broadband networks and the use of a new tool for self-assessment of the use of technology for teaching and learning (SELFIE).

Personal experience of competences, digital training and material and technical prerequisites are essential assumption for the professional development of teachers. In this context, awareness of the potential risk factors related to the use of modern educational technology is of particular importance for assessing the current situation, and providing systemic support during work with the aim of improving the final performance of teachers in the future. Accordingly, it is necessary to build models of prevention and intervention, which will consequently affect the achievement of students, and thus result in the general satisfaction of all participants in the educational process (Sprenger and Schwaninger, 2021).

Given the fact that our research is an integral part of a larger study that examines the effectiveness of online teaching in the Republic of Serbia in the COVID regime, we were limited in terms of a more comprehensive overview of the indicated research problem. Namely, the obtained research results stimulated our research curiosity and, accordingly, future research should be focused on a more detailed understanding of the role and importance of individual competence personal predictors which are the keys to the successful implementation of online teaching (qualitative longitudinal research based on open-ended questions; experimental development of system support instruments for their improvement, both in the organizational conditions of hybrid and online classes). The connection between personal predictors and modern teaching should be observed in different organizational contexts, which should not be opposed to each other, whereby classically organized teaching remains an irreplaceable organizational form in terms of humanizing relationships and socializing students (König, Wagner and Valtin, 2011).

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

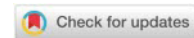
Conceptualization, D. N. V., Ž. P. B, M. Ž. S. and D. M. S.; Data curation D. N. V., Ž. P. B, M. Ž. S. and D. M. S.; Methodology, D. N. V., Ž. P. B, and D. M. S., Formal analysis, D. N. V., Ž. P. B, and D. M. S.; Project administration, D. N. V. and Ž. P. B.; writing—original draft preparation, D. N. V., Ž. P. B, M. Ž. S. and D. M. S.; writing—review and editing, D. N. V., Ž. P. B, M. Ž. S. and D. M. S. All authors have read and agreed to the published version of the manuscript.

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The Effects and Effectiveness of An Adaptive E-Learning System on The Learning Process and Performance of Students

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Abstract: Students acquire learning material in different ways. Some prefer to read, some prefer to listen, others use the third type of sense. Traditional teaching uses only one of these teaching strategies since it is impossible to use all of them in the classroom. However, these days, adaptive e-learning systems enable learning material to be customized to the individual needs of learners. For the purpose of this paper, the researchers designed a model of the adaptive learning management system and implemented it in Moodle. The system was evaluated on 228 students. The incorporation of learning styles in Moodle is based on the VAK learning style model. The authors analysed the effects and effectiveness of an adaptive e-learning system. It was discovered that there are significant differences in learning effectiveness, satisfaction and motivation when students use an adaptive e-learning module in comparison to a standard e-learning module. Moreover, we investigated the durability of knowledge acquired with an adaptive e-learning system by comparing the performance of students not only after the completion of the course but also a month after the course. The results of the research confirmed the authors' expectations and showed that an adaptive e-learning system can increase students' learning results. So far, to our knowledge, no study has evaluated the performance between a control and experiment group a few months after the completion of the course, i.e. by analysing the durability of knowledge acquired through an adaptive e-learning system. Moreover, the motivation of students to continue using an adaptive e-learning system hasn't been analysed until now.

Keywords: adaptive learning system; e-learning; learning style; Moodle.

Introduction

Globalisation, new social trends, and cutting-edge technology have introduced changes in the labour market which have led to changes in the education system. New education concepts combined with cutting-edge technology put an emphasis on learners' autonomy and adaptation of education to learners' needs. The electronic learning systems have been tailored to enhance effective learning and material retention. Moreover, their objectives and content can be changed depending on the individual preferences of students (Cakir, Teker and Can Aybek, 2015).

Students acquire learning materials in different ways. Some of them prefer to read, some prefer to listen, others use the third type of sense (Tamura, Yamamuro and Okamoto, 2006). Traditional teaching tends to use only one of these three teaching strategies since it is impossible to use all of them in the classroom (Kanaksabee, Odit and Ramdoyal, 2011). Rukanuddin, Hafiz and Asfia (2016) pointed out that individual students' preferences influence their learning achievements and performance. Smith-Jentsch et al. (1996) and Ford and Chen (2000) have emphasized that we have to consider students' prior knowledge, experience, background, and learning styles to achieve high learning performance. Nowadays, adaptive e-learning systems enable learning material to be customized to the individual needs of learners.

A learning style is defined as the way a student responds to a teacher's stimulus (Zulfiani, Suwarna and Miranto, 2018). Over the last thirty years, more than seventy different learning style models and theories have been developed that emphasize that students prefer to learn in a different way (Coffield et al., 2004). Some of the most famous learning style models and frequently applied in adaptive e-learning

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systems include: the Fedler-Silverman Index of Learning Styles, the Honey and Munford Model, the Kolb model, the Dunn and Dunn's Model and the VAK/VARK model (Truong, 2016).

After reviewing the current literature, we have identified that adaptive e-learning systems have used different targets for learning styles' adaptation, and some of them have used even more than one target. That majority of authors have adapted learning contents and resources by trying to identify those that would be suitable for users' learning styles (Alkhurajietal, Cheetham and Bamasak, 2011; Baldiris et al., 2008; Brown, 2007; Cabada et al., 2009; Del Corso, Ovcin and Morrone, 2005; Dwivedi and Bharadwaj, 2013; Germanakos et al, 2008; García, Schiaffino and Amandi, 2008; Graf, 2007; Graf, Kinshuk and Liu, 2009; Jovanović, Gašević and Devedžić, 2009; Jovanović, Gašević and Devedžić, 2009; Limongelli et al., 2009; Özyurt, Özyurt and Baki, 2013; Popescu, Badica and Moraret, 2010; Sancho, Martínez and Fernández-Manjón, 2005; Sevarac, Devedzic and Jovanovic, 2012; Siadaty and Taghiyareh, 2007; Sterbini and Temperini, 2009; Sun, Joy and Griffiths, 2007; Yang, Hwang and Yang, 2013). Others have developed personalised tutorials, recommendations and teaching strategies that are adapted according to individual learning styles (Baldiris et al., 2008; Cabada et al., 2009; El Bachari, Abelwahed and El Adnani, 2011; Franzoni et al., 2008; Kelly and Tangney, 2005; Latham, Crockett and McLean, 2014; Latham et al., 2012; Schiaffino, Garcia and Amandi, 2008; Mustafa and Sharif, 2011; Wang, Wang and Huang, 2008). Some authors focused on adapting the assessment and reviewing process to students' learning styles (Baldiris et al., 2008; Cabada, Estrada and García, 2011; Wen et al., 2007). For example, Wen et al. (2007) tried to improve peer assessment by applying learning styles and, thus, decreasing bias. Lin et al. (2013) and Feldman, Monteserin and Amandi (2014) found out that the level of students' creativity can be improved if their learning styles were considered when educational games were developed. Moreover, learning style can be gleaned from the behaviour of students when they play educational games (Feldman, Monteserin and Amandi , 2014).

So far, only some studies have tested the adaptive e-learning system and conducted the evaluation. Generally speaking, most of the results of the evaluation have been positive. The majority of authors used satisfaction questionnaires which have shown that students are satisfied with the system, its usability, helpfulness, usefulness and handiness (Cabada, Estrada and García, 2011; Jovanović, Gašević and Devedžić, 2009; Limongelli et al., 2009; Limongelli et al., 2011; Özyurt, Özyurt and Baki, 2013; Sevarac, Devedzic and Jovanovic, 2012; Mustafa and Sharif, 2011; Latham et al., 2012; Schiaffino, Garcia and Amandi, 2008; Wang, Wang and Huang, 2008). Some of these authors not only evaluated students' opinion but also evaluated teachers' opinion about the system (Limongelli et al., 2009; Limongelli et al., 2011; Sevarac, Devedzic and Jovanovic, 2012; Wang, Wang and Huang, 2008). Several studies used other methods for system evaluation. For example, a few authors evaluated pre-performance and post-performance of both control and experimental groups, with some comparing the performance of a group whose learning styles matched learning material with a group who didn't match (Sanginetto et al., 2008; Siadaty and Taghiyareh, 2007; El Bachari, Abelwahed and El Adnani, 2011; Latham, Crockett and McLean, 2014). The others analysed the time needed to complete the task and browse the material, the level of task completeness and the level of engagement between control and experiment group (Yang, Hwang and Yang, 2013). Finally, there are few studies that used the combination of some or all of these methods (Bajraktarevic, Hall and Fullick, 2003; Brown, 2007; Graf, 2007; Graf, Kinshuk and Liu, 2009; Klačnja-Milićević et al., 2011; Popescu, Badica and Moraret, 2010; Tseng et al., 2008). So far, none of the studies have evaluated the performance between a control and experiment group a few months after the completion of the course, i.e. they haven't analysed the durability of the knowledge acquired through an adaptive e-learning system. Moreover, the motivation of students to continue using an adaptive e-learning system hasn't been analysed so far.

For the purpose of this paper, the researchers have designed a model of the adaptive learning management system (LMS) and implemented it in Moodle. The system was evaluated on 228 students.

Based on the analysed literature we have proposed the following hypotheses for our research:

H1: The adaptive e-learning model, while providing a higher degree of knowledge, more positively influences the knowledge duration than a standard non-adaptive e-learning system;

H2: The adaptive e-learning model increases students' learning motivation compared to a standard non-adaptive e-learning system;

H3: There is a statistically significant relationship between learning styles and achievement scores on A1, A2 and S1, S2 tests;

H4: There is a statistically significant difference between gender, learning motivation, achievement scores on tests and satisfaction with the adaptive e-learning system.

Materials and Methods

Model Design

The incorporation of learning styles in Moodle is based on the VAK learning style model (Fleming and Mills, 1992). The VAK learning model is a sensory model and is an extension of Neuro-linguistic programming models. People usually prefer a learning style that corresponds to one of the three senses, i.e. visual, auditory and kinaesthetic. People who prefer visual learning style learn by seeing things and images. People with auditory learning style learn through hearing and listening, and people with kinaesthetic learning style learn through doing something, through physical activity.

LMSs do not provide adaptivity since their main purpose is technology-enhancing learning. This model enables Moodle, as one of LMSs, to be adaptive; and material is automatically generated to suit students' learning style. Moodle learning objects in the model include: content, various multimedia objects, examples, exercises, self-assessment tests, chats, and forums. Every course that uses the model needs to consist of chapters. Chapters can be divided into learning units and one or more learning objects are included within learning units (e.g. content, examples, multimedia objects, test, etc.). The developed model is independent of Moodle and it can be integrated into every LMSs. The model is very simple, and teachers find it very user-friendly. The added elements are developed in PHP for Moodle. In Figure 1, we have presented the elements that are added to Moodle to make adaptive courses.

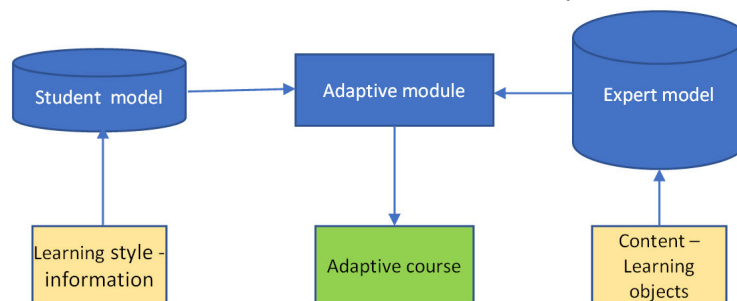


Figure 1. The implemented architecture of the LMS for providing adaptive courses

The purpose of the first element, which is based on the VAK learning style model (Fleming and Mills, 1992), is to identify and store students' learning styles. The VAK learning style questionnaire is incorporated into a student's registration form. After students complete the questionnaire, the preferences for certain learning style is identified for each student and the information is stored in the students' model.

The second element is referred to as the expert model where all available learning objects are deposited. Teachers are able to choose learning objects that will be adapted according to students' learning styles. At this stage, they can also choose objects that will not be adapted.

The third element, the adaptation module, creates courses that suit students' learning styles. The purpose of this module is to generate and provide students with courses that are adapted according to their learning styles.

A type and number of learning objects depend on the students' learning styles. For instance, students with an auditory learning style would have a higher number of audio or video material, expert narration recordings, etc. On the other hand, students with a visual learning style would be given more presentations, graphics, flow charts, text files, etc., while students with a kinaesthetic learning style would have a higher number of case studies, online video lessons, workshops, etc. Table 1 shows learning objects, assessment types and the ways of communication that are the most suitable for visual, auditory and kinaesthetic learning styles.

Table 1
Learning models and objects for VAK learning styles

| Learning Styles | Visual | Auditory | Kinaesthetic |
|-------------------------|--------------------------------|----------------------------|--|
| Learning Objects | Presentations | Video materials | Case studies |
| | Textual online lessons | Audio materials | Online video lessons |
| | Diagrams, graphics, flow chart | Homework /group activities | Problem based lessons |
| | | | Workshops Simulations |
| Assessment | Tests | Oral exams | Tests (e.g. multiple-choice questions, short definitions fill in the blanks) |
| | Essays | Presentations | Research |
| | Demonstrating a process | Tests (e.g. fill in gaps) | Demonstrate a principle |
| | | | Problem solving exercises |
| Communication | E-mails | One to one communication | Forums |
| | Forums | Video conference | Discussion |
| | Chats | | |

The adaptive courses enable students to move to another module when they complete one and students are grouped according to their level of knowledge and successfulness in a course. The questions are created on the bases of individual abilities of students and are adjusted during an assessment. For example, when students answer one question correctly the next one will be more difficult, and if they answer the question incorrectly, the next one will be easier. The students who are better prepared for the exam will have more difficult questions and the other way around. The more difficult questions will carry more points than the less difficult ones.

Sample

We conducted research on the Faculty of Management in Serbia from September 2015 till June 2018. The sample consisted of 228 students. The demographic characteristics of the sample are shown in Table 2. The students attended the third-year undergraduate course Internet Technologies. The research included one group of students. The first half of the semester students attended a standard course, a non-adaptive e-learning course. The second half of the semester students were taught material that matched their learning styles, i.e. they attended an adaptive e-learning course.

Table 2
The demographic characteristics of the sample

| | Number | Percent |
|---------------|--------|---------|
| Gender | | |
| Female | 92 | 40.4 |
| Male | 136 | 59.6 |
| Age | | |
| 20-22 | 182 | 79.8 |
| 23-25 | 29 | 12.7 |
| 26-28 | 17 | 7.5 |
| Total | 228 | 100 |

The whole course was online and adjusted in Moodle. The course consisted of a practical and theoretical part. The course included 12 chapters. In the first 6 chapters students were taught via standard, non-adaptive Moodle. In the other 6 chapters, students were taught via Moodle which was extended by the adaptive concept described above.

Study Procedure

After finishing the first 6 chapters via the standard e-learning course, students completed the test (referred to as the Standard test 1- S1). Before starting the other 6 chapters, students filled out the VAK learning style questionnaire in Moodle. Once they logged into the course, it was automatically adapted to their learning style. After finishing the rest of the chapters, students finalized the test that was also adapted to their learning styles (referred as the Adaptive test 1- A1). In addition to having completed the test, students also filled out motivation and satisfaction questionnaires. One month after completion of

the course, students finalized again two tests for all 12 chapters. We refer to the other two tests as the Standard test 2- S2 and Adaptive test 2- A2.

The dependent variables in this study are the achievement score obtained in the four tests and the results acquired from the two questionnaires.

Description and Characteristics of the Instrument

We have used two questionnaires in the empirical part of the research.

Questionnaire 1

The purpose of the first questionnaire was to establish student preferences during the learning process. In order to determine students' learning styles, we have used the VAK self-assessment questionnaire. This questionnaire asked respondents how they reacted in 25 different situations that directly or indirectly indicate the learning style that a person prefers. The respondents can be divided into one of three preferred styles of learning, and those are: visual, auditory and kinaesthetic style. This questionnaire was integrated into the Moodle system and students filled it out once they registered in Moodle.

Questionnaire 2

The second questionnaire consisted of four groups of questions which students filled out after the completion of the course.

The first group of questions referred to demographic characteristics of the respondents which consists of gender and age.

The second group of questions referred to the evaluation of the adaptive e-learning system. Students had to give their own estimation of how satisfied they were with certain aspects of the adaptive e-learning system. The satisfaction questionnaire consisted of 11 items which were anchored to a five-point Likert scale ranging from 5 (extremely satisfied) to 1 (not satisfied). The items of the questionnaire can be seen in Table 3.

The purpose of the third group of questions was to estimate the extent to which the adaptive e-learning system motivated students for studying. The learning motivation questionnaire included 11 items, and it was created especially for this research. The questionnaire was based on the Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The items of the questionnaire can be seen in Table 4.

Reliability and Validity of the Scales

Since the questionnaires used for evaluation of system satisfaction and learning motivation have not been used with a larger population of students, and as their measurement properties were new to us, it was necessary to test their reliability and validity. The validity of the scales was tested with Principal Component Analysis and we estimated the reliability of the scales with Cronbach's alpha.

Principal component analysis was used to determine the latent variables and to test satisfaction scale validity.

For the satisfaction scale, the analysis extracted 11 components, and only the first one had a characteristic root greater than 1. The first principal component had the largest proportion of variance, about 63%.

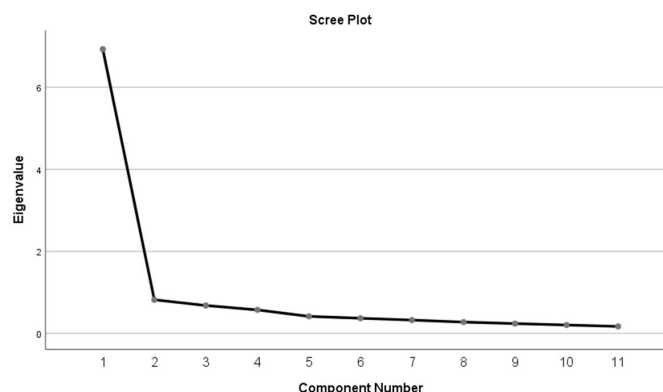


Figure 2. Screen plot

Based on the Scree plot we can see that the first component is significantly different from the others, and therefore we can say that this questionnaire had one principal component that dominantly defines its measure space. (Figure 2)

Table 3

The matrix of the first component structure (system satisfaction questionnaire)

| Items | 1 |
|--|-------|
| 1. System quality | 0.834 |
| 2. System organization (for example, the units and tests don't overlap) | 0.811 |
| 3. Course content | 0.845 |
| 4. Informing students (for example, pages with useful information and materials are available) | 0.655 |
| 5. Lecture, teaching methods | 0.851 |
| 6. Evaluation | 0.821 |
| 7. Availability of resources | 0.663 |
| 8. Group work | 0.800 |
| 9. Acquiring practical knowledge | 0.767 |
| 10. Teachers (for example, relation with students, communication, lectures...) | 0.812 |
| 11. Teachers' support | 0.839 |

All items in the satisfaction questionnaire were highly correlated with the first principal component. The largest contribution to defining the first component was made by items 5, 3, 11 and 1 (Table 3). Based on the structure matrix of the first principal component, we may say that all items in the questionnaire contribute to defining the first principal component, and this confirms the unique measuring tools of this questionnaire (Table 3).

Although the first principal component comprises 63% of the total variance, which means that part of the variability that describes satisfaction with the system was not covered with this component, we may say that this instrument is valid, especially when considering the high level of the saturation of the principal component with almost every statement in the questionnaire.

We estimated the reliability of the satisfaction questionnaire with Cronbach's alpha. The alpha coefficient for the satisfaction scale is very high 0.94. Therefore, we can say that the instrument was reliable at an acceptable level (DeVillis 2003; Kline 2005).

We also used Principal Component Analysis to test the validity of the learning motivation questionnaire and to determine latent variables of this questionnaire.

The analysis extracted 11 components, and only the first one has a characteristic root greater than one, i.e. the root value is 6.9. The first principal component has the largest proportion of variance, about 63%.

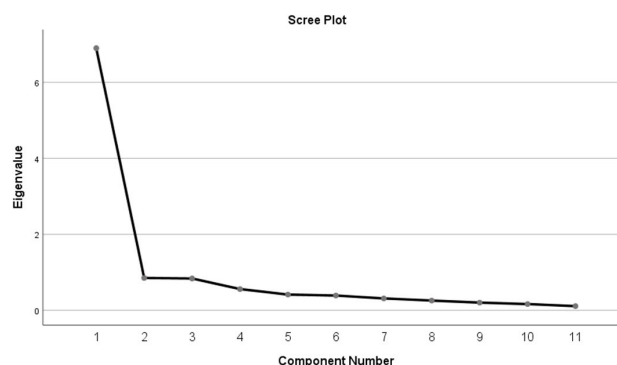


Figure 3. Screen plot

The scree plot confirms that the first principal component is significantly different from the other components, and thus we may say that this questionnaire has one principal component of measurement.

Table 4
The matrix of the first component structure (learning motivation questionnaire)

| Items | 1 |
|--|-------|
| 1. The system motivates me to study more because it is interesting to use | 0.849 |
| 2. The system motivates me to study more because it is more efficient than other systems | 0.764 |
| 3. I would be more motivated for studying other subjects if they used this system | 0.765 |
| 4. The information we need to acquire in this subject are well-organized in this system and thus I am more motivated | 0.683 |
| 5. Faster progress that I have achieved with the use of this system motivates me | 0.822 |
| 6. I am motivated to continue acquiring knowledge in this way | 0.839 |
| 7. This learning system makes me understand lectures better and it motivates me to study | 0.805 |
| 8. This learning system motivates me to study more | 0.800 |
| 9. This learning system contributes to a better motivation of the entire group | 0.760 |
| 10. I am motivated for further studying | 0.923 |
| 11. I would recommend this learning system to others | 0.666 |

We can see from the structure matrix that all statements in the questionnaire are highly and positively correlated with the first principal component. The first component is best defined with statements 10, 1, 6, 5 (Table 4).

Even though some statements are more dominant in defining the first principal component, we see that all statements contribute to defining the first component and this corroborates the unique measuring tools of this questionnaire.

Since the first principal component comprises 63% of the total variance, we may say that a part of the variability that describes student motivation is not covered with this component, but it is a smaller part of the variance, and we thus may say that this questionnaire had satisfactory validity, especially when considering the high level of the saturation of the principal component with the statements of this questionnaire.

We estimated the reliability of the learning motivation questionnaire with Cronbach's alpha. The alpha coefficient for learning motivation scale was very high (0.93). Therefore, we can say that the instrument was reliable at an acceptable level (DeVillis 2003; Kline 2005).

Thus, both scales showed a high level of reliability and satisfactory validity.

Results

Satisfaction with the Adaptive E-Learning System and Student Learning Motivation

The evidence provided in Table 5 shows that the majority of students were satisfied with the adaptive e-learning system. The students expressed the highest level of satisfaction with evaluation; teachers; teachers' support. However, the aspects of the system that could have been improved included informing students and acquiring practical knowledge; since students expressed the lowest level of satisfaction with these aspects.

Table 5
Students' satisfaction with the adaptive e-learning system

| | Mean | Std. Deviation |
|---|-------------|----------------|
| System quality | 4.00 | 1.080 |
| System organization (for example, the units and tests don't overlap, etc.) | 3.98 | 1.153 |
| Course content | 4.04 | 0.933 |
| Informing students (for example, pages with useful information and materials are available) | 3.71 | 1.236 |
| Lecture, Teaching methods | 3.94 | 0.998 |
| Evaluation | 4.12 | 0.897 |
| Availability of resources | 4.00 | 1.136 |
| Group work | 3.79 | 1.162 |
| Acquiring practical knowledge | 3.70 | 1.094 |
| Teachers (for example, relation with students, communication, lectures...) | 4.39 | 0.792 |
| Teachers' support | 4.15 | 0.984 |

The evidence provided in Table 6 shows that students were highly motivated to continue learning after they stopped using the adaptive e-learning system. The highest level of motivation was present in the following segments: “The system motivates me to study more because it is more efficient than other systems”; “I would be more motivated for studying other subjects if they used this system” and “I would recommend this learning system to others”.

The lowest level of motivation was found with the following statements: “This learning system makes me understand lectures better and it motivates me to study” and “This learning system contributes to a better motivation of the entire group”.

Table 6
Students’ learning motivation

| | Mean | Std. Deviation |
|---|-------------|----------------|
| The system motivates me to study more because it is interesting to use | 3.92 | 1.141 |
| The system motivates me to study more because it is more efficient than other systems | 4.25 | 0.937 |
| I would be more motivated for studying other subjects if they used this system | 4.32 | 1.022 |
| The information we need to acquire in this subject are well organized in this system and thus I am more motivated | 4.06 | 1.085 |
| Faster progress that I have achieved with the use of this system motivates me | 4.00 | 1.097 |
| I am motivated to continue to acquire knowledge in this way | 4.16 | 0.998 |
| This learning system makes me understand lectures better and it motivates me to study | 3.79 | 1.112 |
| This learning system motivates me to study more | 3.97 | 1.147 |
| This learning system contributes to a better motivation of the entire group | 3.86 | 1.202 |
| I am motivated for further studying | 4.00 | 1.072 |
| I would recommend this learning system to others | 4.21 | 1.079 |

The Difference Between Score Means for Standard and Adaptive Modules

The first hypothesis of this research attempts to determine whether the implemented adaptive e-learning system provides a higher degree of knowledge and positively influences knowledge duration more than a standard non-adaptive e-learning system. To test this hypothesis, we used a t-test to analyse whether there are significant differences between mean scores for adaptive e-learning systems and non-adaptive e-learning systems. A significance level of 0.05 was used. S1 refers to the results of the test obtained immediately after the completion of the standard module of e-learning and A1 denotes the results of the test obtained immediately after the completion of the adaptive module. S2 refers to the results obtained a month after the completion of the standard module. A2 denotes the results obtained a month after the completion of the adaptive module.

All tests had the same number of questions (10) and they are scored in the same way (each question 1 point), and all the questions were of the same level of difficulty.

The mean values, standard deviations and standard errors of the mean for achievement scores after the S1, S2, A1, A2 tests are shown in Table 7.

Table 7
Mean values, standard deviations and standard errors of the mean for achievement scores

| | Mean | N | Std. Deviation | Std. Error of the Mean |
|--------------|------|-----|----------------|------------------------|
| Scores on S1 | 8.14 | 228 | 1.244 | 0.082 |
| Scores on S2 | 7.36 | 228 | 1.232 | 0.082 |
| Scores on A1 | 8.88 | 228 | 1.157 | 0.077 |
| Scores on A2 | 8.42 | 228 | 1.153 | 0.076 |

The mean score for the S1 test (8.14) is higher than for the S2 test (7.36). The mean score for the A1 test (8.88) is higher than for the A2 test (8.42). Based on the achievement scores, we can see that students achieved higher scores on tests (S1 and A1) carried out immediately after the compilation of both

modules. Moreover, the results have shown that students had better results on both tests (A1 and A2) competed after the adaptive e-learning module.

Table 8

Pearson's correlation coefficient between achievement scores on tests completed after the same module.

| | N | Pearson's correlation coefficient | Statistical Significance (2-tailed) |
|-----------------------------|-----|-----------------------------------|-------------------------------------|
| Scores on S1 & Scores on S2 | 228 | 0.789 | 0.000 |
| Scores on A1 & Scores on A2 | 228 | 0.906 | 0.000 |

Correlation is significant at the 0.01 level (2-tailed)

The correlation coefficient between tests S1 and S2 is statistically significant, of high strength ($r = 0.79$) and positive. The correlation coefficient between tests A1 and A2 is also statistically significant, of high strength ($r = 0.91$) and positive. Based on the obtained values of correlation coefficients between tests done after the completion of the same e-learning module, we may conclude that those students who have achieved higher scores on tests S1 and A1, have also achieved higher scores on tests S2 and A2. (Table 8)

The statistically significant difference in students' knowledge shown on tests S1, S2, A1 and A2 has been tested with the dependent t-tests, and the results are shown in Table 9.

Table 9

Dependent t-tests exploring mean differences between achievement scores

| | t | df | Sig. (2-tailed) |
|-----------------------------|--------|-----|-----------------|
| Scores on S1 - Scores on S2 | 14.647 | 227 | 0.000 |
| Scores on A1 - Scores on A2 | 13.921 | 227 | 0.000 |

Based on the received results we see that both t-tests are statistically significant which means that the differences between the achievement scores obtained in the different periods of time are statistically significant ($p < 0.000$). Students achieved higher results and better knowledge on S1 and A1 tests. It should be emphasized that the difference between tests S1 and S2 is slightly higher than the difference between tests A1 and A2, and thus we may say that the adaptive module showed a smaller decrease in knowledge level.

Table 10

Pearson's correlation coefficient between achievement scores on tests completed after the deferent module

| | N | Pearson's correlation coefficient | Sig. (2-tailed) |
|-----------------------------|-----|-----------------------------------|-----------------|
| Scores on S1 & Scores on A1 | 228 | 0.725 | 0.000 |
| Scores on S2 & Scores on A2 | 228 | 0.467 | 0.000 |

Correlation is significant at the 0.01 level (2-tailed)

The correlation coefficient between tests S1 and A1 is statistically significant, high in strength ($r = 0.73$) and positive. The correlation coefficient between tests S2 and A2 is statistically significant, of slightly lower strength ($r = 0.47$) and positive. Based on the correlation coefficients between tests done after different e-learning modules, we may conclude that those students who achieved better results on the S1 test, also did better the A1 test, and those who achieved better results on the S2 test also had better results on the A2 test. (Table 10)

Table 11
Dependent t-tests

| | | t | df | Sig. (2-tailed) |
|--------|-----------------------------|---------|-----|-----------------|
| Pair 1 | Scores on S1 - Scores on A1 | -12.509 | 227 | 0.000 |
| Pair 2 | Scores on S2 - Scores on A2 | -12.998 | 227 | 0.000 |

Table 11 shows the results for the dependent t-tests used to determine whether there were statistically significant differences between achievement scores on tests. Both t-tests have shown that there are statistically significant differences ($p < 0.000$), which means that there is a statistically significant difference in students' knowledge acquired through the standard and adaptive module. The students performed better on the test completed after the adaptive e-learning module (A1 and A2).

The results indicate that H1 is accepted. The results above show that the adaptive e-learning module provides both a higher degree of knowledge as well as a more positive influence on the knowledge duration compared to a standard non-adaptive e-learning system.

The Relationship Between Learning Motivation and E-Learning Modules

We conducted multiple regression analysis to analyse the relationship between learning motivation and both e-learning systems. Moreover, we wanted to determine whether an adaptive e-learning system increases student learning motivation compared to a standard non-adaptive e-learning system. Student learning motivation was the criterion variable while achievement scores were the set of predictors.

Table 12
The multiple correlation coefficient

| Model | R | R ² | Adjusted R ² | Std. Error of the Estimate |
|-------|-------|----------------|-------------------------|----------------------------|
| 1 | 0.283 | 0.180 | 0.064 | 9.08128 |

Table 13
The statistical significance of the regression model

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|-------|------------|----------------|-----|-------------|-------|-------|
| 1 | Regression | 1606.050 | 4 | 401.513 | 4.869 | 0.001 |
| | Residual | 18390.735 | 223 | 82.470 | | |
| | Total | 19996.785 | 227 | | | |

The regression model is statistically significant at level $p = 0.001$. Multiple correlation coefficient is $R = 0.283$ and set of predictors explains about 18% of the variability of system variables. Based on these results we may say that there is a lower level of relationship between the criteria and the set of predictor variables. (Table 12 and Table 13)

Table 14
The partial contribution of the predictors

| | Beta | t | Sig. |
|---------------------|--------|--------|-------|
| (Constant) | | 5.107 | 0.000 |
| Scores on S1 | -0.124 | -0.983 | 0.327 |
| Scores on A1 | 0.306 | 1.786 | 0.075 |
| Scores on A2 | 0.203 | 1.931 | 0.050 |
| Scores on S2 | -0.089 | -0.584 | 0.560 |

Statistically significant partial effect on the prediction of criterion variable is achieved with the test A2 which has a beta coefficient of 1.203, significant at level $p = 0.05$, while the test A1 is weakly statistically significant at $p = 0.75$. Tests S1 and S2 do not have a statistically significant effect on the prediction of the criterion variable. Tests A1 and A2, completed after the adaptive e-learning system, show a tendency to have a positive effect on student learning motivation. Furthermore, the higher scores students had, the level of their motivation to use the adaptive module increased. Tests S1 and S2, completed after a

standard non-adaptive module, have not displayed a statistically significant effect on student learning motivation (Table 14).

The results support the hypothesis that the adaptive e-learning module increases student learning motivation is accepted.

Relationships Between Learning Styles and the E-Learning Model

We used Canonical Discriminant Analysis to test the relationship between learning style and the use of the e-learning module. The group variable was learning style, while test scores were the set of predictor variables.

Table 15
Eigenvalue, Percentage of Variance and Canonical Correlation

| Function | Eigenvalue | % of Variance | Cumulative % | Canonical Correlation |
|----------|------------|---------------|--------------|-----------------------|
| 1 | 0.071a | 85.3 | 85.3 | 0.258 |
| 2 | 0.012a | 14.7 | 100.0 | 0.110 |

Canonical discriminant analysis extracted two discriminant functions and only one of them was statistically significant. (Table 15)

Table 16
The level of significant of discriminant functions

| Function | Wilks' Lambda | χ^2 | df | Sig. |
|----------|---------------|----------|----|-------|
| 1 | 0.922 | 18.104 | 8 | 0.020 |
| 2 | 0.988 | 2.724 | 3 | 0.436 |

The first discriminant function is statistically significant at significance level $p=0.02$ and with canonical correlation coefficient $R_c=0.258$ which means that there is a difference among student groups and that this difference is of lower intensity. In our further analysis, we will take into consideration only the structure of the first discriminant function. (Table 16)

Table 17
Structure matrix of the first discriminant function

| | Function |
|--------------|----------|
| | 1 |
| Scores on A1 | 0.790* |
| Scores on A2 | 0.608* |
| Scores on S1 | 0.470* |
| Scores on S2 | 0.412 |

All predictor variables are on the positive pole of the discriminant function. This function is best defined with the score on the tests A1 and A2, and the scores on these tests have the highest scores on the discriminant function. (Table 17)

Table 18
Functions at Group Centroids

| Learning styles | 1 |
|-----------------|--------|
| Visual | -0.020 |
| Auditory | -0.227 |
| Kinaesthetic | 0.415 |

Based on the values and directions of the group centroids, we may say that students with a kinaesthetic learning style show somewhat better results on all tests in comparison to students who prefer the other two styles. The group of students with a kinaesthetic learning style is on the positive pole

of discriminant function (0.42), unlike the other two groups of students who are on the negative pole of discriminant function. Students with a visual learning style (- 0.02) have better test results than students with auditory style and worse than students with kinaesthetic learning style. Students with an auditory style have the greatest centroid value on the negative pole of discriminant function (- 0.227) which means that they have the worst results on all tests compared to the other two groups of respondents.

The results support the hypothesis which says that there is a statistically significant relationship between learning styles and achievement scores on the A1, A2, S1 and S2 tests.

The Relationship between Gender, Learning Motivation, Achievement Scores and Satisfaction with the Adaptive E-Learning System

We conducted a series of independent samples t-test to analyse if there is a statistically significant gender difference in motivation, achievement scores on tests and satisfaction with the adaptive e-learning system.

Table 19

Mean values, standard deviations and standard error of the mean for both female and male respondents

| | Gender | Mean | Std. Deviation | Std. Error of the Mean |
|---------------------|--------|---------|----------------|------------------------|
| Scores on S1 | Female | 8.20 | 1.197 | .125 |
| | Male | 8.10 | 1.278 | .110 |
| Scores on A1 | Female | 8.87 | 1.141 | .119 |
| | Male | 8.89 | 1.172 | .100 |
| Scores on S2 | Female | 7.30 | 1.193 | .124 |
| | Male | 7.40 | 1.261 | .108 |
| Scores on A2 | Female | 8.39 | 1.176 | .123 |
| | Male | 8.44 | 1.140 | .098 |
| Learning motivation | Female | 45.4239 | 7.75197 | .80820 |
| | Male | 43.9265 | 10.32984 | .88578 |
| Satisfaction | Female | 45.4783 | 6.20613 | .64703 |
| | Male | 42.7059 | 10.38811 | .89077 |

Based on the mean values we may conclude that respondents of both genders have almost equal average grades on all tests. As seen in Table 19, females show on average a slightly bigger learning motivation than male respondents. A similar situation can be found with satisfaction with the adaptive e-learning system. Female students show a higher level of satisfaction than male students. Statistical significance of these differences has been tested with t-tests (Table 20).

Table 20

Independent samples t-tests exploring mean differences between genders

| | T test | df | Sig. | Mean Difference | Std. Error Difference |
|---------------------|--------|-----|------|-----------------|-----------------------|
| Scores on S1 | .551 | 226 | .582 | .093 | .168 |
| Scores on A1 | -.129 | 226 | .898 | -.020 | .157 |
| Scores on S2 | -.557 | 226 | .578 | -.093 | .167 |
| Scores on A2 | -.320 | 226 | .749 | -.050 | .156 |
| Learning motivation | 1.183 | 226 | .238 | 1.49744 | 1.26587 |
| Satisfaction | 2.297 | 226 | .023 | 2.77238 | 1.20717 |

The results show that there is only a statistically significant difference in the satisfaction with the adaptive e-learning system, i.e. female respondents show greater satisfaction with the adaptive e-learning system.

The received results give partial support to the hypothesis regarding gender differences, and only regarding students' satisfaction with the system.

Discussion

The results of the research have confirmed our expectations and have shown that an adaptive e-learning system can increase students' learning results.

The study has shown that students performed better on the test that they completed after adaptive e-learning module.

Our paper found a number of results that support this conclusion.

First, our study has found that the adaptive e-learning module provides at the same time a higher degree of knowledge and more positively influences the knowledge duration than a standard non-adaptive e-learning system. Prior research on this subject has shown contradictory findings. [Coffield et al. \(2004\)](#) believe that the reason for these contradictory findings lies in the fact that in most of studies the size of a sample was very small, and because respondents were exposed to an adaptive e-learning module for a very short period of time. However, a certain number of researches came to the conclusion that students exposed to adaptive e-learning systems achieved better results than those who were not ([Barjaktarević, Hall and Fullick, 2003](#); [Brown et al., 2006](#); [Brown, 2007](#); [El Bachari, Abelwahed and El Adnani, 2011](#); [Graf, 2007](#); [Graf, Kinshuk and Liu, 2009](#); [Klašnja-Milićević et al., 2011](#); [Latham, Crockett and McLean, 2014](#); [Popescu, Badica and Moraret, 2010](#); [Sangineto et al., 2008](#); [Siadaty and Taghiyareh, 2007](#); [Tseng et al., 2008](#); [Wolf, 2007](#)), and this is in line with the results of our research.

Second, the results have revealed that there is a statistically significant relationship between student learning motivation and the usage of an adaptive e-learning system, while it is not the case with a standard e-learning system. The achievement scores on both tests completed after the adaptive e-learning module have shown a positive effect on student learning motivation. Therefore, we have concluded that an adaptive e-learning system increases student learning motivation.

Third, we have identified that an adaptive e-learning system has different effects on students with different learning styles. Students with a kinaesthetic learning style show better results on all tests in comparison to students of the other two styles. On the other hand, students with an auditory learning style achieved the worst performance on all tests. Although there haven't been many studies that have analysed the effects of students' learning styles on their performance in the context of adaptive e-learning, [Graf, Kinshuk and Liu \(2009\)](#) discovered that adaptive e-learning system can have different effects on students with different learning styles.

Finally, the results of the study have indicated that there is a difference between genders regarding learning motivation, achievement scores on tests and satisfaction with an adaptive e-learning system. Although female respondents have obtained slightly higher than average scores on tests and expressed a slightly bigger motivation than male respondents, there is only a statistically significant difference in the satisfaction with an adaptive e-learning system. Namely, female students have expressed a higher level of satisfaction with the system.

In general, the majority of students have expressed a high level of satisfaction with an adaptive e-learning system which is in correspondence with previous research. Some of the previous studies have also shown that both teachers and students who used adaptive e-learning systems have expressed a high level of satisfaction with the system ([Jovanović, Gašević and Devedžić, 2009](#); [Limongelli et al., 2009](#); [Latham et al., 2012](#); [Limongelli et al., 2011](#); [Özyurt, Özyurt and Baki, 2013](#); [Sevarac, Devedzic and Jovanovic, 2012](#); [Mustafa and Sharif, 2011](#)).

Conclusion

For the purpose of this research, we designed a model of an adaptive learning management system (LMS) and implemented it in Moodle. The developed model of adaptive e-learning is based on the VAK learning style model. The identification of a student's learning style has been proven to increase student learning effectiveness. In general, an adaptive e-learning system enables more meaningful learning since it improves flexibility, provides participation, interaction and real-time feedback ([Kamardeen, 2014](#)).

In this paper, we have analysed the effects and effectiveness of an adaptive e-learning system. We have discovered that there are significant differences in learning effectiveness, satisfaction and motivation when students use an adaptive e-learning module in comparison to a standard e-learning module. Moreover, we have investigated the effectiveness and the durability of knowledge acquired with an adaptive e-learning system by comparing the performance of students not only after the completion of the course but also a month after the course.

So far, to our knowledge, no study has evaluated the performance between a control and experiment

group a few months after the completion of the course, i.e. they haven't analysed the durability of the knowledge acquired through an adaptive e-learning system. Moreover, the motivation of students to continue using an adaptive e-learning system hasn't been analysed so far.

There are several limitations to the study. The first limitation refers to the sample. The same students represented the control and experiment group. For further research, we would recommend that students are divided into two groups, one would be a control group and another an experiment group. Both groups would attend the same course for one semester, but a control group would be presented with a standard e-learning course and an experiment group with an adaptive e-learning course. The adaptive e-learning course would match learning styles of the experiment group.

The second limitation is in regards to the model of an adaptive e-learning system. Our model diagnoses a student's learning style as a measuring instrument, i.e. the VAK questionnaire. We propose that future research use an implicit method, i.e. analyse the behaviour of students and in that way identify their learning styles. By implementing the implicit method in the model, we would avoid psychometric disadvantages of traditional measuring instruments and the model wouldn't be static, i.e. it would regularly update information about student behaviour.

The study leaves a certain space for further growth. First, since our study has shown that there are differences regarding students' performance amongst students with different learning styles, further research can deal more thoroughly with the advantages and potentials of adaptivity regarding students' learning styles. Secondly, other student characteristics, besides learning styles, could be considered when developing an adaptive e-learning system. Those student characteristics could include previous knowledge, student interests, the speed of learning, etc.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

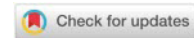
Conceptualization, I.R., and M.R.R.; methodology, I.R., and V.T.; software, I.R., and M.B.; formal analysis, M.R.R., T.S.T., and M.B.; validation, I.R., T.S.T., and V.T.; writing—original draft preparation, I.R., M.R.R., T.S.T., V.T., and M.B.; writing—review and editing, M.R.R., T.S.T., and I.R.. All authors have read and agreed to the published version of the manuscript.

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The Neural Correlates of Exact Calculation in Word and Numerical Formats in Low And High Math Performers: A fNIRS Study

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Abstract: The representation format of math problems can manifest dissimilarly in people with varying levels of math performance. The aim of this study was to investigate the neurocognitive underpinnings of two-digit exact calculation tasks in different formats: numerical and word. Fifty-three students were divided into groups with high and low levels of math performance based on their ability to solve math problems. They were asked to calculate addition problems with two-digit numbers and to read math problems that did not require calculations. Brain activation was recorded using functional near-infrared spectroscopy (fNIRS). General linear model (GLM) analysis revealed that reading math problems without calculation led to increased activation in the inferior temporal and fusiform gyri in a group of high-level performers, while a group of low-level performers demonstrated increased activation in Broca's area and the inferior frontal gyrus in the same experimental condition, as well as during solving arithmetic problems in a word format of the exact calculation task. Analysis after bootstrapping revealed similar activation patterns in both groups. Both domain-specific and domain-general regions of the frontal and parietal brain areas were involved in the calculations. Right and left hemisphere activation was found both in low and high math performers. Comparing experimental conditions with resting state revealed significant activation in Broca's area in all conditions in a group of high-level performers and in a word format of arithmetic problems in a group of low-level performers. Thus, the observed brain patterns suggest the involvement of complex sentence comprehension, especially in high-performing students. These results could be used in future to improve educational practice for students with varying levels of math competence.

Keywords: exact calculation, addition, numerical format, word format, math competence, fNIRS.

Introduction

People use two cognitive systems to understand and operate numbers - non-symbolic system, primarily relying on magnitude estimation without symbols (e.g., Arabic numerals), and symbolic system, based on processing of numbers in symbolic form (Ansari, 2008; Feigenson, Dehaene and Spelke, 2004; Waring and Penner-Wilger, 2017). Development of numerical cognition is a gradual process that started from the nonsymbolic or approximate number system. Approximate number system is an innate cognitive system that supports the estimation of the magnitude without relying on language or symbols. However, the role of symbolic representations of quantity and basic arithmetic skills increases with age (Artemenko, 2021). Basic arithmetic skills are of great importance in everyday life, in STEM education, and in many sciences that involve math: in physics, chemistry, technology and engineering, in various IT applications. Better understanding the underlying brain mechanisms of simple and complex exact calculations is important for numerical cognition and gives an insight into the relation between different brain areas within a network associated within the approximate number system and exact symbolic representation system. In practice, this knowledge can be used in the future in order to improve a person's numerical skills, eliminate problems associated with their lack (decrease in arithmetic and mathematical literacy, dyscalculia). It has been shown that all these shortcomings can have negative consequences for both the economy and society as a whole (Butterworth, Varma and Laurillard, 2011). Therefore, the practical

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significance of the results is substantiated by public demand.

Previous studies at the behavioral level aim to investigate the development of numerical abilities based on both approximate non-symbolic and exact symbolic representations from infancy to adulthood. Experimental evidence shows that infants as young as six months old can differentiate between two arrays of dots as consisting of a different number of objects (Xu and Spelke, 2000). By the age of eighteen months, toddlers can distinguish the order of numbers and choose the larger array of dots, indicating their understanding of relative quantity (Brannon, 2002). At the age of three, children can accurately estimate the number, a concept known as cardinality. In elementary school, children learn about numbers as a representation of numerical values in a non-symbolic format, which is followed by the development of an exact symbolic representation system (Ansari and Karmiloff-Smith, 2002). The symbolic system allows for the processing of discrete numbers and is considered the foundation for math skills such as counting, estimation, addition, subtraction, and other precise numerical calculations (Ansari, 2008; Mundy and Gilmore, 2009; Waring and Penner-Wilger, 2017). Calculations are studied immediately after digits at the same stage of numerical cognition, indicating the importance of the symbolic system (Von Aster and Shalev, 2007; Vanbinst et al., 2016; Schneider et al., 2017).

Reviews on neurophysiological mechanisms associated with exact calculations, indicate the predominant role of the fronto-parietal network in numerical processing, the role of which changes with age (Moeller et al., 2015; Nieder et al., 2016; Clark et al., 2017; Peters and Smedt, 2018; Vogel and Smedt, 2021). Intraparietal sulcus and precuneus in the parietal region, the frontal cortex (e.g., superior and medial frontal gyri), the claustrum, the insula and cingulate are the main structures involved in numerical cognition (Arsalidou and Taylor, 2011). Additionally, inferior temporal and fusiform gyri are associated with processing the numerical shapes and symbols, necessary for calculations with Arabic digits (Piazza and Eger, 2016). Exact calculations are associated with dorsolateral prefrontal cortex, ventrolateral prefrontal cortex, posterior superior parietal lobe, intraparietal sulcus, supramarginal gyrus, angular gyrus, fusiform gyrus, and hippocampus (Vogel and Smedt, 2021). Activation in the frontal cortex overlaps with areas implicated in language processing (Broca's area), working memory and cognitive control (Stuss and Knight, 2013; Devlin, Matthews and Rushworth, 2003; Fadiga and Craighero, 2006; Gentilucci et al, 2006; Barbey, Koenigs and Grafman, 2013).

The role of brain structures depends on the specificity of operations such as addition, subtraction, multiplication and division, as well as task characteristics such as format (numerical and word problems) (Obersteiner et al., 2010; Dresler et al., 2009), complexity of arithmetic problems (simple or complex no-carry or no-borrow or carry and borrow, respectively) (Artemenko et al. 2018a), age (Peters and Smedt, 2018; Vogel and De Smedt, 2021), and level of math performance (Meiri et al., 2012; Artemenko et al. 2018b). Studies have shown that arithmetic operations such as addition and subtraction are determined by the necessity of carry/borrow effects and processing of magnitude, with carry and borrow operations increasing the difficulty of such problems (Klein et al., 2010). The carry means a digit that is transferred from units to tens if the sum of units is more than ten when addition is performed. The borrow means a digit that is transferred from tens to units, if minuend is less than subtrahend when subtraction is performed. The activation of both frontal and parietal regions, including the left inferior frontal gyrus, bilateral middle frontal gyrus, superior frontal gyrus, and left intraparietal sulcus, accompanies carry and borrow effects (Artemenko et al. 2018b). The two-digit calculations require greater working memory load for processing magnitude information and visual identification, with Broca's area, inferior frontal gyrus and left fusiform gyrus being among the neural correlates of complex addition and subtraction, associated with phonological processing, verbal working memory, and visual identification of digits (Dahaene and Cohen, 1995; Pollack and Ashby, 2018).

Recent studies have discussed the role of interconnected areas associated with arithmetic calculations, including the prefrontal, posterior parietal, occipito-temporal, and hippocampal areas, in children compared to adults. (Peters and Smedt, 2018). Mental calculation based on the manipulation of numerical symbols develops with age, and structures associated with symbolic numerical processing may also become more prominent as children grow older. The dynamics is supposed to be influenced by an increase in mathematical competencies; thereby, math skills can influence neural changes in the brain networks involved in the math performance. Thus, Soltanlou et. al (2018) state that the development of psychophysiological mechanisms for the calculations occurs in accordance with the fron-to-parietal shift, known as a shift in brain activation during calculations from frontal structures, in particular precentral premotor and motor areas in children, to parietal regions in adults, reflecting a shift from a labor-intensive procedural to more automatic strategies between ages 8 and 19 (Rivera et al., 2005; Kaufmann et al., 2006; Kucian et al., 2008; Artemenko et al., 2018b).

Individuals may develop mathematical competencies differently, and their level of performance

in math may reflect different neural representations of numerical skills. Some researchers have found differences in activation dependent on math ability in the intraparietal sulcus (Park et al. 2012; Prado et al. 2011). As reported by Artemenko et al. (2018a), some researchers found activation differences in the left angular gyrus (Grabner et al. 2007, 2011; Menon et al., 2000). These differences in activation may be associated with increased or decreased angular gyrus activation depending on processing efficiency or experience/training (Amalric and Dehaene 2016; Grabner et al. 2007, 2011). Additionally, low math performers have shown higher activation in the dorsolateral prefrontal cortex during error processing (Ansari et al., 2011). The intraparietal sulcus, right dorsolateral prefrontal cortex, and left angular gyrus may be influenced by math ability during single-digit arithmetic in multiple ways (Artemenko et al. 2018a), but the underlying process remains unknown. Furthermore, adults with high mathematical abilities demonstrate higher activation in frontal regions during calculations accompanied by carry and borrow effects, which contradicts the fronto-parietal shift (Artemenko et al. 2018a).

Overall, exact calculation, whether it involves complex or simple math problems, rely on parietal brain areas (intraparietal gyrus, angular gyrus, supramarginal gyrus), which represent domain-specific processes, occipital (inferior temporal gyrus and fusiform gyrus) and frontal areas (interior frontal gyrus and middle frontal gyrus), which represent domain-general processes. There are various mechanisms involved in arithmetic processing and mental calculation, which can be attributed to either domain-general processes that are related to cognitive processing in general or domain-specific processes that are specifically linked to mathematical performance (Gilmore et al., 2018). Number magnitude processing, which is associated with domain-specific processes, is located in the intraparietal sulcus (IPS) (Artemenko, 2021). Among domain-general processes that play an important role in calculation are working memory, which is represented in left inferior frontal gyrus (IFG) and bilateral middle frontal gyrus (MFG), and fact retrieval, which is represented in supramarginal gyrus (SMG) and angular gyrus (AG).

According to the most influential model of numerical cognition (Triple-Code Model) there are three representative codes for number: analogue non-symbolic representations of quantity (in particular, the ability to estimate the number of objects without counting), verbal-phonological representations of quantity (words denoting Arabic numbers, and oral counting), and visual representations of Arabic numbers (Dahaene and Cohen, 1995; Dehaene et al., 1999). Each of these representations is provided by functionally separate brain mechanisms (Lavander-Ferreira, 2020). Numerical representations of number activate the lower parietal regions of both hemispheres, while tasks with numerical codes (Arabic numbers) activate the fusiform gyrus of both hemispheres. Finally, the semantic designations of the number, represented by verbal information, cause activity in the left perisylvian areas and the left angular gyrus. However, most studies investigate only one specific representations, rather than all three at the same time. Moreover, the Triple-Code Model does not explain how the brain performs calculations for math word problems. Monti, Parsons and Osherson (2012) demonstrated the role of different areas of the brain in syntactic tasks and algebraic operations. Fuchs et al. (2006) showed the importance of arithmetic word problems as a cognitive predictor of arithmetic calculations in the Assessment of Math Fact Fluency test of the Math Battery, which incorporates two subtests: Addition Fact Fluency and Subtraction Fact Fluency. Differences in brain activation patterns are found in the calculation or simple reading of two-digit addition problems involving a numerical or text format (Richter et al., 2009). In another study (Dresler et al., 2009), higher average oxygenation is demonstrated in the parietal and posterior frontal regions for calculation compared to reading in word problems in primary and secondary school students. Comprehension skills influence arithmetic word problem performance. Thus, it is shown that even for successful word problem solvers, performance decreases if the text of the word problem is semantically complex (Boonen et al., 2016). Daroczy et al. (2015) consider some components of word problem difficulty, such as the linguistic complexity of the problem text itself, the numerical complexity of the arithmetic problem, and the relation between the linguistic and numerical complexity of a problem. Moreover, two factors complicate the solution of word problems: linguistic and numerical complexity (Verschaffel, Greer and De Corte, 2000). However, most researchers do not consider these factors together in their study.

The problem of exact calculations has been examined in various studies. However, tasks that require different formats, such as reading or basic calculation have not been thoroughly investigated. Studying the neural mechanisms of different formats of exact calculation tasks might help to provide evidence for or against the Triple-code model. Recent studies provide arguments against Triple-code model. For example, Skagenholt et al. (2018) examined all three modes of representative codes for number simultaneously to identify the neural correlates of number processing in adults (N=46) using fMRI. The analysis of the task-control condition contrast revealed task-dependent activity, which can be seen as partial support for the Triple-Code model, but also revealed a complex distributed fronto-parietal network involved in all numerical codes. The results show that the Triple-Code Model correctly predicts the existence

of some functionally dissociated neural substrates, but needs to be up-dated to consider the interactions with attentional processes. Contrasts corresponding to differences in task complexity revealed specific neural correlates of the numerical distance effect (i.e., numbers that are close together are more difficult to distinguish than numbers that are farther apart). The connectivity analysis demonstrated overlapping of neural correlates in all tasks, confirming the notion of a front-to-parietal number processing network. Thus, the authors offer arguments in favor of revising the Triple-Code Model.

The comparison of the brain mechanisms involved in numerical or word format calculations is promising for educational neuroscience (Dresler et al., 2009). Arithmetic math problems with numerals embedded in text that describe everyday situations are common in school curricula. However, math problems with numbers written in words (for example, “forty-seven plus twenty-one is...”) are not typical in education. Problems of this type are thought to be related to alternative mechanisms of numeral manipulation. Research in this area may be useful in finding effective ways of teaching mathematics, especially for children with math difficulties who have problems processing numerical symbols. It is important to understand the neural correlates of math problem calculations in various formats, paying special attention to individual differences, particularly, math performance.

The aim of the present study is to measure brain activation in frontal and parietal regions reflected in oxygenation changes measured by fNIRS and to estimate the differences in neurocognitive foundations of exact calculation problems (addition) in numerical or word formats in non-overlearned conditions (two-digit numbers) in young adults who vary in level of math competencies. This study addresses the brain mechanisms of exact calculation problems represented both in traditional format for educational system (problems with numerals in Arabic notation) as well as atypical format (problems with numerals written in words). Thus, we consider the influence of linguistic complexity on solving word problems. In addition, we focus on processing math problems in various formats by students with different levels of mathematical ability. The results obtained will contribute to a better understanding of the nature of domain-specific or domain-general processes in the brain that accompany exact calculations, and can be applied in educational neuroscience, for example, for develop new types of math problems.

The hypotheses of the present study are:

H1 - Tasks in word and numerical formats of exact calculation can cause activation in different areas of the brain, since these two formats of presenting arithmetical problems differ in the amount of cognitive effort needed and in the brain processes involved in calculation.

H2 - Brain activation during solving exact calculation in a word format might involve “language” areas, such as Broca’s area, and occipital (ITG, and fusiform gyrus) and frontal areas (IFG and MFG) that represent domain-general processes.

H3 – Individual differences based on levels of math competencies are expected to be observed.

Materials and Methods

Participants and Procedure

Sixty-five adults were recruited through a university mailing list to participate in the study. All subjects were native Russian speakers, have normal or corrected-to-normal vision and do not have any history of neurological or mental disorders. Some participants were excluded from the sample due to noisy NIRS data (n=7), technical difficulties (n=2), and very poor behavioral results (n=3). For the present analysis, the remaining subjects were divided into groups according to their performance in solving addition and subtraction problems in word and numerical formats. We calculated error rates of 53 participants in 100 addition and subtraction problems with and without carry procedure in a word format and 100 addition and subtraction problems with and without borrow procedure in a numerical format. Participants, who correctly solved more than 70 % of math problems in a word format and more than 85% of math problems in a numerical format formed the group with high level of math competencies (n=19). Those who solved less than 50 % of math problems in a word format and less than 65% of math problems in a numerical format formed the group with low level of math competencies (n=17). Participants from both groups significantly differed in solving math problems (see Table 1). The final sample consists of 36 subjects aged 18-25 (M = 19,5, SD = 1,877, 41 females). Participants provided an informed consent to participate in the study and received a monetary reward for their time and effort. The study was approved by the Ethics Commission of Psychological Institute of Russian Academy of Education, 2020/11-3.

Materials

The experiment consisted of 225 arithmetic problems presented on the computer screen. There were addition and subtraction exact calculation problems and some math problems for reading only. In the present study only addition tasks that included 50 problems in a numerical format with Arabic numerals (for example, $45+23=$), and 50 problems in a word format with numerals written in Russian (for example, fifty-six plus seventy-one is) of different complexity levels: with and without carry procedure were analyzed. 25 tasks were presented as a math problem without calculation embedded in text (for example, Ann had 15 flowers and Teddy brought her 32 flowers more. How many flowers did Teddy bring to Ann?).

Addition and subtraction tasks were represented by two-digit numbers in both operands with a two-digit solution not exceeded 100 in each task. The main selection criteria for two-digit addition and subtraction tasks were to induce computational efforts, but not guessing or retrieving results from declarative memory (Kong et al., 2005) since when using the recall strategy, arithmetic skills are not involved and, and other parts of the brain were activated (Ischebeck et al., 2006; Zago et al., 2001). Pure decades (e.g., 20), as well as tie numbers (e.g., 44) were not used in exact calculation tasks, since they were much easier to solve (for a similar procedure see (Dresler et al., 2009; Klein et al., 2009; Artemenko et al., 2018b)). In two-digit mathematical problems in a word format, a simple logico-mathematical scheme to compute the quantities in the problem based on the assumption that the word problem is only numerical was applied.

Procedure

The recent study is a part of a larger experiment. The duration of this part of the experiment was 30 minutes. The measurement was conducted individually with each participant seated comfortably in front of the computer screen. Each session began with an introduction to the NIRS measurement and the experimental procedure.

During fNIRS measurement, participants were instructed to perform exact calculation tasks in two different modalities (types): in a numerical format (condition 1), and in a word format (condition 2), as well as to read without calculating the arithmetic problems embedded in text (condition 3). The experiment was in a block design, with a total number of 25 blocks, with an inter-block-interval of 20 s for a short rest. There were three conditions in the experiment: (1) addition exact calculation problems in a numerical format (10 blocks); (2) addition exact calculation problems in a word format (10 blocks); (3) reading condition (5 blocks). Each measurement started with an fNIRS resting state recording for 3 minutes. The number of trials was limited and equal for all participants. The sequence of the blocks within each condition and conditions themselves was randomized. Before each condition there were detailed instructions presented on the screen, and 3 training trials. No feedback was given to participants.

The trial started with a fixation cross, presented for 0.5 – 0.8 s in a randomized order to prevent adaptation to it, and was followed by the arithmetic task for 4.5 s. After that, an empty screen with a grey block to insert the answer appeared for 2.5 s. The sequence of a trial is shown in Fig. 1. If no answers were presented within the given time, the next trial appeared on the screen. The participant had an opportunity to correct the answer if a mistake was made within the limited time of 2.5 s. In our study we applied a written production paradigm as the most typical format of giving the solution for the math problem in the education system. In a written production paradigm, adults had to type in the solution to the math problem with the help of numerical keyboard as quickly and accurately as possible.

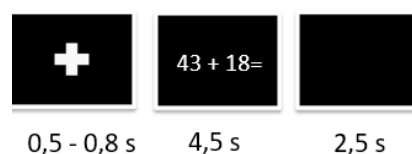


Figure 1. Scheme of a trial

Participants were instructed to read the problems silently and choose one out of two numbers in a reading condition, or calculate mentally in exact calculation conditions. The participants could either wait until the time for presenting the stimulus finished or press the spacebar as soon as they had calculated the problem or completely read it and chosen the answer, respectively.

The exact calculation and reading only problems were presented horizontally in white against a dark grey background at the center of the computer screen using the free software package PsychoPy (Peirce, 2007).

fNIRS data acquisition

fNIRS recordings were acquired using the mobile near-infrared spectroscopy device NIRSport Model 88 (NIRx Medical Technologies, LLC, NY, the USA) with eight light-emitters and eight photodetectors. A probeset of 14 channels, with an interoptode distance of 30 mm, was integrated into an elastic cap to cover the frontal and parietal brain regions of both hemispheres (see Fig.2). All optodes were positioned according to the 10-20 system (Jasper 1958), with the center in P3 and P4 positions in the parietal region, and in F1 and F2 in the frontal regions. Two near-infrared laser beams with wave-lengths of 760 and 850 nm were emitted, and the sampling rate was 7.8125 Hz. The correspondence of fNIRS channels to the underlying cortical areas was estimated using the fNIRS optode's location decider (fOLD), software (Zimeo Morais, Balardin and Sato, 2018), which utilizes the Automated Anatomical Labeling 2 (AAL2) atlas (Tzourio-Mazoyer et al. 2002; Rolls, Joliot and Tzourio-Mazoyer, 2015) for probing arrangement.

In our study, we defined 4 regions of interest (ROIs) that included parietal and frontal regions known from previous studies to be related to exact calculation and reading arithmetic problems. In the parietal brain area, ROIs were formed in the left hemisphere by channels S1-D1 (left angular gyrus, intraparietal sulcus, Wernicke), S1-D2, and S2-D1 (left supramarginal gyrus), S2-D2 (left middle temporal gyrus), S2-D3 (left inferior temporal gyrus, fusiform gyrus); and in the right hemisphere by channels S3-D4 and S3-D5 (right angular gyrus, intraparietal sulcus), S4-D4 (right supramarginal gyrus), and S4-D5 (right middle temporal gyrus). In the frontal brain, area ROIs were formed in the left hemisphere by channels S5-D6 (Broca's area, left inferior frontal gyrus), S5-D7 and S6-D7 (left middle frontal gyrus); and in the right hemisphere by channels S7-D8 and S8-D8 (right middle frontal gyrus) (channels can be found at Fig.2).

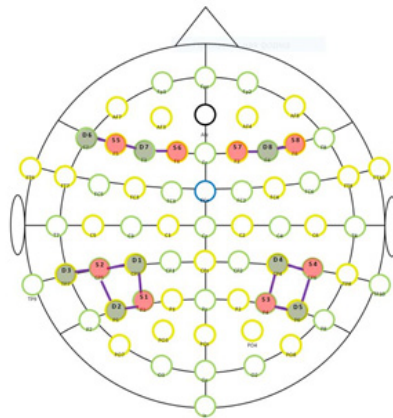


Figure 2. Probeset used for the fNIRS measurements indicating optode positions (red - source, green - detector) and channels that are formed by source-detector pair (violet lines)

Behavioral analysis

The results of the participants were analyzed for task performance (accuracy score) and reaction time (response time, RT). The accuracy score was calculated as the number of correct answers divided by the total number of trials. Response time (RT) was defined as the time from when grey box for inserting the answer appeared until the time when the actual answer was given or the space bar was pressed (see Table 1).

The estimation of accuracy score and response time differences by group and task type was performed by a two-factor repeated measures ANOVA with partial eta-squared as the effect size measure. Post-hoc comparisons were conducted using pairwise repeated measures t-test with Tukey correction. The analysis was performed in R 4.1.2 and Jamovi 2.2.3.

Statistical analysis of NIRS data

fNIRS data was preprocessed and analyzed using a custom script based on free software packages MNE-fNIRS (Esch et al, 2019; Luke et al., 2020). MNE provides complete data analysis pipelines and toolboxes in Python for fNIRS data processing.

During fNIRS data preprocessing, the raw intensity values were first converted to optical density. At this stage, the coupling quality between the scalp and optodes was quantified using the scalp coupling index (SCI index, for detailed description see Pollonini et al., 2014). The SCI index helps to detect a strong cardiac oscillation in fNIRS raw signals, which is undesirable for measuring evoked cortical hemodynamic responses (Themelis et al., 2004). By applying this method to raw data of all participants, we scanned all channels to find out the presence of synchronous signals in the frequency range of cardiac signals across

both photodetected signals. Channels with SCI below 0.6 were marked as bad channels and eliminated from any further analysis. Remaining noisy channels in filtered data were interpolated using the mean of the surrounding channels (nearest method). To remove motion artifacts from the analyzed data, the temporal derivative distribution repair filter (TDDR) was applied (Fishburn et al., 2019). According to recent studies, the TDDR filter shows better results when applied to the optical density of fNIRS data before calculating the relative concentration changes of hemoglobin (Fishburn et al., 2019). Next, the relative concentration changes of oxygenated (O₂Hb) and deoxygenated hemoglobin (HHb) were estimated for every channel using the modified Beer-Lambert law. However, in this study, we focused on the parameter O₂Hb as several researchers regarded this hemoglobin chromophore more sensitive to changes in cerebral blood flow (Hoshi, Kobayashi and Tamura, 2001; Dresler et al., 2009). Finally, we applied a 0.02-0.2 Hz band-pass filter to the data to remove heart rate oscillations as well as slow drifts.

To separate and remove physiological confounds from fNIRS data, a general multivariate regression model (general linear model, GLM) analysis (Yücel et al., 2021; Luke et al., 2021) available in the MNE-NIRS package (Yucel et al., 2021) was applied to examine the task-specific neural activity associated with reading, exact calculation in a numerical format, exact calculation in a word format in two experimental groups. We modeled the expected neural response for each experimental condition using the SPM hemodynamic response function (HRF) combined with the stimulus event times and durations. All fNIRS signal changes unrelated to task-specific neural responses were marked as drifts, and included in the design matrix as cosine drift regressors. We specified 5 regressors with a 1/ high pass filter cut off (in our case 0.002 Hz). For every group three contrasts, such as (1) reading versus addition exact calculation in a numerical format; (2) reading versus addition exact calculation in a word format; (3) addition exact calculation in a numerical format versus addition exact calculation in a word format) based on beta-values were calculated.

Additionally, to test if there were task-specific neural activation compared to a non-task baseline activation we compared all three task-related contrasts with resting-state derived contrast. Resting-state was used in our study as a baseline marker of brain activity. Resting state may be considered as a brain activity without work load or any purposeful cognitive process activated and assumed as a 'baseline' for any comparison with task specific activity (Hurlburt et al., 2015), however this view sometimes argues (Morcom and Fletcher, 2007). In our study 3 minutes resting state with closed eyes was used as a new condition with activity unrelated to math or reading. Comparison of three experimental conditions with resting state allowed tracing of changes specific related to calculation and reading in general. Resting state with close eyes was analyzed.

Bootstrapping (random sampling with replacement) with 200 iterations for multiple comparisons correction for every contrast in both groups was applied to reduce the risk of the type I error (false positive) and to overcome the possible problems caused by small samples. Bootstrapping estimates properties of estimands by sampling from an approximating distribution. In our study we applied the following scheme for bootstrapping: first were randomly chosen 14 subjects from the main sample (random sampling), on the next step three contrasts were calculated 200 times (a numerical format versus a word format of the calculation; a word format of calculation versus reading; a numerical format of the calculation versus reading) and 200 beta values for each channel was obtained. A median value for each channel out of 200 iterations was set as a typical beta value for this channel. The significance of each channel was defined based on Z criterion, so that if in more than 50% of iterations the significance was true, the channel was marked as significant. For analyses of statistically significant differences between groups, the pairwise comparisons were made using permutation Mann-Whitney test.

Results

Behavioral results

Table 1 presents the results of the participants' task performance accuracy and response time (RT) are presented in Table 1. The lowest accuracy and response time were observed for calculation problems in a word format. While performing the reading task, both experimental groups showed consistent performance, however, the accuracy was lower and response time was higher across all conditions for low-performers.

Table 1

Mean scores and mean response time within three experimental conditions in groups of high-level and low-level performers

| Group | Task | Accuracy | | Response Time | |
|-------|---------|----------|--------|---------------|------|
| | | Mean | SD | Mean | SD |
| high | reading | 0.930 | 0.0445 | 2.70 | 3.38 |
| | num | 0.865 | 0.109 | 3.16 | 2.85 |
| | word | 0.652 | 0.175 | 5.05 | 3.36 |
| low | reading | 0.851 | 0.239 | 3.05 | 3.04 |
| | num | 0.678 | 0.143 | 3.94 | 2.77 |
| | word | 0.341 | 0.152 | 5.72 | 2.23 |

Note. num – a numerical format of the exact calculation, word – a word format of exact calculation, high – group with high level of math competencies, low - group with low level of math competencies

Table 2 presents the results of the ANOVA comparison between task format and group. The analysis showed significant ($p < 0.01$) differences in the accuracy across the three task conditions (reading, calculation problems in a word format, calculation problems in a numerical format), as well as significant interaction between task format and group. Regarding response time, only the tasks showed significant differences, with no difference observed between high and low groups.

Table 2

Within and between subjects' effects in task and group comparison

| | | Sum of Squares | df | Mean Square | F | p | η^2_p |
|--------------------------|--------------|----------------|----|-------------|--------|--------|------------|
| Accuracy | | | | | | | |
| Within Subjects Effects | Task | 2.691 | 2 | 1.3456 | 117.86 | < .001 | 0.792 |
| | Task * group | 0.223 | 2 | 0.1115 | 9.77 | < .001 | 0.24 |
| | Residual | 0.708 | 62 | 0.0114 | | | |
| Between Subjects Effects | group | 0.916 | 1 | 0.9155 | 18.8 | < .001 | 0.377 |
| | Residual | 1.511 | 31 | 0.0487 | | | |
| Response Time | | | | | | | |
| Within Subjects Effects | Task | 111.656 | 2 | 55.828 | 15.234 | < .001 | 0.330 |
| | Task * group | 0.831 | 2 | 0.415 | 0.113 | 0.893 | 0.004 |
| | Residual | 227.207 | 62 | 3.665 | | | |
| Between Subjects Effects | group | 8.81 | 1 | 8.81 | 0.46 | 0.503 | 0.015 |
| | Residual | 594.62 | 31 | 19.18 | | | |

Table 3 presents the results of the post-hoc analysis conducted on the ANOVA results. The analysis indicated significant differences in the accuracy among all groups (defined by task format and group). Regarding response time, significant differences were observed only between the calculation task in a word format and the other two task formats. The calculation task in a word format showed significantly higher response time than the other two tasks.

Table 3
Post-hoc comparison

| | | | Accuracy | | | | |
|-------|---------|---------------------------------|----------------------------|--------|--------|--------|--------|
| | Factor | Factor | Mean Difference | SE | df | t | Ptukey |
| Task | reading | calculation, a numerical format | 0.12 | 0.0267 | 31 | 4.49 | < .001 |
| | | calculation, a word format | 0.394 | 0.032 | 31 | 12.33 | < .001 |
| | | calculation, a numerical format | calculation, a word format | 0.274 | 0.0185 | 31 | 14.81 |
| Group | high | low | 0.192 | 0.0444 | 31 | 4.33 | < .001 |
| | | | Response Time | | | | |
| | Factor | Factor | Mean Difference | SE | df | t | Ptukey |
| Task | reading | calculation, a numerical format | -0.674 | 0.411 | 31.0 | -1.64 | 0.245 |
| | | calculation, a word format | -2.514 | 0.522 | 31.0 | -4.81 | < .001 |
| | | calculation, a numerical format | calculation, a word format | -1.840 | 0.474 | 31.0 | -3.88 |
| Group | high | low | -0.597 | 0.881 | 31.0 | -0.678 | 0.503 |

Note. high – group with high level of math competencies, low - group with low level of math competencies

fNIRS results

We used GLM analysis and estimated the activation of brain areas for each of three experimental conditions based on statistically significant channel-specific effects, assessed by thresholding a test statistic Z (Yucel et al., 2021). Individuals with high level of math competencies showed significant neural activation in the left angular gyrus (AG), intraparietal sulcus (IPS), and in left inferior frontal gyrus (IFG), and deactivation in the left middle temporal gyrus, specifically in a numerical format of the exact calculation task (Fig. 3, a). In contrast, in the same condition, the group with low level of math competencies showed no significant activation (Fig. 3, b).

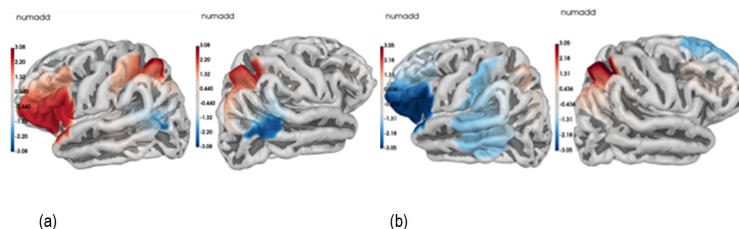


Figure 3. Activation associated with a numerical format of calculation task in (a) group with high level of math competencies, and (b) group with low level of math competencies

Note. Numadd – addition task in a numerical format

Regarding a word format of the exact calculation task, individuals with high level of math competencies did not demonstrate any significant neural activation. However, individuals with low level of math competencies showed significant activation in the right middle frontal gyrus (MFG), right angular gyrus (AG), and intraparietal sulcus (IPS) (Fig. 4, b).

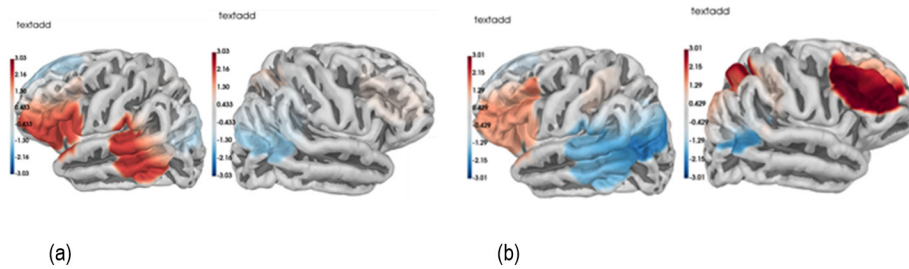


Figure 4. Activation associated with a word format of calculation task in (a) group with high level of math competencies, and (b) group with low level of math competencies
Note. Textadd – addition task in a word format

Regarding the reading condition (without calculation), subjects with high level of math competencies showed increased activation in the left middle temporal gyrus and fusiform gyrus (Fig. 5. a). In contrast, in the same experimental condition, subjects with low level of math competencies showed no significant activation.

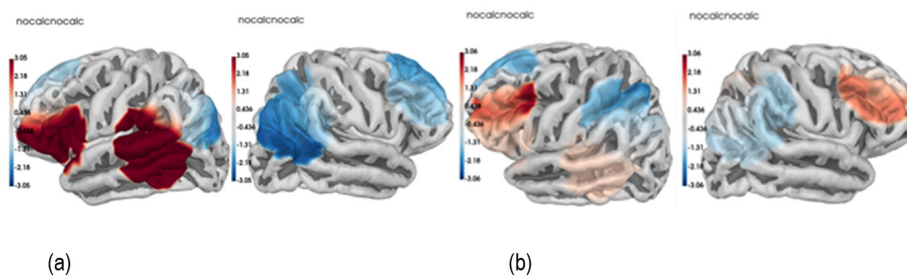


Figure 5. Activation associated with reading of math problem without calculation in (a) group with high level of math competencies, and (b) group with low level of math competencies
Note. Nocalc – reading

On the second level of GLM analysis, the coefficients of neural activation in each channel within different experimental conditions were compared between individuals in a group with high level of math competencies, as well as between individuals in a group with low level of math competencies. In the group of individuals with high level of math competencies, significant activation was identified in the reading task, in comparison to a numerical format and a word format of the exact calculation tasks, in the inferior temporal gyrus and fusiform gyrus (Tables 4 and 5).

Table 4
Beta coefficients of second level of GLM contrast “reading task versus a numerical format of calculation” in high level performers

| | Coef. | Std.Err. | z | P> z | Significant |
|----------------------------|-----------|----------|-----------|----------|-------------|
| ch_name[S1_D1]:Chroma[hbo] | -2.684699 | 2.499011 | -1.074305 | 0.282686 | False |
| ch_name[S1_D2]:Chroma[hbo] | -2.102969 | 2.499011 | -0.841520 | 0.400056 | False |
| ch_name[S2_D1]:Chroma[hbo] | -1.237461 | 2.499011 | -0.495181 | 0.620473 | False |
| ch_name[S2_D2]:Chroma[hbo] | 2.977359 | 2.499011 | 1.191415 | 0.233491 | False |
| ch_name[S2_D3]:Chroma[hbo] | 6.620436 | 2.499011 | 2.649223 | 0.008068 | True |
| ch_name[S3_D4]:Chroma[hbo] | -3.919274 | 2.499011 | -1.568330 | 0.116804 | False |
| ch_name[S3_D5]:Chroma[hbo] | -3.444847 | 2.499011 | -1.378484 | 0.168054 | False |
| ch_name[S4_D4]:Chroma[hbo] | -0.600722 | 2.499011 | -0.240384 | 0.810033 | False |
| ch_name[S4_D5]:Chroma[hbo] | -0.072426 | 2.499011 | -0.028982 | 0.976879 | False |
| ch_name[S5_D6]:Chroma[hbo] | 1.130424 | 2.499011 | 0.452348 | 0.651018 | False |
| ch_name[S5_D7]:Chroma[hbo] | -1.517347 | 2.499011 | -0.607179 | 0.543732 | False |
| ch_name[S6_D7]:Chroma[hbo] | -0.980016 | 2.499011 | -0.392162 | 0.694939 | False |
| ch_name[S7_D8]:Chroma[hbo] | -1.659996 | 2.499011 | -0.664261 | 0.506523 | False |
| ch_name[S8_D8]:Chroma[hbo] | -1.588489 | 2.499011 | -0.635647 | 0.525006 | False |

Table 5
Beta coefficients of second level of GLM contrast “reading task versus a word format of calculation” in high level performers

| | Coef. | Std.Err. | z | P> z | Significant |
|----------------------------|-----------|----------|-----------|----------|-------------|
| ch_name[S1_D1]:Chroma[hbo] | -0.434118 | 1.767808 | 0.245569 | 0.806016 | False |
| ch_name[S1_D2]:Chroma[hbo] | -1.122363 | 1.767808 | 0.634890 | 0.525500 | False |
| ch_name[S2_D1]:Chroma[hbo] | -0.131702 | 1.767808 | 0.074500 | 0.940612 | False |
| ch_name[S2_D2]:Chroma[hbo] | 0.609404 | 1.767808 | -0.344723 | 0.730302 | False |
| ch_name[S2_D3]:Chroma[hbo] | 4.884222 | 1.767808 | -2.762869 | 0.005730 | True |
| ch_name[S3_D4]:Chroma[hbo] | -2.391980 | 1.767808 | 1.353077 | 0.176031 | False |
| ch_name[S3_D5]:Chroma[hbo] | -1.276862 | 1.767808 | 0.722286 | 0.470119 | False |
| ch_name[S4_D4]:Chroma[hbo] | -0.008876 | 1.767808 | 0.005021 | 0.995994 | False |
| ch_name[S4_D5]:Chroma[hbo] | -1.172701 | 1.767808 | 0.663364 | 0.507097 | False |
| ch_name[S5_D6]:Chroma[hbo] | 1.470108 | 1.767808 | -0.831599 | 0.405635 | False |
| ch_name[S5_D7]:Chroma[hbo] | -0.989686 | 1.767808 | 0.559838 | 0.575590 | False |
| ch_name[S6_D7]:Chroma[hbo] | -0.066429 | 1.767808 | 0.037577 | 0.970025 | False |
| ch_name[S7_D8]:Chroma[hbo] | -2.006148 | 1.767808 | 1.134822 | 0.256450 | False |
| ch_name[S8_D8]:Chroma[hbo] | -1.958984 | 1.767808 | 1.108143 | 0.267800 | False |

In the group of individuals with low level of math competencies, a different pattern of significant neural activation was found. In the reading task, in comparison both to a numerical as well as to a word formats of the exact calculation task, significant activation was identified in the inferior frontal gyrus (IFG) and middle frontal gyrus (MFG), particularly in the Broca's area (Tables 6 and 7).

Table 6
Beta coefficients of second level of GLM contrast “reading task versus a numerical format of calculation” in low level performers

| | Coef. | Std.Err. | z | P> z | Significant |
|----------------------------|-----------|----------|-----------|----------|-------------|
| ch_name[S1_D1]:Chroma[hbo] | -3.321510 | 1.777946 | -1.868173 | 0.061738 | False |
| ch_name[S1_D2]:Chroma[hbo] | -0.570957 | 1.777946 | -0.321133 | 0.748110 | False |
| ch_name[S2_D1]:Chroma[hbo] | -0.013137 | 1.777946 | -0.007389 | 0.994105 | False |
| ch_name[S2_D2]:Chroma[hbo] | 1.863506 | 1.777946 | 1.048123 | 0.294582 | False |
| ch_name[S2_D3]:Chroma[hbo] | 2.526878 | 1.777946 | 1.421234 | 0.155249 | False |
| ch_name[S3_D4]:Chroma[hbo] | -2.227532 | 1.777946 | -1.252868 | 0.210254 | False |
| ch_name[S3_D5]:Chroma[hbo] | -0.983827 | 1.777946 | -0.553350 | 0.580023 | False |
| ch_name[S4_D4]:Chroma[hbo] | -1.586537 | 1.777946 | -0.892343 | 0.372209 | False |
| ch_name[S4_D5]:Chroma[hbo] | -1.355199 | 1.777946 | -0.762228 | 0.445924 | False |
| ch_name[S5_D6]:Chroma[hbo] | 3.982777 | 1.777946 | 2.240100 | 0.025084 | True |
| ch_name[S5_D7]:Chroma[hbo] | 3.862199 | 1.777946 | 2.172281 | 0.029834 | True |
| ch_name[S6_D7]:Chroma[hbo] | -1.183841 | 1.777946 | -0.665848 | 0.505508 | False |
| ch_name[S7_D8]:Chroma[hbo] | 1.821818 | 1.777946 | 1.024676 | 0.305516 | False |
| ch_name[S8_D8]:Chroma[hbo] | 1.176466 | 1.777946 | 0.661699 | 0.508164 | False |

Table 7
Beta coefficients of second level of GLM contrast “word versus a numerical format of calculation” in low level performers

| | Coef. | Std.Err. | z | P> z | Significant |
|----------------------------|-----------|----------|-----------|----------|-------------|
| ch_name[S1_D1]:Chroma[hbo] | -0.859091 | 1.822687 | -0.471332 | 0.637403 | False |
| ch_name[S1_D2]:Chroma[hbo] | -2.613143 | 1.822687 | -1.433676 | 0.151665 | False |
| ch_name[S2_D1]:Chroma[hbo] | 2.323436 | 1.822687 | 1.274731 | 0.202404 | False |
| ch_name[S2_D2]:Chroma[hbo] | -1.516720 | 1.822687 | -0.832134 | 0.405333 | False |
| ch_name[S2_D3]:Chroma[hbo] | -0.071017 | 1.822687 | -0.038963 | 0.968920 | False |
| ch_name[S3_D4]:Chroma[hbo] | -0.408854 | 1.822687 | -0.224314 | 0.822513 | False |
| ch_name[S3_D5]:Chroma[hbo] | 0.865124 | 1.822687 | 0.474642 | 0.635042 | False |
| ch_name[S4_D4]:Chroma[hbo] | 0.477964 | 1.822687 | 0.262231 | 0.793144 | False |
| ch_name[S4_D5]:Chroma[hbo] | -2.247213 | 1.822687 | -1.232913 | 0.217608 | False |
| ch_name[S5_D6]:Chroma[hbo] | 4.439445 | 1.822687 | 2.435660 | 0.014865 | True |
| ch_name[S5_D7]:Chroma[hbo] | 2.818197 | 1.822687 | 1.546178 | 0.122062 | False |
| ch_name[S6_D7]:Chroma[hbo] | -0.281116 | 1.822687 | -0.154232 | 0.877427 | False |
| ch_name[S7_D8]:Chroma[hbo] | 2.050653 | 1.822687 | 1.125071 | 0.260559 | False |
| ch_name[S8_D8]:Chroma[hbo] | 2.544455 | 1.822687 | 1.395991 | 0.162717 | False |

We also performed bootstrapping with 200 iterations for multiple comparisons correction for every contrast in both groups. Consistent results were found in a group of high-level performers, with significant neural activation in the inferior temporal gyrus and fusiform gyrus in the reading task in comparison to the calculation in a numerical format, but not in a word format. In the group of low-level performers, significant activation after bootstrapping remained in the left IFG, particularly in the Broca’s area, in a word format of the exact calculation task in comparison to a numerical format.

Furthermore, comparison of task-specific brain activation with brain activation during a 3 minutes resting-state revealed significant differences in low performers during the calculation task in a word format, with activation in the left IFG, particularly in the Broca’s area, and in the right MFG, as well as deactivation in the angular gyrus, Wernicke’s area, and IPS. In high-performers, significant differences were found in the reading task in the left IFG, particularly in the Broca’s area in a word format of the exact calculation task in the Broca’s area, as well as in the ITG and fusiform gyrus and in a numerical format of the exact calculation task in the right AG and IPS, as well as in Broca’s area.

As the experimental groups did not follow a normal distribution, we used the Mann-Whitney test to statistically compare neural activation between individuals with high and low levels of math competencies in reading task and exact calculation tasks, both in numerical and word formats. To correct for multiple comparisons, we used a post hoc permutation test with 90 iterations (Ye et al., 2009; Yucel et al., 2021). Our analysis found statistically significant differences in neural activation in the exact calculation tasks in a numerical format in the right SMG and IPS (U=98, Z=6.9703, p=0.0455). We also observed marginal differences in the left SMG (U=100, Z=6.7507, p=0.0545).

Discussion

We analyzed and compared fNIRS data of subjects from two groups: with low and high levels of math competencies to detect the neural foundations of calculation of two-digits addition problems, both with and without carry effect, in two formats: numerical and word. Additionally, we added a third experimental condition of reading math problems without calculation to account for word processing, and linguistic complexity of text itself, and the relation between linguistic and numerical complexity within a math problem. Two out of three tasks/conditions in our experiment (a numerical format of calculation and reading arithmetic tasks embedded in text) were highly corresponding to school curriculum. However, the third one (a word format of calculation) is not typical for school mathematics tasks and could cause additional involvement of domain-general cognitive processes to solve them. This research is in line with studies investigating the effects of mathematical competency and math task format (numerical and word problems) (Dresler et al., 2009; Obersteiner et al., 2010), as well as with studies that consider brain activation and individual differences in arithmetic performance (Menon et al. 2000; Grabner et al. 2007; Artemenko et al., 2018a). Our study revealed that young adults with high level of math competencies did not have significant differences in engaging frontal or parietal brain areas for solving exact calculation problems in numerical or word formats, while individuals with low level of math competencies recruited left frontal areas associated with language comprehension and understanding of complex sentences for processing problems in a word format, the same as for processing the reading task.

Mental calculation and reading in high level performers

In this study, GLM analysis revealed significant left hemisphere activation in the frontal and parietal regions for exact calculation tasks in exact calculation task in a numerical format, and in the left inferior temporal gyrus and left fusiform gyrus in reading tasks in individuals with a high level of math competencies. The activation of the left angular gyrus, left inferior temporal, and left fusiform gyri could be associated with domain-general abilities, while left IPS activation could be associated with both domain-general and domain-specific abilities. Angular gyrus, especially in the left hemisphere, has been shown to be associated with numerical and mathematical processing, particularly arithmetic problemsolving (i.e., mental arithmetic) (Delazer et al. 2003; Zamarian, Ischebeck and Delazer, 2009; Seghier 2013). It could be linked to the retrieval of numerical information from memory (Dehaene et al., 2003), but in our study it could not be explained solely by fact retrieval. According to the recent review (Sokolowski, Matejko and Ansari, 2022) recent research has suggested that AG activation in high performers could be due to the involvement in mapping numerical symbols and their meaning (symbol-referent theory), as well as engaging bottom-up attention required when an arithmetic solution was recalled from memory. Traditionally, IPS is considered a core region in processing symbolic numerical information and in calculation (Matejko and Ansari, 2017). Left hemispheric IPS activation could be associated with symbolic arithmetic in Arabic notation (Venkatraman et al., 2005; Artemenko et al., 2020). In terms of frontal regions, we found significant activation in the left inferior frontal gyrus, which is a language-related region of arithmetic processing involved in calculations and visuospatial processing (Zamarin, Ischebeck and Delazer, 2009). Left angular gyrus, together with left inferior frontal gyrus, is thought to be involved in exact calculation (Dehaene et al., 1999), and higher activation in the left angular gyrus is associated with a high level of arithmetic skills (Grabner et al., 2007). Deactivation in the left middle frontal gyrus could be associated with decreased demand for working memory load due to automatization of addition. The left temporal gyrus, including the fusiform gyrus, is known to be involved in processing semantic information and word recognition.

The group level of GLM, as well as the bootstrap analysis, revealed brain patterns specific to the reading versus a numerical format of the calculation in the occipito-temporal region, particularly in the left inferior temporal gyrus and left fusiform gyrus. These regions are involved in recognizing symbolic objects (Pammer, Korrel and Bell, 2014; Rüsseler et al., 2018) and processing the phonology of written characters while reading and comprehending text. The fusiform gyrus is also important for reading and can be impaired in dyslexia. Our results suggest that high performers experienced increased workload in reading skills, particularly in transcribing between number words, rather than in calculation skills. The absence of specific activation for math problems in a numerical format as well as in a word format may indicate that this group was able to perform calculations relatively easily without additional brain effort due to the involvement of domain-general processes.

Mental calculation and reading in low level performers

The results of the first level of GLM analysis in the group with low math competencies showed significant activation in the right hemisphere, specifically in the middle frontal gyrus (MFG), angular gyrus (AG), and intraparietal sulcus (IPS), but only in a word format of exact calculation task. The activation of MFG and AG is related to domain-general processes, while IPS is activated during both domain-general and domain-specific processes. In case of a word format of calculation task, angular gyrus might be associated with reading, and interpretation of what is written, as well as arithmetic processing. Within this group, a more workload was necessary for calculation in a word format. Thus, analysis revealed that some patterns of activation are not specific for this format. This finding can be used as an argument in favor of domain-general theories as opposed to domain-specific theories, particularly the Triple-code model. Overall, the calculation-induced increased activation in the parietal regions is consistent with the results of previous studies. In research by [Richter et al. \(2009\)](#), participants calculated or read two-digit addition problems either in a numerical or text format. Calculations in both formats compared to reading task induced parietal activation. This may be partly related to the peculiarities of the tasks used in the study. The study also found that the carry effect was shown to activate several brain regions, including the intraparietal sulcus and the middle frontal gyrus. Previous studies demonstrated that the carry effect induced activation in the bilateral MFG, the cingulate cortex, the left IFG and the left IPS in tasks combining two-digit with single-digit operands ([Kong et al., 2005](#); [Klein et al., 2009](#); [Yi-Rong et al., 2011](#)). Nevertheless, the carry effect and related brain activation analysis was not the aim of this study, so this problem requires further detailed analysis. In line with aforementioned studies, problems with carry effect used in our study in half of the trials might be a possible explanation for middle frontal gyrus that was activated during a word format of math problems. MFG involvement can be explained in two ways. One of them is a categorical effect that is based on the distinction of whether the carry operation has to be applied or not ([Klein et al., 2010](#); [Verner et al., 2013](#)). In our study participants were also constantly required to switch between tasks with carry operation and without it. Another explanation can be related to the working memory which supports the role of place-value integration arising during carry operation with multi-digit numbers ([Owen et al., 2005](#)). The role of working memory in the carry effect in addition is highlighted by a number of authors ([Fürst and Hitch 2000](#); [Imbo, Vandierendonck and De Rammelaere, 2007](#); [Klein et al. 2010](#); [Moeller, Klein and Nuerk, 2011a](#); [Moeller, Klein and Nuerk, 2011b](#); [Nuerk et al., 2011](#); [Caviola et al., 2012](#); [Göbel et al., 2014](#)). Of particular importance is working memory capacity that can predict math performance ([Peng and Fuchs, 2016](#); [Cragg et al., 2017](#); [Fanari, Meloni and Massidda, 2019](#)). According to a number of authors, the phonological loop (the verbal component of working memory) is crucial for exact calculations ([Frisovan den Bos et al., 2013](#)). The role of working memory in exact calculations is related to the phonological loop (the verbal component of working memory) being crucial for encoding and processing number words, which is important for math word problems solving. Additionally, working memory is involved in manipulating number words, such as performing arithmetic calculations and retrieving arithmetic facts from long-term memory ([Lavander-Ferreira, 2020](#)). At the same time, our results support findings of other authors that confirm involvement of parietal areas in the carry effect ([Artemenko et al., 2018a](#)). Nevertheless, carry effect and related brain activation analysis was not the aim of this study, so this problem requires further detailed analysis.

Generally, the second level of GLM analysis and analysis after bootstrapping showed consistent results in the low performers. GLM revealed an increased activation in tasks involving word problems (a word format of exact calculation and reading task) in the frontal cortex, including Broca's area, and IFG. Although Broca's area and inferior frontal gyrus are thought to be crucial regions for speech production, some investigations demonstrated its involvement in comprehension of complex sentences ([Grewe et al., 2005](#)). Our results are consistent with previous findings that report higher activation of inferior frontal regions in high-ambiguity sentence processing ([Rodd et al., 2005](#)): possible ambiguity is associated with an unusual format for presenting math problems in a word format and arithmetic tasks embedded in text that do not require solving. Analysis after bootstrapping demonstrated an increased activation in exact calculations in a word format compared to numeric format in the Broca's area and left inferior frontal gyrus. Thus, the predominant role of the frontal regions in comprehension was confirmed.

Differences between young adults from groups with high and low levels of math competences

It's worth noting that significant activation in low performers was mostly in the same brain regions as in high performers, however in right hemisphere, but not in left hemisphere. In the literature there were some viewpoints that cerebral hemispheres played different roles in processing information depending on the solution strategy applied to solve the task. Solution-irrelevant interpretations of words in the problems might lead to rough semantic coding associated with the right hemisphere ([Beeman and Bowden, 2000](#)).

Therefore, a possible explanation is that the right hemisphere is activated in stressful situations. In our case, for most individuals, due to their low math performance, solving exact calculation tasks in a word format was stressful. In support of this finding, previous studies found that right dorso-lateral prefrontal cortex (DLPFC) activation is associated with high trait anxiety (Basten, Stelzel and Fiebach, 2012). MFG can be referred to as DLPFC. Klados et al., (2015) reported frontal changes during arithmetic calculation that are thought to be related to the influence of math anxiety on working memory. However, our results demonstrated activation patterns versus deactivation shown in some other studies (Klados et al., 2015). Nevertheless, our assumption about the effect of anxiety needs additional investigation.

Another important finding was the detected specificity in the groups of low and high performers, which indicated differences in the mechanisms for solving the same type of tasks depending on the level of mathematical competence. This result is consistent with the neural efficiency hypothesis, according to which individuals with higher intelligence spend less brain resources on solving cognitive tasks (Nussbaumer et al., 2015). This is expressed in the absence of differences in activation during solving math problems in various formats in high-level performers in our study. In low-level performers, there were significant differences in activation in different formats of exact addition problems solving. Between-groups comparison showed statistically significant differences in neural activation in exact calculation tasks in a numerical format as well in bilateral supramarginal gyrus (SMG) and right intraparietal sulcus. The SMG is known to be involved in complex calculation due to the high demands of visuospatial working memory (Zago et al., 2001). Two-digit non-overlearned calculation is regarded as recruiting storage of intermediate results in a short-term memory to successfully solve the math problem (Menon et al., 2000). Therefore, our findings might indicate specific activation for calculation based on the differences in performance.

Differences between task-induced activation and resting state

Comparison of brain activation during tasks and resting state also revealed a certain heterogeneity in brain mechanisms of math abilities. In the high performing group, all three conditions were associated with higher involvement of Broca's area and inferior frontal gyrus, as well as some task-specific activation. As mentioned previously, the Broca's area and IFG could be related to understanding complex sentences. Involvement of Broca's area and IFG in the math processes could possibly be attributed to the reading of the actual presented stimulus (Rogalsky, Matchin and Hickok, 2008; Klein et al., 2015). Reading numerals written in a word format in our study and subsequent analysis of semantics, however, might be related to two opposite processes. On the one hand, activation of speech-related areas could indicate the process of transformation of any numerical information into semantic form followed by the calculation process. On the other hand, it might reflect the process of transformation of any symbolic information into nonsymbolic form for the following calculations. Considering higher activation of Broca's area in a word format of calculation in this study, we might have weak evidence for the second process, however this evidence is far from decisive and the first process might be more important for math abilities, both processes might operate simultaneously. This problem needs to be addressed additionally in future research. In the low-performing group, only a word format of calculation task significantly differed from resting state, with higher activation in Broca's area, inferior frontal gyrus and middle frontal gyrus and lower activation in angular gyrus, Wernicke, and IPS. This pattern of activation seems to be consistent with the inter-task comparison. We detected no significant difference in activation between resting state, reading task and a numerical format of the calculation task. The absence of any task-induced activity could be the result of weak implication of executive functions (Bull and Lee, 2014). People with weak executive functions demonstrate difficulties in remembering and following instructions, inhibiting irrelevant information and staying focused on task, as well as quickly choosing appropriate task strategies. There might be a substantial variability in brain mechanisms related to poor performance in calculations and this variability prevents statistically significant difference in activation induced by resting state and tasks. Therefore, high and low levels of performance in calculations might be attributed to different neurocognitive mechanisms.

Limitations

Our study has several limitations. Firstly, we have a relatively small sample size and have used group comparison as the primary method of assessing the level of math competence. Secondly, we did not fully estimate the differences between the two groups, and it may be important to use more appropriate methods for comparing group (or individual) performance within one condition. Thirdly, our analysis was limited to four areas of interest and did not cover the whole brain activity. Finally, we did not assess carry/no-carry effects and compare addition from the perspective of brain activation during various conditions. We plan to address all these limitations in future studies.

Conclusions

Our study aimed to measure brain activation in frontal and parietal regions using fNIRS to investigate the neural correlates of exact calculation problems with two-digit numbers in different formats (word versus numerical). We found that tasks in word and numerical formats activate different areas of the brain, since these two formats of presenting arithmetical problems differ in the amount of cognitive effort required and processes involved in calculation. Our findings support domain-general theories in numerical cognition, which suggest that both domain-specific skills such as magnitude processing, and domain-general skills such as working memory, fact retrieval, and attention are involved in mental calculation. Solving of arithmetical problems presented in a word format requires several steps, including understanding the verbal information underlying mathematical relations, and transitioning to symbolic mathematical expression. This processing of numerical information is more complex, and results in higher oxygen consumption compared to solving numerical problems. We also found that the patterns of neural activation differed between individuals with low and high levels of math competencies. Low performers demonstrated right hemisphere activation, while high performers showed left hemisphere activation. Right hemisphere activation in low performers when solving exact calculation tasks in a word format might be stress-induced, as solution-irrelevant interpretations of words within a task might lead to rough semantic coding associated with the right hemisphere. We observed increased activation in the Broca's area and left inferior frontal gyrus in low performers when solving problems in a word format compared to a numerical format. In high performers, we found increased activation in the occipi-to-temporal region, particularly in the left inferior temporal gyrus and left fusiform gyrus, when solving problems in a reading format compared to a numerical format. In summary, our findings demonstrate that the neural correlates of two-digit exact calculation in numerical and word formats differ in individuals with low and high math competencies. These results suggest that future research should consider cognitive performance when describing neurocognitive mechanisms of calculation.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, study design and stimuli preparation: M.A.S., J.A.M. and T.V.A.; software for preprocessing and analysis: G.O.P., R.G.A.; data collection and analysis: MAS and R.G.A.; writing-original draft preparation: M.A.S., J.A.M. and T.V.A.; writing-review and editing: M.A.S. and J.A.M. All authors approved the final version of the manuscript for submission.

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Representation of Roma Content in Curricula and Textbooks at the Initial Education Level in Serbia

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Abstract: The 1989 Convention on the Rights of the Child guarantees all children the right to an education, and this paper focuses on Roma children and that right. The extent of Serbia's strategy documents was reviewed, particularly in light of their responsibility for guaranteeing equity, accessibility, and equal educational opportunities for all children. The study's objective is to assess how content related to the Roma is portrayed in current curricula (N = 16) and textbooks (N = 93) for the 2022–2023 academic year. It was discovered that despite the objectives in each of the analyzed courses (Serbian language, The World around Us, Nature and Society, Music Education, and Civic Education) clearly promote equality, diversity, and mutual appreciation, democratic values, inclusion, and anti-discrimination, none of them explicitly mention the words Roma or the Roma people. Only a few times do the Roma people explicitly appear in textbooks on nature, society, and music, and then only as a numerical representation of the national minority; no mention is made of the positive traits of the Roma people, who have their own identity, tradition, and culture as well as well-known members. The results highlight the need for textbooks to include specific content about the Roma people as fundamental teaching tools. This content should also be included in the curriculum because it would help students of Roma origin feel less excluded and more empowered to participate in school on an equal footing.

Keywords: right to education, initial education, Roma people, Roma students, non-discrimination.

Introduction

The Roma community, with over 10 million people, is the largest ethnic minority group in Europe, according to UNICEF data from 2011. Throughout Central and Southeastern Europe, mostly in Bulgaria, Hungary, Romania, Serbia, Slovakia, North Macedonia, the Czech Republic, and Poland, there are primarily over 70% of Roma. Their academic achievements are much lower than those of other children in each of these nations. Even while it is highlighted that this scenario in Serbia has been worse over the past 20 years, they have even less probability of finishing their education (Apostolović, 2019). Numerous studies reveal that Roma children continue to be excluded from educational practices even in the modern era, despite the widely accepted doctrine of human rights, the Convention on the Rights of the Child, and the Millennium Development Goals, which explicitly stated that every child has a right to an education (Aleksandrović, Macura and Trikić, 2012; Baucal, 2012; Marković Čekić, 2016).

This paper focuses on Roma children and their right to an education in Serbia. Every child has the right to a high standard of education thanks to the ratification of the [Convention on the Rights of the Child in 1990](#), the passage of the Law on its ratification in 2001, and the Republic of Serbia's Constitution in 2006. In order to ensure that everyone has an equal opportunity to receive a high-quality education, the established policies of public documents in the field of education (Law on the Basics of the Education System and Education; Law on Preschool Education; Guidelines on the Basics of the Preschool Education - Years of Ascent, 2018) were established. As such, they can be used as a tool to end social inequalities. There is a good likelihood that this will not be sufficient to support further significant advancements in the problem of addressing the Roma population's general social and economic involvement in the currents of society, as well as their inclusion in the public school system. The majority of the Roma population is

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severely impacted by poverty and social exclusion, and they continue to be a victim of both overt and covert discrimination, especially in the area of education, according to [Serbia's strategy for the social inclusion of Roma and Roma women for the years 2022–2030](#).

The first section of this paper examines the educational opportunities for Roma students from the perspective of children's rights established by the 1990 UN Convention on the Rights of the Child, with a focus on one of its fundamental principles: nondiscrimination (Article 2); and articles 28, 29, and 30 regarding education. The curricula for classroom subjects are then examined to get a picture of whether there is content in lessons about the Roma population. The textbook is then seen as a tool for the operationalization of curricula and one of the fundamental teaching tools in the Serbian education systems ([Law on Textbooks, 2018](#)), which can help reduce prejudice and stereotypes, influence the promotion of mutual understanding, respect for diversity, and tolerance, and help develop critical thinking about those who are different from oneself as a barrier against distance, division, and conflict ([UNESCO, 2017](#)). The aforementioned elements of textbooks for Serbian pupils in the first level of education were taken into consideration by assessing the content of 93 textbooks.

The [1948 Universal Declaration of Human Rights](#) established, among other things, the right to education and mandated that states strengthen the observance of fundamental liberties and human rights. The significance of human rights education is reiterated in [the 2011 United Nations Declaration on Education and Training for Human Rights](#) (it covers all social strata and all forms of education - Article 3, paragraph 2). Every child has the right to education and the right to education of a sufficient standard under [the 1989 United Nations Convention on the Rights of the Child](#), which states this specifically in Articles 28 and 29. Serbia committed to ensuring children's wellbeing through respect for their rights when it ratified the [Convention on the Rights of the Child](#) on December 18, 1990. The Committee on the Rights of the Child of the United Nations continuously monitors Serbia's compliance with this commitment (UN). According to the 2017 Report for Serbia, the government should launch campaigns at all levels and in all provinces to address negative social attitudes toward Roma. It should also take decisive action to stop violence and hate speech against Roma and ensure that all applicable laws prohibiting discrimination are fully implemented, which includes stepping up public education campaigns that address these attitudes.

While the [Strategy for the Development of Education](#) in the RS until 2030, for the following period, specifically emphasizes the need to strengthen the educational role of the school, the Constitution of the Republic of Serbia (2006), the country's highest legal document, stipulates the right to education under equal conditions (2021). Dedicated to the goal of Serbia as a society in which Roma men and women exercise their rights without prejudice, the [Strategy for Social Inclusion of Roma Men and Women in the Republic of Serbia between 2022 and 2030](#), and the leading principle for the overall education states that it is necessary to "...ensure that everyone has access to education and can exercise their right to it equally, without discrimination and in accordance with social justice and equal opportunity" ([Ibid: 33](#)).

According to Article 9 of the [Law on Primary Education in the Republic of Serbia](#) from 2019, the primary responsibility of the school is to ensure that each child and student receives a quality education under equal circumstances. Other objectives include the development of positive human values, the advancement of racial, national, cultural, linguistic, religious, gender, and age equality, as well as tolerance and respect for diversity (Article 21). In order to achieve the desired results, students must be able to actively participate in the realization of human and children's rights, as well as recognize and respect other people's traditions, identities, and cultures and be able to work cooperatively with them ([Ibid: 6-8](#)). The teaching materials, which are chosen based on the curricula, are the foundation upon which the aforementioned is most fully realized. This paper presents a thematic analysis of the representation of Roma in curricula at the level of initial primary education in Serbian schools, and then in the textbooks from which they learn, in an effort to provide an answer as to what are the possibilities to contribute to the learning content to increase tolerance towards Roma, and help Roma students to reduce the problems that distance them from other children. The responses provided would guide efforts in identifying solutions so that the content's selection and didactic-methodological transformation could positively affect the motivation of Roma students on a personal level (learning, attendance, academic achievements), as well as in the course of their social integration into the school community. Seeing Roma education in Serbia from the perspectives of interculturality in raising, education, and inclusive teaching is necessary. The fact that the education of pupils from the Roma population is legally regulated in many ways in the Republic of Serbia illustrates how important it is to observe this process from the perspective of interculturalism ([Petrović, 2016](#)). These are also supported by the findings of various studies that have been published in prominent magazines around the world. They demonstrated how a distinct approach to the development and teaching of Roma students produces the desired educational results in the classroom. When teaching and learning are implemented with the goal of developing the identity belonging of Roma students to the

Roma people, better benefits are also achieved in the academic and social development of students of the Roma population. According to some studies done in the Republic of Serbia (Milenović, Lapat and Aleksandrović, 2011) and England (Gül and Eren, 2018), teaching the Roma population's students is more engaging when it incorporates material from their history, tradition, culture, folklore, and especially music. In these situations, they are also more interested in participating more in the teaching process and their learning. With this approach, the Roma in Serbia (as well as other national minorities and ethnic communities facing comparable challenges) can receive equal rights as well as the greatest possible conditions for education (Ilić, 2010).

By respecting some of their differences, educational needs, and interests, the aforementioned idea helps society to accept and value Roma as they are. This seems especially important in the beginning of education, as a proportion of Roma pupils self-segregate for a variety of reasons (Suzić, 2007). There is also an agreement that one of the causes of the Roma population's pupils' deficient participation in teaching and their learning is the Roma population's insufficient support for education, especially for education that is not required by law (Milenović, Lapat and Aleksandrović, 2011). Relationships in society, the social standing of the Roma population, the economic crisis, and other variables that inevitably have an impact on the entire society all play a significant role in this predicament. The situation is similar when it comes to other minority communities in Serbia, such as the Vlasi population in the area of Homolje and the Gorani population in Kosovo and Metohija, even though the subject of this study is the representation of elements and content about Roma and the Roma population in curricula at the level of initial education (Milenović, Lapat and Aleksandrović, 2011), including also places where the bulk of the population is Serbian, as in the area of the Gadžin Han municipality in Zaplanje region (Milenović, 2013), where there are likewise no elements and content in the curricula and textbooks at the primary education level. The findings of numerous studies conducted abroad (Bjartveit and Panayotidis, 2017; Otsuka and Jay, 2017) demonstrate the significance of textbook contents that present information about a particular society's concepts and are in line with the analyses presented in the theoretical approach to the problem under study in this paper.

Materials and Methods

The objective of this paper is to analyze teaching curricula in terms of the presence of components that relate to Roma and the Roma population and to identify teaching materials that at the primary education level include references to Roma and the Roma population.

The research was based on the general premise that, at the level of primary education known for self-segregation, elements referring to Roma and the Roma population are an important motivating tool for greater inclusion of Roma students in teaching. However, because they are not sufficiently represented in curricula and textbooks, the expected educational effectiveness in greater involvement of Roma students in teaching is lacking. Additionally, it was based on the specific supposition that the research would establish the content of the underrepresented Roma population-related teaching programs at the primary education level and in the textbooks for the subjects Serbian Language, The World Around Us, Nature and Society, Music Education, and Civic Education.

Sample and Procedure

A sample of textbooks and teaching materials made up the research sample. The initial education sample of teaching programs included 16 curricula for the following subjects in all four grades: Serbian language, The World Around Us, Nature and Society, Music Education, and Civic Education. The study examined four curricula from the group of compulsory subjects as well as one optional course (Civic Education) for the first four grades of primary school. The analysis excluded the optional subject of Roma language with national cultural aspects. The phrase Roma, Roma people, or syntagms were specifically used as the program's analytical unit: Roma song, story, legend, music, and dance (in words or pictures). Content on the following subjects, which the textbook would implicitly support: children's rights, filial piety, democracy, equality and tolerance, diversity, respect for the other and different, would assist the teacher in explaining these concepts in class from the perspective of the Roma population (in words or pictures).

The textbook sample consisted of approved textbooks (For all subjects in the first and second cycles of initial education, new textbooks have been approved, and curricula have been restructured as of the 2018–19 academic year (author's note)) published by the publishers that are most frequently used in schools (Table 1). A sample of 93 textbooks were examined for the textbook study. Textbooks describe each lesson—or portion of a lesson—in which the Roma are depicted in verbal or visual form, either

explicitly or implicitly—as a unit of analysis. The selected textbooks were reviewed in their entirety. The presence of the terms “Roma,” “Roma people,” or syntagms such as “Roma song,” “Roma tale,” “Roma music,” or their equivalents was identified during the quantitative review.

Table 1

List of analyzed textbooks - publishers

| No. | Publisher | Year of publication | Place of publication |
|-----|--------------------|---------------------|----------------------|
| 1. | Zavod za udžbenike | 2020 | Belgrade |
| 2. | Kreativni centar | 2019 | Belgrade |
| 3. | Novi Logos | 2020 | Belgrade |
| 4. | Klett | 2019 | Belgrade |
| 5. | Vulkan izdavaštvo | 2021 | Belgrade |
| 6. | Freska | 2020 | Belgrade |
| 7. | Eduka | 2021 | Belgrade |
| 8. | BIGZ-školsvo | 2020 | Belgrade |
| 9. | Nova škola | 2021 | Belgrade |

With these information, typical descriptive statistical techniques were applied as well as an examination of their frequency. The techniques of analysis, comparison, and generalization were all incorporated in qualitative analysis. The current information regarding the Roma was taken into account, and the way in which they were specifically portrayed in the textbook lessons was examined. Answers to the following questions: How are Roma people portrayed? What types of stereotypes exist, if any? What other situations could the Roma still be included in textbooks, and in which thematic contexts are the Roma mentioned? (friendship, empathy, mutual help, togetherness). Research matrices (for textbooks and programs) made specifically for the examination served as the research instrument.

Instrument

The study was carried out during the first semester of the 2022–2023 academic year. Historical, descriptive, transferal and comparative methods were used. By examining the material in textbooks and curricula, research data was gathered. Standard record lists created for the needs and scope of the research are known as research instruments.

Statistical analysis

By calculating frequency (N) and percentages (%), descriptive statistics were used to analyze the research data. Tables are used to present the research findings.

Results

The research findings are provided according to the calculated frequencies and percentages based on examined curricula and textbooks.

Curricula

According to the curricula at the level of primary education in Serbia, it is found that the following objectives are clearly positioned among those of primary education: offering a stimulating and safe environment for students' total development - with nonviolent behavior and zero tolerance for violence; thorough development of each student in accordance with age, needs, and interests; developing solidarity, understanding, and cooperation; and fostering friendship; development of positive human values; developing competencies for understanding and respecting children's rights, human rights, civil liberties; development and respect for racial, national, cultural, linguistic, religious, gender and age equality, tolerance and respect for diversity; as well as the development of personal and national identity, tradition and culture of the Serbian people and national minorities ([Law on the Fundamentals of Education, 2019](#)). The objectives are accomplished with the help of curricula, which are viewed in this paper from the perspective of compulsory subjects. These are: the Serbian language; The World around Us; Nature and Society; Music Education; and Civic Education, which is an elective subject. The goal of the paper was to find content that will aid in achieving the stated objectives and mention or make reference to students from the Roma population. The study discovered that none of the curricula for the aforementioned subjects explicitly mentions the terms “Roma” or “Roma people” (Roma song, story, legend, music, or game).

First grade. The word “Roma” or any materials on this subject are not included in the Serbian

language curriculum for the first grade. The student will be able to behave in a way that respects the diversity of his peers and other people after finishing the first grade, according to the program for the World around us, which lists this as one of the outcomes ([The Guidelines on the Curricula for the First Grade of Primary School, 2017: 28](#)). The following thematic units' material make this possible: Me and Others (Similarities and Differences by Gender, Age, Ability, and Interests), as well as the topic Family Home, School (Groups of people: family, school community, class, neighbors; Rights and obligations of group members; Rules of conduct for individuals and groups; Holidays: family, school). Also, the document expressly omits any references to the Roma and their population. The word "Roma" does not appear in the Music Education curriculum, and neither do any of the songs or dances (although, for instance, in the Musical Dance section of the curriculum, there is a Slovak song: Pisma u kolu [Singing in a circle dance]) ([Ibid: 38](#)). The curriculum for the mandatory elective subject Civic education defines as learning objectives (among others): "...that, after completing the course, the student will be able to notice mutual differences and similarities with other students in the class, will be able to behave in a way that does not endanger the needs, rights and feelings of others, recognizes examples of respect and violation of children's rights in their environment, stories, films" ([Ibid: 47](#)). These learning objectives are made possible especially by Areas/Topics: Human rights: Me and others in the class (through content about the talents and interests we possess, as well as our similarities and differences, the needs and rights of the child - recognition of rights, as well as recognition of their violation); and Democratic society: Class/group as a community (contents on equality, responsibility and solidarity in the class, respect and concern for others, tolerance, fairness, honesty, as well as respect for diversity). It can be said that the curricula for the subjects The World Around Us and Civic Education through specific topics enable the inclusion of some content about the Roma, which would contribute to the realization of the set outcomes, even without the stated explicit presence of the word Roma/Roma song, story, legend, music, or dance.

Second grade. In the second-grade Serbian language course's curriculum, the term "Roma" is not mentioned. [The Guidelines on the Curricula for the Second Grade of Primary School \(2018: 48\)](#) state that one of the learning objectives of the subject "The world around us" is that the student will be able "...to behave in a way that respects the differences of other people." However, there are no specific contents that mention the Roma. Through individual and group musical experiences, which foster the growth of creativity, aesthetic sensibility, and a sense of community as well as a responsible attitude towards the preservation of one's own and other nations' musical heritage and cultures, the teaching and learning of music aims to foster students' interest and love for music ([Ibid : 60](#)). The word "Roma" does not appear in the Music Education curriculum, and neither do any of the music or dances. One of the learning objectives of the Civic Education curriculum is that "the student is able to state and explain in his own words the basic rights of the child contained in the [Convention on the Rights of the Child](#); as well as to accept and explain with examples from life that every child has the same rights regardless of differences" ([Recommendation of the Committee of Ministers, 2020](#)). Certain Areas/Topics are used to meet these objectives: Human rights - I and others in different groups (contents about expressing our own feelings, feelings of others, how we recognize and appreciate them; connections of feelings with thoughts and behaviors; convention on children's rights - we are different, but our rights are the same; human rights apply everywhere and for everyone; violation and protection of rights - I am not an observer, I react to situations of violation of children's rights in the class and school).

Third grade. The third-grade Serbian language curriculum does not include any required books about the Roma. Understanding and appreciating the similarities and differences between individuals and groups is one of the tasks in the Nature and Society course ([The Guidelines on the Curricula for the Second Grade of Primary School, 2019: 76](#)). The topics of Human activity - population of our region (similarities, differences, coexistence), children's rights, and group norms (knowing, respecting, and living in accordance with them) were stated as the contents with which it is realized ([Ibid: 76](#)). One of the three learning objectives of the Music Education curriculum is to "develop sensitivity to musical values by getting to know the musical traditions and culture of one's own and other nations," which is accomplished by "getting to know the traditional and artistic music of one's own and other nations," according to the program ([Ibid: 85](#)). Nevertheless, not a single piece of content makes any reference to the Roma community. Developing students' awareness of the importance of respecting diversity and individuality, identifying and eradicating stereotypes related to gender, age, appearance, behavior, and origin, and empowering students to understand and respect children's rights and be able to actively contribute to their realization are all tasks that are explicitly mentioned in the Civic Education curriculum ([Ibid: 119](#)). The specific learning contents which allows these objectives to be met refer to: appreciating diversity and uniqueness; recognizing and overcoming stereotypes related to gender, age, appearance, behavior, and origin; the occurrence of exclusion from the group (considering differences that do not

please them - exchanging experiences and reasons for exclusion from the group); behavior that deviates from the expected (observing the effects of a sympathetic or judgmental attitude); and the occurrence of exclusion from the group (exchange of sanctions for breaking agreements between children, whether revenge is a moral offense, what is fair, how to resolve a conflict of needs non-violently).

Fourth grade. The Serbian language curriculum for the fourth grade includes no texts that mention Roma. It is advised to select at least three more, and no more than five more, literary works to cover as supplementary ones, therefore, it might be possible that some of these texts may be used in the lesson plan (although there is not much optimism for that, and in any case, their eventual presence cannot be traced). One of the objectives for the course Nature and Society is that the student "...will be able to accept national and cultural variety as a basis for the coexistence of all inhabitants of the Republic of Serbia" after completing the course ([The Guidelines on the Curricula for the Second Grade of Primary School, 2019: 42](#)). Specific topics include interculturality, Serbian nationals' rights and obligations, and societal aspects of Serbia (Topic: Natural and social characteristics of Serbia). For example, "...developing interest and love for music through individual and collective musical experience that encourages the development of creativity, aesthetic sensibility, and the spirit of community, as well as a responsible attitude towards the preservation of musical heritage and culture of their own and other peoples" is one of the objectives of Music Education course in the fourth grade ([ibid: 47](#)). The Roma are not specifically mentioned in any of the compositions for listening, singing, or performing within the curriculum, nor are the Roma people's representatives the compositions' writers. "...The ability to argue the benefits of the common life of people belonging to different cultures, while citing elements of their people's traditions and culture and showing interest and respect for other cultures and traditions [...] giving examples from everyday life lives that illustrate the meeting of different cultures, and discusses how ignorance of other cultures affects the emergence of stereotypes, preconceptions, and prejudices," is one of the objectives of the Civic Education elective course ([ibid: 55](#)). In this way, the following concepts are learnt through the thematic unit Democratic society - culture and tradition: cultural identity (cultivating one's own traditions and culture while respecting the traditions and culture of others); multiculturalism and interculturality (living next to or together with people of different cultures); and meeting cultures (meeting and permeating different cultures without losing cultural identity).

Textbooks

This section of the paper evaluates the material on the Roma in the Serbian language, the World around Us, Nature and Society, Music Education, and Civic Education textbooks.

Table 2

The presence of the terms Roma, Roma people/Roma song, story, legend, music, game in reading books from the 1st to the 4th grade of primary school

| Grade | Number of reviewed reading books | Overall number of texts | Explicitly | | | | Implicitly | | | |
|--------|----------------------------------|-------------------------|------------|----|-------|----|------------|-------|-------|-------|
| | | | Text | | Image | | Text | | Image | |
| | | | f | % | f | % | f | % | f | % |
| I | 7 | 338 | 0 | 0% | 0 | 0% | 1 | .29% | 3 | .88% |
| II | 6 | 294 | 0 | 0% | 0 | 0% | 2 | .34% | 2 | .34% |
| III | 8 | 322 | 0 | 0% | 0 | 0% | 4 | 1.24% | 1 | .31% |
| IV | 8 | 442 | 0 | 0% | 0 | 0% | 5 | 1.13% | 2 | .45% |
| Total: | 29 | 1396 | 0 | 0% | 0 | 0% | 12 | 3% | 8 | 1.98% |

Serbian language. Roma are not directly mentioned in any of the 29 reading materials from first to fourth grade that were examined; instead, they are only mentioned indirectly through certain textual issues in percentages ranging from .29% to 1.24%. (Table 2). In order to preserve the traditions and culture of the Serbian people and promote intercultural understanding, one objective of Serbian language subject curriculum at the primary education level, among others, is to enable students to interpret chosen literary and other artistic works from the Serbian and global heritage. The investigation of the reading materials reveals that not a single piece of content in them overtly features the Roma, either directly or through a Roma tale, legend, tradition, or myth. Two required texts about the Roma were eliminated from the new third and fourth grade curricula (The fairy tale about the white horse, i.e. The Gypsy praises his horse), so there are no contents about the Roma population from the 2019 editions and onwards. This indicates that these items may appear if they fit inside the parameters of the aforementioned additional (supplementary) programs (at least three more, and at most five more works to be used). As a result, a third-grade reading book contained the amusing folktale *Da imamo masla* [If we had butter]. Three gypsies—a gypsy woman, a gypsy boy, and a gypsy man—serve as the story's main characters and all have fantasies involving pie. The family imagines butter, flour, a bakery oven, and a dinner that will make them feel better, with the

humorous educational lesson that one should not eat everything by himself. Although other peoples, races (Chinese, Africans, Eskimos), and children with disabilities (According to the new Guidelines on detailed instructions for identifying the right to an individualized education program, its application and evaluation from 2018, the term persons with additional support needs in education is used.), do feature in some of the reading books that were analyzed (in certain contexts), there is not a single photo or depiction that, in any context, clearly portrays a member of the Roma people. If we are talking about texts that encourage tolerance, understanding of diversity of any kind (in terms of age, interest, behavior, etc.), democratic values, and respect for others, then the following examples may be taken as implicitly encouraging the Roma issue as an issue of one of the groups of people that has issues with the majority.

If we are talking about texts that in reading books promote tolerance, understanding of diversity of any kind (in terms of age, interest, behavior, etc.), democratic values, respect for others, then the Roma issue as an issue of one of the groups of people that has problems with the majority, can implicitly perceive prompted by the following few examples. One reading book for the fourth grade includes supplementary reading Socializing, going out and having fun, the part of which explains how to act when you find yourself in the company of a person with developmental disabilities or a person with a disability. In the same reading book, there is also the text I am different from others, which instructs the student that the image of ourselves often leads to a loss of self-confidence, and offers solutions in the form of avoiding mean people, talking to those we trust and strengthening personal abilities. Another publishing house has included Check if you are a good friend - Test for a student in the reading book for the fourth grade (a friend should be listened to and understood, a friend should be helped), one also contains the title Etiquette - about tolerance; or for example the supplementary text About the Button and Happiness, which talks about the situation when children with developmental disabilities are avoided by other children. The analysis reveals that there are no Roma texts in reading materials, despite the fact that they are a teaching tool with a significant capacity for educating students with the help of texts and the didactic-methodological apparatus (which accompanies them in the analysis). However, there are no such mentions within the context of themes like unity, good manners, tolerance, diversity, etc., which might at least obliquely include the Roma people.

Table 3

The presence of the terms Roma, Roma people/Roma song, story, legend, music, game in the textbooks "The World Around Us" and "Nature and Society" from the 1st to the 4th grade of primary school

| Grade | Number of reviewed textbooks | Overall number of texts | Explicitly | | | | Implicitly | | | |
|--------|------------------------------|-------------------------|------------|-------|-------|------|------------|-------|-------|-------|
| | | | Text | | Image | | Text | | Image | |
| | | | f | % | f | % | f | % | f | % |
| I | 6 | 268 | 0 | 0% | 0 | 0% | 2 | .74% | 0 | 0% |
| II | 6 | 239 | 0 | 0% | 0 | 0% | 1 | .41% | 1 | .41% |
| III | 7 | 322 | 7 | 2.17% | 1 | .31% | 12 | 4.03% | 2 | .62% |
| IV | 8 | 354 | 11 | 3.11% | 1 | .28% | 15 | 4.23% | 6 | 1.69% |
| Total: | 27 | 1183 | 18 | 5.28% | 2 | .59% | 30 | 9.41% | 9 | 2.72% |

The World Around Us and Nature and Society. The subject World around us in the first and second grade textbooks does not explicitly include Roma. The analysis of the textbooks revealed the implicit representation of the Roma population. This is consistent with the established fact that the first grade World Around Us subject curriculum includes content about the individual and the group, the observation of similarities and differences, relationships within the group, and behavior. Out of a total of 268 lessons, there was text on good behavior and feelings in two lessons (.74%). The student is guided by their methodological apparatus to address the issue of When Nobody Understands Me, that is "how can I help a friend who is withdrawn and always by themselves in class", which provides the opportunity to discuss Roma students in class and open up other significant topics for them. A dark-skinned child is shown in one of the images from the lesson Others and Myself. The percentage of even implied mention of the Roma issue in second-grade textbooks is much smaller (.41%). (Table 3). The analysis of 322 lessons from the 7 textbooks under review revealed that Roma explicitly appear 7 times, while in one textbook, in the lesson titled Residents and peoples of the region, a picture of the town square with various people was presented. This is in accordance with the thematic units of the Nature and society subject curriculum in the third grade, which talks about the population of the region, children's rights, and group rules. Look at the picture, says the assignment in the textbook. Do the actions of the persons depicted on it strike you as having any striking parallels or differences? and the pupil ought to recognize a young Roma musician, among other things.

The textbooks in this grade provide the opportunity for discussion about others and those who are different from oneself (implicit appearance in 12 courses), and the teacher may also discuss many facets of the Roma population. Students learn about Serbia's social characteristics and evolution in the

fourth grade, including its population, democratic way of life, rights, and respect for one another. Roma are specifically mentioned in 11 lessons (3,107%) of the lessons regarding Serbian residents. Out of the 8 textbooks reviewed, on had no explicit mention of the word Roma (it was stated that various peoples live in Serbia, some were listed, and then it was written “and others”), while in two textbooks this name appeared more than once.

As a result, in one lesson on Serbia’s population, there is also a line like this: In the regions of southern and eastern Serbia as well as in Vojvodina, Roma are the most numerous. The following phrases about the Second World War were only intentionally included by the author’s team in one textbook: The executions that took place at the end of 1941 were among the largest. Then thousands of Serbs, Jews, and Roma were killed by the Germans. Based on the texts in the textbooks, lessons on diversity (“The diversity between peers is an opportunity to get to know other people, customs, and traditions”), mutual appreciation, and respect could be used in the classroom to discuss issues pertaining to the Roma population (“Other people should be respected and appreciated”; “Respecting the rights of members of all nations living in Serbia means that we respect those rights without prejudice and giving unverified opinions”). In the first two grades, there was some evidence of the implicit presence of several subjects that might serve as a catalyst for conversation about Roma; however, in the third grade, the highest percentage is 4.03% (text) and .62% (picture), and in the fourth, it is 4.23% (text) and 1.69% (image) (Table 3).

Although they only list the Roma as a minority people in Serbia, with only two illustrative examples, the textbooks from the subjects The World around Us and Nature and Society contain numerous examples in contrast to the reading books that do not explicitly mention the Roma. However, these textbooks lack any accompanying apparatus, such as tasks for thinking, further independent research, interesting things, etc.

Music Education. Only one of the 26 analyzed texts from Music Education course material specifically addresses the Roma (Table 4). In particular, the co-authors assigned the student the following challenge in the fourth-grade textbook’s lesson on Treasures of my homeland: Listen to the track Gypsy Dance from Georges Bizet’s opera “Carmen”; does the music gradually quicken or slow down in this section? There are a total of 20 lessons in these textbooks, the content of which may indirectly include examples of Roma music, dance, and traditional clothing. Thematic sections that make reference to it include Children and Friendship, Music of My Homeland, and Traditions of Other Peoples.

Table 4

The presence of the terms Roma, Roma people/Roma song, story, legend, music, dance in the “Musical Culture” textbooks from the 1st to the 4th grade of primary school

| Grade | Number of reviewed textbooks | Overall number of texts | Explicitly | | | | Implicitly | | | |
|--------|------------------------------|-------------------------|------------|------|----------|----|------------|-------|----------|----|
| | | | Text | | Image | | Text | | Image | |
| | | | <i>f</i> | % | <i>f</i> | % | <i>f</i> | % | <i>f</i> | % |
| I | 6 | 274 | 0 | 0% | 0 | 0% | 7 | 2.55% | 0 | 0% |
| II | 6 | 204 | 0 | 0% | 0 | 0% | 2 | .98% | 0 | 0% |
| III | 7 | 297 | 0 | 0% | 0 | 0% | 3 | 1.01% | 0 | 0% |
| IV | 7 | 383 | 1 | .26% | 0 | 0% | 8 | 2.08% | 0 | 0% |
| Total: | 26 | 1158 | 1 | 0,26 | 0 | 0% | 20 | 6.62% | 0 | 0% |

Although a responsible attitude toward one’s own and other peoples’ music heritage is emphasized as one of the music education course objectives at the primary school level, the amount of content about the Roma people in the textbooks, who unquestionably made a significant contribution to Serbia’s cultural heritage, is utterly minimal.

Table 5

The presence of the terms Roma, Roma people/Roma song, story, legend, music, game in the textbooks for “Civic education” from the 1st to the 4th grade of primary school

| Grade | Number of reviewed textbooks | Overall number of texts | Explicitly | | | | Implicitly | | | |
|--------|------------------------------|-------------------------|------------|----|----------|----|------------|--------|----------|-------|
| | | | Text | | Image | | Text | | Image | |
| | | | <i>f</i> | % | <i>f</i> | % | <i>f</i> | % | <i>f</i> | % |
| I | 4 | 84 | 0 | 0% | 0 | 0% | 6 | 7.14% | 2 | 2.38% |
| II | 3 | 73 | 0 | 0% | 0 | 0% | 2 | 2.73% | 0 | 0% |
| III | 2 | 63 | 0 | 0% | 0 | 0% | 4 | 6.32% | 3 | 4.76% |
| IV | 2 | 58 | 0 | 0% | 0 | 0% | 3 | 5.17% | 0 | 0% |
| Total: | 11 | 278 | 0 | 0% | 0 | 0% | 15 | 21.36% | 5 | 7.14% |

Civic education. In the textbooks of the mandatory elective course Civic Education, the lessons are structured by the topics of the curriculum. In the textbooks for the first grade, the lessons about our similarities and differences, friendship, tolerance and care for others in the class, as well as about the rights of the child (in textual form - in 6 lessons, 7.14%, in visual form/ as pictures - in 2 lessons, 2.38%). A co-author team designed their Civic Education textbooks in form of a journey through topics that explain two boys and two girls, one of whom is represented with a darker skin color, which could be an occasion for the teacher to talk to the students about the Roma people. This idea is constantly used by the authors in all four grades. Two lessons (2.73%) about children's rights were found in the second-grade textbooks. These lessons may have sparked students' interest in the right of children to an education in a setting that protects them, values their differences, and is free from discrimination. In the third grade, sentences in four lessons (6.32%), which state: "We are as rich as we are different", and pictorial content in three lessons (4.67%), could be used to subtly promote content about the Roma. In the fourth grade, three lessons (5.17%) were identified that could imply conversations directed at the Roma population. One of them is the Story of a New Student, which describes diversity, and the discrimination that often accompanies it, which is why the textbook indicates how these situations can be resolved in the classroom (Table 5). There is no explicit mention of the word Roma in Civic Education textbooks. Despite the fact that this subject in lower grades of primary school is structured around four areas (Human Rights, Democratic Society, Processes in the Modern World and Civic Activism) which together make it possible to achieve the following learning objective – "fostering in pupils a sense of responsibility for their own rights and the rights of others, an openness to compromise and cooperation, and a readiness to actively engage in school life while respecting the norms, practices, and values of a democratic society" ([The Guidelines on the Curricula for the Second Grade of Primary School, 2018: 92](#)), the analysis shows that the textbook still underutilizes its resources when it comes to including Roma content.

Discussion

It might be said that today's textbooks in Serbia missed the opportunity to include the Roma. Moreover, identical findings have been obtained by recent international studies using far larger samples. The findings of an analysis of the inclusion of Roma in European educational curriculum and textbooks were recently presented in a collaborative research report by the Council of Europe, the Georg Eckert Institute, and the Foundation for Roma Education. The study that included 22 countries revealed that, except from the mention of Roma as war victims and in lectures about the structure and size of the population, there is generally nothing more known about the Roma and their culture ([Spielhaus et al., 2020](#)).

The situation is similar with regard to the representation of some other minority communities in Serbia, such as the Vlasi population in the area of Homolje and the Gorani population in Kosovo and Metohija ([Milenović, 2012](#)), but also in some areas where Serbian population is the majority, for example in the area of the Gadžin Han municipality in Zaplanje region ([Milenović, 2013](#)) – the conclusion is that there is no program content in the curricula and textbooks from the first to the fourth grade of primary school in the Republic of Serbia.

This review of curricula and textbooks from 22 different countries revealed that, aside from mentioning and appreciating Roma as war victims, democratic ideals, inclusion, and anti-discrimination - they missed the chance to incorporate Roma. Indeed, identical findings have been found in international studies using far larger samples. There is little more information about the Roma and their culture in a recent research report and in the teachings on the population's structure and size ([Spielhaus et al., 2020](#)). It has already been established that the curricula and assessment models in Serbia are designed to conform the dominant culture in which a certain level of literacy and mathematical proficiency is expected, without respecting differences in culture, lifestyle and individual capabilities ([Baucal, 2012](#); [Marković Čekić, 2016](#)). According to reports from civil society organizations on the usage of the Committee for the Rights of the Child's (2017) recommendations, school curricula are not tailored to the culture of the Roma people, and there is no contextualization to help people understand how cultural diversity affects society as a whole. The authors hold that the curricula should direct teachers' efforts toward interculturality and introducing students to a sense of diversity through the teaching materials. This is made possible by incorporating a variety of examples into the teaching process, mostly from literature and the visual arts ([Jokić Zorkić, 2018: 176](#)), and particularly from music, which has been shown to play a significant role in the growth of multiculturalism, peace, and democracy ([Jeremić and Markov, 2015](#)). Despite the fact that experts concur that a successful educational concept takes care of all children, including Roma children,

providing them with quality in the process of teaching, education, and preservation of language, tradition, and customs (Jazbec, Čagran and Lipavic Oštir, 2013), specific components of the Serbian educational system do not set the foundation for the inclusion of Roma and their culture in actual school life.

All of the European Union's attempts to protect Roma people and promote intercultural dialogue fail at one point: fundamental mindset alterations that place a greater emphasis on respect for variety than on integration (Ferreira, 2019: 47). The European Union believes that we should work to include material about Roma, Roma history, and Roma culture in curricula as we design and implement new strategies to ensure the equality, inclusion, and participation of Roma from 2020 (both in the member states and in those that are in the process of joining) (Recommendation of the Committee of Ministers, 2020). It is advised to include information about the Roma in the curricula of already-existing courses as well as in teaching aids and textbooks. This information should cover things like the Roma's characteristics, legends, and stories, as well as their musical talent, traditions, and customs. It should also cover how the Roma contributed to the development of the Holocaust, how the Roma remember their past, and other topics that can help foster a climate of respect and tolerance. It is important to update textbooks to eliminate stereotypes and innovate with information that familiarizes readers with the Roma people, fosters mutual respect and understanding, and fosters positive social interactions between Roma and non-Roma students in the class and throughout the school community.

The development and education of society's youngest members are crucial to the goal of fostering a tolerant and inclusive society. Schools that implement programs on the value of interculturality and promote understanding and respect for various cultures, languages, faiths, skin colors, and nationalities are now important to provide education free from discrimination (Vučković Šahović et al., 2018). So far, the research findings indicate that Roma students are faced not only with discrimination by their peers, but also with discrimination by their teachers (Milenović, Lapat and Aleksandrović, 2011). Roma students often sit in the last row of classrooms, do not read their homework aloud, nor are they generally encouraged to learn in school (Battaglia and Lebedinski, 2015).

In the classroom, the teacher has the most influence over how equal students interact and collaborate. The key person in charge of assisting Roma pupils' study and social participation should be qualified teachers (Starčević, Dimitrijević and Milovanović, 2016: 88). Teachers are not only unprepared for working in diverse classrooms during their initial education, but they are also frequently at odds – on the one hand, there are inflexible curricula where the issue of teaching content automatization and rigid topic organization has been seen (Lazić, Maričić and Milinković, 2015: 681), as well as traditional textbooks, while on the other hand, the instruction teachers provide must be flexible and take into account how a child's cultural background affects their learning and worldview (Convention on the Rights of the Child). The strategic regulation mentions the need to print textbooks in the languages of national minorities from the perspective of the diversity of students at school, but nowhere does it mention the need to review the content of regular textbooks from the perspective of bias, stereotypes, and prejudice (Petrović, 2016).

Conclusion

There are no special materials that refer to the Roma and their population in the analyzed curricula. Nevertheless, the Roma are explicitly mentioned several times in the Nature and Society and Musical Culture textbooks, while they are absent in the reading books, the World Around Us and Civic Education textbooks. The representation of Roma is observed in limited thematic contexts: the population of Serbia, and suffering in the World War 2. The only thing that was noticed was the simple mention of the word Roma in connection with several minority peoples in population censuses or in connection with people who were war victims. The Roma are not the subject of separate lessons. The analysis of the theme of appearance revealed that there is no mention of the features of the people as an essential element of society; rather, the Roma are depicted as a national minority, or as a portion of society represented by numbers. Not only are there no lessons in the textbooks, but no sentences were found that would describe Roma communities, periods of history, or prominent people with names, biographies, or accomplishments.

Despite the fact that education policies are clearly focused on promoting democratic values such as tolerance, fostering one's own and others' identities, respect for diversity among people, respect for ethnicity, etc., Serbia does not exhibit any appreciable concrete changes toward the proclaimed social discourse through the educational system (at least in the reviewed portion for primary school). The only way to help foster a positive image, lessen feelings of exclusion and prejudice, and empower Roma children for more equal participation in school is by including information about Roma and their people in curricula and textbooks. In this regard, our findings highlight the need for the academic and scientific

communities, as well as the education sector, to finally and seriously consider the options for including information regarding the Roma into the teaching process.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

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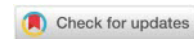
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The Associations Between Personality Traits, Leisure Activities, and Memory Performance in Older Adulthood

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Abstract: The present study examines the links between personality traits, leisure activities, and memory in older adults after controlling for leisure activities and demographic factors. The research sample consisted of 24,930 individuals aged 65 to 101 years from 27 European countries (43.2% men and 56.8% women). Data from the 7th Wave of the Survey of Health, Ageing, and Retirement in Europe was analyzed. Memory was assessed using a modified version of Rey's Auditory Verbal Learning Test (RAVLT). Personality traits were assessed using the BFI-10 Personality Traits Questionnaire. Data analysis revealed that personality traits such as openness to experience and neuroticism allow for the prediction of memory capacity in older adulthood. These relationships remained significant even after controlling for cognitively stimulating leisure activities and age. These results show that personality traits such as neuroticism and openness to experience might be valuable in predicting memory functioning among older adults.

Keywords: personality traits, memory, leisure activities, older adults, SHARE.

Introduction

During recent decades, the global population has rapidly become an ageing one. Because of this, cognitive functioning and age-related cognitive changes, especially the deterioration of memory, have become some of the most significant concerns of modern society (Park and Festini, 2017; Cadar et al., 2017). Memory not only provides opportunities to learn new things and properly function in everyday life, but also allows individuals to accumulate memories of their experiences that are important for shaping and preserving a sense of identity (Erber, 2012). There is evidence that even a minor decline in memory reduces a person's independence (Ikeda et al., 2019). Therefore, memory impairment can become not only a cause of mundane day-to-day issues due to forgetting important tasks, but can also cause emotional suffering and have a negative impact on relatives and carers. The reduction in independence due to memory impairment can also cause indirect losses to a country's economy (Chaves et al., 2015; Hock et al., 2014).

Memory consists of various systems, and not all of them undergo age-related changes. According to some studies, the working and episodic memory systems are particularly sensitive to aging processes (Nyberg et al., 2012). The deterioration of these systems is an individual process, and may depend on a series of different factors. These changes are mainly associated with education, IQ, and professional and leisure activities. Studies show that people with higher levels of education, IQ, and professional activity have a better memory capacity in later adulthood and exhibit less age-related memory decline (Stern, 2002, 2009). These relationships are often explained by the cognitive reserve hypothesis, which states that there are interpersonal differences in how individuals are able to cope with neuropathology (Stern, 2002, 2009; Newton et al., 2016). It is assumed that the education, professional experience, and leisure and social activities that a person has acquired—as well as other possible factors—enable compensatory cognitive strategies at the onset of age-related cognitive decline or other neurodegenerative processes (Walker and Tesco, 2013; Stern, 2002; Newton et al., 2016), and ensure better memory capacity in later adulthood. Current studies provide evidence to confirm this assumption by shedding more light on the role

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of leisure activities (Litwin, Schwarts and Noam Damri, 2017; Adam et al., 2013; Mousavi-Nasab, Kormi-Nouri and Nilsson, 2014). It is hypothesized that various activities might be associated with formation and preservation of cognitive reserve (Adam et al., 2013; Stern, 2002, 2009).

Recent research shows that personality traits may also be associated with memory in later adulthood, and are considered to be contributing factors in building a cognitive reserve (Klaming, Veltman and Comijs, 2016; Soubelet and Salthouse, 2011; Hill et al., 2014; Leavitt et al., 2017). Personality shapes how a person copes with various challenges throughout their life and, accordingly, engages in a variety of activities or behaviors (Newton et al., 2016; Jackson et al., 2019) that may be directly related to brain health (Klaming, Veltman and Comijs, 2016; Curtis, Windsor and Soubelet, 2015).

To assess the relationship between cognitive abilities—including memory—and personality, the Big Five model is most commonly used. The model states that there are five universal personality traits common for each individual—neuroticism, extraversion, openness, agreeableness, and conscientiousness (Costa and McCrae, 1992; Rammstedt, Lechner and Danner, 2018). Usually, neuroticism is most commonly associated with memory and other cognitive abilities. High levels of neuroticism are associated with poorer cognitive abilities and faster, as well as more abrupt, cognitive decline over the course of an individual's life (Stephan et al., 2020; Maldonado et al., 2017; Luchetti et al., 2016; Curtis, Windsor and Soubelet, 2015; Sutin et al., 2019). This relationship is primarily explained by behavioral aspects: personality traits might have an impact on a person's dietary choices, drug use, adherence to treatment instructions, etc. (Terracciano et al., 2008; Möttus et al., 2012; Axelsson et al., 2011). Individuals with higher levels of neuroticism are more likely to choose an unhealthy lifestyle due to weaker impulse control, not follow treatment instructions, and experience sleep disorders (Terracciano and Costa, 2004; Sutin et al., 2016; Lahey, 2009; Duggan et al., 2014). Factors such as these have an adverse effect on brain health and, consequently, on memory abilities (Boyle et al., 2010). The relationship between memory and personality can also be explained by neurophysiological mechanisms. Individuals with higher levels of neuroticism are more likely to experience stronger emotions when faced with stressful situations. Therefore, their blood cortisol level is usually higher than that of less neurotic individuals (Hock et al., 2014). Increased emotional sensitivity eventually damages neural connections in the brain, and is associated with a decrease in cortical volume in the frontal lobe area and a faster loss of gray matter (Hock et al., 2014; Klaming, Veltman and Comijs, 2016; Jackson, Balota and Head, 2011).

There is also evidence to indicate links between memory and openness (Luchetti et al., 2016; Leavitt et al., 2017; Weinstein et al., 2019; Stephan et al., 2020). Studies show (Stephan et al., 2020; Leavitt et al., 2017), that a higher level of openness is associated with better memory and a lower risk of memory impairment regardless of age, education, or IQ. However, the exact mechanism of this relationship is still unclear, and the relationship itself is sometimes considered to be indirect. People who are open to new experiences are more likely to engage in a variety of mentally engaging activities (Schwaba et al., 2018; Stephan et al., 2020; Jackson et al., 2019), and often pursue higher education—which is frequently linked to better cognitive capacity (Chapman et al., 2012; Jackson et al., 2019). Other studies point out that higher level of openness is also linked to more physically active life-style and healthier eating patterns (Sutin et al., 2016), which are known to benefit memory performance in older adulthood (Schott and Krull, 2019). There is also evidence to suggest that openness to new experiences may be associated with neurophysiological mechanisms—for example, dopamine neurotransmitters (Maldonado et al., 2017). Dopamine is one of the physiological factors that stimulates human action while influencing cognitive processes (Maldonado et al., 2017). Despite these findings, there are studies that show negative correlations or no correlations at all between memory and openness (Uttl et al., 2013; Waris et al., 2018).

Some studies show positive associations between memory and the trait of extraversion. Higher levels of extraversion are associated with better memory, especially long-term memory (Meier, Perrig-Chiello and Perrig, 2002; Graham and Lachman, 2014; Maldonado et al., 2017). Extraversion is often seen as a propensity toward greater social stimulation (Newton et al., 2016). This means that extroverted individuals are more likely to engage in various activities, communicate with others, explore new places, and so forth. Existing studies confirm this assumption (Stephan et al., 2020; Newton et al., 2016). This provides opportunities to gain miscellaneous experience that is associated with better memory performance. These links can also be explained by some neurophysiological studies. Extroverts are considered to be individuals who show more optimistic attitudes, and to seek to cultivate more positive emotions in their environment. It is assumed that if the process of encoding information (i.e. remembering something) is accompanied by positive emotions, then certain markers—which are stored together with the so-called memory trace (a hypothetical constant change in the nervous system that occurs when someone remembers something)—are formed in the brain. These markers then enhance the retrieval of a particular memory. In other words, certain information becomes easier to remember (Curtis, Windsor and

[Soubelet, 2015](#)). However, just as is the case with openness, some studies show the opposite association between extraversion and memory ([Luchetti et al., 2016](#); [Chapman et al., 2012](#)).

There is little evidence to link the trait of conscientiousness to memory abilities, and results in this vein are scarce and contradictory. On the one hand, positive correlations are found between conscientiousness and memory ([Luchetti et al., 2016](#); [Leavitt et al., 2017](#); [Sutin et al., 2019](#)). On the other hand, some researchers provide data showing that the relationship between conscientiousness and cognitive abilities is a negative one ([Chapman et al., 2012](#); [Waris et al., 2018](#)). Currently, evidence to link the personality trait of agreeableness to memory is also lacking. Several studies show weak links between agreeableness and better memory ([Hock et al., 2014](#)), and yet, according to other studies, no significant associations are found ([Luchetti et al., 2016](#)).

Despite various studies, the question remains as to what level of influence personality traits have on changes in memory over the course of life, and, if an influence is present, how this is exerted. Some studies show that there are associations between some personality traits and faster cognitive decline, weaker cognitive abilities in general, and an increased likelihood of dementia in old age ([Hock et al., 2014](#); [Luchetti et al., 2016](#); [Boyle et al., 2010](#); [Duberstein et al., 2011](#)). On the other hand, not all studies provide such results ([Wetherell et al., 2002](#)).

In the current study, we aimed to examine the links between personality traits and memory performance in older adults after controlling for leisure activities and demographic factors. We used the data from the 7th Wave of the Survey of Health, Ageing, and Retirement in Europe. Correlation coefficients were calculated to assess the links between personality traits, memory, and leisure activities. Hierarchical multiple regression models were constructed to assess the prognostic value of personality traits on memory performance in older adulthood over and above the demographic and leisure activity factors. It was expected that memory capacity and such personality traits as extroversion, neuroticism and openness to experience will be significantly related. Involvement in leisure activities was also expected to be related to memory capacity in older adulthood. Finally, It was expected that personality activities will allow for the prediction of memory capacity in older adulthood even after controlling for cognitively stimulating leisure activities and other demographic factors.

Materials and Methods

Study design

This study was conducted using data from the Survey of Health, Ageing, and Retirement in Europe (SHARE), which has been performed every two years since 2004. SHARE involves more than 140,000 people aged 50 and above from 27 European countries and Israel ([Bergmann et al., 2019a, 2019b](#)). Survey materials are administered as a Computer Assisted Personal Interview (CAPI), supplemented by a paper questionnaire. The questions cover various socioeconomic, health-related, and psychological variables, and interviews are conducted in respondents' homes, lasting approximately 90 minutes. Data collection was approved by the internal review board of the University of Mannheim, Germany (until 2011), and by the Ethics Council of the Max Planck Society for the Advancement of Science (2011 onward).

Participants

Data for the present study has been drawn from the 7th wave of SHARE ([Börsch-Supan, 2019](#); [Börsch-Supan et al., 2013](#); [Bergmann et al., 2019b](#)). To increase the reliability of results, subjects with neurological diseases (Parkinson's and Alzheimer's disease) or comorbidities that may affect cognitive abilities (cancer, affective disorders, etc.) were excluded from the sample. Therefore, the final analytic sample consisted of 24,930 individuals from following countries: Austria (N = 1363), Germany (N = 629), Sweden (N = 1036), Spain (N = 1130), Italy (N = 1549), France (N = 1320), Denmark (N = 822), Greece (N = 1393), Switzerland (N = 1136), Belgium (N = 1590), Israel (N = 661), Czech Republic (N = 1426), Poland (N = 1315), Luxembourg (N = 139), Hungary (N = 628), Portugal (N = 141), Slovenia (N = 1198), Estonia (N = 1951), Croatia (N = 764), Lithuania (N = 631), Bulgaria (N = 772), Cyprus (N = 470), Finland (N = 613), Latvia (N = 631), Malta (N = 461), Romania (N = 704), and Slovakia (N = 528). The age of the participants was 65 to 101 years (M = 73.67; SD = 6.74), 43% of participants were men, and 56.8% were women. Of the participants, 67.1% were married and cohabited, 1.0% lived in a partnership, 1.1% were married but did not cohabit, 3.9% were single, 6.9% divorced, and 20.0% widowed.

Variables

Memory was selected as a dependent variable, which consisted of two measures: immediate and delayed recall. Memory was assessed using a modified version of Rey's Auditory Verbal Learning Test (RAVLT), which is designed to evaluate working memory (Dal Bianco, Garrouste and Paccagnella, 2013; Litwin, Schwartz and Damri, 2017) and is also used to evaluate episodic memory (Cheke and Clayton, 2013). In the modified version of the test, participants were asked to remember as many words as possible from a list of ten words, which was read by a researcher. After 5–10 minutes, participants were asked to remember as many words as possible from the list read earlier. Each respondent's score was then calculated from 0 to 10 based on the number of correct responses.

Personality traits were chosen as independent variables, and leisure activities were selected as control variables. Personality assessment was based on the Big Five model (Sutin et al., 2019), which states that there are five universal dimensions of personality traits for all people: neuroticism (shows a person's tendency to experience negative feelings and is associated with less emotional stability and resistance to stress); extraversion (related to a person's sociability, activity, propensity to communicate a lot, optimism, and arousal); openness to experience (associated with a person's aesthetic sensitivity, desire for knowledge, propensity for creativity, and curiosity); agreeableness (defined by a person's modesty, ability to understand and empathize with others, efforts to help, and altruism); and conscientiousness (includes personal control and discipline, ability to plan, organize, set goals and objectives, and the need to achieve something new) (Costa and McCrae, 1992). Personality traits were assessed using the BFI-10 Personality Traits Questionnaire (Sutin et al., 2019). This version of the questionnaire is based on the longer Big Five Inventory 44 (BFI-44), and is often used in studies covering a wide range of factors with limited research opportunities due to a lack of time or other restricting circumstances. The BFI-10 consists of only 10 questions, where each trait is assessed with two questions on the Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). To ensure the reliability of the questionnaire, the comparability between BFI-10 and BFI-44 has been assessed by its creators. Significant and strong correlations ranging from $r = 0.74$ (agreeableness) to $r = 0.89$ (extraversion) were found. Test–retest results were also satisfactory—correlations between $r = 0.65$ (openness) and $r = 0.79$ (extraversion) were identified over a period of 6 to 8 weeks in a sample of American students. Research shows that the BFI-10, even with very few questions, has satisfactory psychometric characteristics, and is therefore a suitable tool for measuring personality traits (Sutin et al., 2019). To test the internal consistency of the BFI-10 in the present sample, Cronbach's alpha was calculated for each personality trait as follows: neuroticism = 0.30; agreeableness = 0.20; extraversion = 0.43; conscientiousness = 0.41; and openness = 0.18.

Participation in leisure activities was assessed by asking respondents if they had taken part in any of the following activities in the past year: voluntary or charity work; educational or training courses; sport, social, or other similar clubs; political or community-related organizations; word or number games (such as crossword puzzles/Sudoku); reading books, magazines, or newspapers; or playing card games or games such as chess. Responses were coded either 0 (for nonparticipation in a certain activity) or 1 (for participation in a certain activity).

The study also considered other sociodemographic variables that may have been important in understanding the links between personality traits, memory, and leisure activities. Age and place of residence by country were taken into account. The countries were grouped by region into four groups based on the UN Geoscheme for Europe produced by the UN Statistics Division: north (Sweden, Denmark, Ireland, Spain, Lithuania, Finland, Latvia); west (Austria, Germany, the Netherlands, France, Switzerland, Belgium, Luxembourg); east (Czech Republic, Poland, Bulgaria, Hungary, Romania, Slovakia); and south (Spain, Italy, Greece, Israel, Portugal, Slovenia, Croatia, Cyprus, Malta). The variables were transformed into dummy variables by selecting the countries of the northern region as the reference group.

Data analysis

IBM SPSS Statistics 22 software was used for statistical data analysis. Descriptive statistics and Pearson's correlation coefficients were calculated, and linear and hierarchical multiple regression models were constructed.

Results

The links between personality traits and memory were assessed first, and Pearson's correlation coefficients were calculated for this purpose (Table 1). Memory showed statistically significant but weak correlations with all personality traits, with its strongest relationship being found with openness to experience ($r = 0.18$, $p < 0.001$; $r = 0.17$, $p < 0.001$). Higher levels of openness were associated with better immediate and delayed recall among older adults.

Table 1
Pearson's correlation coefficients linking memory and personality traits (N = 24,930)

| | Immediate recall | Delayed recall | Extraversion | Agreeableness | Conscientiousness | Neuroticism | Openness |
|-------------------|------------------|-----------------|--------------|---------------|-------------------|-------------|----------|
| Immediate recall | 1 | | | | | | |
| Delayed recall | 0.730** | 1 | | | | | |
| Extraversion | 0.065** | 0.067** | 1 | | | | |
| Agreeableness | 0.022** | 0.020** | 0.160** | 1 | | | |
| Conscientiousness | 0.035** | 0.029** | 0.172** | 0.159** | 1 | | |
| Neuroticism | -0.080** | -0.085** | 0.214** | -0.234** | -0.136** | 1 | |
| Openness | 0.175** | 0.166** | 0.131** | 0.014* | 0.094** | -0.071** | 1 |

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. The highest value is marked in bold

The relationship between cognitively stimulating leisure activities and memory in older adults was also examined, first by calculating Pearson's correlation coefficients (Table 2). Memory had statistically significant but weak correlations with all leisure activities. The strongest statistically significant relationship was found with reading books, magazines, or newspapers ($r = 0.26$, $p < 0.001$; $r = 0.27$, $p < 0.001$), and solving puzzles (such as crosswords or Sudoku puzzles) ($r = 0.22$, $p < 0.001$; $r = 0.25$, $p < 0.001$). Reading books, magazines, or newspapers and solving verbal or numerical puzzles is associated with better immediate and delayed recall among older adults.

Table 2
Pearson correlation coefficients between memory and leisure activities (N = 24,930)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------|---------|---------|---------|---------|----------------|----------------|---------|
| Immediate recall | 0.171** | 0.159** | 0.193** | 0.090** | 0.260** | 0.268** | 0.170** |
| Delayed recall | 0.175** | 0.166** | 0.195** | 0.089** | 0.223** | 0.253** | 0.170** |

Note: 1 = voluntary or charity work; 2 = educational or training courses; 3 = sport, social, or other similar clubs; 4 = political or community-related organizations; 5 = books, magazines, or newspapers; 6 = word or number games (such as crossword puzzles/Sudoku); and 7 = card games or games such as chess; ** $p < 0.01$; *** $p < 0.001$. The highest values are marked in bold.

Finally, a four-step hierarchical linear regression analysis was applied to assess the prognostic value of personality traits on memory performance in older adulthood over and above the demographic (i.e., age and country of residence) and leisure activity factors (Figure 1). In the first regression model (Table 3), immediate recall was selected as a dependent variable; and in the second (Table 4), delayed recall was chosen. Independent variables were included in four stages: 1) age; 2) country group (European countries were divided into 4 groups according to the geographical regions of east, west, south, and north); 3) leisure activities; and 4) personality traits.

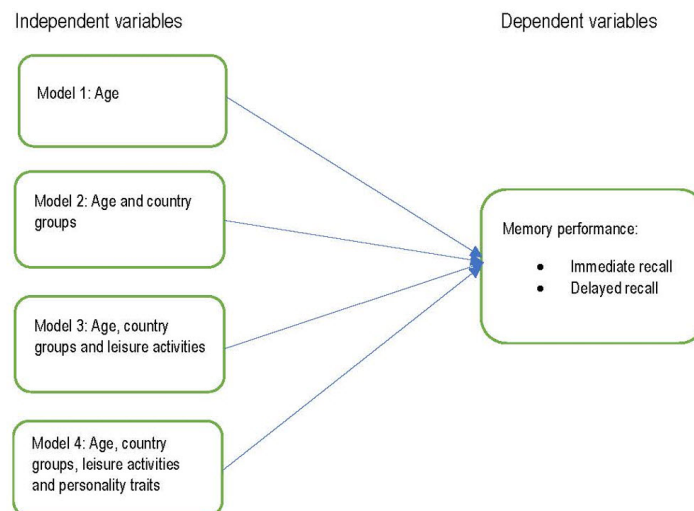


Figure 1. Graphic model of 4- step hierarchical multiple regression analysis assessing prognostic value of personality traits on memory performance in older adults over and above the demographic and leisure activity factors

There were no outliers in the data (all Cook's distance values were < 1), and no multicollinearity problem was identified (all VIF values < 4). Based on the plotting of residuals, no problems of homoscedasticity were identified. The results of the hierarchical linear regression models are presented in Tables 3 and 4.

The first regression model—using age as a prognostic factor—explained 9% of the variance of immediate recall and 8% of delayed recall. This suggests that memory declines as the age of participants increases.

The second regression model included another sociodemographic variable (country groups), and explained 13% of the variance of both the immediate and delayed recall results. R^2 change = 0.03 and R^2 change = 0.04 were statistically significant (F change = 321.25, $p < 0.001$; F change = 421.8, $p < 0.001$). This suggests that the first and second models were statistically significantly different. The country group variable, included in the regression equation along with age, additionally explained 3% of the variance of immediate and 4% of delayed recall. These results suggest that living in western and northern countries predicts better memory capacity in older adulthood.

The third regression model included leisure activities, and explained 21% of the variance of immediate recall and 19% of delayed recall. R^2 change = 0.08 and R^2 change = 0.06 were statistically significant (F change = 362.03, $p < 0.000$; F change = 283.48 $p < 0.001$). This shows that the second and third regression models were statistically significantly different. The leisure activities variable, included in the regression equation along with the age and country groups, additionally explained 8% of the variance of immediate and 6% of delayed recall. In this equation, memory was most strongly predicted by the age variable and leisure activities such as verbal and numerical games (crosswords or Sudoku puzzles) and reading.

Table 3
Results of hierarchical multiple regression analysis with the results of immediate recall as a dependent variable (N = 24,930)

| Prognostic factors | Model | | | |
|--|-------------|------------------------|---|---|
| | Age | Age and country groups | Age, country groups, and leisure activities | Age, country groups, leisure activities, and personality traits |
| | Beta (β) | | | |
| Age | -0.32*** | -0.33*** | -0.28*** | -0.28*** |
| Country group 1 | | -1.11*** | -0.00 | 0.01 |
| Country group 2 | | -0.09*** | -0.00 | -0.00 |
| Country group 3 | | -0.09*** | 0.07*** | 0.06*** |
| ALY: done voluntary or charity work | | | 0.06*** | 0.05*** |
| ALY: attended an educational or training course | | | 0.06*** | 0.05*** |
| ALY: gone to a sport, social or other kind of club | | | 0.07*** | 0.07*** |
| ALY: taken part in a political or community-related organization | | | 0.02*** | 0.02** |
| ALY: read books, magazines or newspapers | | | 0.14*** | 0.12*** |
| ALY: did word or number games (crossword puzzles/Sudoku...) | | | 0.15*** | 0.14*** |
| ALY: played cards or games such as chess | | | 0.03*** | 0.03*** |
| Openness | | | | 0.10*** |
| Neuroticism | | | | -0.03*** |
| <i>R</i> ² | 0.09 | 0.13 | 0.21 | 0.22 |

Note. **p* < 0.05; ***p* < 0.01; ****p* < 0.001. All ANOVA values of the models are statistically significant. The largest value in each model is marked in bold. ALY = activities in last year.

The final regression model included personality traits, and explained 22% of the variance of immediate recall and 20% of delayed recall. *R*² change = 0.01 and *R*² change = 0.01 were statistically significant (*F* change = 65.21, *p* < 0.001; *F* change = 58.25, *p* < 0.001). Therefore, the third and the final regression models also differ statistically significantly, which means that—even when controlling for leisure activities—personality traits improve the prediction of immediate and delayed recall by 1%. However, in this equation, memory was predicted only by the traits of openness to experience and neuroticism.

Table 4
Results of hierarchical multiple regression analysis with the results of delayed recall as a dependent variable (N = 24,930)

| Prognostic factors | Model | | | |
|--|-----------------|------------------------|---|---|
| | Age | Age and country groups | Age, country groups, and leisure activities | Age, country groups, leisure activities, and personality traits |
| | Beta (β) | | | |
| Age | -0.30*** | -0.31*** | -0.27*** | -0.26*** |
| Country group 1 | | -0.14*** | -0.05*** | -0.04*** |
| Country group 2 | | -0.10** | -0.02** | -0.02** |
| Country group 3 | | 0.09*** | 0.07*** | 0.07*** |
| ALY: done voluntary or charity work | | | 0.06*** | 0.05*** |
| ALY: attended an educational or training course | | | 0.07*** | 0.06*** |
| ALY: gone to a sport, social or other kind of club | | | 0.07*** | 0.07*** |
| ALY: taken part in a political or community-related organization | | | 0.02** | 0.02** |
| ALY: read books, magazines or newspapers | | | 0.09*** | 0.07*** |
| ALY: did word or number games (crossword puzzles/Sudoku...) | | | 0.14*** | 0.13*** |
| ALY: played cards or games such as chess | | | 0.04*** | 0.04*** |
| Openness | | | | 0.09*** |
| Neuroticism | | | | -0.04*** |
| <i>R</i> ² | 0.08 | 0.13 | 0.19 | 0.20 |

Note. *p < 0.05; **p < 0.01; ***p < 0.001. All ANOVA values of the models are statistically significant. The largest value in each model is marked in bold. ALY = activities in last year.

Discussions

The aim of this study was to examine the relationship between personality traits and memory abilities in older adulthood. The current study contributes to our understanding of the relationship between personality traits and memory by also examining engagement in leisure activities. These results have revealed that, although age is the strongest predictor of memory performance in older adulthood, there are significant associations between leisure activities, memory, and personality traits. Leisure activities such as reading books and solving puzzles predict memory capacity in older adulthood, however associations between memory and personality are traitspecific. Although all five personality traits are related to memory, only neuroticism, extraversion, and openness to experience predict memory abilities in older adulthood. After controlling for sociodemographic variables and leisure activities, only neuroticism and openness to experience significantly predicted memory. However, it must be noted that the size of this effect was quite small, and therefore these results need to be interpreted carefully. Nevertheless, these findings support previous literature on the relationship between personality traits and memory (Klaming, Veltman and Comijs, 2016; Soubelet and Salthouse, 2011; Leavitt et al., 2017), and also allow new assumptions to be made.

Our results show that memory abilities in older adulthood might be predicted by the trait of neuroticism—a finding consistent with other studies. This relationship is often explained by behavioral factors: individuals with higher levels of neuroticism are more likely to experience anxiety during cognitive assessment, and this might affect their final cognitive results (Curtis, Windsor and Soubelet, 2015;

Maldonado et al., 2017; Katsumi, Denkova and Dolcos, 2017). Long-term behavioral factors may also be important, as various studies have shown that people with high levels of neuroticism are more likely to choose an unhealthy lifestyle due to weaker impulse control, not follow treatment instructions, and experience sleep disorders (Terracciano and Costa, 2004; Lahey, 2009; Duggan et al., 2014). These factors have an adverse effect on brain health and, consequently, on memory abilities (Boyle et al., 2010). According to Maldonado and colleagues (2017), neuroticism is also often associated with a poorer socioeconomic situation, which restricts a person's access to involvement in mentally stimulating activities (leisure activities, for example). Poorer experiences are in turn associated with poorer cognition in older adulthood. However, in our study, neuroticism predicted memory even after controlling for involvement in leisure activities. This suggests that there are other possible mechanisms which link this trait to memory.

According to our study, higher levels of extraversion and openness to experience—the latter in particular—predict better memory. These associations are also often explained by indirect mechanisms. For example, people with higher levels of openness are more likely to engage in a variety of mentally engaging activities (reading books or newspapers, solving crossword puzzles, or playing musical instruments), pursue higher education, use technologies, engage in social and cultural activities, and so on (Wang et al., 2013; Fancourt and Steptoe, 2018; Chapman et al., 2012; Jackson, Balota and Head, 2011). Extraversion is also seen as a prerequisite for greater social stimulation (Meier et al., 2002; Maldonado et al., 2017), as extroverted individuals are more likely to be involved in various activities, communicate, go out and explore new places, etc.

One possible mechanism for explaining the relationship between openness, extraversion, and memory is the cognitive reserve hypothesis (Stern, 2002, 2009). This idea states that people who are more open to experience and prone to extraversion are more likely to engage in a variety of leisure activities and gain a wide range of experiences, and these factors are protective of a level of cognitive performance that includes memory (Hultsch et al., 1999; Clare et al., 2017; Arenaza-Urquijo, Wirth and Chételat, 2015; Scarmeas and Stern, 2003; Leavitt et al., 2017). However, the results of the present study show that even after controlling for involvement in leisure activities, openness to experience significantly predicts memory abilities in older adulthood. Thus, it can be assumed that there are other mechanisms that link openness to experience and memory—and these results are consistent with those of other studies. For example, Soubelet and Salthouse (2011) conducted a study to examine the impact of involvement in various general and leisure activities on the association between openness and cognitive abilities. Although the study also showed a relationship between openness and cognitive abilities, it could not be explained by the effect of involvement in leisure activities. In fact, the links between measures of activity and both openness and cognition were modest. Therefore, it was concluded that the relationship between openness and cognitive functioning might not be due to engagement in activities.

The pathway for openness is still mostly unknown, however the scientific literature provides the assumption that openness and cognitive ability may be related because they largely measure the same construct. Another possible explanation is that there might be some behavioral factors that mediate the relationship between openness and better memory capacity in older adulthood. For example, individuals who are more open to experience often choose a healthier diet and are more physically active (Sutin et al., 2016) and the fact that these factors preserve cognitive function in older adulthood is documented (Schott and Krull, 2019). The latest research also provides an opportunity to explain the association between personality and cognitive abilities from a neurophysiological perspective. There is evidence that openness to experience may be associated with the release of dopamine, which is considered to be one of the main physiological factors that stimulates human action while influencing cognitive processes (Maldonado et al., 2017). There is little research examining these links, however, and so the need for further research is emphasized.

This study did not avoid some limitations. Firstly, only the links between major traits and memory were assessed. In recent years, there has been a growing body of research showing that the low-level traits (facets) of the Big Five model may be associated differently with the same cognitive functions (Chapman et al., 2012; Rammstedt, Lechner and Danner, 2018; Graham and Lachman, 2014; Maldonado et al., 2017). This means that some facets may have positive associations while others have negative ones, or even no association with cognition at all. Thus, the final result of the study might be skewed, and this may partially explain the diversity of current data in the scientific literature (Curtis, Windsor and Soubelet, 2015). An analysis of the relationship between lower-level personality traits and cognition would provide an opportunity to take a new look at the role of personality in cognitive functioning over the course of life (Graham and Lachman, 2014). It should also be noted that only the relationships between separate personality traits and memory were assessed. A complex analysis including different combinations of various personality traits and their associations with cognition could expand the field of research and

reveal different results. It is also important to mention that, in order to analyze data from more countries, only one wave (the 7th and latest) of SHARE data was used for the analysis. The inclusion of other waves could provide more comprehensive data and would allow for the identification of longitudinal changes in memory performance over time.

Despite these limitations, the current study employs a large community-dwelling sample and sheds light on the association between personality traits and memory performance among older adults. The data adds to existing research in the field by showing that personality might be an important factor in understanding individual differences in memory capacity in older adulthood, and contributes to a better understanding of cognitive aging.

Conclusions

In future research, it would be useful to examine more complex associations between personality and cognition, taking into account that facets of the same personality trait might interact differently with each other. For example, neuroticism can affect memory depending on the level of conscientiousness. A narrow focus on personality traits and an analysis of their interactions with memory could benefit the theorists who research age-related issues and significantly expand the field of existing knowledge (Colombo et al., 2019). Waris and colleagues (2018) suggest also taking into account the context in which one or another personality trait manifests. This knowledge might not only occupy the niche of absent data, but could also be useful for planning interventions for individuals with memory impairment. In future, it will also be important to conduct longitudinal research that examines the causal relationships between personality traits and memory, and perform a mediation analysis of these relationships that takes into account other potentially important variables.

In conclusion, personality traits are associated with memory in older adulthood. Higher levels of neuroticism predict worse memory, while higher levels of openness and extraversion predict better memory. These associations might be explained by indirect mechanisms such as certain behaviors or lifestyle factors that contribute to building both the cognitive reserve and neurophysiological processes. Identifying the relationships between personality traits and cognition helps to better understand individual cognitive differences and age-related changes in cognition. While personality traits are known to be quite stable over the course of life, some of them can be influenced to some extent. Thus, despite the limitations of this study, the research contains important results that not only provide a better understanding of the relationship between personality, memory, and leisure activities, but also contribute to our ability to predict cognitive functioning in older adulthood and thereby help to shape appropriate support programs for people with memory impairment.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

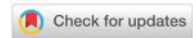
Conceptualization, V.Ivleva and A.Kairys; methodology, V.Ivleva and A.Kairys; formal analysis, V.Ivleva; writing -original draft, V.Ivleva; writing - review and editing, V.Ivleva and A.Kairys; supervision, A.Kairys. All authors have read and agreed to the published version of the manuscript.

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Use of Information Technologies in Higher Education From The Aspect of Management

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Abstract: The development of modern information-communication technologies has enabled the development of electronic knowledge distribution channels that expand the effective level of general and specialist education. This trend is also present in higher education because higher education institutions and institutes increasingly rely on the use of modern information-communication technologies in their operations. The effects of the use of personal computers, the Internet and global social networks are multiple in the higher education system as well. In the process of acquiring new knowledge, developing creativity, as well as ensuring greater activity in the process of education, new learning technologies, with the use of multimedia systems, created the prerequisites for the engagement of all individual and collective resources. The most important source of the state's competitive advantage is the ability to educate and retain highly educated personnel in the field of information technologies. From that aspect, the paper discusses information technologies as a scientific discipline and general conditions for education in the field of information technologies. The impact of technical and pedagogical changes on education in this area is analyzed with particular attention. It is known that information technologies are suitable for vocational education, and the modern environment sets specific requirements regarding the applicability of knowledge acquired in higher education institutions. The dynamic and turbulent market emphasizes the applicability of knowledge as a key requirement in the educational process. These short researches propose new educational modules that should structure teaching in the field of information technologies in accordance with the global demand in this sector. Every society strives for a more efficient and economical system of education, and therefore the issue of the use of new information technologies in education comes down to the problem of creating a theoretically ideal model of the use of these technologies at all levels of education and work.

Keywords: information technologies, higher education, management, learning, knowledge.

Introduction

The education of young, highly educated personnel, that is, the education of students at faculties, as well as the continuous education of employees in the information technology sector (training) in conditions of long-term structural and financial insecurity can be the main source of competitive advantages and one of the strategic models for exiting the social crises. It is a well-established opinion that informatics and information technology are important contents of the educational process at all its levels, starting from preschool to university. The progress achieved in the development of new technologies, starting with personal computers, through networking - the Internet, has led to the creation of new opportunities for innovating and transforming the educational process, first of all in the developed countries of the world, but increasingly in our country as well. Current and future students expect from the educational system numerous innovative and alternative opportunities to improve their knowledge. The dynamic development of ICT enables young people, and above all students, who are being educated, greater independence and a good basis for self-education and permanent education. This is precisely what indicates that even those who are about to go on to university education will spend their entire working life and life in a permanent relationship with information technologies. However, they should, already during the process of their education, be trained for the effective application of new technologies that represent suitable teaching

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and then working tools. These technologies provide the possibility of controlling, regulating and managing the teaching process. Continuity is reflected in the management of the work process and success based on continuous feedback that motivates to a good extent and then represents the basicity of the evaluation process system and fair assessment of employee performance and progress in the level of education. In numerous theoretical discussions, the starting point is that traditional, mechanical, passive educational processes, in which there are no transactions in teaching, should be greatly and radically reduced. Bearing in mind that the computer has become a part of everyday life in the economy and in the domain of the work process, as well as a part of everyday life in free time, in the household and in every other human area, the question arises about its indispensable place in the innovation of education and its positioning in that complex process, in general.

Information technologies and manager education

Modern educational processes for the outcome have an investment in human resources that is profitable for all economic and non-economic subjects. Especially in the conditions of general crises, business entities are interested in organizing practical training of innovators and managers who, thanks to the effective use of the latest information technology, would ensure the efficient operation of the company and the conquest of new markets. This includes significantly raising the level of innovation and quality of higher education in the field of ICT and striving to raise it to the highest possible level.

From the perspective of the operationalization of educational processes, there are still different opinions about what are the elements, that is, the main factors that promote education in the field of entrepreneurial activities and information technologies. Many experts believe that the existing education system does not provide the appropriate competencies that are needed in modern conditions of frequent and constant changes in the environment. From this aspect, the paper analyzes the role of education in the field of information technologies, in the time of constant changes and growing global competition, in all segments of economic and social life. The dynamic and exponential development of ICT has conditioned the increased role and importance of education in this area, and it is becoming more and more evident, both in the world and in Serbia and the surrounding countries. However, in order to prepare pupils and students for the dynamic conditions of modern business and the challenges of innovation, it is necessary to change or improve the existing education system. Traditional methods and courses do not ensure the effective application of acquired knowledge. Many experts, therefore, believe that a new approach is needed in modern education, where the emphasis is placed on the acquisition of practically applicable knowledge and skills that are in demand on the global market and relate to effective management in all areas. It is undeniable that the development of computer science and new technologies represents a long dynamic cycle. The digital world has become a support for everyday life, but also an essential lever in the globalization of the world. Computers are integrated into modern culture on the one hand, while on the other hand, they are recognized as a leading force in the growth of the world economy (Vrhovac et al., 2017). With the emergence and intensity of the development of Industry 4.0, which shortens the life cycle of products, new technologies are implemented in that area and taking into account its exponential growth and development (the so-called clock speed industry). It also shortens the usage life cycle and improves the management (Hermann, Pentek and Otto, 2015). In addition, the accelerated development of new technology has decisive importance on the effectiveness of the education system and refers to numerous techniques, methods and contents. For example, networking and the Web have become a critical basis of computer technology, but also one of the most important pedagogical tools, leading to changes in the concrete educational system, not only in computer science but also in other areas (Bernon, Rossi and Cullen, 2011). In situations where we talk about the process of education and acquiring new knowledge, that process has always ranged from traditional learning, learning through audio lessons, video lessons, electronic learning, and distance learning, to today's mobile learning. Professors and teachers, adapting to new technologies, correct their position and role in the education process, but its basic function is still dominant. Namely, although globalization in the field of informatics allows students to visit distant museums, and archaeological sites, and communicate via video conferences, the lecturer is still present to direct and teach them critical thinking, social behaviour, work discipline, and personal responsibility, which guides them towards model recognition and the mentor's work style, i.e. develops and supports curiosity, which directs them towards conclusions and, eventually, scientific contribution (Bogdanović, 2009). Therefore, new technologies greatly contribute to a new way of learning, because at every opportunity the expansion of the Internet and the complex information technologies affect all domains of life in the world and in Serbia, as well as in the domain of the educational process. This technology is definitely the most advanced technology that has been devised in the history of human civilization.

Adaptability to the new way of (digital) learning

Modern information and communication technologies, i.e. computer science, have influenced all segments of life and work, but also leisure time, methods and models by which the educational process takes place at any level and the way in which new information is adopted. Precisely for this reason, it can be considered that the information revolution is not only technological, but to a large extent sociological and ethical (Bogdanović, 2010).

A new approach to the organization of the educational process, i.e. scientific and educational work, was made possible by the effective use of information and communications technology. This approach emphasizes and initiates a faster development of the individual abilities and interests of students. In addition, it enables faster and more efficient transmission, transfer and absorption of knowledge, and closer ties between students. Then, and with the formed database, encourages activity, independence and engagement of mental power and creativity of students. This possibility of activating pupils-students and their independent work is the basic characteristic of the basic process, which is greatly supported by the computer (Vilotijević, 2007, p. 12). Consolidated, changes in teaching and overall education have been influenced by technical, scientific and technological advances and innovations. Then, the introduction of new approaches in the organization of educational content into the teaching process brings about significant changes. Major changes are taking place, such as the introduction and application of new procedures, methods, techniques, means and media. Modern educational technologies have become an integral part of the teaching process, with the tendency not only to improve the teaching process but also to fundamentally change it. Multimedia, as a part of information technologies, is often used in teaching, so it can be concluded that multimedia is an important feature of the modern education system. Considering the fact that the centre of gravity of the teaching process has already begun to shift out (from the teaching content and the teacher to the student), multimedia undoubtedly has a great contribution to the modernization of traditional teaching (Vilotijević, 2007, p. 14). However, on the other hand, it should be borne in mind that so-called mobile learning is a kind of distance learning (d-Learning) and electronic learning (e-Learning). Therefore, experts believe that it is necessary to enable the student to create his own constructions of knowledge acquisition. It is considered in this way this constructivist approach represents the position that effective multimedia teaching strategies should be created and shaped, which enable different ways of learning. In these theoretical frameworks, the importance of multimedia influences and semantically rich transfer of information lies in ensuring the possibility of self-realization, i.e. affirmation of the needs of all students, which enables them to acquire new knowledge, develop abilities, acquire skills, habits and form attitudes (Krneta, 2007). From the application aspect, many experts are in favour of constantly innovating the knowledge of teachers, who should permanently acquire new knowledge, understandings and approaches. In addition, under the influence of ICT, it is desirable to set new attitudes and a changed role in the education process. This means that more versatile forms of professional profile and development are necessary because the profile of the educational process, in the Internet domain, is well dependent on the latest information and communications technologies and the ability of educators to understand and accept the "electronic alphabet" as the basis of a modern model of education.

The technology of telephony and computing has created increased mobility, so communication and connectivity (networking) are now understood at every moment and in every place. Connectivity that provides access to information in any situation has become a common occurrence in everyday life. Several billion inhabitants have access to the Internet, wired and wireless, and the number of devices that will soon be connected to the Internet will be tens of billions (Internet of things). However, while the previously wired connection was the rule and wireless the exception, now it is the other way around: wireless is the rule and wired is becoming the exception. Technical changes in the last decade have increased the content of many teaching contents, such as (Pokorni, Kuleto and Radić, 2018):

- World Wide Web and its applications ,
- Network technologies, especially those based on TCP/IP,
- System administration and maintenance,
- Graphics and multimedia,
- Web systems and technologies,
- Service-oriented architecture,
- Electronic commerce technologies,
- Relational databases,
- Client-server technologies,
- Interoperability,
- Integration and development of technologies,

- Object-oriented programming,
- More perfect programming interfaces (APIs)
- Human-computer interaction,
- Security,
- User domains

The above contents (as well as many others that will undoubtedly be introduced and developed in the very near future) are the practical result of the extraordinary progress and expansion of the effective application of information and communications technologies. The Internet and the Web contributed the most to the increase in the number of study areas and applied and theoretical programs in information technology. On the other hand, in addition to quality, a special problem can be the availability of labour. The quality of implementation of educational programs for future IT experts will depend on the availability and structure of study programs. In this sense, there are different goals, contents and teaching methods. Students' interest in self-employment should be encouraged during their studies. Graduate students need practical help - concrete support for their business ideas. The training program for IT activities should be aimed at acquiring knowledge and skills that will enable students to be:

- creative/innovative, highly motivated, self-aware, confident,
- communicative, courageous when making decisions, leaders-negotiators, managers,
- less dependent, ready to take risks, able to recognize opportunities

Under certain conditions and appropriate modification for the field of IT, it is realistic to create different programs for different groups of students with special reference to the following aspects of the application of entrepreneurship (Lajović, 2011, p. 264):

- Entrepreneurship within business schools and economics studies focuses on business startups and new venture creation and on the management and growth of SMEs. Students of economics learn to work with students from different fields (engineering, scientific studies, etc.).

- Entrepreneurship within science and technology studies is especially concerned with exploiting intellectual property, creating spin-off companies and venturing, and offering courses on issues such as: management techniques; marketing, commercializing and selling of technology-based ideas; patenting and protecting technology-based ideas; financing and internationalizing high-tech ventures.

- For students of the humanities, the focus is on social entrepreneurship, the development of the area that provides an opportunity for advancement of the community;

- Entrepreneurship for the creative arts and design focuses on opportunities emerging through creative working, preparing graduates to work as freelancers or self-employed people, or creating small enterprises and ventures.

Respecting the existing differences between entrepreneurship as a general term and IT entrepreneurship as a special term, it is possible to create an adequate plan of activities that would adapt the elements mentioned above to new IT-specific content.

The importance of the Internet in distance learning

In the second half of the nineties of the last century, there was an expansion of information and communications technologies (ICT), and the result was the rapid development of the Internet. In this way, in the era of dynamic and sudden growth of different, above all electronic media, which cover, at any time, practically all parts of the planet, the importance of the Internet is increasing, and young people are starting to use it earlier and with a longer number of hours. Not only in the process of education, but the Internet as a global medium creates the attitudes and opinions of all layers of society.

By working on a computer and using the Internet, young people learn in a fun and interesting way how to use modern technology, which will certainly benefit them in their studies and leisure activities. On the other hand, an increasing number of different human activities are connected to the Internet (education, science, culture, trade and entertainment), so it goes without saying that the Internet is an increasingly present and influential factor in the work and life of many individuals, social groups and communities. The Internet is the main mass media today. Therefore, its role in upbringing and education is very significant. The Internet, as one of the virtual institutions, is a dominant medium for communication, education and business (Bubaš, 2000, p. 14). The Internet brings the virtual world closer, which represents a great provocation for the educational process because it is, over time, more and more attractive and challenging than the classic educational system. Individuals are increasingly trying to distance themselves from the daily pattern of living and the conditions of mass communication. From that aspect, the Internet affects beliefs, attitudes, social norms and universal cultural values and patterns in all directions (directly and indirectly). The Internet especially has a great influence on young people, that is, on their functional

upbringing and education, as one of the most important factors. After the initial difficult and unreliable steps, distance learning (DL) has crossed international borders and Serbia is already entering the international market of electronic learning. The USA is a competitive market in electronic learning and education (the experience that America, Canada and Australia have in this domain dates back to the eighties of the nineteenth century). In modern conditions, electronic learning is quite a common phenomenon even at the most famous faculties (Harvard, Stanford, MIT), which offer a wide selection of the most diverse accredited academic courses in their virtual classrooms. The electronic form of distance learning has replaced paper forms with a new name - electronic learning (e-Learning). All educational material, in this form, is sent to users in electronic form, which is why e-mail, FTP protocol (File Transfer Protocol), and HTTP protocol (Hypertext Transfer Protocol) are used. Also, the user returns all completed tests to the educational institution by e-mail or does it using a specialized Web site - portal, which records the student's answers in the database. Mobile learning (m-learning) is electronic learning in which access to learning materials is made possible through the effective use of personal digital assistants (PDAs), mobile phones, smartphones and tablets.

Typically, e-learning is described as learning "anytime, anywhere", but with access to a computer and an Internet connection. Mobile learning doesn't need those connections. All the student needs is a PDA or mobile phone and a wireless network (Vrhovac et al., 2017). Information technologies are introduced into the curricula of higher education institutions. The College of Vocational Studies for Information Technologies was founded in 2006 in Belgrade, and since 2017, in addition to the basic vocational studies, accredited vocational master's studies have been introduced, which train professional information technology engineers. In this context, it can be stated that information technologies have developed into a special scientific discipline. Defining the concept of information technology is not simple, because it is believed that there is no universal definition of information technology. For example, information technology is defined as a scientific discipline that deals with the study of systemic approaches in the selection, development, application, integration and administration of secure computer technologies - which should enable users to achieve personal, organizational and social goals (Pokorni, Kuleto and Radić, 2018). However, almost ten years earlier, information technologies were defined so that in the broadest sense they encompass all aspects of computer technologies, i.e. IT, as a scientific discipline, deals with problems related to the representation and satisfaction of user needs within the organizational and social environment, through choice, creation, application, integration and administration of computer technologies (Lunt et al., 2008). The aforementioned definitions indicate that information technologies are largely oriented towards meeting the needs of users and that more and more attention is being paid to problems related to security at all levels of the economy and society.

Interdependence of ICT and management in the education process

In the modern conditions of living and doing business, the interdependence of ICT and the study of management as a scientific and business discipline is increasingly close because dynamic technical-technological development directly imposes numerous changes that are increasingly present in every sphere. Continuity in the development and raising of the level of application of information technologies directly influenced the improvement of the level of education, exchange of information, and especially the level of performance in the business and production functions of the company. The most important component is computers and computer equipment. The use of computers makes it possible to exchange various information and data very quickly, easily, efficiently and cheaply, not only in the field of business but also in education in the field of management. It is especially important that it enables effective conversation in an internal and external environment. Acquiring and raising the level of knowledge via the Internet, as an important means and method of knowledge distribution, has a number of advantages, which can be (Bubaš, 2000): fast distribution - participants access the offered material via the WWW, it is possible to include hypermedia materials, the service can be used simultaneously by individuals and groups, the possibility of connecting "linking", multimedia content. Information technologies in an indirect way - through information systems, have a significant impact on the efficiency of company management. However, if the information system is fast, reliable and comprehensive in the sense that it ensures the timely creation of reports on the company's performance, the management will have a good information basis for management, that is, the process of managing the company will be more efficient. Through it, companies carry out daily operations smoothly, and at the same time provide support in making business decisions through advanced reporting. The components of the information system consist of information technologies (hardware, software, data and communications), people and processes. The software contains a set of business rules and important formalized knowledge about the performance of business

processes, and in interaction with it, employees perform their work tasks (Vesić, 2022).

Information systems that companies use to increase business efficiency are usually classified into the following types according to their purpose (Jovičić, Đokić and Stanić, 2018):

- (1) MIS (Management Information System) for management support based on the automation of report creation,
- (2) DSS (Decision Support Systems) for decision support,
- (3) TPS (Transaction Processing Systems) to support the transaction processing process,
- (4) KMS (Knowledge Management Systems) to support knowledge management and
- (5) Information system for office automation - OAS (An office automation system)

Since the beginning of the twenty-first century in Serbia, there has been a sudden increase in the interest of young people in various study programs in the field of information technology. In addition, higher education institutions or faculties are increasing their activity in this domain. On the one hand, the increased motivation of students for ICT studies in Serbia is a positive consequence of two main factors:

- (1) the technology sector is one of the few in Serbia with a labour shortage, and
- (2) the average salary of employees in the technology sector is significantly (four to seven times) higher than the Serbian average

On the other hand, in developed countries, students' interest in the ICT sector is declining because salaries in that sector are more dependent on international competition compared to salaries in other sectors. On the other hand, it should be borne in mind that the domestic IT market is shallow and that the companies operating in this area are focused on the global market. These are mostly large companies because individuals do not have the financial potential needed to operate on the global market. In recent years, there has been a trend for global tech companies to relocate resources and production from developed to less developed countries. However, relocation did not occur in all branches. On the one hand, the production of security-sensitive highly profitable products such as rocket systems and technologies related to space exploration has not been displaced because it is prohibited by law. On the other hand, the production of financial applications (for banking), trade applications (internet trade) and payment applications (money transfer) are, as a rule, relocated to less developed countries (Jovičić, Đokić and Stamatović, 2018).

The main goal of ICT studies is to provide students with a high-quality education so that after completing their studies, they have the knowledge and skills needed to work in appropriate positions in the field of information technology. In addition, students should be able to continue their education - master and doctoral studies in this field. In general, IT education should be aimed at acquiring the ability of a modern approach to solving problems, where the use of technology that enables different methods and ways of working is assumed. It is predicted that as early as 2027, Serbia will enter a serious labour market crisis, which would be reflected in the lack of manpower needed for continued economic growth. In addition, if the existing economic structure were to be maintained, due to higher demand compared to labour supply, the growth of wages would be higher than the growth of inflation, which would have a negative impact on the level of competitiveness of the Serbian economy and the general slowdown of economic activity (Petrović, 2019, pp. 32-38).

In front of managers and innovators, society puts the demand on the knowledge economy. In such an economy, a large part of employees is no longer involved in the physical production and distribution of material goods, but in their design, then in development, in technologies, marketing, effective sales and maintenance. Under these conditions, companies are directed towards the creation of special systems and procedures aimed at acquiring, memorizing, disseminating and using organizational knowledge (Lutovac, 2012, p. 182). Modern networking technologies increase the possibility of communication and provide unlimited access to information. On the other hand, networking technology has become an essential pedagogical tool in most higher education (academic) programs. These changes are considered to fall into two categories - technological and pedagogical - each of which has a significant impact on the education of IT professionals (Lunt et al., 2008). However, when developing an information technology curriculum, it is important to include all changes in technology. In addition, the approach to teaching is also changing, as the focus shifts to the student, learning outcomes and appropriate competencies. To achieve quality in the education of young IT experts and operatives, a number of factors that influence the success of the planned training programs should be taken into account. Many of success factors are divided into several broad categories, indicating the degree to which favourable conditions need to be created or improved. Special attention in this entire process is paid to the level of quality of the educational program, i.e. modules, and the level of quality of educators. Certainly, it is the most sensitive point in the

entire program or approach, because it can contain a number of subjective assessments and attitudes. The quality of the manager's entrepreneurial spirit and leadership abilities depends on the quality of his education. Conversely, the charge of positive energy of a leader in the phase of organization creation also requires special personality qualities, the ability to adapt in turbulent circumstances, to solve problems on the fly, to accept change as a challenge and to be able to create a climate of trust in the fluid unstructured environment of the organization, a common goal and a special mission, which means the readiness of employees to solve all problems as a team in conditions of rapid and sudden changes (Petrović, Pavlović and Vujić, 2018).

On the other hand, technology also affects the nature of pedagogy. This implies a transition from the previously known so-called didactic triangle (pupil-student, teaching content, teacher), to the didactic quadrilateral, where teaching technology is added to the previous triangle - which changes over time, and today it is dominated by computers, software, the Internet and networking. In this sense, demonstration software, computer projections and individual laboratory stations significantly improved the way of learning by using new information technologies.

New multidisciplinary subjects/modules

In the modern structure of an ICT company, which is engaged in the production of applications, from the aspect of the type of work performed in it, in the broadest sense, three large groups of work can be distinguished: programmers, analysts and DevOps.

The first group of employees deals with coding, which used to be called programming and more recently is called development. Employees in this group/sector are mostly students of the Faculty of Mathematics, Electrical Engineering and Organizational Sciences. Former programmers are now more often referred to as developers.

Another group of employees are analysts who interpret client requirements, specify the tasks of programmers and test the produced applications. This group does not program but provides a connection between the requests of clients - users of applications (for example, to create a banking application for managing client's accounts) and programmers in an IT company who produce (code) the requested application. Employees in this sector usually come from the Faculty of Economics and the Faculty of Organizational Sciences and are engaged in one of the following activities: business analyst (BA), quality assurance (QA), project manager (PM), and product manager (Product Manager).

The third group of employees are DevOpses who deal with providing technical prerequisites for business, building and long-term configuration of the necessary IT infrastructure. Their role is to speed up the process of development, testing and release of software into production as much as possible, through different ways of automation and the use of specialized software tools. In this way, they enable the ICT company to meet the needs of clients in the shortest possible time, reducing the time of the software development life cycle. In addition to classic system administrators, this includes those who maintain virtual machines (VM) and configure cloud services, maintain connectivity (internal networks, Internet connections with the outside world) and the availability of databases and data warehouses.

With the aim of increasing the efficiency of teaching, it is desirable to structure teaching modules so that each module deals with topics/material that corresponds to the requirements of individual jobs that appear in modern IT companies. Bearing in mind the identified roles in the IT company, the effort is to create teaching modules that correspond to the modern needs of the global market. On the one hand, the mentioned roles (BA, QA) require knowledge that cannot be obtained by a single faculty in the current system of higher education. On the other hand, the existing deviation between the requirements of a job in an IT company and the school program of individual faculties can be effectively overcome by introducing new teaching units (courses/subjects) that would provide the required, multidisciplinary knowledge. This suggests that, in a practical sense, it is necessary to create several new subjects that would provide knowledge that is required for certain workplaces in IT companies, and which, according to the current system, are acquired at several different faculties. At the same time, there is also the phenomenon that certain knowledge is available within one, or even in a larger number of subjects, but they are not structurally organized into one coherent whole, so it is not possible to achieve sufficient benefit from them in modern business and modern practices of software development.

It is proposed to create the following five thematic units or subjects: business analysis, quality assurance, IT project management, IT product management, and DevOps:

(1) Business analysis is a module/subject that should provide the knowledge and skills required for the position of business analyst in an IT company (BA). Its main role is to define business requirements in communication with clients. A business analyst should, in addition to the domain knowledge (e.g. finance)

acquired at the Faculty of Economics, also possess technical skills, e.g. to search databases (via basic SQL queries) that are studied more at the Faculty of Organizational Sciences, and less at the home Faculty of Economics as well as at complementary faculties and study programs. This module would provide basic knowledge related to databases. In addition, students would learn business specification writing techniques, which are an integral part of the analyst's job. Finally, the material would cover the creation of test plans for the needs of testing new code, which is an indispensable job of every analyst. In this way, it is ensured that the software product implements the agreed business scenarios.

(2) Quality Assurance (QA) is a module/subject that should provide knowledge and skills related to automatic or manual testing - performed on a daily basis in order to improve the quality of new code/application. In this course, students would learn the theory of testing and gain practical skills in using several standard automated testing tools, such as QTP and Selenium.

(3) Project management is a module/subject that should provide the knowledge and skills needed for the position of Project Manager (PM) in IT companies. This subject should not be confused with existing project management, because this is a subspecialization related to IT project management, in the sense of creating, testing and implementing a new application that an IT company makes for its client. Students would gain knowledge about the basic phases of an IT project, the connection between those phases and the standard problems accompanying the implementation of IT applications, such as the lack of interest of the client in the initial phase, expected delays and potential additions and changes to the original requirements during implementation.

(4) Product management is a module/subject that should provide the knowledge and skills needed for the position of product manager (Product Manager or Product Owner). Students would master the agile methodology for developing new and supporting existing products and precisely understand the roles each participant (developer, BA, QA) has in daily operational work.

(5) DevOps is a module/subject that should provide knowledge and skills that are needed in the workplace in the DevOps sector of an IT company. Students would be able to conceptually understand the various technical prerequisites and practices required to create and manage a complex IT infrastructure, which may include networking, cloud computing, operating systems, code versioning software, security, testing, etc.

The proposal for the creation of new teaching units aims to fill the current gap, i.e. remove the problem of IT companies related to the introduction of trainees. Introducing interns to work is quite difficult due to the fact that the workplace requires multidisciplinary knowledge that, according to the current curriculum, is acquired at several different faculties. In practice, it takes several years for a beginner to understand the day-to-day business activities in an IT company, and the new modules would reduce this adjustment time from several years to a few weeks.

In the described way, the possibility would also be created for young people to be more effectively educated for work in modern IT companies that nurture agile development practices, such as example, Scrum, which by its very nature requires more IT specialists, compared to public companies and large state systems, which generally do not have such practices, and because of the staff deficit, they tend more to be IT generalists.

Conclusion

Information technologies differ from other computer disciplines in terms of applicability. Unlike other computer disciplines, which are largely theoretical and insufficiently applicable, information technologies are more applied, i.e. focused on system infrastructure and the full application of technology. Demands for connection to a fully networked service, anytime, anywhere, in recent years have led to a growth in the number of wireless networks, similar to the rapid growth in the number of Internet users in the last decade of the twentieth century.

They are experiencing a special, dynamic expansion of information technology thanks to the so-called start-up companies. In the development of education, education and science, and from the aspect of various education modalities, Serbia strives to introduce international standards. In essence, the development of economic and non-economic activities, i.e. society as a whole, depends a lot on these efforts. Certainly, interdependence and openness towards world trends, in the areas of the social superstructure, require strategic determinants, that is, the existence of clear national goals and values.

Keeping that broader aspect in mind, the ICT sector is important for the development of the economy and society, both in the domain of higher education and in the domain of fast-growing start-up companies. An effective concept of education for ICT experts is especially required to know the technological and pedagogical level and predispositions. In connection with technological changes, effective networking is

emphasized.

In the effective application of ICT technology in the education of managers, the most important thing is to adapt to dynamic changes in the environment. Therefore, the primary task of educators is to determine not only positive but also negative influences and to adequately treat them in models of the educational process. The process of education of modern managers, in modern crises and turbulent conditions, will increasingly depend on the way and extent of using information and communication technologies.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization: D.V., Formal Analysis: D.V., D.L., S.Lj.V., Investigation: S.Lj.V., Methodology: D.V., S.Lj.V., Project administration: D.L., Resources: D.L., S.Lj.V., Writing – original draft: D.V., D.L., S.Lj.V., Writing – review & editing: D.V., D.L., S.Lj.V. All authors have read and agreed to the published version of the manuscript.

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Internet in The Function of Promotion of Bestiality: Profiling Zoophiles

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Abstract: The Internet is an inseparable part of contemporary man's everyday life. The catalog of positive sides of this global information system, which encourage the development of creativity, is inexhaustible. Simultaneously, many negative aspects of the Internet in the context of breach of security, exposure to inappropriate content and promotion of bestiality exist. Therefore, in this paper we pay special attention to zoophilia, a specific disorder from the domain of paraphilia, which includes a sexual preference for animals with ethical and harmful consequences for health. According to the available data from the digital space, it is noted that this disorder affects a significant number of individuals. It is a very complex and sensitive disorder, which requires a multidisciplinary approach, including a psychopathological approach that would explore the symptoms, nature and factors (hereditary, organic and social) of pathological conditions and processes in these individuals. With tendency that this scientific paper represents an adequate reaction to make this disorder more visible, as part of preventive programs before the late manifestation, we applied methods: quantitative and qualitative content analysis, comparative analysis (reaction to zoophilia) and descriptive and analytical statistics. The goal is to recognize zoophilia as a disease and bestiality, that is, inhuman behavior, which requires an effective response from the social community.

Keywords: Internet, paraphilia, bestiality, zoophilia, profiling.

Introduction

In the hierarchy of human needs, the libido occupies one of the key places, where it symbolizes the energy of the sexual drive. Human nature itself is often unfathomable and unpredictable, and accordingly human sexuality is quite complex, broad and varied in terms of the stimuli that cause desire in individuals. It is normal for a human being, the object of desire that sexually attracts/takes over him, is another human being, with fulfilled criteria of mutual physical and mental maturity for establishing close relationships. However, there are people who have a disorder of sexual preferences, which directs them to atypical objects of desire, and their behavior some instances is even illegal and harmful to themselves and/or others. Within this group, characterized by paraphilia disorders, the category of individuals w to prefer animal species, called zoophiles, stands out.

Paraphilias include sexual arousal towards atypical objects, situations and/or target groups (for instance, children, animals, corpses...). Certain sexual activities that seem unusual to another person or a health professional do not constitute a paraphilic disorder just because they are unusual. Certain individuals may have paraphilic interests without meeting the criteria for a paraphilic disorder. Namely, not all forms of attraction are paraphilias - they only become so when they are the only way of sexual satisfaction. Dozens of paraphilias have been described, while some are rarely represented. Affected persons may have more than one paraphilic disorder, and these persons may also have significant personality disorders (antisocial, sadistic, narcissistic...), further complicating treatment procedures (Bjelajac, 2020). In individuals who exhibit such behaviors, obsessive sexual needs or fantasies dominate, which causes significant disturbances or deficiencies in the social, work, or living environment.

Sexual contact with animals (SCA) is called zoophilia or bestiality. This topic has been present in numerous cultures since the ancient times, and attracts the attention of researchers for a long time. It consists of specific antisocial/psychopathological actions, which most often results in the stigmatization

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of the perpetrators and the abuse of animals. Zoophilia is generally speaking, a psychosexual defect that mainly affects adults, in such a way that they become obsessed with desire to have sexual relations with particular animals. Its causes and conditions are hard to determine, as to why a human being determines animals as objects of sexual desire, which also applies to the prevalence in the general population. The prevalence is difficult to determine, therefore, because those who have this paraphilia usually do not admit it and because the Internet we use (surface web) is only a small part of the Internet, the tip of the iceberg, which displays millions of visits to an incalculable amount of zoo sex content. There is also another part, which is not visible, and which represents the bottom of the iceberg (dark web), which is accessed in a difficult way. The dark web offers its users anonymity, while they cruise through "hidden" pages, where you can find all the worst things you can think of, including the most depraved bestiality of zoophiles.

It must be taken into account that the aforementioned practices are punishable by law in several countries due to animal abuse. Maintaining sexual relations with animals can also cause the transmission of serious diseases, the occurrence of sexually transmitted infections such as venereal lymphogranuloma and other changes that can cause major problems in the quality of life of a person, as well as of other people with whom he comes into contact. Likewise, during the act, physical injuries can occur, both to the person and to the animal, as well as behavioral changes after copulation. Because of all the above, the profiling of zoophiles is a matter of social importance, not only in the domain of suppressing this unacceptable and incriminated antisocial behavior, but also from the aspect of early detection of these persons and their treatment with professional help. Furthermore, the psychotherapeutic treatment of individuals affected by this paraphilia is hampered by shame and/or fear of social judgment. Consequently, a complex approach is necessary to solve this problem, with a focus on the de-erotization of the object of sexual desire and redirecting the individual's sexual preference to a socially acceptable object.

Human nature and paraphilic disorders

The term paraphilia refers to sexual pleasure and passion resulting from fantasizing and unusual sexual behavior. People who exhibit such behaviors are dominated by obsessive sexual needs or fantasies that cause significant disturbances or deficiencies in the social, work, or living environment (Bjelajac, 2020). These are patterns of sexual behavior in which desire, arousal, or pleasure are largely dependent on atypical elements, although this does not necessarily imply pathology. Paraphilias that are also recognized in the Fifth edition of the Diagnostic and Statistical Manual of Mental Disorders of the American Psychological Association (DSM-5) are exhibitionism, fetishism, frotteurism (touching or rubbing against people who do not want it), pedophilia, sexual masochism (humiliation or suffering), transvestite fetishism (wearing clothes of the other sex) and voyeurism (observation of another's sexual activity), while other paraphilias include zoophilia, necrophilia, and gerontophilia.

Zoophilia causes strong emotional reactions and debates both in scientific circles and in public. Academic research and reliable statistical data are generally scarce because zoophilia and bestiality are generally considered rare and unworthy of serious research or debate. The lack of research can be a consequence of different legal regulations, disinterest of scientists due to the taboo that accompanies this topic, complex data collection, resentment and misunderstanding of society, etc. The development of information and communication technologies and the Internet made it possible to examine the psychosocial characteristics of zoophiles much more easily than before. The reason for this is the anonymity of people with zoophilic interests, tendency for avoiding judgment, belonging to the zoophile sub-culture on the Internet, and connecting with people with the same interests in closed communities away from the public eye (Williams and Weinberg, 2003). Internet pages allow them to discuss on different forums with people with similar paraphilic disorders, but also to exchange pornographic materials. Although zoophile websites and online communities attract zoophiles as well as those who visit these sites out of curiosity, it is still unclear what the motivations are for using this type of pornography. Science is faced with the task of determining those motives. It is similar with other forms of paraphilia (pedophilia, necrophilia) and one of the goals of this paper is to contribute to that field. Several studies have investigated the motivation for consuming pornographic material, which could reveal predisposing psychological factors for its use and possibly underlying behavioral problems (De Souza and Baltieri, 2016, 144). The fear of stigmatization and social alienation of zoophiles suggests that they stick to secrecy and isolated groups with similar interests, which can negatively affect their psychological health and depression (Maratea, 2011).

What are the motives that lead a certain person to enter into sexual relations with animals have not been precisely determined and defined so far. As with other paraphilias, science has not answered this question clearly. Numerous factors have been investigated; one of the dominant ones is the lack of

a sexual partner. Miletski (Hani Miletski) researched paraphilias; one of the topics she dealt with was zoophilia and bestiality. In her studies, she examined the motives of the sexual orientation of zoophiles. She viewed sexual orientation from three aspects (Miletski, 2017):

- affective orientation - who or what we are emotionally attached to;
- sexual fantasy orientation - with whom or what we fantasize about having sex;
- erotic orientation - with whom or with what we prefer to have sex.

The results of several studies conducted by Miletski showed that sexual attraction and expression of love are two basic motives for sexual affection towards animals. Most of the respondents had sexual fantasies before the first sexual act with an animal, and the most obvious sexual fantasy is seeing others having sex with animals. Some respondents feel jealous if their animal has a relationship with someone else. Most of the respondents consider themselves zoophiles because they justify their relationship with an animal as an act of love, while a smaller part of the respondents consider themselves bestialists considering that they have a relationship with an animal only for sex. Also, the majority of respondents stated that they do not want to stop having relations with animals, stating that this is their sexual orientation and that they like it (Miletski, 2017).

Other research indicates that bestiality and zoophilia represent a specific psychiatric disorder. Wochner and Klosinski studied 1502 aggressive children and adolescents and found that 25 were zoosadists. These were exclusively boys, dominated by those aged 13, 17 and 18, which could be related to puberty problems, social restrictions and proving masculinity. Compared to a control group of "just aggressive" patients, zoosadists can be diagnosed with organic brain damage due to pregnancy or childbirth complications, harsh and tough parenting, and the absence of a positive father figure (Wochner and Klosinski, 1988).

Bestiality and zoophilia are often associated with other violent acts of the individual. Many studies have shown "a significant relationship between animal abuse and interpersonal violence, including domestic violence as well as social violence" (Alleyn and Parfitt, 2019). One reason for this association is that in some cases of domestic violence, abusers inflict injuries on animals in order to exert control over their victims. On the other hand, violence between family members and acts of violence witnessed by children can be a significant indicator of children's violence against animals, which is also manifested through zoophilia.

Zoophilia as paraphilic disorder

Zoophilia is a special form of paraphilia in which a person experiences sexual pleasure in a relationship with an animal. There is no agreement in the scientific and professional literature about what is considered zoophilia. Even the name itself causes numerous disagreements and debates among experts, about which we will present our opinion in the remainder of the paper.

Sexual behavior with animals includes various activities such as masturbation, anal intercourse (Peretti and Rowan, 1983), exhibitionism, voyeurism (McNally and Lukach, 1991). There is no uniform understanding of the different forms and classifications of zoophilia. Different terms can be found in the literature to explain the unnatural relationship between human and animal. Some of these terms are zoophilia, zoophilism, bestiality, zooerasty, bestiosexuality, etc. One of the classifications of zoophilia that is accepted in the literature and tries to prevent and avoid the existing terminological confusion is based on the classification of necrophilia as one of the paraphilic disorders. This classification ranks all shades of zoophilia from the least harmless behavior to the most criminal (Aggrawal 2011, p. 74). It includes the following categories of zoophilia (Aggrawal, 2009):

- Category I: Zoophiles do not use animals for sex at all but are only so-called role players. They express the desire that their partners in real life behave or imitate animals. The partner is reduced to the status of an animal as a symbol of showing authority and dominance.
- Category II: This category includes romantic zoophiles who keep an animal as a pet for psychosexual stimulation but do not engage in sex with animals.
- Category III: A category that includes zoophilic fantasies without actual sexual intercourse (masturbation in the presence of an animal, zoophilic voyeurism and exhibitionism).
- Category IV: Tactile zoophiles who experience sexual excitement by touching, petting or caressing an animal or its erotic parts.
- Category V: Zoophile fetishists who keep animal parts, especially fur, and use this as a fetish for their zoophilic activities.
- Category VI: Sexual pleasure comes from sadistic activities with an animal, such as torture (zoosadism). People of this class use animals for sexual excitement without actually having intercourse

with them.

- Category VII: This is the first category in which there is sexual intercourse between man and animal. Although they have sexual relations with people, these people would not refrain from sexual relations with animals if they were given the opportunity. There is no emotional connection between man and animal, but they use the situation in which they find themselves without the presence of other persons (shepherds, gamekeepers, etc.).

- Category VIII: This category includes "classic" zoophiles. They do not enjoy sexual relations with humans and prefer animals for relations. However, they can have sex with both humans and animals. In this sense, they differ from zoophiles from category X, who can only have sex with animals. These are people who show emotions towards animals, do not hurt them and do not cause them pain, and they manifest their love through sexual intercourse with the animal.

- Category IX: A special category of zoophiles that is related to necrophilia as a special form of paraphilia. These people are also called necrozoophiles because they have to kill an animal to have intercourse with it (necrozoophiles). They are, however, capable of having sex with live animals, but the need to have sex with dead animals is so great that they have to kill animals to have sex with their cadavers (Hickey, 2006).

- Category X: Sexual intercourse is possible only or mainly with animals, with the practical complete exclusion of human partners. Sexual activity with animals can occur due to the unavailability of suitable human partners or as a form of sexual experimentation. In such cases, the use of animals is not always the preferred method of achieving sexual arousal.

The classification of zoophilic disorder is important for therapeutic treatment, although it is quite complicated to obtain data on the history of zoophilic behavior in the earlier period of life due to feelings of shame, resentment or fear of sanction. Persons classified in the first five categories can undergo therapeutic treatment aimed at modifying and correcting behavior, while zoophiles from the other categories would have to be treated with more rigorous forms of treatment such as various pharmacological medications (Saleh and Guidry, 2003; Codispoti, 2008).

Although there are studies that show that people who have sexual relations with animals consider bestiality and zoophilia as a sexual orientation and not punishable behavior, in most developed countries such forms of behavior are sanctioned. Legislation differs from country to country and there are conflicting opinions whether animal protection should be a constitutional category or whether it should be regulated by legal and bylaws (criminal, misdemeanor). Animals do not have legal capacity; only people can be the subject of basic rights and freedoms and only people have a right to dignity. Today, in Europe, basic human rights are simultaneously protected at the country level, by the European Union and the European Convention (Cassel, 2016). The results of a study that was carried out in 15 European countries (Hungary, Austria, Czech Republic, Denmark, France, Germany, Italy, The Netherlands, Norway, Poland, Slovakia, Slovenia, Spain, Sweden, and Switzerland) and which examined the legal status of animals and the criminal law regulation of zoophilia, are quite contradictory. The study investigated whether certain forms or all actions with animals are punishable and whether the possession and distribution of pornographic material with animals is punishable.

According to the obtained results, the criminal legislation of the Netherlands, Norway and Switzerland is the most complete in assessing and sanctioning zoophilia. At the other end of the ranking list are Hungary, Italy and Slovenia because their criminal law does not include special sanctions in cases of zoophilia. In 5 out of 15 countries, animal protection is listed in some form as a constitutional category, and the Swiss legislation is the most complete. In Sweden, it is forbidden to show content with elements of animal cruelty in the media. There are also legal provisions against videos or recordings made using other technical means that depict violent acts or threats to people or animals, which are directed at minors. In many cases, illegal images of animal violence also violate the law. Most legislations give animals a special status, not considering them just things and objects, but state that they are living beings that perceive the world around them with their senses. The situation in which a sexual act with an animal cannot be considered abuse is most often disputed because there are no physical injuries. In those cases, the question of the dignity of animals was raised. Some countries, although they do not mention the dignity of animals in their constitutions or laws (with the exception of Switzerland), take it into account when they sanction cases motivated by zoophilia that do not result in animal injury. The dignity of animals is one of the main arguments of those in favor of strict sanctions against zoophiles (Vetter, Boros and Ózsvári, 2020, 9). Common in most legislations is the term animal welfare, which has also found application in our legislation. Domestic legislation is much more advanced than most EU countries. "The Criminal Code of the RS in Article 269 provides for the crime of Killing and abusing animals, which seeks to criminalize all behavior that endangers animals (murder, injury, torture or other abuse). Animals do not have clearly

and unequivocally established rights and freedoms like humans, and therefore the notions of deprivation of life, physical injury or torture of animals cannot be analogous to those of humans. Therefore, it was necessary to introduce acts into our legal order that will remove these doubts by prescribing what can and cannot be done with animals" (Ristivojević and Bugarski, 2014, 2). This article of the criminal law was elaborated in the special [Law on Animal Welfare \(2009\)](#), which protects animals from all negative forms of behavior of individuals or companies that harm the welfare of animals. This law was created as a result of harmonization of Serbian legislation with European legislation within the EU accession process. Animal welfare, which is regulated by this law, refers to animals that can feel pain, suffering, fear and stress. In Article 5 of this law, animal abuse is defined as "any treatment or failure to treat animals that intentionally or negligently causes pain, suffering, fear, stress, injury, violates the genetic integrity of the animal and causes death, including physical and psychological abuse". Physical abuse also includes sexual violence. Article 7, paragraph 1, prohibits the abuse of animals, while paragraph 24 states that it is forbidden to "kill, abuse, and incite an animal to aggressiveness and unnatural behavior for the purpose of producing films, advertisements, and other works on filmstrips, videotapes, and other carriers of images and sounds, as well as to put into circulation, rent and publicly show such films, commercials and other works". Therefore, we see that certain behaviors are sanctioned even though the sanctions according to this law are primarily monetary. Of course, the part related to sexual abuse of animals is regulated by law, but we cannot be satisfied with the fact that zoophilia and bestiality are not mentioned anywhere, and that there are no criminal sanctions for this type of concrete behavior towards animals.

Visible and dark side of web in the context of zoophilia

The Internet is an unfathomably large digital space. It seems perspicuous to the average user, because search engines such as Google, Yahoo, or Bing, in fractions of a second, list the results for the given search term, and for the most popular Internet services, there are also applications for almost every existing operating system for every device. However, even from its beginnings, and especially in this iteration of the Internet, that visible and transparent part of the Internet represents only a small part of that colossal global network, and therefore frequent comparisons are made with icebergs, where only the tip is above the water, while the rest, both in massiveness and in depth far below the surface. Hence the distinction between the visible web and the invisible is often referred to as the dark part of the Internet, Dark Net or Dark Web. Although most of the everyday access to the Internet occurs in the surface part of the Internet, which is subject to stricter control, which is mostly carried out through search algorithms that do not display search results for certain terms, the Dark Web occasionally comes into the public spotlight, most often when some criminal network or illegal activities are exposed, like in the case with Silk Road, an online marketplace where a wide variety of illegal products, from weapons to hard drugs such as heroin or cocaine, could be purchased, and payment was made in cryptocurrencies to avoid detection by the financial authorities. Silk Road operated smoothly from 2011 until 2013, when the FBI arrested the site's founder and owner Ross William Ulbricht and seized the website. (see more: [Bjelajac, 2022](#)). Of course, that particular site was the most famous and popular. Its discovery led to raising the level of awareness of the existence of the dark side of the Internet, but similar sites still exist on the Dark Net. With them, there is also a wide variety of content, some of which are the most strictly prohibited, such as child pornography, snuff pornography, and which is the subject of this paper, zoophilia. The dark side of the Internet cannot be accessed through conventional browsers and search engines, but a particular encrypted system is used, such as the Tor network (The Onion Routing Network). The US Navy initially developed this technology, and for some time was its exclusive user, for the needs of protected and secure communication. Later, the technology moved to open source, and thus its use began for these purposes as well (see more: [Frankenfield, 2022](#)). The technology is still functional today, and is used to access hidden sites, forums and other internet forms in a secure way, and most zoophile content is accessed in this way.

Although the largest number of sites dedicated to bestiality is located in the depths of the Dark Web, people with zoophilic tendencies can satisfy their urges even on the visible part of the Internet. Below we provide an overview of the availability and interest in zoophilic content on the visible side of the Internet that can be accessed by conventional means. A total of 1,839 searches for the given term "zoo sex" were performed on the Google search engine in a period of 30 days, from February 16th, 2023 to March 12th, 2023. The following chart shows interest over time in that period.

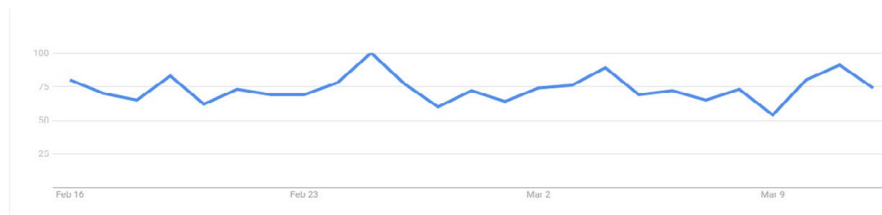


Figure 1. Google search for term „zoo sex“, worldwide interest over time in period 16.02.2023-12.03.2023. (source: Google Trends)

The graph represents the curve of the number of searches per day, while the vertical axis shows the sums of daily searches for that term. There were not more than 100 of them in one day in the period in question, but, at the same time, there were more than 50. When we talk about the geographical distribution, we can see it in the following illustration.

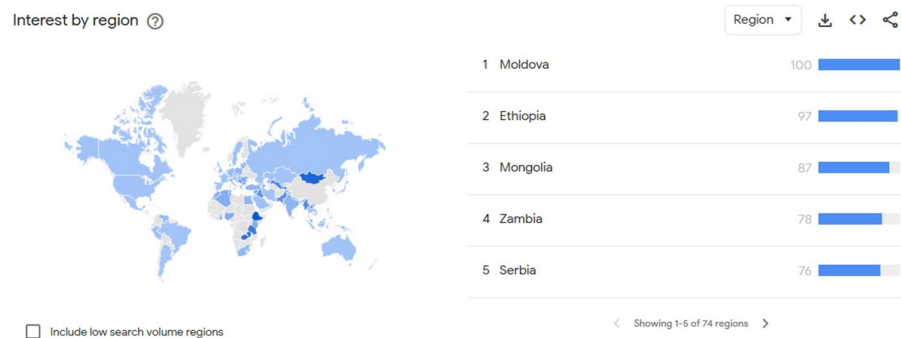


Figure 2. Google search for term „zoo sex“, worldwide interest per region, in period 16.02.2023-12.03.2023. (source: Google Trends)

On the map that can be seen in the illustration, the countries with a higher number of searches are marked with a darker color, and as we can see in the list, out of 74 countries in which this term was searched, Serbia is in fifth place. The Google Trends service also offers a list of searches for related terms in the same subject period, which included 24 queries, and the terms included are “animal sex”, “zoo porn”, “dog sex”, “horse sex”, “zoo tube”, “zoo porn”, as well as numerous other variations that include animal names with the word sex, porn, or porno. In the period in question, there were 1204 such searches for terms related to the term “zoo sex”. By searching for the term “zoo sex” on the Google search engine, you can find about 90 sites with bestial content, and almost every one of these sites offers its own list of links to sites with similar content. The filters built into Google’s search engine remove the largest number of results, and the actual number of sites with zoophile content is immeasurably higher, and it should be emphasized that Google only searches the visible part of the Internet and does not go into the Dark Web, where most of the zoophilic sites, forums and other internet forms dedicated to this paraphilia are located. According to modest estimates, there are tens of thousands of sites with bestial content, where there are several thousand video clips and photos of sex with animals, which are usually divided by categories, and the categories are usually by the types of animals involved in sexual relations.

In our digital/virtual world, we encounter programs every day that lead many individuals to be fascinated by criminal behavior and in those same individuals develop an interest in what causes people to commit such acts. Deviant behaviors, related to disorders that are socially conditioned, harmful and unacceptable, because they deviate from established standards and norms, are known as social pathology. Under social deviations in social pathology we include those types of individual and group behavior that result in the appearance of socially destructive, pathological and delinquent behavior. In a broader sense, we mean all those cases that cause a social reaction due to the threat of universal social values (Bjelajac and Filipović, 2022a). The development of the Internet, and the positioning of the Internet as one of the main preoccupations of modern man, has brought new opportunities for satisfying socially unacceptable, or even directly criminal urges. Before the Internet, people with inclinations to sex with animals could not satisfy their urges in a simple way, especially those people who are excited by sex with animals, but are not direct participants in sexual relations with animals, but satisfy their urge by watching. While people with a penchant for conventional pornography could find pornographic magazines or films

relatively easily, people with various paraphilias, including bestiality, found it incomparably more difficult to find such materials. What is also important, they could not do this while remaining invisible, mobile, and with multiplied presence. Before the Internet, such pornographic materials were obtained through communication with other paraphiles, such as zoophiles. However, with the advent and enormous spread of the Internet, it became easier to find and access these contents, which directly influenced the increase in the number of people with zoophilic tendencies who do not directly participate in sexual relations with animals, but observe and, as a rule, enjoy themselves by consuming and contents. In this sense, we can divide people involved in the chain of bestiality on the Internet into three categories:

- Participants - those persons who have sexual contact with animals, whether male or female, and who can be seen having sex with animals in videos or photos available on the Internet, very often for money they receive from producers and distributors of zoophile content;

- Observers - those persons who generally do not have direct sexual contact with animals, but primarily satisfy their needs by watching bestial content on the Internet, whether they have ever experienced SCA or not, and in this category we note the greatest expansion as a result of the development of the Internet and the availability of bestial content on internet, and the fact that these people most often do not achieve SCA does not reduce the risk of a potential SCA at an opportune moment, and who, in addition to zoophilia as a paraphilic disorder, also have other paraphilias as comorbidities, such as voyeurism and exhibitionism;

- Distributors – persons who put zoophile contents into circulation, i.e. make them available for users, who are often producers/creators of those contents, and can but do not have to be zoophiles themselves. The majority of distributors are in this business for profit, and do not suffer from paraphilic disorders, but a number of distributors who are also creators of the content they distribute suffer from the bestial disorder. Naturally, if we consider that zoophilic pornography is only one of the pornographic niches, it often happens that distributors, i.e. operators of web sites, have other types of pornography in their offer, and if we are talking about Dark Net sites, that offer also includes pornography related to for other paraphilias, such as pedophilia, necrophilia, sexual sadism, fetishism, etc.

The numbers we arrived at by researching the visible part of the Internet do not seem large, especially when compared to the number of sites with conventional pornography. However, since most of the content and Internet traffic related to bestiality is located deep in the Dark Web, we can conclude that the prevalence of this content is immeasurably greater. Also, sites dedicated to such contents, which cause the greatest number of people deep repulsion and disgust, cannot earn from advertising stemming from the number of visits, so they are mostly located behind paywalls, i.e., in order to access such contents, the user must pay a large amount of money, usually in cryptocurrencies. The Internet itself already offers anonymity, which encourages sexually deviant people to consume content that corresponds to their sexual preferences, and the Dark Web, most often reach by using the Tor network, provides even more anonymity, for all the parties involved, users and operators of the web-sites where criminal contents are often found. Therefore, the efforts of states, societies, and international organizations should be focused on acting against distributors of bestial content. Out of everything we mentioned before, it is clear that this job is not at all easy and that while one distributor is removed, several new ones appear, but this must not be a reason for passivity in acting against this dangerous and unnatural phenomenon, which, in addition to mental and moral risks, also carries enormous public health risk, starting from the transmission of zoonotic viruses, through various bacteriological infections, up to the increased risk of penile cancer as a consequence of SCA.

Significance of zoophile profiling

It is very difficult but also very important to profile people with zoophilic disorder. “The issue of profiling in criminal investigations is quite complex and not easy to define, which is why it contains a lot of ambiguities but also underestimations. Profilers are individuals / experts who are able to construct the psychological profile of the perpetrator but also the victim. They strive to be close and / or identical to their characteristics in real terms. Profiling begins on a solid scientific basis, but during this process intuition and imagination begin to prevail. An experienced criminal investigator thinks about the perpetrator of a crime permanently, and when he gathers all the facts about him, he selects them in his mind in different ways. After that, he begins to imagine a person, sees him more and more clearly and forms an image of him, making reasonable predictions about how that person will react in certain specific situations” (Bjelajac and Filipović, 2022b). As part of law enforcement teams, they use their knowledge, intuition and experience to reconstruct a crime from start to finish and create psychological profiles of potential suspects (Bjelajac, 2022). Criminal profiling is a forensic technique that predicts personality patterns, behaviors and

demographic characteristics of offenders. This technique gives the user insight and a better understanding of the perpetrator's characteristics of a crime or offense. It is significant from the aspect of predicting certain forms of behavior in order to prevent them from occurring. The prediction of certain criminal acts, among which zoophilia is certainly one, contributes to the creation of adequate prevention programs that will be directed at the risk group or individual. Today, profiling has found significant application in all spheres of science and technology. The growth of the Internet has brought the automatic collection of data on each individual that can be easily generated and sublimated, creating a profile of that person with all his habits, needs, interests, desires, behavior patterns, demographic characteristics (gender, age, education, occupation, marital status, place of residence). This data is used to predict the behavior of individuals and groups, their interests and preferences. It is similar with people who are prone to paraphilias and therefore to zoophilia. Numerous scientific research aimed at gathering more data and information based on which it would be possible to create profiles of criminals and predict their behavior. By sublimating the results of a large number of research we have listed in this paper, certain conclusions can be drawn that point to the profile of a person prone to zoophilia, regardless of which category of zoophiles that person belongs to. Zoophiles use Internet to connect with other zoophiles (26.6% to have casual sex, 17.7% for dating, and 17% to exchange pornography). Connections are easiest to be established in countryside, where zoophilia clusters. In fact, there are village communities of zoos where explicit sharing of animal sexual partner(s) (28%) and/or voyeurism (30%) serve as bonding ritual. Over 40% of zoophiles are reluctant to meet other zoos in person, since they view them as "weird", pointing to phenomenon of internalized stigmatization due to having non-normative sexuality (Sendler and Lew-Starowicz, 2017). It seems that the common feature that connects people suffering to this disorder is related to the reluctance to make friends and dating peers during the adolescent period. Therefore, the sexual energy of a mature young person is channeled to another object in a substitutive way, due to the impossibility of access and the barrier to the real object of desire. This zoophilic practice is particularly visible in isolated and hard-to-reach rural areas, where human contact is limited and access to domestic animals is relatively easy. Therefore, the choice of SCA in these circumstances is situational, mechanical, as an alternative for the lack of normal peer intimate relationships. Unlike people from rural areas who fulfill their sexual fantasies in the described way, individuals from urban areas who suffer from this disorder usually fulfill their sexual fantasies indirectly by watching zoo sex content on the Internet. Many visitors to these platforms are actually "unfulfilled zoophiles", who enjoy voyeurism and exhibitionism, watching others. Zoophiles are most often people who come from dysfunctional families in which separation, the presence of domestic violence with elements of abuse (physical, psychological and sexual) and neglect, with episodes of animal abuse have been recorded. In a study of 171 men who committed bestiality, 29.8% reported committing it with a group of men, and 70.2% reported doing it alone. The same study found that 62% had sex with multiple animals, while 38% always used the same animal and 14% said they had sex with an animal once, 15% said they did it monthly, and 39.5% said they did it weekly or more (Zequi et al., 2012). Due to the impossibility of obtaining valid data from zoophiles on a voluntary basis, some research are based on data obtained from zoophiles who committed a crime and were therefore legally prosecuted. The data obtained in this way contributed to the profiling of zoophiles and their easier detection. According to one of the studies with arrested zoophiles (Edwards, 2019) it was shown that almost one third (31.6%) of sex offenders with animals also sexually abused children and adults, while 52.9% of sex offenders against animals in the earlier period committed crimes with elements of violence, property crimes and abuse of psychoactive substances and alcohol. According to the same study, 72.5% of incidents involved an animal that lived with or was known to the perpetrator, 27.6% of offenders had sex with more than one animal or multiple sexual interactions with the same animal. When we talk about personality characteristics, we can conclude that these are people who have low intellectual potential, a pronounced sense of guilt, shame or fear of social judgment, with a feeling of rejection and a lack of empathy, prone to alienation and social exclusion, a lack of trust in themselves and others, a feeling insecurities and problems in social functioning. Poor hygiene habits usually affect poor health and zoophilic disorder itself can be comorbid with other diseases and conditions such as brain aneurysm, neurological disorders and psychoses (Marshall, 2007).

The recording of all data related to the characteristics of zoophiles contributes to the timely detection of these persons as well as the application of adequate treatment measures, which can be medicinal or therapeutic, depending on which category of zoophiles we are talking about.

Discussion

There are few studies dealing with zoophilia and mostly they give conflicting results. So far, two groups of researchers with different views regarding the phenomenon of SCA have been distinguished.

The first group of researchers, (Kinsey, Pomeroy and Martin, 1948; Peretti and Rowan., 1982). suggests that “zoophilia is predominantly ego-dystonic and that its origins have a dysfunctional background”. Another group of more modern researchers (Beetz, 2004; Miletski, 2001; Earls and Lalumiere, 2009) advocates the point of view that “not all people with zoophilia have a dysfunctional background and that they do not experience frustrations due to their experience with SCA”. The contemporary point of view, compared to the traditional one, explains that the affected persons prefer sexual contact with animals as their sexual preference.

In support of this, the fact that there are no agreed positions on zoophilia in the scientific community is also indicated by the fact that this phenomenon was not classified as a mental disorder until the third edition of the APA's Diagnostic and Statistical Manual for Mental Disorders (DSM-3). In the DSM-5, zoophilia is listed in the section “Other Specified Paraphilic Disorder” which refers to “repeated and intense sexual arousal involving . . . animals’ and causing significant stress and impairment in social, occupational and other important areas of functioning” (APA, 2013). Furthermore, this behavior is not treated as normal if it becomes ego-dystonic and harmful. Simultaneously, if a certain country's legislation prescribes it as such, it can be a misdemeanor or felony, so there can be various legal consequences for persons suffering from this disorder.

In any case, we should unequivocally define ourselves in relation to this phenomenon despite the evident contradictions. First, zoophilia is a serious disorder/disease characterized by a kind of psychopathic behavior. Second, this disorder leads to criminalized treatment of animals and has legal implications in many jurisdictions, due to animal abuse and crimes against nature. Third, zoophilia cannot be treated as an unimportant community health problem, which isolates and marginalizes the individual exposed to this problem without a comprehensive treatment plan. Fourth, the Internet, as the largest global information system, should be denied the right to promote and affirm anti-social and bestial content, which is contrary to social norms. Fifth, since an animal cannot consent to sex, SCA should be treated and legally regulated as pedophilia, making no distinction between the sexual abuse of children and the sodomization of animals, however problematic and unpleasant that may be.

Conclusions

Bestiality and zoophilia are unjustifiably neglected by the scientific and professional public considering that they represent a serious health and social problem. The lack of more research and valid data is no justification for neglecting this topic. The fact that 2% or even 10% of the population at least sexually fantasizes about animals calls for an urgent response from society. It is necessary to open a public and professional discussion on the topic of bestiality and especially on animal abuse. Our research has shown that the problem of zoophilia is much bigger than official data portrays. The easy availability of the Internet and covert communication, visiting sites in the visible part of the Internet, and especially on the Dark Web, indicate the seriousness and spread of this form of paraphilia. As with other paraphilias, bestiality and zoophilia represent a serious problem that is most often characterized by disorder and psychopathic personality traits, in most countries it is criminalized by criminal legislation, negative implications for the social life of the individual, consequences for the health and well-being of animals, which requires a multidisciplinary approach to this problem. Sexual relations with animals they expose people to various health risks and often cause physical harm to the animal involved in sexual intercourse.

Resulting from everything stated above, the collection of data on zoophiles is the basis of valid and necessary profiling, the goal of which is the early detection of these cases and persons with paraphilic disorders. Profiling allows us to create adequate preventive measures in order to prevent the manifestation of this form of behavior. In addition to numerous conflicting views, it is also necessary to harmonize legal regulations and precise incrimination that will recognize zoophilia, as well as pedophilia, as a criminal offense. Controlling the Internet and the content displayed on it is one of the best preventive measures in order to prevent the spread of zoophilia and zoophilic pornography. The indecisive and indifferent attitude of society, the scientific and professional public towards this form of paraphilia must be changed in the direction of greater engagement of experts of different profiles, but also of other state authorities, the media, non-governmental organizations, animal protection societies and other relevant entities.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, Ž.B., B.M. and A.M.F.; methodology, Ž.B.; supervision, Ž.B.; formal analysis, B.M. and A.M.F.; writing—original draft preparation Ž.B., B.M. and A.M.F.; writing—review and editing, Ž.B., B.M. and A.M.F. All authors have read and agreed to the published version of the manuscript.

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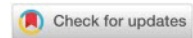
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The School of Athens, the Philosophical Artwork that Conveys All Human Knowledge

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Abstract: The School of Athens, the fresco by Raphael, is an artwork in which the whole world has seen for five centuries, not only the aesthetic, emotional and spiritual aspect of art, but also the philosophical and intellectual one. In this fresco Raphael painted the human mind. This work is a holistic variation of cultural anthropology and cultural cognitive science. It is a university in which all human knowledge is summoned. Raphael combined paganism and humanism within the Vatican premises. Making this fresco a significant work, reflecting and conveying the core cultural values and universal ideals, offering an excellent opportunity for any viewer to engage in a multicultural cognitive act and process. This paper presents how this multi-dimensional and multi-disciplinary work serves as an ideal example for today's works and philosophy to connect all creative and philosophical disciplines into one, inspiring today's thought and the new works of creative arts to contain the human knowledge of the ages, uniting the past and future, as a meeting point of history, reason, discovery and human aspirations. It will present how this complex artwork includes knowledge, philosophy, art, morals, customs, etc, acquired by any member of society to understand human cultural cognition.

Keywords: Athens, Raphael, Plato, Aristotle, Cultural Cognition.

Introduction

While Michelangelo was painting the dome of the Sistine Chapel in Vatican, a few feet away, another artist was painting a fresco that would go down in history as one of the world's masterpieces. This artist was Raffaello Sanzio da Urbino (1483-1520), who today is known, after Leonardo da Vinci and Michelangelo, as the third figure of the most important artistic trinity of the Golden Renaissance, even of the entire history of art.

Raffaello, whom we know today as Raphael, is the author of The School of Athens fresco (1509-1511), in which the whole world saw for five centuries, not only the aesthetic, emotional and spiritual aspect of art, but also the intellectual aspect. In this fresco, Raphael painted the human mind. This work is a university in which all human knowledge is summed up. This work is a holistic variation of cultural anthropology and cultural cognitive science, engaging any viewer in a multicultural cognitive act and process.

The School of Athens is considered one of the best examples, and even the pinnacle of the classical Renaissance style. It depicts a pleasant scene of people dressed in ancient clothes and engaged in various forms of intellectual activity: conversations, readings, explanations and listening. All the figures are composed within a luxurious Roman architectural structure, through which the eye is drawn to the blue sky seen in the background.

The identities of the 58 figures in the painting have intrigued scholars and researchers for a long time. Many of the figures are known and easily recognizable, but some others still remain a mystery.

In the room where the fresco is located, Pope Julius II, in 1508, ordered the young master from Urbino to paint the walls of his personal rooms in the Vatican Palace. The School of Athens is found

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on one of the four painted walls of the Stanza della Segnatura (Signature Room), designated to be the Pope's personal library.

This paper presents how this multi-dimensional and multi-disciplinary work serves as an ideal example for today's works and philosophy to connect all creative and philosophical disciplines into one, inspiring new thought and new works of creative arts to contain the human knowledge of the ages, uniting the past and future, as a meeting point of history, reason, discovery and human aspirations. It will present how this complex artwork includes knowledge, philosophy, art, morals, customs, etc, acquired by any member of society to understand human cultural cognition.

The School of Athens

At that time, libraries were divided by categories; in this case, the room is divided into four categories: Theology, Philosophy, Poetry and Law. All four categories are marked on the ceiling of the room. Philosophy has a female figure engraved with the motto *causarum cognitio*, (knowledge of causes). Theology, with the motto *divinarum notitia* (knowledge of divine things). The other two are Poetry and Law. The two dominant frescoes of the room facing each other are Theology and Philosophy illustrated with The School of Athens fresco, as two confrontations between the worlds of intellect and religion. Together, they expressed the world that Pope Julius II wished to promote: a glorious synthesis of the totality of learning within the seat of papal power. Pagan antiquity welcomed into the bosom of the Church. (Bosman, 2014, p. 67).

The fresco technique is one of the most difficult techniques in painting. Unlike canvases or wood paintings, which can be created for years and years, the fresco must be created in a day. The process is very difficult and requires a great preparation of materials and speed in casting the colors. To paint this fresco, Raphael first drew each figure on paper, then joining the pieces, he placed them on the wall, piercing the drawing lines with nails, and then sprinkled black powder to leave a trace of the figures on the wall. The biggest difficulty was with the paint. The helpers plastered the wall and the master painted quickly before it dried, so that the wall would absorb the paint and become resistant to time. Imagining this difficult technique, we can understand the genius and skill of Raphael who created such a work.

Raphael chose the subject of his fresco from Greece of the V century BC, from the speech of Pericles where it was said "Athens, is the school of Greece." Therefore, the two central figures of the fresco are the two colossi of world knowledge and philosophy: Plato and Aristotle. These two figures are the center of the fresco from which all the diagonal lines and reference points for linear perspective originate.

At the center of the picture are Plato (pointing up to his ideals in heaven) and Aristotle (gesturing down to the real world here on earth (Haas, 2012, p.8)). Plato, on the left, holds his *Timaeus* while Aristotle, on the right, holds his *Ethics*. Plato, depicted with the portrait of Leonardo da Vinci, is dressed in pink and purple, colors that symbolize fire and air, while Aristotle is dressed in blue and brown, the colors of water and earth. Both of these figures symbolize the four physical elements of the universe but also the two basic worldviews of philosophy. Plato has the index finger of his right hand pointing towards the sky, while Aristotle has his palm pointing towards the earth. One the sky and the other the earth, this was also the dividing line between the philosophers of the two enlightened minds.

Placing these two figures at the center and next to one another, was a philosophical, existential and cultural cognitive symbolism engaging the viewer to participate and make a stance in the conflicting presence of these two philosophers who represented two opposing views and beliefs in almost every discipline of thought.

Plato believed that concepts had a universal form, an ideal form. Aristotle believed that universal forms were not necessarily associated with each object or concept, and that each instance of an object or concept had to be analyzed on its own. For Plato knowledge was a virtue while Aristotle believed it had to be earned. Plato stood out in the world as "the great apostle of morality." He believed that God's voice left an echo in the human heart, but for Aristotle, God was indifferent to virtue. He was an opinion and not a moral. For him morality had no eternal basis, no divine nature, and no reward in the next world. Aristotle's philosophy emphasized reason and ignored conscience and heart (Cocker, 2018, p.886). Thus, the idealist and the pragmatist, painted in the center of this fresco, with the right hand of one and the left of the other integrated into the architectural arch that stands above them like an aura of glory.

Raphael adds to this peaceful conflict other important figures, such as Socrates, Zeno of Citium, Epicurus, Boethius, Pythagoras, Alexander the Great, Pericles, Xenophanes, Parmenides, Heraclitus, Euclid, Archimedes, Zoroaster, Ptolemy, Protogonus, and dozens of philosophers and outstanding ancient

Greek and Roman figures who form the center of this fresco, but organized in three horizontal and two vertical groups, belonging to either the philosophy of Plato or Aristotle. For five centuries, scholars and historians have always agreed on their identities and symbolism, which now are considered as public domain.

In the background there are several arches and stairs that illustrate perspective, an important discovery and element of that time, which form a Greek cross, illustration of the harmony between pagan philosophy and Christian theology. In the background there are also two sculptures, that of Apollo, on the left, the god of light, bows and music, holding a lyre in his hand, while the other sculpture is Athena, the goddess of knowledge.

Raphael was a great admirer of two art colossi who were his contemporaries, Leonardo and Michelangelo. Thus, both of them are painted in this fresco. Leonardo in the portrait of Plato, and Michelangelo in the figure of Heraclitus, the foreground figure of the fresco, leaning thoughtfully with his elbow on a block of marble, solitary and introvert, as Michelangelo really was, and so was Heraclitus. Raphael is said to have repeatedly dropped by to check on Michelangelo as he worked on the Sistine Chapel dome fresco in the next hall, a few meters away. The figure of Heraclitus, i.e. Michelangelo, was added last, after the fresco was finished. Just as Plato and Aristotle stood for opposing ideologies and beliefs, Leonardo and Michelangelo were two opposing figures of the Renaissance in personal aspects, and sworn enemies and fierce competitors in art and society. This harmonious conflict represented in the fresco is an open invitation for cognitive processing and cultural apprehension.

In the lower right corner, the bent figure, with a red cape and flowing hair, is found the friend and cousin of Raphael, Donato Bramante, the Pope's architect, who is sketching a geometric shape with a compass in his hand, which is actually the floor plan of St. Peter's Basilica where this fresco is located, created by the hand of the master Bramante, whom Raphael compares to Euclid, the outstanding Greek mathematician, the father of geometry. But behind Euclid, Raphael left his signature, painting himself through a self-portrait hidden behind the column, wearing a black hat, half-profile and looking towards the viewer, as a message for future ages that art is an integral part of the universal school. He has painted himself hidden, somehow enigmatic, just like his own short life of thirty-seven years, which in history has remained only as a shadow, a sfumato, without living the kind of greatness that is manifested in his works. (Forcellino, 2015, p.7).

Behind Euclid are Zoroaster, the Iranian philosopher and spiritualist, holding a celestial globe, and Ptolemy, the astrologer, with a terrestrial globe. In the figure of Zoroaster, Raphael painted Jacopo Sadoleto, the pope's secretary. The celestial and terrestrial globes were important elements for the Renaissance, due to the extraordinary discoveries and expansion of the world at the time of Pope Julius II. The Cape of Good Hope was discovered in 1487, the West Indies and America in 1492, India in 1498 and Brazil in 1500. Balboa would discover the Pacific in 1513 and Magellan would complete his circumnavigation of the globe in 1521. The geographical horizon had greatly expanded during the papacy of Julius II and Christian preachers were being sent to India, Africa and the New World. Thus, these ancient scholars unfolded by the hand of Raphael were suited to the Christian interests of Pope Julius (Joost-Gaugier, 1998, p.760).

In the lower left corner of the fresco, Pythagoras is seen seated, writing, covered with a white robe, with flowing hair. He is engrossed in writing in his book with the young disciple holding a slate diagramming musical intervals and the mystic formula $1+2+3+4=10$ (Haas, 2012, p.9). He is also surrounded by thinkers of antiquity, among them, as distinguished by the white turban and the dark skin, is also Averroes, the Arab philosopher, known as Ibn Rushd.

Pythagoras is known as the great mathematician and astronomer but Raphael pays homage to his Great Theory of Beauty. The Ancient Greeks formulated The General Theory of Beauty according to which beauty consists in the proportions of the parts; in the proportions and the proper arrangement of the parts, or, even more precisely, in the size, quality and number of the parts and their interrelations. The Great Theory was developed by the Pythagoreans. The Pythagorean School defined beauty in terms of perfect structure, and structure was defined in terms of the proportions of the parts (Kostov, 2013, p.3). This Pythagorean definition is expressed explicitly in the fresco, incorporating also moral beauty and combining aesthetics and ethics.

In the center of the fresco, under the two main figures of Plato and Aristotle, stands out the Greek philosopher Diogenes, known as Diogenes the Cynic, as he was one of the founders of Cynic philosophy. Posed on the steps of the stage, covered in a blue cloak, appearing as a beggar, Raphael has depicted him as he was known, a philosopher who chose a simple lifestyle, eating and sleeping where he pleased, but homeless, in order to criticize social values and institutions which he considered corrupt.

Raphael is not timid to include the Arab philosophers at the heart of Christianity, and he has even shown himself to be very brave with Epicurus, who is on the left with a blue cloak and a laurel wreath on

his head, a philosopher very contradictory to the Christian faith, since he promoted pleasure as good, death as the annihilator of body and soul, and promoted the idea that the gods neither reward nor punish mankind. The school of the Epicureans, but also the Stoics, brought a philosophy which ridiculed the doctrines of resurrection and judgment. Their philosophy directed attention only to the welfare of the individual in this world; it was simply a philosophy on life and not like Plato's, which was "a preparation for death." The followers of Epicurus believed that "Pleasure is the chief good, the end of life is self-pleasure; therefore do not fear the gods any more, and above all do not fear death. Others took refuge in the Stoics, saying "fata nos ducunt – the fates guide us! Live according to reason." (Cocker, 2018, p.887). This is another timeless conflicting atmosphere on religion, wisely and harmoniously presented as a stage play, requiring once again the cognitive participation of the viewer.

But, however liberal The School of Athens fresco may seem, considering the period and the location, as well as how conflicting with the creed of Christianity, if analyzed in the historical context and considering some unexplained but implied elements of the work, it is understood that it was neither a manifestation of rebellion nor a threat for the Christian faith and the papacy. The whole scene of the ancient scholars, and the brightest minds of mankind, takes place in the lower half of the fresco. The upper half is covered only with architectural space, which culminates with three small windows which, like in Leonardo's Last Supper, not only serve to create the notion of space for a room without windows, but also serve as symbolism of the holy trinity, thus transmitting the message that the greatest knowledge of humanity, however magnificent it may be, remains earthly, and always under the presence of the divine. This method brought about an intertwining of religion with emotion and cognitive process. The intertwining of religion and emotion was deeply rooted in the Christian anthropology that commended the power of human emotion. In this fresco the language about religion, conveyed through imagery, religious experience and emotion is intertwined, creating a new approach how religion was conceptualized (Corrigan, 2017, pp.3-5). By adding elements of paganism Raphael raises this cognitive and emotional approach to a new level.

In order to understand this setting the viewer had to be personally part of the atmosphere, engaging all his faculties and perceptive abilities and senses. Raphael's work impacts the visual perception, i.e. the capacity to identify, classify, and interpret visual stimuli in light of prior knowledge, describing the cognitive skills that integrate visual information into higher cognitive functions and processes (Ferah-Ozcan and Yildiz, 2022, p.2).

It is worth noticing that Raphael combined paganism and humanism within the Vatican with the full blessing of Pope Julius II, at a time when the papacy itself had been more open to ancient lore and pagan mythology for centuries. The penetration of Humanism into the practices of Christianity had been evolving slowly and gently for centuries. It was Thomas Aquinas (1225-1274) a well-known Dominican and theologian of his time, who believed that man had rebelled against God but that his fall was partial. According to him, the will of man was corrupted while the intellect was not affected. Therefore people could rely on human wisdom by mixing the teachings of the Bible with the teachings of ancient non-Christian philosophers.

Thanks to him, Aristotle was accepted to be taught in the universities, and the geniuses of the Renaissance created works where Christianity clearly mixes with paganism and humanism, as seen in the works of Leonardo, Michelangelo, and Raphael. Even Dante Alighieri followed the path of Aquinas in his work *The Divine Comedy*, where in *Inferno*, the guide is the Roman poet Virgil, who was to Dante what Aristotle was to Aquinas, and as the greatest sinners of hell Dante named Lucifer who betrayed God, Judas who betrayed Christ, as well as Brutus and Cassius who betrayed Caesar (Schaeffer, 2022, p.56). Therefore, the mixture of paganism and Christianity had become a fashion over the centuries and an artistic tool for the art of the Renaissance, which, like *The School of Athens*, could also be interpreted as a cult work for man, the power of human thought and the tradition of pagan gods in history of humanity. The coexistence between this cult and Christianity was so organically intertwined and difficult to distinguish that it allowed pagan gods within the premises of church worship.

Even St. Augustine, one of the church fathers, seems to accept their union when he wrote that "Plato made me know the true God, while Jesus Christ showed me the way to Him." (Augustine, 2015, p.184). This union would be copied in the future by Enlightenment, philosophical groups, and revolutionaries who would tone down the divine nature of Christian places of worship and promote more human nature and attributes. For example, eighteenth-century church architecture features churches decorated with angels and cherubim as if they were out-of-this-world drawing rooms, colorfully decorated to entice the masses and create choir resonance. Pushed by art, church music also went through a metamorphosis, including the music of Bach, Handel, Heide, Beethoven and Mozart in church services (Green, 2000, p.230).

Certainly, it also expanded into literature and politics. Niccolo Machiavelli's famous work *The Prince*, published a few years after the completion of *The School of Athens* fresco, promoted pragmatism

rather than morality, humanism rather than faith. Complicated in political nature, Machiavelli's advice is far from canonical biblical principles. They are typically humanist and pragmatist. For example, Machiavelli advises the prince, in this case Lorenzo de' Medici, that he should not be merciful but mean, not gentle but rude, not fair but manipulative: If he is wise, the prince need not fear the reputation of being bad... We have not seen great things done, except by those who have considered themselves evil... For this reason it is wiser to have a reputation for being mean because it brings you a rebuke without hatred... (Machiavelli, 1998, Ch. XVI-XIX).

Whenever we see or discuss such works of art, to understand them better we need to be well informed and well read. Art as mere aesthetics is amateurism and naivety. A work of art either has the heart or the mind, or both. Raphael's portraits, Saint Mary and other paintings are full of heart and feeling as they radiate a sensuous and almost divine delicacy and beauty, but in this case, with the fresco The School of Athens, with this university work, the viewer must put his mind to work, interact, use his faculties and cognitive thinking, and call for knowledge as aid, because it is a true reflection of the events, achievements and developments of time.

A viewer may naively ask why there are so many names of philosophers in this fresco. And the answer comes from history. On May 29, 1453, the Ottomans entered the golden city of Constantinople, today's Istanbul, thus signaling the end of Byzantine Christian culture. This forced all the scholars, who were much desired by the royal courts, to flee to western countries, finding refuge in the many universities that had sprung up in Europe during the past two centuries. Two of the destinations where the scholars arrived were Florence and Rome. This emigration was highly significant, as it brought many classical thinkers back to the attention of Western culture. Furthermore, due to Johann Gutenberg's invention of the printing press, texts such as the Bible, ancient works only available to a few could now be widely read. By 1500, over half a million printed books were circulating in Europe, spreading new intellectual ideas across the continent (Kissik, 1993, p.151). Thus, mythology and ancient lore became a thing of fashion and an inspiration for the academic and intellectual ranks. Hence, under this spirit, Renaissance artists manifested that ancient lore and knowledge through their works.

The artists of the Renaissance were not simply painters or sculptors, they were engineers, researchers, historians, poets, etc., and among other things Raphael was also an architect and an archaeologist, thus, The School of Athens fresco consists in a large part of architectural forms. In his time, Raphael was well-known and important figure. Raphael's interest in architecture provides much of the grandeur in The School of Athens. By 1514 he was named the papal architect, a position suggesting he had a substantial knowledge of practical mathematics (Haas, 2012, p.6).

As the architect of St. Peter's he held an important position with many other architects under his command. As a painter he had a world-wide known name and a staff of assistants for his paintings. And as an archaeologist he was the leader of excavations and tried to systematize the measurements and restorations of ancient Rome. He accurately measured the architectural remains of Rome's old buildings. He wanted to reveal the foundations of ancient Rome in all its grandeur; therefore, although the figures in his fresco are Athenian, the architecture of the work reflects his work as an archaeologist and architect, painting it as Roman. Because of the great passion he had for archaeology, Raphael exhausted himself and his death came because of the fever that he caught during the excavations (Kissik, 1993, p.21). Due, to his architectural knowledge and talent, The School of Athens conveys an immersive experience and storytelling that makes the user lose the separation between real and virtual world (Bonacini, 2021, p.37) requiring the cognitive participation of the viewer to perceive the scene and understand the artwork.

"Raphael! As we merely whisper this magical name," writes a 19th-century author, "our whole being seems enchanted. Wonder, delight, and awe seize our souls, throwing us into a whirlwind of strong emotions." However, today he still remains unknown. An artist of intelligence, sensuality and the divine. It was not only Giorgio Vasari, the well-known biographer, who thought that Raphael's art was divine, there was no master of the Florentine school in the early 16th century who did not acknowledge his superiority (Crowe and Cavalcaselle, 2022, p.2). His masterful talent and genius is surely demonstrated in The School of Athens, where all the human senses, including that of space, of the notion of past, present and future, perspective and cognitive abilities, are required.

It is not known exactly when Raphael started painting, but it is known that he started very early. Perhaps he painted from the moment he could hold a brush in his hand. His father was a highly respected painter of the school of plastic perspective, so Raphael learned easily to depict the human form and to practice geometry and perspective in his works. The School of Athens is an intelligent fresco, but the artistic delicacy of Raphael's brush is more noticeable in the portraits and other compositions which radiate a reflection of beauty unprecedented in the history of art, making Raphael known as one of the "most known and most loved" of the Golden Renaissance (Berenson, 2005, p.94). Even Pope Leo X,

successor of Pope Julius II, emphasized the mastery of the artist. In the middle of the 16th century Raphael was thought to be the ideal painter, the universal artist in his talent, meeting all the absolute standards and obeying all the rules that govern art (Blunt, 1962, p.76). Today he is considered one of the absolute masters in history.

There is one point in The School of Athens that might trouble today's viewer, however it serves evoking another element on the cultural cognitive process, i.e. the fresco contains no women. Among the greatest minds of human knowledge and intelligence, Raphael did not include Hypatia, or Aspasia, or the wise woman Diotima of Mantinea who was Socrates' teacher. In extenuation though, Raphael paints the great Greek woman poet Sappho, prominently positioned and labeled, on the adjacent wall fresco Parnassus celebrating the arts and music (Haas, 2012, p.11). This urges the reflective senses and social cognitive participation.

Conclusion

The School of Athens summoned all the knowledge of the past, influencing the knowledge of the eras to come. As the viewer stands before it, in what is now known as the Raphael's Hall, one kneels with reverence before art and knowledge, and engages in the cultural cognitive process analyzing that ancient expression, attributed sometimes to Socrates and sometimes to Plato, ipse se nihil scire id unum sciat, I know that I know nothing.

Is this not the genesis of all knowledge, and the essence of art itself? Is this not the most inviting exercise for cognitive thinking, and cultural cognitive involvement and participation? This multi-dimensional and multi-disciplinary work serves as an ideal example for today's works and philosophy to connect all creative and philosophical disciplines into one. It inspires how new works of creative art can contain the human knowledge of the ages, uniting the past and future, as a meeting point of history, reason, discovery and human aspirations. It is a complex artwork that includes knowledge, philosophy, art, morals, customs, faculties of the mind, perception abilities, and more, (Moore, 2022, p.194) acquired by any member of society to understand human cultural cognition.

The work creates a semiotic activity that at its core there is a self-exceeding mechanism, which triggers a moving-backward-and-forward relation between the sign and the interpreter. The concept of "representation" is used to define this relationship (Cerella and Bradley, 2023, pp.6-8). It stimulates the cognitive, didactic, reflective, and affective domains, fusing knowledge, thinking skills, and the centrality of emotions, values, beliefs, and moral issues into a cohesive experience. The human world is constantly being reopened and formed through the creation of new meaning.

The use of the symmetrical style mirrors the laws of nature and mathematics. The incorporation of historic figures, architectural elements, specific symbols, as well as seemingly insignificant objects, referring to philosophical concepts, invites humanity to understand and interact with the world.

This work is a holistic variation of cultural anthropology and cultural cognitive science. It is a university in which all human knowledge is summoned. Through this fresco, intellectuals, philosophers, as well as ordinary individuals, seek to use and intertwine the results from the cognitive science of culture to determine or construct debates over many philosophical questions and beliefs, considering it as a transformative example into modernity.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization: B.K. and A.I., Data curation: B.K. and A.I., Formal Analysis: B.K. and A.I., Investigation: A.I., Resources: B.K. and A.I., Software: B.K. and A.I., Supervision: B.K. and A.I., Validation: B.K. and A.I., Visualization: B.K. and A.I., Writing original draft: B.K. and A.I., Writing review & editing: B.K. and A.I. We confirm that all authors have read and agreed to the published version of the manuscript.

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JM Goldberg and Neff (1961) and ME Goldberg and Wurtz (1972) studied ...

- If the same author or the same authors cite two or more references, then in brackets do not repeat names but just add a year for the next release.

Past research (Edeline & Weinberger, 1991, 1993) ...

Past research (Gogel, 1984, 1990) ...

- When the same author we have more work during one year, then these sources labeled the letters of the alphabet a, b, c and so on.

Several studies (Gogel, 1984, 1990a, 1990b) ...

- When several authors cite in the same bracket, or when we point to the consent of the author, references detach semicolon and listed them in alphabetical order.

Several studies (Balda 1980, Kamil 1988, Pepperberg & Funk, 1990) ...

- If with some of the references cite a source that confirms what is specific to this reference, then the source listed below see also, but that goes with the source of reference, but not alphabetically.

Several studies (Minor 2001; see also Adams, 1999; Storandt, 1997) ...

- When quoting hearsay, cite the author's name and year of the original work, followed by a semicolon and then cited code, then last name, year and foreign labor from which he quoted original work.
The first definition of intrinsic motivation gave Decy (1975; see Suzić 2005, p. 108) ...

- If we know the year of the first publication of the work, then it is to be connected age translation by first listed year of first publication, a slash and then year translation.

(James, 1890/1983)

- For an Internet source that does not have a bookmarked Web page, use a pair of ¶ and paragraph number on the page where it was published.

(Myers, 2000, ¶ 5)

- Personal communication or publicly spoken words in a lecture to quote only in plain text, but not in the list of references, but does mention the date of actual communication.

Decy (personal communication, April 18, 2001) ...

REFERENCES

- Form Guidance papers in the journal is as follows:

The author's name [comma], initial / names [point], [open small brackets] year of publication [close little brackets] [point] title of the paper [point], the name of the magazine - in italics [comma] the number or volume - in italics [comma] page starting work [line] Page completing work [point].

Dennis, TA, Cole, PM, Wiggins, CN, Cohen, LH & Zalewsky, M. (2009). The functional organization of preschool-age children's emotion expressions and actions in challenging situations. *Emotion*, 9, 520-530.

- Form quoting the works of authors of books is as follows:

The author's name [comma], initial / names [point], [open small brackets] year of publication [close little brackets] [point] title deeds - in italics [point], the city (and state) [two counts], the publisher [Point].

Hirsch, Jr., E. D. (1996). *The schools we need and why we do not have them*. New York: Doubleday.

- When you mention a paper published in a journal or as part of a book as a chapter, then applies the following form:

The author's name [comma], initial / names [point], [open small brackets] year of publication [close little brackets] [point] title of the paper [point], In Proceedings ... (note that the work was published in a journal or book ...) The name of the publisher [open small brackets] Issue. (Note that this is a publisher) [Close little brackets] [comma] title of the collection - in italics [open small brackets] page starting work [line] Page completing work [point], the city (and state) [two counts], publisher [point].

Barrett, KC, & Campos, JJ (1987). Perspectives on emotional development: II. A functionalist approaches to emotions. In Osofsky JD (Ed.), *Handbook of Infant Development* (2nd ed., Pp. 555-578). Oxford, England: Wiley.

- If seven or more authors, then we will list the names of the six authors, and the seventh and the rest fall into the category of " and associates " .

Adam, JJ, Paas, F. Teeken, JC van Loon, EM, Van Boxtel, MPJ, Houx, PJ, et al. (1998). Effects of age on performance and a finger-precuing task. *Journal of Experimental Psychology: Human Perception and Performance*, 24, pp. 870-883.

Second and last author in a list of references are always stating afterward conjunctions & English.

- In magazines published articles cite the following form:

the author's name [comma], initial / names [point], [open small brackets] day, month and year of publication [close little brackets] and the title [point], the name of the magazine or newspaper - italics [comma], number of journals or Newspapers - italics [comma], page beginning of the text [line] Page completing the text [point].

Henry, W. A., III. (1990, April 9). Beyond the Melting Pot. *Time*, 135, 28-31.

- When we need to with the title of the article mention what kind of material it is then enclosed in square brackets after the title of the paper is printed by it is a brochure, video recording and the like.

Research and Training Center on Independent Living. (1993). Guidelines for reporting and writing about people with disabilities (4th ed.) [Brochure]. Lawrence, KS: Author.

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taken (note that work will take) the day, month and year, with (internet address).

Schwarzer, R. (1989). Statistics software for meta-analysis [Computer software and manual]. Retrieved March 23, 2001, http://www.yorku.ca/faculty/academic/schwarze/meta_e.htm

- When the list reference is made to the work that is being prepared for the press, after the authors' names, in parentheses, listed in the press in English.

Zuckerman, M. Kieffer, SC (in press). Race differences in faceism: Does facial prominence imply dominance? *Journal of Personality and Social Psychology*.

- When the list of references cites a newspaper article without the author prints the name of the article, then the time of publication, then the title and number - in italics, and at the end of the page on which the article was published. If the title is long, we can shorten the optimum number of words by taking the first few words.

The new health-care lexicon. (1983, August / September). *Copy Editor*, 4, 1-2.

- If within the journal as publisher publishes a special issue as a monograph, it is necessary after heading indicate that it is a monograph.

Ganster, DC, Schaubroeck, J. Sime, WE, & Myers, BT (1991). The nomological validity of the Type A personality among employed adults [Monograph]. *Journal of Applied Psychology*, 76, 143-168.

- When an abstract or summary of the quote as the original source, after the title should be in parentheses to indicate that it is abstract.

Wolf, NJ, Young, SL, Famselow, MS, & Butcher, LL (1991). Map-2 expression in cholinceptive pyramidal cells of rodent cortex and hippocampus is altered by Pavlovian conditioning [Abstract]. *Society for Neuroscience Abstracts*, 17, 480 harvesters.

- Titles that are not in English, and we want them to be published in the journal in English, listed in their native language, and then in the square brackets give the title translation into English. In addition to the title, everything else remains the mother tongue.

Ising, M. (2000). Intensitätsabhängigkeit evozierter Potenzial their EEG: Sindh impulsive persons Augmenter stage Reducer? [Intensuty dependence and event related EEG potentials: Are impulsive individuals augmenters or reducers?]. *Zeitschrift für Differentiel und diagnostisch Psychology*, 21, 208-217.

- In the list of literature translated work following a text that we have a year of the original edition listed in parentheses at the end behind the publisher. When we quote in plain text, year of first publication and translation writing along with a slash between (eg. Laplace, 1814/1951).

Laplace, P. S. (1951). A philosophical essay on probabilities (FW Troscott & FL Emory, Trans.). New York: Dover. (Original work published 1814)

- When the list of references cites a paper published in the Proceedings of the translated, italics will print the name of the collection at the end to add when it published the original.

Freud, S. (1961). The ego and the id. In J. Strachey (Ed. & Trans.), The standard edition of the complete psychological works of Sigmund Freud (Vol. 19, pp. 3-66). London: Hogarth Press. (Original work published 1923).

- When you cite articles published on the university or one of the official institutions, universities, publishers listed as the first name of the university and then university.

Broadhurst, RG, & Maller, RA (1991). Sex offending and recidivism (Tech. Rep. No. 3). Nedlands: University of Western Australia, Crime Research Center.

- When the list of sources cites a report of an organization or institution that has no author, it is best to nominate as the author of this organization, which is also the publisher.

Employee Benefit Research Institute. (1992, February). Sources of health insurance and characteristics of the uninsured (Issue Brief No. 123). Washington, DC: Author.

- When the work was published on the Internet as a photocopy, it should cite the original source noting that this is the electronic version.

Vandenbos, G. Knapp, S., & Doe, J. (2001). The role of reference elements in the selection of resources by psychology undergraduates [Electronic version]. *Journal of Bibliographic Research*, 5, 117-123.

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Vandenbos, G. Knapp, S., & Doe, J. (2001). The role of reference elements in the selection of resources by psychology undergraduates [Electronic version]. *Journal of Bibliographic Research*, 5, 117-123. Retrieved October 13, 2001, from <http://jbr.org/articles.html>

- When you download from the Internet a document which has no date or author, then the document name takes the place of the author or the first place.

8th GVU's WWW User Survey. (Od). Retrieved August 8, 2000, from http://www.cc.gatech.edu/gvu/user_surveys/survey-1997-10/

- Material from the symposium or a scientific paper which was only exposed, but not published, listed with the note on which the scientific or professional meeting is material exposed. If the author has presented on the site, it is desirable to name and web page.

Cuter, LD, Frölich, B., & Hanrahan, P. (1997, January 16). Twohanded direct manipulation on the responsive workbench. Paper presented at the 1997 Symposium on Interactive 3D Graphics. Abstract retrieved June 12, 2000, from <http://www.graphics.standard.edu/papers/twohanded/>

- Computer software listed noting computer software. Name of the software we write italics.

Miller, M. E. (1993). *The Interactive Tester (Version 4.0)* [Computer software]. Weastminster, CA: Psytek Service.

- Data downloaded from the website of the government or other official organization listed noting data file. The filename of the data listed in italics.

Department of Health and Human Services, National Center for Health Statistics. (1991). *National Health Provider Inventory: Home health agencies and hospices, 1991*. [Data file]. Available from the National Technical Information Service Web site, <http://www.ntis.gov>

Standards take according to Suzic, N. (2010). *Pravila pisanja naučnog rada APA i drugi standardi* [Rules scientific APA work and other standards]. XBS Banja Luka.

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EndNote (<http://www.endnote.com/support/enstyles.asp>) and

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Above management software have plug-ins to word processing where authors only need to select the appropriate journal template when preparing their article and the list of references and citations to these will be formatted according to the journal style as described in this Guide. If you cannot find an available template, see the list of sample references and citations provided in this Guide to help you format these according to the journal style.

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Thank you Reviewers!

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