ISSN 2334-847X (Printed)
ISSN 2334-8496 (Online)

IJCR SEE

INTERNATIONAL JOURNAL OF COGNITIVE RESEARCH IN SCIENCE, ENGINEERING AND EDUCATION

IJCRSEE

Special Issue

Current Research and Trends in Cognitive Sciences 2020

www.ijcrsee.com

ISSN 2334-847X (Printed)
ISSN 2334-8496 (Online)

INTERNATIONAL JOURNAL OF COGNITIVE RESEARCH IN SCIENCE, ENGINEERING AND EDUCATION

IJCRSEE

Special Issue – Current Research and Trends in Cognitive Sciences 2020

www.ijcrsee.com

IMPRESSUM

International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE)
Special Issue – Current Research and Trends in Cognitive Sciences 2020

Editor in chief:
Dr. Lazar Stošić

Publisher:
The Association for the development of science, engineering and education
Address: Prvi maj 18, 17500 Vranje, Serbia
Phone: +381 17 400 165, + 381 63 700 4281
https://urnio.org.rs/
E-mail: predsednik@urnio.org.rs

Don State Technical University
Address: Gagarin Square 1, Rostov-on-Don, Russia, 344000
https://donstu.ru/

For publisher:
Dr. Lazar Stošić
Dr. Alla Belousova

Print:
Aurora O. D. Vranje

Circulation:
50 copies

Indexed & Abstracted:
Web of Science (Clarivate Analytics) – Emerging Sources Citation Index (ESCI), SCOPUS, SJR - Scimago Journal, ProQuest, EBSCO (Academic Search Ultimate Magazines and Journal), DOI Serbia, Central and Eastern European Online Library (CEEOL), Dimensions, CyberLeninka, e-Library RU, COBISS.SR, MIAR, Sherpa/Romeo, CNKI, Turkish Education Index, ROAD, GoogleScholar, Dialnet, Index Copernicus, Harvard University Library, WorldCat, PUBDB DESY Publication Database, Journals Index (OAJI), I J-Gate, Cabell's Directory, JOUR Informatics, Academic Journals Database, WorldWideScience Sources, UlrichsWeb, TIB-German National Library of Science and Technology, Science Central, Electronic Journals Library, Academic Keys, ETH-Bibliothek, BASE, PBN, OAJ, JournalTOCs...

International Journal of Cognitive Research in Science, Engineering and Education

(IJCRSEE)

EDITORIAL

In modern science, interest in multidisciplinary research has sharply increased, due to the" challenges " of modern reality, the complexity of information and communication processes, and changes in scientific paradigms. Currently, science is dominated by monodisciplinary research, limited by the object and means of knowledge of a particular scientific field. This leads to some fragmentation of scientific knowledge, which limits the construction of a complete picture of the object under study.

According To V.E. Klochko (2012), currently science acts as a monodiscipline, although it can no longer properly perform its social functions in the same form. However, modern sciences do not seek to change their classical subject fields and try to preserve their sovereignty. Science is faced with the most complex problems that require cooperation. Scientists will probably have to get used to the possibility of the existence of science in the form of dynamic communities focused on solving the nodal problems put forward by time (V.E. Klochko, 2012). Science is forced to rebuild itself, demonstrating its ability to self-organize, as proper open self-developing systems. The current global situation related to the challenges presented to the world by COVID-19 only confirms and strengthens these trends.

The need to restructure the science due to the fact that highly popular for its constructive dialogue monosciences that can generate such a knowledge which is beyond the boundaries of individual science. has appeared J. Piaget in 1972, wrote that in science "we should expect a higher stage – transdisciplinary, which is not limited to interdisciplinary relationships, and will place these relations within the global system without strict boundaries between disciplines" (J. Piaget, 1972).

According to G. Miller (2003), cognitive science was born as an interdisciplinary education that includes: psychology, philosophy, linguistics, anthropology, neuroscience, and computer science. At present, we can say that cognitive science, born in the middle of the last century, combining the Humanities and natural science, can be considered a science that meets the main trends of transdisciplinarity.

In recent years, researchers have begun to pay growing attention to the importance of human cognitive functions in understanding the subject and social world. In part, this shift in focus reflects changes in science, which is increasingly turning to a cognitive approach to explaining human behavior. The ability to perceive and recognize the psychological States of other people is the basis of the process of social interaction. As a rule, a person evaluates other people's actions not just as patterns of behavioral or verbal activity. Behavior rather acts as a key to understanding other people's desires, intentions, and beliefs. In real life, a person is constantly building cognitive models to understand and predict the behavior of other people, which include our knowledge of our own mental states and the mental states of other people. Understanding and predicting the behavior of other people is the basis of interaction, since cognitive models of human behavior are predictions about the possibilities of our interaction with the world.

The theory of Embodied Cognitive Science (P. Calvo, & T. Gomila, 2010; H.R. Maturana, F.J. Varela, 1987) has become popular in cognitive science, gaining the status of interdisciplinary knowledge and having a broad impact on the development of system concepts of self-organizing systems.

It is known that the subject of modern science is complex self-developing systems (H. Haken, 1995), which include a person, i.e. the logic of the development of scientific knowledge led to the discovery of new laws and the development of the further cycle of cognitive science. The well-developed and popular theory of self-organization was illustrated with natural science material (mainly from the fields of physics, chemistry, and mathematics). Its provisions were equally applicable to both social and psychological systems.

We are talking about cognitive science as an established phenomenon, the interdisciplinary context of which continues to require discussion. This raises the question of whether cognitive science has already

developed as a special “transdisciplinary science” with its own subject of research, its own research methods, its own methodology, its own research principles, and a well-established categorical apparatus that allows researchers to understand each other.

Cognitive science as a new interdisciplinary field is aimed at studying the dynamics of the formation of cognitive systems at different levels. It showed that many cognitive patterns discovered in certain disciplinary areas of knowledge can be applied to social and psychological systems.

Currently, there are signs of convergence between cognitive science and other technologies, which is expressed primarily in the expansion of interdisciplinary research related to the practical application of cognitive research. Traditionally, this is manifested in the study of technologies of human-computer interface, artificial intelligence systems, and mathematical pattern recognition. At the same time, there is a convergence of cognitive science with biotechnologies and nanotechnologies (B.M. Velichkovsky, 2008). All this allows us to say that cognitive research goes beyond the scope of laboratory study, being implemented not only in the usual areas of science and education, but also in media technologies, in technology development.

Articles aimed at studying the implementation of cognitive research in the field of science and educational practice are one of the most interesting aspects of IJCRSEE content.

The purpose of this special issue is to offer a new approach to the discussion and presentation of cognitive science today. The special issue is aimed at discussing the main trends in the development of cognitive science and research, sharing experience and results of scientific reflection. The journal provides an interdisciplinary platform for academic scientists, researchers, and academics to present and discuss current innovations, challenges, and pathways, as well as practical problems and solutions made in the field of cognitive science and research.

We are pleased to have engaged with authors and researchers from different countries, cultures, and spheres in the field of cognitive science and practice. This issue contains articles covering a fairly wide range of problems in cognitive science. We hope that the authors ‘ positions will attract the attention of specialists and get an impetus for further development of the problems of cognitive science.

Guest editor
Dr. Alla K. Belousova
Don State Technical University, Faculty of Psychology, Pedagogy and Defectology,
Rostov-on-Don, Russian Federation,
e-mail: akbelousova@donstu.ru

CONTENTS

Purković, D. & Kovačević, S. (2020). Teachers' perception of the influence of the teaching context on cognitive Achievements in general technology education, *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE), (8),* Special issue of Current Research and Trends in Cognitive Sciences 2020, 1-15.

Original scientific paper

UDK: 371.12:159.923.3

Received: October, 09.2020.
Revised: November, 24.2020.
Accepted: December, 04.2020.

doi: 10.23947/2334-8496-2020-8-SI-1-15

Teachers' Perception of the Influence of the Teaching Context on Cognitive Achievements in General Technology Education

Damir Purković[1*], Stjepan Kovačević[2]

[1]Study of Polytechnics, University of Rijeka, Rijeka, Croatia, e-mail: damir@uniri.hr
[2] Department of Polytechnics, Faculty of Science, University of Split, Split, Croatia, e-mail: stjepan@pmfst.hr

Abstract: High achievements in the cognitive domain are the ultimate goal of any education, within it is important to understand the role of the teaching context. In this regard, the purpose of this research was to determine how teachers perceive the role of the teaching context on the pupils' achievements in the cognitive domain in general technology education. For this purpose, a survey of teachers' perception towards the influence of isolated elements of the teaching context, specific to technology education, on the achievements of learning objectives was conducted. The study was conducted as a survey on a stratified sample of technology education teachers (N = 194) from Croatia. ANOVA repeated measurements statistical procedure was used to process the research results. The analysis of the results showed that teachers give preference to certain contextual elements over others. These are activities with technological artifacts, models and simulations, service-learning activities, field trips, work in an appropriate space and the student's presentation of their own results. These elements can be considered as a contextual basis for the cognitive development of pupils in general technology education. Teachers' perception of the influence of other elements of the teaching context is not negligible, but obviously there is no priority over these elements, which is why further research is needed.

Keywords: teaching context, contextual approaches, elements of teaching context, cognitive achievements, technology education.

Introduction

For decades, contextual learning has been considered a successful way of achieving teaching goals, especially in science and technology education. The teaching context in which such teaching performs has an important and irreplaceable role. The teaching context can be described as a system of interior and exterior factors and conditions of human behavior and activity, which may affect perception, understanding and transformation of a particular situation, and which determine the meaning and sense of the situation as a whole and its comprising components (Verbitsky and Kalashnikov, 2012). From such a definition, it is clear that the learning context is related to situated learning theory, that is, that learning cannot be achieved or looked at separately from the context in which it occurs (Bell et al., 2013). The context can be viewed from a structural and functional (process) aspects. From a structural point of view, the context can be viewed as an imaginary multidimensional space in which different materials and communication situations are organized topologically and logically around a central object and give meaning to that object (Bateson, 1972; Verbitsky and Kalashnikov, 2013). The functional aspect refers to the relational understanding, as a mechanism that connects mental contents. Since information is the basis for understanding, it can be understood as a reflection of a certain impact on the recipient (here the student is meant), which implies a comparison of the previous and accompanying condition of the recipient (Stepansky, 2006). In other words, understanding any information that an individual receives cannot exist without context, because information can be perceived and understood only in the context of the individual's previous mental state (Purković, 2016). Therefore, the teaching context can be viewed from a structural and functional point of view. The structural aspect of the teaching context actually makes the connection of new teaching content with authentic and socially relevant knowledge. It is actually the tangible or visible (physically) part of the learning environment connected with the learning content. At the same time, the functional aspect integrates new content into a stimulating learning environment, which consists of social interactions and situations in which learning and teaching activities take place. The structural and functional aspects together should give the student the sense and meaning of the learning

*Corresponding author: damir@uniri.hr

subject matter, and should ensure the student's understanding of the content they are learning, which is a priority of the teaching process. In doing so, students should be clear about what they need to achieve and should lead to the opportunity for different, performative behaviors, which is only possible in scenarios that include that content (Gardner, 1993; Biggs, 1996; Biggs et al., 2001). The existence of such a context can facilitate and secure the contextual learning process. Contextual learning Brown (1998) defines as a strategy for helping students construct knowledge and meaning of new information through a complex interaction of teaching methods, content, situations and time. Berns and Erickson (2001) see such learning as a concept that helps teachers establish subject-matter relations with real-life situations and motivates students to relate knowledge to application in their lives as family members, citizens, and workers, and to participate in the hard work that learning requires. Johnson (2002) presents contextual learning and teaching as a holistic system, that is, an educational process that aims to help students understand the meaning of the academic content they are learning, by combining it with the context of everyday life. That is to say, with the context of their personal, social, and cultural circumstances. The importance of contextual learning and teaching, as a concept that involves relating content to the context in which such content will be applied, has been pointed out by other researchers. (Petrina, 1992; Kelley and Kellam, 2009). Such linking of content to the meaningful context that should provide contextual learning and teaching should be achieved through specific contextual approaches to teaching. So contextual approaches are actually strategies or teaching procedures that will provide students with learning in an appropriate teaching context. In theoretical considerations, these approaches most often include problem-based learning, collaborative situational learning, project-based learning, service learning, and work-based learning, as teaching approaches that include context as a critical component (Putnam, 2001; Berns and Erickson. 2001; Purković and Bezjak, 2015). From the point of view of general technology education, Purković and Bezjak (2015) include in these approaches: a) project-based learning (and teaching), b) service learning activities, c) professional excursions (field trips), d) problem-based learning, and f) anchored instructions and g) isolated practical activities. Therefore, the teaching context should allow students to understand the content through contextual learning, while contextual approaches should provide appropriate teaching activities that support such learning.

Despite relative clear theoretical definitions of the teaching context, contextual learning, and contextual approaches to teaching, exploring the impact of such teaching on student achievement is fraught with problems. The biggest problem is the many performance differences in teaching policies and practice, including differences in technology education, where the real contextual approaches do not dominate. In such circumstances, contextual approaches have been explored, mainly as part of experimental researchadapted situations, which differ notably from the realities in which teaching is conducted. On the other hand, if the research deprived of such situations and carried out in real-world teaching conditions, then it is difficult to distinguish the influence of contextual teaching from the influences of other contextual factors outside school (parents, society, social and cultural environments, etc.). Therefore, it is often necessary to analyze such approaches and investigate the effects of partial elements or components of contextual approaches to teaching. Such difficulties are also present when researching the impact of contextual approaches in primary schools in Croatia, which includes general technology education. Specifically, general technology education in Croatia mainly realizes through the regular curriculum of the Technical Culture subject and through various extracurricular activities. The regular curriculum realized over only 35 hours per year, as a 90-minute class with the whole class every other week. Given the long-standing closed and traditionally oriented curriculum, teaching generally consists of simple individual activities (Teaching programmes for compulsory education, 2006). During the realization of the subject, pupils learn about technology (depending on the class) and carry out basic technical activities (e.g. design, production, assembly, testing, etc.) (Purković, Suman and Jelaska, 2020). Due to the limited duration, important elements of the contextual approach are missing, such as pupils' collaborative activities on the realization of their own ideas in a meaningful context. In a significantly different role are pupils attending extracurricular activities, which realized through an open or semi-open curriculum for two or more hours per week. However, even in such programs, the teacher-mentor often directly imposes students' projects and activities, while in very few cases activities are the fruit of the pupils' ideas. Such organization and realization of general technology education in Croatia clearly indicates that the impact of contextual approaches to teaching is not possible to research directly since such approaches generally do not exist in practice in the full sense of their meaning. Nevertheless, the different ways and forms of realization of technology education and the rich experiences and successes of teachers in the development of technical creativity (Malinar, 2008) speak in favour of the role and importance of the teaching context, regardless of the forms and approaches to teaching in a specific Croatian context. It is therefore worth exploring this impact on student achievement. However, such research presupposes an

analytical approach, that is, the isolation of elements of the teaching context and contextual approaches to teaching in order to explore their impact on students' achievements and development (Purković, 2016). Given the key role in teaching, teachers' beliefs and attitudes also impose themselves as an important medium through which this impact can be explored.

Teachers' perception of the effectiveness of their own teaching is related to their knowledge but also related to their attitudes and beliefs. Teachers' beliefs and attitudes are closely related to their behavior and practice in the classroom (Nespor, 1987), and can be defined as a subset of a group of constructs to name, define, and describe the structure and content of mental states considered to guide the actions of a particular person (Richardson, 1996). Although the individual's attitudes and beliefs as a whole represent his or her personal understandings, beliefs, values, judgments, opinions, cognitions, prejudices, perceptions, preferences, personal theories, and similar constructs about a particular reality, they are scientifically relevant only if they are the product of cognition and experience in such reality. The construct of educational beliefs is broad and refined for research purposes into a number of specific sub-constructs (Pajares, 1992). These sub-constructs include beliefs about their own influence on the level of student achievement (teacher effectiveness), beliefs about the nature of knowledge (epistemological beliefs), beliefs about self-perception (own-concept), and beliefs about self-confidence in performing certain tasks (self-efficacy) (Albion, 1999). Given that, unlike knowledge, beliefs are based on assessment and judgment (Pajares, 1992), teachers' beliefs about effectiveness and self-efficacy in teaching are important in such research. Although teachers' beliefs can strongly influence their perception and be an unreliable guide to the nature of things, due to the connections between educational beliefs with planning, decision-making, and practice, they can be powerful predictors of teacher behavior and teaching success (Pajares, 1992; Albion, 1999; Archambault et al., 2012). The importance and influence of teacher perception on student achievement has its foundations in social-cognitive theory (Bandura, 1986) through the notion of self-efficacy. This specific situational construct tells how the very perception of teaching, if positive, can have a positive effect on achievement. Teachers with a strong sense of teaching effectiveness are more tolerant toward students' mistakes, strive to fight for student success, and are more willing to take the risks of implementing new strategies in teaching, because of reduced fear of failure (Knoblauh and Hoy, 2008). Research also shows that teachers' beliefs about student success are indeed related to student achievements (Abudu and Gbadamosi, 2014; Jordan, 2018; Ekperi et al., 2019), which contributes to the validity of this research as well. These researches show that teachers' beliefs and knowledge can be predictors of student success, and the role of teachers' evaluative thinking as support for assessment abilities has been recognized (Buckley et al., 2015; Schwandt, 2015). This term defined as critical thinking applied in the context of evaluation, motivated by an attitude of inquisitiveness and a belief in the value of evidence (Buckley et al., 2015). Studies of the impact of context on teaching and teacher beliefs have shown that context can significantly influence teachers' perceptions of performance, as well as the effect of teaching (Bandura, 1997; Goddard and Goddard, 2001; Jordan, 2014; Wardani et al., 2020). Despite such findings, context is not an area where primary consideration should be given to teacher effectiveness (Labone, 2004), but to teaching success. This brief review showed that an experienced teacher is the most competent internal evaluator and can reliably assess what can affect the success of teaching. Nevertheless, a teacher's perceptions should be viewed as his or her subjective perception rather than as a measurable magnitude of student achievement. In this sense, teacher perception may represent a certain limitation in the analysis of the results of such perceptions. This limitation does not diminish the value of the teacher's perception of the achievement of teaching objectives, as a real indicator of that achievement, but also as a result of the influence of various factors on this perception. In this sense, the relation between the teacher's perception and the success of teaching can be viewed as the influence of the teacher's perception on the teaching process, as the influence of different contextual (environmental) elements and factors on that perception, and as the influence of contextual elements and factors on the teaching process (Purković and Jelaska, 2014). Regardless of the point of view, the teacher's perception of what positively affects student achievement should be taken as a relevant indicator, which also applies to elements of the teaching context.

Materials and Methods

Due to the importance of the teaching context for student achievements and the importance of teachers' beliefs for teaching success, the main aim of this research is to find out how the teachers of Technical Culture perceive the importance of the specific elements of the teaching context to the students' achievements in the cognitive domain. This is important in order to scientifically substantiate the

importance of the role of the teaching context in the process of developing students' cognitive abilities in technology. In this way, the aim is to influence the further development of the technology education curriculum in Croatia and beyond. Namely, the concept of knowledge in technology differs greatly from most other subjects and areas, which is why the process (path) of cognition itself differs (more in Purković, 2018). In this sense, it is important to shed light on what context in technology learning has priority, so that the curriculum can be optimized. Namely, lately there are tendencies that favour learning "by the book" and online learning of all subjects. At the same time, technological literacy is often reduced to information literacy. Such trends negatively affect the development of the curriculum, and thus the development of students. Given the importance of teachers in the teaching process, their perception of the teaching reality should be taken into account in the process of improving teaching. In this sense, the elements of the teaching context elected by the previous analysis of the elements of contextual approaches to technology education (Purković, 2016), while students' levels of the achievements are classified according to the structure of the dimensions of knowledge (Krathwohl, 2002). The isolated elements of the teaching context were:

- Conducting professional excursions (field trips),
- Activities in student cooperatives, camps, gardens and workshops (service learning activities),
- Activities in a suitable space (workshop, laboratory, computer classroom, etc.),
- Use of models and simulations (3D models of machines, software simulations, etc.)
- Use of video materials and films (know-how videos, technological macro-context films, etc.)
- Use of photographs, pictures, drawings and schemes during the activity,
- Use of books, textbooks, magazines and texts (reading, working on a text, solving tasks, etc.)
- Activities with customized learning materials (mental maps, self-assessment materials etc.)
- Use of technical documentation (drawings, plans, technological lists etc.)
- Use of computers and ICT within activities (drawing, programming, digital content creation, etc.),
- Activities with artefacts of technology (materials, tools, machines, devices and instruments),
- Presentation of their own results (products, plans, solutions etc.)

The structure of dimensions of knowledge included: a) knowledge of subject content (factual knowledge); b) understanding of the content (conceptual knowledge); c) the application of knowledge (procedural knowledge); and d) managing one's own learning; and e) self-assessment of one's own knowledge as elements of the metacognitive dimension of knowledge. Factual knowledge is a basic element that students must know how to be familiar with a discipline or solve problems (Krathwohl, 2002), such as knowledge of terminology and specific details and elements. Conceptual knowledge is the interrelationships between the basic elements in a larger structure that allow them to function together. Here it is knowledge of the physical and functional nature of artefacts of technology, knowledge of the structure and principles of operations, classification and categorization of creations and technologies, understanding of graphic representations, etc. Procedural knowledge related to methods of inquiry, and criteria for using skills, algorithms, techniques and methods. Here it refers to knowledge of technology (know-how) and application of knowledge and skills for decision-making, design, manufacture and testing of creations and products. Learning self-regulation and knowledge self-assessment are part of the metacognitive dimension. This dimension represents knowledge of cognition in general as well as awareness and knowledge of one's own cognition, and include strategic knowledge, knowledge about cognitive tasks, and self-knowledge. Here, this includes the pupil's awareness of one's own knowledge and abilities, i.e., the ability to assess one's own knowledge, and discover one's own ways to achieve learning success.

Teachers' perceptions of the effect of isolated elements of the teaching context and contextual approaches on achievement were examined by an internet questionnaire. Questionnaire management, communication with teachers, and initial processing of results were conducted using an open source system Limesurvey. The data collected through the KONTK (KONtekst Tehničke Kulture) instrument, was previously validated and used in a comprehensive study of the impact of the teaching context on the achievement of the goals of teaching Technical Culture (Purković, 2016). For the purposes of this research, the questionnaire was reduced to examine the perception of the effects of teaching context elements on achievements in the cognitive domain. Therefore, the questionnaire covered teachers' beliefs about the effect of selected elements and approaches on pupils' knowledge of teaching content (KNOW), content understanding (UNDR), application of knowledge (APPK), self-regulated learning (SREG), and self-assessment of their own knowledge (SEVA). Teachers responded to the posted effect statements based on a scale of Likert-type assessments ranging from 1 to 5, with 1 indicating the smallest and 5 the largest effect on student achievement. Elements of the teaching context and contextual approaches to teaching were extracted based on an analysis conducted by Purković (2016), which included 12 elements

of the teaching context specific to the Croatian educational environment. These elements include pupils activities in: conducting professional excursions (FTRP), working in student cooperatives, camps, gardens and workshops (SELE), activities in appropriate space (ASPA), use of models, models and simulations (MSIM), use of videos and films (VIMA), use of photographs, images, drawings and schemes (FPPS), use of books, textbooks, magazines and texts (LIBR), activities with customized learning materials (MATL), use of appropriate technical documentation (PLAN), use of computers and ICT (CICT), activities with artefacts of technology - materials, tools, machines, devices and instruments (TART), presentation of their own results (PRER).

The research was carried out on a proportional stratified sample (N = 194) of teachers of Technical Culture, as the Croatian version of general and compulsory technology education subject. The sample was selected according to the typical structure of the total population of technical culture teachers in Croatia (Purković and Ban, 2013; Purković and Jelaska, 2014; Purković, 2015; Purković, 2016). Accordingly, the sample of teachers consisted of 5% of teachers with less than 5 years of teaching experience, 15% of teachers with 5 to 10 years of experience, 45% of them with 10 to 20 years of experience, and 35% of teachers with more than 20 years of teaching experience. The sample was dominated by 55% of teachers with targeted teacher education, 35% of teachers with engineering education, while 10% of teachers had a different education or a lower level of education than provided for by existing legislation. Considering the total number of about 740 active technical culture teachers in the Republic of Croatia and the large proportion of teachers with years of teaching experience, the data obtained from such a sample of teachers can be considered a valid basis for generalization of the research results.

After collecting the data and eliminating incomplete answers, their computer processing and analysis was performed. Relevant values of descriptive statistics were calculated for all variables, while the results of the research showed only the most necessary ones, such as mean (M) and standard deviation (SD). Repeated measures ANOVA was used to determine the statistical significance of differences within teachers' assessments of the effect of contextual elements and approaches on individual student achievement in the cognitive domain. In this way, differences with the first type error $\alpha = 0.05$ were identified and the squared partial eta ($\eta p2$) was determined as a measure of the effect size. The limit values of this indicator were selected according to the limitations and guidelines for the application of this indicator (Cohen, 1973; 1992): $\eta p2 < 0.10$ for low effect; $\eta p2 < 0.25$ for medium effect and $\eta p2 < 0.40$ for high effect. For significant F-values, Bonferroni post-hoc tests were applied to identify statistically significant differences between effect assessments of contextual elements for each student achievement. All the results were interpreted qualitatively, thus distinguishing a group of contextual elements and approaches that, from a teacher's perspective, significantly influence the pupils' achievements in the cognitive domain in general technology education.

Results

For testing the appropriateness of distributions for estimates using ANOVA rm statistical procedure, descriptive statistical analysis was performed and baseline parameters were extracted (Table 1). The normality of the distributions was then examined and their sphericity was determined by Mauchly's test. The normality of the distribution was examined by Kolmogornov-Smirnov and Shapiro-Wilks tests, which established that most of the distributions from the datasets were normally distributed and suitable for such statistical processing. Exceptions related to the deviations of some distributions from the normal, due to the characteristics of the research sample, are not thought to significantly affect the results of the analysis (Harwell et al., 1992; Lix et al. 1996). Sphericity tests revealed the disturbed sphericity of distributions in all datasets, which is why the GG correction of degrees of freedom presented in Table 2 applied.

Table 1

Basic parameters of descriptive statistics (M, SD) for the estimates of the effect of contextual elements on a pupils' achievements: knowledge of content (KNOW), content understanding (UNDR), knowledge application (APPK), ability of self-regulated learning (SREG), self-evaluation of achievements (SEVA).

Pupils activities at ...	Knowledge (KNOW)		Understanding (UNDR)		Applying knowledge (APPK)		Self-regulated (SREG)		Self-evaluation (SEVA)	
	M	SD	M	SD	M	SD	M	SD	M	SD
conducting a professional excursion [FTRP]	4.15	0.688	4.12	0.709	4.08	0.726	3.60	0.848	3.73	0.741
Students' cooperative, workshops... [SELE]	4.22	0.709	4.24	0.664	4.45	0.611	3.97	0.730	4.11	0.666
in appropriate spaces - classrooms [ASPA]	4.44	0.674	4.40	0.736	4.53	0.621	4.14	0.793	4.22	0.696
activities with models and simulations [MSIM]	4.49	0.621	4.52	0.613	4.45	0.675	4.09	0.787	4.11	0.825
use of video materials and films [VIMA]	4.08	0.757	4.02	0.798	3.86	0.852	3.49	0.967	3.41	0.973
use photography, pictures, schemes [FPPS]	3.88	0.796	3.85	0.797	3.73	0.877	3.49	0.962	3.36	0.984
activities with books, journals, texts [LIBR]	3.38	0.943	3.35	0.955	3.23	1.024	3.24	0.995	3.09	0.998
activities with learning materials [MATL]	3.86	0.795	3.89	0.764	3.81	0.891	3.66	0.891	3.66	0.926
use of technical documentation [PLAN]	3.78	0.866	3.73	0.901	3.80	0.901	3.52	0.956	3.50	0.978
activities with computers and ICT [CICT]	4.04	0.848	4.06	0.828	3.98	0.870	3.77	0.951	3.60	0.962
activities with technology artefacts [TART]	4.54	0.691	4.59	0.647	4.67	0.647	4.21	0.801	4.41	0.716
the pupil's presentation of the activity [PRER]	4.24	0.738	4.29	0.728	4.36	0.750	4.28	0.772	4.35	0.720

From the basic data of descriptive statistics, it can be seen that teachers consider the activities with artefacts od technology (TART) to be the most effective for most students' achievements in the cognitive domain. The exception is the perception of the effect on self-regulated learning, for which teachers consider the presentation of pupils' own activities (PRER) to be the most effective element. Teachers rated the effect of student activities with books, textbooks, journals and text material (LIBR) as being the lowest on average. The data presented show the smallest deviations of the estimates for those elements that was the highest estimated. This group includes pupils' activities with artefacts (TART), professional excursions (FTRP), service learning activities (SELE), activities in appropriate space (ASPA), and activities with models and simulations (MSIM). This means that teachers largely agreed on the effect of these elements on students' cognitive achievement. On the other hand, estimates of the effect of the use of books, textbooks, journals and texts (LIBR), but also the use of technical documentation (PLAN), are the most varied, which indicates a higher dispersion of teaching perceptions about the use of these elements. Surprisingly, average estimates of using computers and ICT use (CICT) are significantly lower than expected, especially for higher levels of pupils' cognitive achievements. The presented results indicate the need for further analysis of the collected data.

Table 2

Results of repeated measures ANOVA of the teachers' perceptions on pupils' achievements in cognitive domain: coefficient of correction of degrees of freedom (εG G), degrees of freedom with GG correction (dfG-G), mean squared (MS), F-value (F), statistical significance (p), effect size (ηp 2).

Pupils' achievements in the cognitive domain	$\varepsilon_{G\text{-}G}$	$df_{G\text{-}G}$	*MS*	*F*	*p*	η_p^2
Knowledge of teaching content [KNOW]	0.704	7.774	30.540	**53.377**	0.000	0.217
Understanding teaching content [UNDR]	0.714	7.855	33.941	**55.567**	0.000	0.224
Application of acquired knowledge [APPK]	0.666	7.321	51.551	**72.700**	0.000	0.274
Self-regulated learning [SREG]	0.718	7.902	31.191	**46.405**	0.000	0.194
Self-assessment of one's own achievement [SEVA]	0.669	7.358	54.116	**70.769**	0.000	0.268

Repeated measures ANOVA for each level of student achievement in the cognitive domain examined the statistical significance of differences within teachers 'assessment of the effect of contextual elements (Table 2). The analysis of the results reveals that the effect size, and therefore the significance of the differences, is highest for the data set associated with assessing the effect on students' applied knowledge [F (7.321) = 72.700, p < 0.01, ηp2 = 0.274, observed power = 1] and with the student's ability to self-assess achievements [F (7.358) = 70.769, p < 0.01, ηp2 = 0.268, observed power = 1]. Slightly lower effect sizes, as well as significance differences, are made by assessments on the understanding of teaching content [F (7.714) = 55.567, p < 0.01, ηp2 = 0.224, observed power = 1] and on the student's knowledge of teaching content [F (7.704) = 53.377, p < 0.01, ηp2 = 0.217, observed power = 1]. The smallest effect size and significance of differences, although not less important, were observed for assessing the effect of elements of the teaching context on students' ability to manage their own learning [F (7.718) = 46.405, p < 0.01; ηp2 = 0.194, observed power = 1]. From these differences within the estimates, it is clear that the statistical significance of the differences, F values and effect sizes are respectable. Therefore, it is worth further analysing the differences between assessing the effect of contextual elements and approaches on students' achievements. In order to isolate those contextual elements and approaches that, from a teacher's perspective, significantly influence student achievement in the cognitive domain, Bonferroni's post-hoc tests highlighted the differences between assessments of the effect perceptions for each level of achievements.

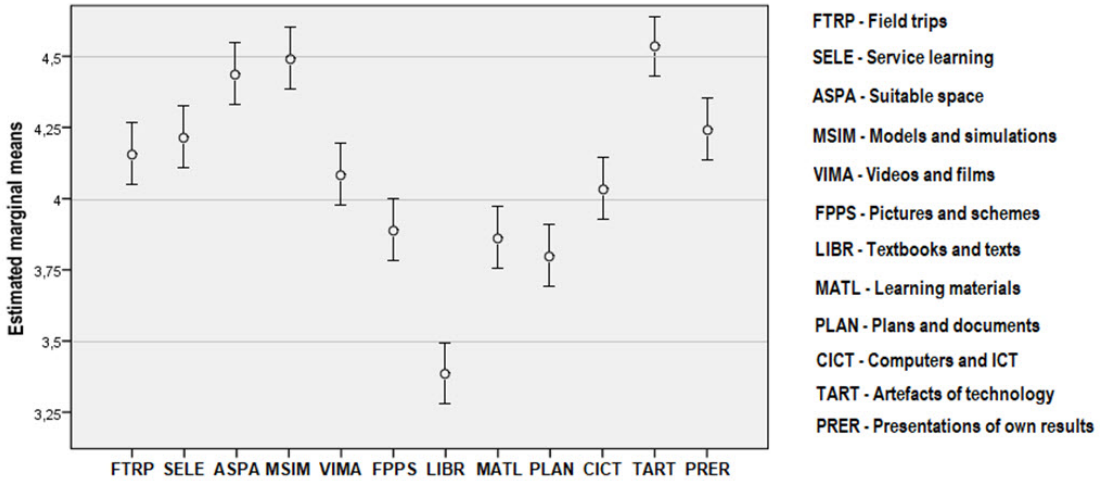

Figure 1. Estimates of the influence of contextual elements on pupils' knowledge

Among the assessments of the effect of contextual elements and the approach on students' knowledge, a group of elements that teachers consider the most important stand out (Figure 1). This group consists of student activities with artefacts of technology (TART), use of models and simulations (MSIM), and activities in appropriate spaces (ASPA), whose estimates are not statistically different but differ from the estimates of other elements at the level of statistical significance p < 0.05. The group of elements whose assessments of the effect on students' knowledge that are not negligible include; the pupils' presentation of their own results (PRER), activities in pupils' cooperatives, camps, gardens and

work-shops - service learning (SELE), professional excursions (FTRP) and the use of video material in teaching (VIMA). The values of the estimates of these elements do not differ significantly, however they differ from the lower estimated elements at the level of statistical significance $p < 0.05$. An exception is the assessment of the use of computers and ICTs (CICT), which estimates are not significantly different from the estimates of the use of video materials in teaching (VIMA). However, due to the statistical significance of differences with respect to other elements in this group, use of computers and ICT (CICT) we can only cautiously classify as a part of this group. Elements whose effect is not highly estimated include the use of photographs, images, drawings and schemes (FPPS), the use of learning materials (MATL), and the use of technical documentation (PLAN), whose values of estimates differ from others at the statistical significance level $p < 0.01$. The effect assessments of the lowest-scoring element, the use of books, text-books, journals, and texts (LIBR) are different from other estimates at the level of statistical significance $p < 0.001$, making this element the least effective on pupils' knowledge.

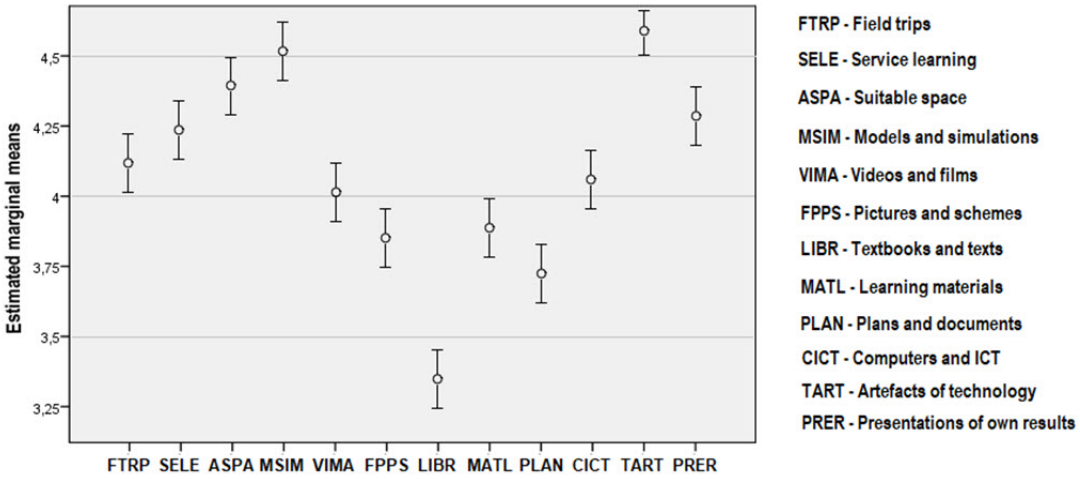

Figure 2. Estimates of the influence of contextual elements on pupils' understanding

In assessing the effect on pupils' understanding of content (Figure 2), teachers consider the most effective are the activities with artefacts of technology (TART), and the use of models and simulations in teaching (MMSI), whose assessment values differ from most others at the statistical significance level of $p < 0.05$. The exception here is the assessments of effect of the activities in appropriate Space (ASPA), whose estimation values are not significantly different from using models and simulations (MSIM), which is why we can count this element as the part of the group with the highest effect. Somewhat lower, but still high, is the estimated effect of pupils' presentation of their own results (PRER), activities in student cooperatives, gardens, camps and workshops (SELE) and professional field trips (FTRP). The values of the estimates of these elements differ from those estimated lower at the level of statistical significance $p < 0.05$. The exception is the implementation of professional excursions (FTRP), whose estimates do not differ significantly from the assessments of video material use (VIMA) and computer and ICT use (CICT), making the effect of these elements relatively influential for the content understanding. However, due to the absence of a statistically significant difference from the lower estimated effects of the use of photographs, images, drawings and schemes (FPPS) and activities with learning materials (MATL), the above elements can be included in the same effect group. Specifically, the values of estimates within this group do not differ from each other, and they differ from most of the others at the level of statistical significance $p < 0.05$. Activities with technical documentation (PLAN) form a relatively separate element since the values of the estimates do not differ statistically significantly from the elements (FPPS) and (MATL) of the previous group, but differ from the lowest estimated effect of the use of textbooks, journals and texts (LIBR) at the level of statistical significance $p < 0.001$.

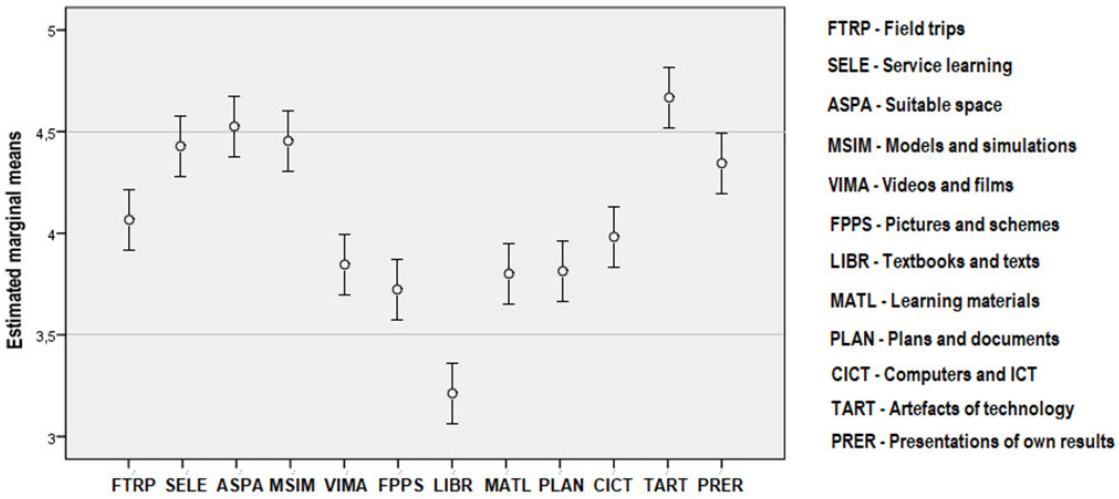

Figure 3. Estimates of the influence of contextual elements on pupils' application of knowledge

When it comes to pupils' application of knowledge (Figure 3), teachers' estimates of student activity with artefacts of technology (TART) are by far the most significant and different from other estimates at the level of statistical significance $p < 0.05$. An exception is the activities of students in a suitable space (ASPA) whose estimates are not statistically significantly different from the previous element. In the group of highly assessed elements, whose estimates differ from all lower ones at the level of statistical significance $p < 0.01$, should be included already mentioned activities in the appropriate space (ASPA), activities with models and simulations (MSIM), service learning activities - cooperatives, gardens, workshops (SELE) and pupils' presentations of their own results (PRER). The group of elements whose influence on the application of knowledge is lower estimated consists OF professional excursions (FTRP), use of computers and ICT (CICT), use of video and film (VIMA), use of photographs, pictures, drawings and schemes (FPPS), activities with learning materials (MATL) and use of technical documentation (PLAN). The values of the estimates from this group do not differ statistically from one another, and they differ from other estimates at the level of statistical significance $p < 0.001$. The lowest estimated influence was the use of books, journals and texts (LIBR), whose values of estimates differ from others at the level of statistical significance $p < 0.001$.

When it comes to assessing the influence on pupils' self-evaluation abilities (Figure 4), the group of elements whose influence the teachers have highly evaluated are highlighted here: The highest estimated influence was the activity of pupils with artefacts of technology (TART), presentation of their own results (PRER), and the influence of activities in a suitable space (ASPA), activities in student cooperatives, gardens, camps and workshops (SELE) and the use of models and simulations (MSIM).The values of estimates from this group are not statistically different, but they differ from other estimates at the level of statistical significance $p < 0.001$. The much lower-rated elements here include the estimates of professional excursions (FTRP), activities with computers and ICT (CICT), use of technical documentation (PLAN), activities with learning materials (MATL), use of videos (VIMA) and the use of images, drawings and photographs (FPPS). The values of the estimates of the elements in this group differ statistically from the other estimates at the level of statistical significance $p < 0.01$. The effect of using textbooks, books, magazines and texts (LIBR) again rated lowest, with estimates differing from the others at the statistical significance level of $p < 0.01$.

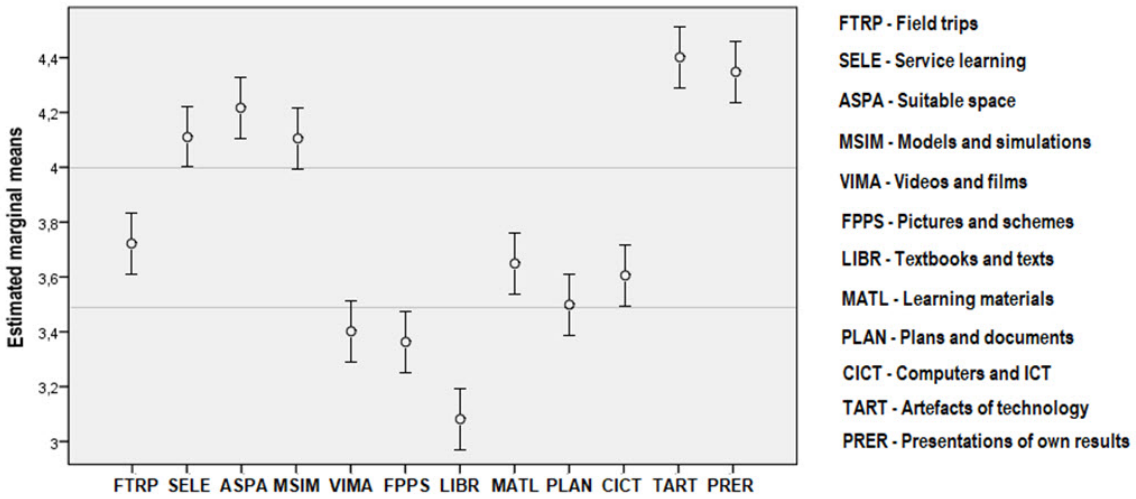

Figure 4. Estimates of the influence of contextual elements on pupils' self-evaluation abilities

Among the assessments of the influence of contextual elements and approaches on pupils' management of their own learning, the highest are the assessments of pupils' presentations (PRER), but also activities with artefacts of technology (TART), activities in a suitable space (ASPA), and the use of models and simulations in teaching (MSIM). The values of estimates from this group do not differ statistically from one another, but differ with respect to the lower estimated elements at the level of statistical significance $p < 0.01$. An exception is the difference between the estimates of the last two elements (ASPA) and (MSIM) with respect to activities in student cooperatives, gardens, camps and workshops (SELE) according to which these estimates are not statistically significant. This finding places pupils' activities in student cooperatives, gardens, camps, and workshops (SELE) as important elements, yet are inferior to the highest-rated (PRER) and (TART) elements. Within the group of substantially lower assessments, consists the use of computers and ICT (CICT), learning materials activities (MATL), professional excursions (FTRP), use of photographs, pictures, drawings and schemes (FPPS), use of video materials (VIMA) and activities with technical documentation (PLAN). Specifically, the estimates of the elements in this group are generally not statistically different from one another, but differ from other elements at the level of statistical significance $p < 0.05$. Nevertheless, it is worth noting that the estimates of activity with computers and ICT (CICT) in this group differ from the lower estimates (VIMA), (FPPS), (PLAN) at the level of statistical significance $p < 0.05$. Such a finding means that the use of computers and ICT in teaching from a teacher's perspective has some influence on pupils' self-regulation of learning. Again, the lowest estimated influence is the use of books, journals and texts in teaching (LIBR), whose values of estimates differ from all others at the level of statistical significance $p < 0.05$.

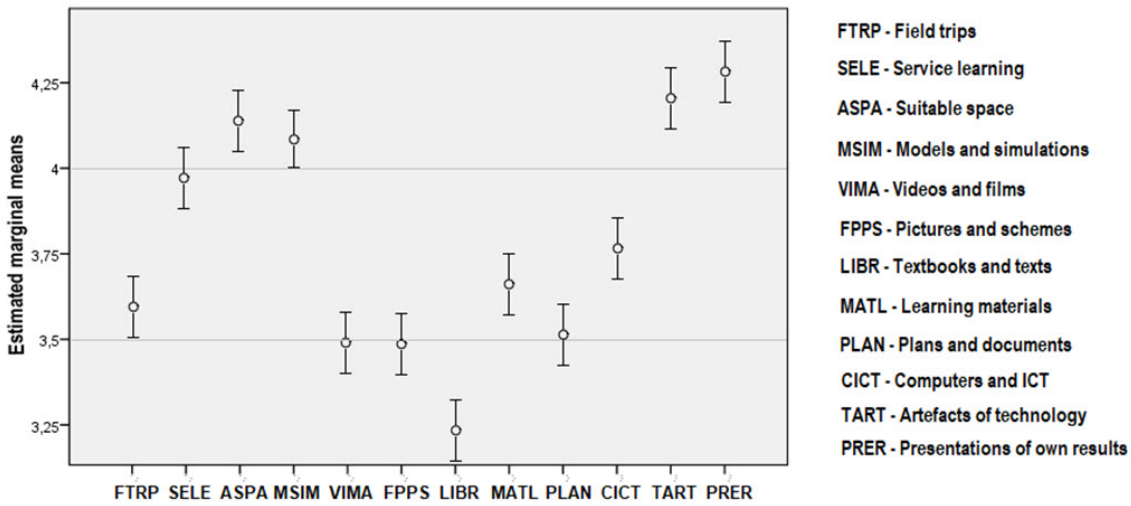

Figure 5. Estimates of the influence of contextual elements on pupils' self-regulated learning

Discussions

Within the teacher's assessments of the impact of contextual elements on the student's achievements in the cognitive domain, a certain hierarchical structure of the importance of these elements is recognized. Predictably, the greatest influence of context seen by teachers in the application of acquired knowledge and the pupils' abilities of self-assessment of their own achievements. Given the structure of the sample, which consists mainly of middle-aged teachers, it is certain that this hierarchy is not the result of "contemporary" educational trends. Moreover, it is opportune to assume that teachers base this judgment on personal experiences of the influence of the teaching context on the process, above all, of teaching and evaluating the level of student achievements. Precisely through the evaluation of procedural knowledge, but also the metacognitive skills of students, teachers can feel the "fine nuances" in the levels of student achievement, but also the role of the teaching context in these processes. It is expected that teachers are often not even aware of how certain interventions and innovations in the teaching process actually change the context, or elements of the teaching context. However, they are well aware of the results of that act. Especially if they result in better performance for students and are manifested in a real self-assessment of students' own achievements.

The pupil's factual knowledge and understanding of the teaching content are aspects of cognition that, according to teachers, can greatly influence the teaching context. Namely, the estimates of the impact of some contextual elements for these types of knowledge are slightly higher than the estimates for other types. Given that this knowledge represents lower levels of knowledge, this is logical and expected. Such an order represents the material-cognitive foundation of procedural (and meta-cognitive) knowledge and reflection of student achievements. However, in assessing these two, emphatically cognitive components of this domain, there is no real application of knowledge, and therefore the impact of the teaching context is more difficult to determine. Therefore, such a ranking of the impact of the teaching context would not be justified to interpret as the need to marginalize these types of knowledge and as an escape of teachers from traditional patterns of learning and teaching. Moreover, it seems that teachers, through assessing the impact of the teaching context, perceive and position teaching content more realistically than a large number of theorists and proponents of contemporary educational approaches.

Managing one's own learning is a cognitive aspect of student achievement where teachers see the least influence of the teaching context. However, it should be emphasized here that it is actually about the attitudes of teachers towards the impact of context on the pupil's management of their own learning. It is about assessing the most complex psychological processes in students, learning! Teachers actually cannot determine the actual impact of context on managing students' own learning. They only indirectly, probably again through the level of student achievements, evaluate the extent to which meaningful and realistic teaching of the technology influences the students' thinking strategies. In doing so, teachers believe that the influence of context in managing their own learning is significant, which is certainly true, but difficult to objectively validate.

The problem of isolating contextual elements that significantly affect students' cognitive achievements from the teacher's perspective is much more complex. The results as a whole indicate that for lower levels of achievement (knowledge and understanding) the differences in assessments are significantly smaller than the differences for applied knowledge and metacognitive skills. Already from the preliminary descriptive analyses, it has been suggested that the traditionally established elements of the context in the teaching and teaching of the Technical Culture are considered by teachers to be less effective in the sphere of the progression of student cognition. Given the number of respondents, and the current educational policy and implementation of the Technical Culture curriculum, this information is critical. In particular, influence assessments of the use of books, textbooks, journals and texts (LIBR), as well as the use of technical documentation (PLAN), are the lowest ranked elements of context in the prediction of cognitive development. The teaching practice of Technical Culture in Croatia shows that these are the dominant contextual patterns for the teaching and learning process. Additional analysis of data for these two variables determined a certain dispersion of results within the sample of respondents, which would be useful to investigate with additional analyzes. Nevertheless, the general view of teachers is that they have the least influence in all the cognitive achievements discussed here, even for the lowest levels of knowledge. Furthermore, the results show that the average assessments for using computers and ICT (CICT) in teaching are significantly lower than expected, especially for higher levels of cognitive achievement. This finding can be interpreted in several ways. One of them is certainly the animosity of teachers towards computers and ICT as teaching content, which has been the legitimate content of Technical Culture for almost two decades in Croatia. However, such content is not treated as a technology development tool, though it accounted for almost 20% of the total curriculum share, which is twice as

much as most core technological content. The relatively low assessments of the impact of computers and ICT can be attributed to the informal forcing of this element of context in all fields of education, especially in technology education. While this is implied for this education, it also often leads to inappropriate virtualization of learning and teaching, thus learning about the context rather than within it. Ultimately, such an approach leads to learning about the technological environment, a diametrically opposite effect from the curriculum-determined educational intent of learning within the technological environment, in a realistic context. This is supported by the results of determining the influence on students' cognitive achievement for the students' activities with artefacts of technology (TART). Precisely, this element of context that teachers find most influential in the development of all levels of cognition, except for self-regulation (self-management) of their own learning. The activities of pupils with technological artifacts represent the real context of the natural, social and technological environment and their interaction. Even without additional scientific studies, it is clear that activities with technological artifacts should be the basis for materializing the educational goals of technology teaching at all levels of education. Unfortunately, it is not the case, even at the highest levels of educational policies. Such results are broadly in line with previous research into teachers' perceptions of the impact of elements of the teaching context on the achievement of teaching goals (Purković, 2016), in which the activities of students with artefacts of technology have also been a dominant element of influence. After all, scientists agree that artefacts of technology, by their physical and functional nature, are the most direct way for a student's first understanding of technology (Mitcham, 1994; De Vries, 2016; Jones et al., 2013; Purković, 2018). However, it should emphasize that any educational reform and curricular approach, in addition to formal, declarative and cosmetic changes, also completely redefine the role of the teacher. Thus, the responsibility for the elements of context that will potentially result in cognitive student progression is borne by the teacher at all levels considered here.

In the opinion of teachers at almost all levels in the cognitive domain, except for self-regulated learning, important elements of context are pupils' activities with artefacts of technology (TART), field trips (FTRP), service-learning activities (SELE), activities in a suitable space (ASPA) and activities with models and simulations (MSIM). Although the impact of computer and ICT activities (CICT) is moderately assessed, today it forms an integrative "fabric" of technological literacy development and should be associated with important elements of the context. All of these elements actually complement the context of students' activities with artefacts of technology and are largely constrained by technological reality and the immediate environment. It should be noted that all significant elements of the context, apart from the responsibilities (and competences) of teachers as human resources, also require material resources, from appropriate space needs, teaching resources and aids to the financial resources for organizing and conducting field trips.

For pupils' self-regulation of their own learning, which also means the development of metacognition, teachers most assessed the impact of pupils' presentation of their own activity results (PRER). With the highly appreciated impact of activities with artefacts for this level of cognition, it is evident that teachers consider it important to invest a great deal of mental effort on the part of students to elaborate their own activities, especially with artefacts of technology. Given that pupils necessarily collaborate with each other in the process of preparing a presentation, by exploring sources and arguments, it can be observed that teachers understand the importance of the human aspect of technology for the development of pupil cognition.

Conclusions

The teaching context proves to be an important factor, but also a predictor of the success of each teaching, and especially of the technology education. However, given the permanently limited school conditions, the influence of contextual learning and teaching is not easy to explore. Therefore, analysis of the teaching context, which can be relevant to the learning process, is often the only "path" of research, and teachers are often the only "litmus" to determine which elements of teaching context can influence student achievements in the cognitive domain.

The teacher's perception of the influence of elements of the teaching context and approaches specific to general technology education clearly emphasizes the importance and hierarchical structure of the importance of those elements and approaches that should dominate this teaching. Pupils' activities with artefacts of technology (tools, machines, devices and instruments) are considered essential in technology teaching, and according to teachers, they have the greatest influence on content knowledge, content understanding and application of knowledge. Here, of course, it must be assumed that such activities are meaningful to the content that is learned from the pupil's perspective. In addition to activities with artefacts

of technology, for developing pupils' self-regulated learning and self-assessment of their own learning, as part of metacognition, teachers emphasize the importance of pupil's presentation of the results of their own activities. At the same time, for each level of achievement in the cognitive domain, teachers highly rate the importance of student activities with models and simulations, service-learning activities, and the implementation of all activities in a space appropriate for technology education. Adding to these elements and high estimates of the influence of field-trips on achievements in the cognitive domain, a set of teaching context elements obtained as a set of dominant contextual activities in general technology education. Of course, activities with computers and ICT, although moderately influential, are imposed as an unavoidable element of the context, but without a decisive influence on the cognitive achievements of pupils. All other elements of the teaching context observed, which are common in almost all classes, from the teacher's point of view, are merely a means of contextualizing teaching content in general technology education and are not the basis for students' cognitive development. This highlights the fact that the process ("path") to technological knowledge is important for achieving a high level of student achievement and cannot be skipped by "serving knowledge" that abounds in books and the Internet. Therefore, these findings are an important step towards optimizing the general technology education curriculum in which certain context elements should take precedence over others.

Despite such findings, it should be emphasized that it is a teacher's perception of influence, rather than a real measurement of the impact of certain activities on student achievements. At the same time, it should be noted that no element of the context was considered unimportant by teachers, which is why all elements have a certain importance and significance for student achievement. Although the teacher is an important factor in the quality of teaching and can best assess what may have an impact on students in a particular teaching, here is elaborated a general perception that cannot be applied to every student and in every environment. Therefore, future research into the impact of the teaching context should explore how the achievements of students who have been intensively exposed to these dominant activities are distinguished. It is also necessary to investigate the impact of all elements of the teaching context on different brains, in order to gain a clearer insight into how students conceptualize technology in their own minds with respect to their individual differences. This will give a "clearer picture" of the real impact of the teaching context on the group and individual pupil achievements, which may shape the best structure of the learning and teaching context, as well as the future curriculums of general technology education.

Acknowledgments

We would like to thanks all the teachers of Technical Culture in Croatia who agreed to participate in this research and creation of this paper. We also thank the Croatian Education and Teacher Training Agency and the Croatian Association of Teachers of Technical Culture who animated teachers and were often crucial support in conducting our research.

Conflict of interests

The authors declare no conflict of interest.

References

Abudu, K. A., & Gbadamosi, M. R. (2014). Relationship between teacher's attitude and student's academic achievemnt in senior secondary school chemistry. A case study of Ijebu-Ode and Odogbolu Local Government Area of Ogun state. *Wudpecker Journal of Educational Research, 3*(3), 035-043.

Albion, P. R. (1999). Self-efficacy beliefs as an indicator of teachers' preparedness for teaching with technology. In *Society for Information Technology & Teacher Education International Conference* (pp. 1602-1608). Association for the Advancement of Computing in Education (AACE). Retrieved from https://www.learntechlib.org/primary/p/8156/

Archambault, I., Janosz, M., & Chouinard, R. (2012). Teacher beliefs as predictors of adolescents' cognitive engagement and achievement in mathematics. *The Journal of educational research, 105*(5), 319-328. https://doi.org/10.1080/00220671.2011.629694

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. Longman Publishing Group.

Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs, NJ, 1986, 23-28.

Bandura, A. (1997). *Self efficacy: The exercise of control,* New York: Freeman.

Bateson, G. (1972). *Steps to an ecology of mind.* Northvale, NJ: Jason Aronson.

Bell, R. L., Maeng, J. L., & Binns, I. C. (2013). Learning in context: Technology integration in a teacher preparation program informed by situated learning theory. *Journal of Research in Science Teaching, 50*(3), 348-379.

Berns, R. G., & Erickson, P. M. (2001). *Contextual teaching and learning: Preparing students for the new economy* (Vol. 5). Columbus: National Dissemination Center for Career and Technical Education.

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher education, 32*(3), 347-364.
Biggs, J., Kember, D., & Leung, D. Y. (2001). The revised two-actor study process questionnaire: R-SPQ-2F. *British journal of educational psychology, 71*(1), 133-149.
Brown, B. L. (1998). Aplying Constructivism in Vocational and Career Education, *Information Series no. 378. Columbus: ERIC Clearinghouse on Adult, Career, and Vocational Education*, Center on Education and Training for Employment, the Ohio State University. Retrieved from https://files.eric.ed.gov/fulltext/ED428298.pdf
Buckley, J., Archibald, T., Hargraves, M., & Trochim, W. M. (2015). Defining and teaching evaluative thinking: Insights from research on critical thinking. *American Journal of Evaluation, 36*(3), 375-388. https://doi.org/10.1177/1098214005581706
Cohen, J. (1973). Eta-Squared and Partial Eta-Squared in Fixed Factor Anova Designs. *Educational and Psychological Measurement, 33*, 107-112, https://doi.org/10.1177/001316447303300111
Cohen, J. (1992). A Power Primer. P*sychological Bulletin, 112*(1), 155-159.
De Vries, M. J. (2016). *Teaching about technology: An introduction to the philosophy of technology for non-philosophers*. Springer. Retrieved from https://link.springer.com/book/10.1007%2F978-3-319-32945-1
Ekperi, P., Onwuka, U., & Nyejirime, W. (2019). Teachers' Attitude as a Correlate of Students' Academic Performance. *International Journal of Research and Innovation in Social Science (IJRISS), 3*(1), 205-209.
Gardner, H. (1993). *Frames of Mind: The Theory of Multiple Intelligences*. NY: BasicBooks.
Goddard, R. D., & Goddard, Y. L. (2001). A multilevel analysis of the relationship between teacher and collective efficacy in urban schools. *Teaching and Teacher Education, 17*(7), 807-818. https://doi.org/10.1016/S0742-051X(01)00032-4
Harwell, M. R., Rubinstein, E. N., Hayes, W. S., & Olds, C. C. (1992). Summarizing Monte Carlo results in methodological research: The one-and two-factor fixed effects ANOVA cases. *Journal of educational statistics, 17*(4), 315-339. https://doi.org/10.3102/10769986017004315
Johnson, E. B. (2002). *Contextual teaching and learning: What it is and why it's here to stay*. Thousand Oaks, CA: Corwin Press, INC.
Jones, A., Buntting, C., & de Vries, M. J. (2013). The developing field of technology education: A review to look forward. *International Journal of Technology and Design Education, 23*(2), 191-212. https://doi.org/10.1007/s10798-011-9174-4
Jordan, A. (2018). The supporting effective teaching project: 1. Factors influencing student success in inclusive elementary classrooms. *Exceptionality Education International, 28*(3), 10-27. https://doi.org/10.5206/eei.v28i3.7769
Kelley, T. R., & Kellam, N. (2009). A theoretical framework to guide the re-engineering of technology education. *Journal of Technology Education, 20*(2), 37. Retrieved from https://digitalcommons.usu.edu/ncete_publications/33/
Knoblauch, D., & Hoy, A. W. (2008). Maybe I can teach those kids." The influence of contextual factors on student teachers' efficacy beliefs. *Teaching and Teacher Education, 24*(1), 166-179. https://doi.org/10.1016/j.tate.2007.05.005
Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into practice, 41*(4), 212-218. https://doi.org/10.1207/s15430421tip4104_2
Labone, E. (2004). Teacher efficacy: Maturing the construct through research in alternative paradigms. *Teaching and teacher education, 20*(4), 341-359. https://doi.org/10.1016/j.tate.2004.02.013
Lix, L. M., Keselman, J. C., & Keselman, H. J. (1996). Consequences of assumption violations revisited: A quantitative review of alternatives to the one-way analysis of variance F test. *Review of educational research, 66*(4), 579-619. https://doi.org/10.3102/00346543066004579
Malinar, J. B. (2008). *Nastava tehničke kulture u osnovnim školama Hrvatske* [Teaching technical culture in primary schools in Croatia]. In D. Labaš (Ed.), 40 godina zajedno: i pola stoljeća nastave tehničke kulture u našim osnovnim školama (pp 59–86). Zagreb: Hrvatski savez pedagoga tehničke kulture.
Mitcham, C. (1994). *Thinking through technology: The path between engineering and philosophy.* University of Chicago Press.
MSES/MZOŠ. (2006). *Teaching programmes for compulsory education* (pp. 304–309).
Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of curriculum studies, 19*(4), 317-328. https://doi.org/10.1080/0022027870190403
Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of educational research, 62*(3), 307-332. https://doi.org/10.3102/00346543062003307
Petrina, S. (1992). Curriculum change in technology education: a theoretical perspective on personal relevance curriculum designs. *Journal of Technology Education, 3*(2), 37-47. https://doi.org/10.21061/jte.v3i2.a.5
Purković, D., & Ban, E. (2013). Odnos formalnih kvalifikacija nastavnika i percepcije postignuća u nastavi tehničke culture [The Relationship of Formal Qualification of Teachers and Perception of Achievement in Teaching Technical Education]. *Život i škola: časopis za teoriju i praksu odgoja i obrazovanja, 59*(29), 223-238. Retrieved from https://core.ac.uk/download/pdf/20340117.pdf
Purković, D. (2015). *Realiteti tehničke kulture* (Realities of Technical Culture). Rijeka: Faculty of Humanities and Social Sciences (e-book), Retrieved from http://www.ffri.uniri.hr/files/izdavacka/D_Purkovic-Realiteti_TK.pdf
Purković, D., Bezjak, J. (2015). Kontekstualni pristup učenju i poučavanju u nastavi temeljnog tehničkog odgoja i obrazovanja [Contextual approach to learning and teaching in the teaching of basic technical education]. *Školski vijesnik, 64*(1), 131-152. Retrieved from http://skolskivjesnik.ffst.hr/wp-content/uploads/2020/08/2015_7_PURKOVIC_BEZJEK.pdf
Purković, D., & Jelaska, I. (2014). The impact of selected contextual factors on the teachers' perception of the achievement of goals and objectives in teaching technical culture. *Croatian Journal of Education: Hrvatski časopis za odgoj i obrazovanje, 16*(4), 977-997. Retrieved from https://cje2.ufzg.hr/ojs/index.php/CJOE/article/view/644
Purković, D. (2016). The elements of contextual learning and teaching approaches as factors of success of teaching technical culture. *Doctoral thesis.* University of Split, Faculty of Science, Retrieved from https://dr.nsk.hr/islandora/object/pmfst%3A536
Purković, D. (2018). Conceptualization of technology as a curriculum framework of technology education. In *Proceedings TIE 2018.* University of Kragujevac, Faculty of Technical Sciences Čačak, Serbia. Retrieved from https://bib.irb.hr/datoteka/940081.P1.pdf
Purković, D., Suman, D., & Jelaska, I. (2020). Age and gender differences between pupils' preferences in teaching general and compulsory technology education in Croatia. *International journal of technology and design education*. https://doi.org/10.1007/s10798-020-09586-x

Purković, D., & Kovačević, S. (2020). Hierarchical structure of the importance of teaching context in general technology education. *Knowledge International Journal, 40*(2), 317-325. Retrieved from https://ikm.mk/ojs/index.php/KIJ/article/view/3900

Putnam, A. R., (2001). *Problem-Based Teaching and Learning in Technology Education*. Retriever from http://files.eric.ed.gov/fulltext/ED465039.pdf

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In Sikula, J., Buttery T. J. & Guyton, E. (Eds.), *Handbook of research on teacher education* (2nd ed.), 102-119, New York: Simon & Schuster Macmillan.

Schwandt, T. (2015). E*valuation foundations revisited: Cultivating a life of the mind for practice.* Stanford University Press.

Stepansky, V. I. (2006). *Psihoinformatsiya. Teoriya. Experiment* [Psychoinformation. Theory. Experiment]. Moscow: Moscowskij psihologo-sotsialnyj institut.

Verbitsky A. A., & Kalashnikov V. G. (2012). Category of „Context" and Contextual Approach in Psychology. *Psychology in Russia, State of the Art, 5*, 117-130.

Verbitsky, A. A., & Kalashnikov, V. G. (2013). Contextual approach in psychology. *European Scientific Journal, 9*(32). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.896.9759&rep=rep1&type=pdf

Wardani, N. F. K., Sunardi, S. & Suharno, S. (2020). Context-Based Thematic Teaching Materials to Improve Elementary Students' Learning Achievements. *Jurnal Pendidikan Indonesia (JPI), 9*(2), 193-202, https://doi.org/10.23887/jpi-undiksha.v9i2.22822

Original scientific paper

UDK:
159.922.72-057.875
159.953.5

Received: Seprember, 30.2020.
Revised: November, 24.2020.
Accepted: December, 03.2020.

doi: 10.23947/2334-8496-2020-8-SI-17-28

Reflexive Competence in Metacognitive Monitoring of Learning Activity of HEI Students

Eduard Balashov[1], Ihor Pasichnyk[1], Ruslana Kalamazh[1], Tetiana Zdrobylko[1]*

[1]Department of Psychology and Pedagogy, National University of Ostroh Academy, Ostroh, Rivne Region, Ukraine,
e-mail: eduard.balashov@oa.edu.ua; oa@oa.edu.ua; ruslana.kalamazh@oa.edu.ua; tetiana.zdrobylko@oa.edu.ua

Abstract: The manuscript presented here reports the theoretical aspects of the concepts of reflexive competence and reflexivity, which is considered, in learning activities through a prism of metacognitive monitoring of HEI students. An essence of metacognitive monitoring and reflexive competence has been theoretically studied. The role of reflexive competence and its components in the process of metacognitive monitoring of the educational activities of students of HEIs has been described. Reflexive competence at the metacognitive level is viewed as a system of formed reflexive abilities, which ensures high productivity of the intellectual activity of the subject by activating the metacognitive resources that are necessary and organizing reflexive actions. The results of empirical research with the use of questionnaire "Reflexive skills (cognitive and metacognitive level scales) (O. Savchenko), Methodology "Reflexive strategies of task solution" (O. Savchenko and M. Makiienko), Metacogntive Awareness Inventory - MAI (G. Scraw and R. Dennison) and "Methodology of Self-Evaluation of Metacognitive Knowledge and Metacognitive Activeness" (M. Kashapov & Y. Skvortsova), and correlation analysis with the use of ANOVA analysis of variance and Spearmen's rank correlation coefficient, have proved that student's overconfidence can cause mistakes in the evaluation of the results of the work. Senior students have better indicators of reflexive skills at the metacognitive level and more sophisticated reflexive problem-solving strategies. Thus, the results indicate that senior students have a higher level of reflexive skills at the metacognitive and cognitive levels and a higher level of reflexive problem-solving strategies than the first- and second-year students.

Keywords: reflexivity, reflexive competence, self-regulation, metacognitive monitoring, learning activity.

Introduction

The current stage of educational development is characterized by a focus on the competency-based approach in the preparation of graduates. The student must have not only a certain amount of knowledge but also be oriented towards self-improvement, self-development, and self-actualization. Besides this, upon graduation, students are expected to possess the various competencies required for further professional activity. Reflection has recently become one of the basic competencies in the education system and has lately been actively studied by scholars along with other concepts such as reflexivity and reflexive abilities. The main function of reflexive competence, as the ability to observe and control one's own actions and decision-making process, is the most effective and adequate implementation of reflexive processes; the realization of reflexive ability, which provides the process of development and self-evolution, promotes creativity to professional activity and achievement of its maximum efficiency and performance. There is a link between metacognitive monitoring and reflexive competence, and it should be noted that due to the existence of a set of reflexive skills, metacognitive processes can be implemented.

The aim of this article is to study the role of reflexive competence and its components in the process of metacognitive monitoring of the educational activities of students of higher education institutions (HEI).

The concepts mentioned above are considered mainly as a professional quality of personality in the context of pedagogy, educational psychology, general psychology and cognitive psychology. In particular, the reflexive processes have been studied by such as the following national psychologists Balashov, 2019; Dotsevych, 2014; Balashov et al., 2018; Maksymenko, 2017; Pasichnyk et al., 2014; Savchenko, 2016; Tytarenko, 2013. Self-reflection and metacognition at the personal level is considered in the studies of Dunlosky and Metcalfe, 2009; Hrynkiv, 2016; Karpov, 2012; Kholodnaya, 2002; Koriat and Bjork, 2005.

The phenomenon of reflexive competence was developed by such scholars as Babaian, 2014;

*Corresponding author: eduard.balashov@oa.edu.ua

Dotsevych, 2014; Leontyev and Averina, 2011. In her works, O. Savchenko investigated and characterized the components and levels of reflexive competence (Savchenko, 2016).

Nowadays, studies of metacognitive processes include the theoretical and empirical analysis of various issues that reflect the role of metacognitive activity in learning activities. Issues of metacognition and metacognitive monitoring, namely, the functions and structural components of these phenomena, self-efficacy and learning strategies have been studied by foreign and domestic scholars (Andrade and Heritage, 2018; Avhustiuk, 2016; Bandura, 1997; Bembenutty et al., 2013; Dabbagh and Kitsantas, 2013; Flavell, 1979; Schunk, 1987; Winne, 2010; Zabrucky, 2010; Zimmerman and Schunk, 2011). R. Ryan and E. Deci studied self-determination and basic psychological needs of a subject in motivation, development and wellness (Ryan and Deci, 2017). The link between metacognitive monitoring and the success and productivity of the learning activity in the context of studying the accuracy and reliability of this process is the main problem that is explored in this field (Dunlosky and Metcalfe, 2009; Fomin, 2012; Koriat and Bjork, 2005; Nietfeld et al., 2005; Savin, 2011; Valdez, 2013). The connection between reflection and the metacognitive experience of personality has been indicated by Dovhaliuk and Voloshyna, 2015; Dotsevych, 2014; Karpov, 2012; Kholodnaya, 2002; Pasichnyk and Dovhaliuk, 2016; Savin and Fomin, 2011.

Reflexive competence is a relatively new concept in scientific literature, so it is necessary, for a more detailed understanding, to refer to the concepts which form its basis: reflection and reflexivity. Self-reflection, as a process, refers to the regulatory component of the subject and consists of the self-knowledge of the subject's own internal mental acts and states. In general, reflection is self-oriented. In philosophy, reflection (from the Latin reflexio – "bending back") is considered as a person's process of thinking about his or her consciousness. In psychology, there are also other interpretations of this concept. As the most promising approach of explaining the phenomenon of reflection, we have defined that in which reflection is the general capacity of the individual which provides the opportunity to "interrupt this continuous process of life and bring the person mentally beyond its limits". The study of reflexive processes has faced some challenges because the methodological toolkit is not well developed to study all aspects of this phenomenon. Besides, the concept of reflection according to A. Karpov has several modes, namely: a reflective mechanism, reflection as a process, reflection as a state and reflexivity as a personal ability (Hrynkiv, 2016).

Reflexive competence is an integrative personal formation. Its formation occurs through the acquisition of reflexive experience by the subject, whose main function is to coordinate other components of the experience and ensure the effective use of reflexive skills in the process of the activity. The reflexive competence of a person is understood by the subject mastered through a set of qualities, both professionally and personally important, which are formed directly during the reflexive activity. There are three levels of reflexive activity (O. Savchenko): cognitive (understanding of the nature of the flow and grounds of one's intellectual activity), metacognitive (providing regulation of the external and internal activity of the subject), and personal (self-knowledge and self-expression of personality).

There are also its four components:

1) informative, which is about the awareness of individuals regarding the features of their personality that are important in using the information available to ensure the efficiency and effectiveness of the process of solving the problem and making a decision.

2) instrumental, which includes skills aimed at regulating the subject's learning activity. In this component, the main mechanism is the actual process of reflection.

3) assessment-motivational, characterized mainly by prognostic abilities, which are manifested in three processes: probabilistic programming, expectations, anticipation. Predictive features are influenced by one's personal qualities as well as the development of the subject's cognitive and metacognitive skills.

4) behavioral, that is, the activation of the formed skills and abilities of the subject in order to apply it to the process of problem-solving or decision-making (Savchenko, 2016).

Organizational psychology offers another interpretation of reflexive competence; in particular, it is considered to be the ability to regulate mental activity (Leontyev and Averina, 2011). Its essence, according to Y. Babaian, lies in using deep versatile analysis to enable awareness of its vocation, further self-fulfillment in the appropriate direction, and establishment of the social value of the result of its activity (Babaian, 2014). According to T. Nelson and L. Narens, reflexive competence is the professional quality of a person which provides the most effective and adequate realization of the reflexive processes and of the reflexive capacity that promotes the development and self-evolution of the subject. It ensures the use of a creative approach in professional activity and the achievement of its maximum efficiency and effectiveness (Nelson and Narens, 1990).

Along with the essence of reflexive competence, scholars consider the essence of metacognitive

monitoring, which also refers to the regulatory component of the activity. Metacognitive monitoring is a part of the "metacognition" system, and the study of metacognitive processes began from this development/ discovery (Hrynkiv, 2016). The first researcher to examine and develop the structure of metacognition was J. Flavell. He considered metacognitive processes as a system of human knowledge about the characteristics of his or her cognitive sphere and ways of controlling it, and distinguished four classes of phenomena: (a) metacognitive knowledge, (b) metacognitive experience, (c) goals (or tasks), (d) actions (or strategies). The first two components are reflexive formations, through which human intelligence acquires some new quality, called by J. Flavell "cognitive monitoring", which he explains as the ability to view introspectively and track the progress of intellectual activity. The scholar points to the advantage of the regulatory function of metacognitive processes and attaches particular importance to reflection (Flavell, 1979).

In psychology, metacognitive monitoring is considered to be the process of observing the course of one's thinking processes, of one's learning activity directly in the process of solving problems or making a decision, as well as the results of one's learning activity (Avhustiuk, 2016). The main feature is the presence of conscious and meaningful observation of the course of one's thoughts and actions; that is, the active position and control by the subject of activity. Metacognitive monitoring performance criteria include the subject's ability to prioritize tasks, evaluate the amount of time and effort needed to solve a problem and organize ongoing control over intellectual activity. It is worth noting that among scholars there are different points of view on the essence of metacognitive monitoring. Some of the researchers see it as a process (Avhustiuk, 2016; Balashov et al., 2018; Nelson and Narens, 1990; Pasichnyk et al., 2014; Savin and Fomin, 2011).

Despite the broad coverage of these concepts in scientific literature, there is no united view of their correlation. There are several views, two of which are the principal: the first one is that reflexive competence is a broader concept and involves the process of metacognitive monitoring; the second approach considers metacognition and metacognitive monitoring to be the broader concepts; that is, reflexive skills form an element that makes it possible to set and implement metacognitive monitoring. The connection between reflection and the metacognitive experience of personality has been investigated by Dotsevych, 2014; Pasichnyk and Dovhaliuk, 2016; Karpov, 2012; Kholodnaya, 2002; Savin and Fomin, 2011; Dovhaliuk and Voloshyna, 2015. The main contribution of these scholars is that the basis of acquisition of metacognitive experience is a reflection of mental activity (Fomin, 2011). In the works of T. Dotsevych, it is stated that reflexivity is an important factor in organizing all metacognitive experience, through which metacognitive involvement and awareness are activated (Dotsevych, 2014). A. Karpov points to the uniqueness of the issue of reflection and proposes to view reflexivity as a meta-skill that performs a regulatory function and is at the highest systemic level in the structure of all mental processes (Karpov, 2012).

At the metacognitive level, reflexive activity is manifested in the subject's ability to organize monitoring of a current activity in order to consciously monitor the progress of the activity and its results. The ability to analyze, comprehend and understand past experiences, mistakes, and successes, which is a reflexive competence, helps to gain new experience, new knowledge in the learning process and to gain new success (Babaian, 2014). A high level of organization of reflexive competence promotes the organization of more effective forms of reflexive activity through realization of the ability to create probable models of problem-solving, to carry out self-analysis of one's actions, to activate abilities to understand the consequences of the events of one's own life, and to use more time for decision-making in multiple control situations to evaluate one's own intellectual abilities (Balashov, 2019).

Materials and Methods

The empirical study we conducted was to diagnose the instrumental and behavioral components of reflexive competence, as well as the metacognitive characteristics (involvement, activity, and metacognitive knowledge) of the subjects of learning activity. The study was conducted at the National University of Ostroh Academy, and empirical data was collected during June-August 2019. The sample population was formed by a spontaneous method from the full-time students of all years of study. Thus, 62 respondents (9 males and 53 females) regardless of major, aged from 17 to 24 years (M=20,71, SD=1,868) participated in the study. To analyze the empirical data, the sample population was divided into three groups according to the year of study:

1. the first group – first and second years of study (N=22; M=19,32; SD=1,673);
2. the second group – third and fourth years of study (N=18; M=20,50; SD=1,543);

3. the third group – the fifth and sixth years of study (N=22; M=22,27; SD=0,883).

To study the above indicators, we selected the following methods:

Method #1 - "The reflexive skills (metacognitive level)" (O. Savchenko). In order to study the level of development of students' reflexive skills according to O. Savchenko's classification, namely: the ability to organize the process of problem-solving, to direct efforts towards achieving the goal; the ability to predict possible mistakes and difficulties, to analyze one's capabilities; the ability to regulate one's emotional states, to set mind to work; the ability to plan, evaluate and validate one's actions; the ability to create probabilistic models of problem-solving, to carry out self-analysis of one's actions, peculiarities of one's behavior; the ability to monitor current forms of mental activity, to regulate the significance of the problem taking into account the current state; the ability to critically evaluate one's intellectual abilities, capabilities, and limitations, as well as the overall level of development of reflexive metacognitive skills.

Method #2 - "The reflexive skills (cognitive level)" in the development of O. Savchenko, which allowed determination of the level of formation of the following reflexive skills: the ability to explain to yourself and others the course of your reasoning and reasons for choosing a certain solution or strategy; the ability to be aware of your own emotional experiences, to control their course, to maintain a sense of confidence; the ability to keep oneself in the plane of reflexive reasoning, to analyze the reasons for one's own actions and the causes of failures; the ability to regulate the process of finding a solution, to verify one's assumptions; the ability to evaluate results by various criteria, formulate judgments; the ability to be aware of various aspects of the decision-making process: cognitive, emotional, behavioral, as well as the general level of development of reflexive cognitive skills.

Method #3 - "The reflexive strategies of problems solving" (O. Savchenko, M. Makiienko), which contains 8 scales corresponding to various reflexive strategies for solving problems. Four scales correspond to primary strategies: deep processing of information, censoriousness in the analysis and evaluation of information, decision-making with an orientation to internal standards, and a rational approach to finding a solution to a problem.

The following four scales are complex and combine the primary strategies that we have indicated above.

1. "Metacognitive Awareness Inventory" G. Schraw & R. Dennison (MAI) was used to evaluate the level of development of human reflexive functions, how they affect activity, namely the pattern of their participation in human activity.

2. Method of diagnosis for self-assessment of metacognitive knowledge and metacognitive activity (M. Kashapov & Y. Skvortsova) consisting of two scales:

1) Metacognitive knowledge, which the authors understand as knowledge about their cognitive processes, namely knowledge about the means of obtaining and processing information, the type and content of tasks and requirements for its solution, about a person's ability to obtain metacognitive strategies.

2) Metacognitive activity is directly represented by the processes of human activity: obtaining and selecting information, controlling, transforming and planning metacognition.

The accuracy and validity of the research, which was executed with the use of MS Excel 2010 and StatSoft STATISTIKA 21, was ensured by representativeness of the sample, the use of the methods relevant to the topic, aim and tasks of the study, the use of quantitative and qualitative analysis of the received empirical data by using the following methods of mathematical statistics.

• descriptive statistics – calculated indicators, which allow to determine the distribution of values of the variable. We used it to describe our sample and indicators of the development of reflexive skills, strategies and metacognitive characteristics in different groups of respondents. The following indicator from the first group was informative for our study: the indicator of evaluation of the central tendency – the average value (the sum of all values of the variable divided by their number); and the indicator of the second group, which characterized the variability of the variable values related to its mean – the standard deviation (square root of dispersion),

• the one-factor dispersion analysis of variance (ANOVA) for searching for statistically significant dependencies/differences in the indicators by the methodologies described above, among the students of different years of study. We can confirm that in the presence of statistically significant differences between two indicators, their development occurs differently, as the certain indicator is usually higher that another, therefore, the development of the certain skill happens faster and so on.

• Spearman's correlation coefficient for evaluation of the indicators of metacognitive functions, particularly metacognitive activity, knowledge and involvement to activity, and the indicators of formation of students' reflexive skills of cognitive and metacognitive level and reflexive strategies for solving the

tasks. Correlation is a statistical indicator that allows determining and evaluating the probabilistic relations between two variables. It should be noted that the peculiarity of the probabilistic relation is that one value of a certain variable corresponds to a number of values of another variable. The presence of a positive direct correlation indicated that the increase of indicator of one value cause the increase of such indicator of another one.

Results

In our research with the use of one-factor dispersion analysis of variance ANOVA and the results of descriptive statistics, we evaluated the level of development of cognitive-level reflexive skills by the methodology developed by O. Savchenko. Thus, the development of a high level of ability to explain to yourself and others the course of your reasoning, the reasons for choosing a particular solution and strategy is observed at the third and fourth years of study (M=2.50, SD=0.514) [F (2, 56)=10.164, p=0,000]. The indicators of the greatest ability to recognize one's own emotional experiences, control their course and maintain a sense of confidence [F (2, 56)=12,188, p=0,000] are observed in the first years of study (M=2.71, SD=0.463), and subsequent years' indicators are statistically significantly lower and remain at the same level: third and fourth years of study (M=2.00, SD=0.000), master's course (M=2.00, SD=0.775). Studying the general level of development of reflexive skills at a cognitive level, we determined that in the last years of study (master's program) (M=1.71, SD=0.717), the indicators are the lowest [F (2, 56)=5.601, p=0.006]. Thus, we refute the hypothesis according to which senior students (graduate students) have a higher level of formation of reflexive skills at the cognitive level compared to first- and second-year students. We cannot argue the fact that the level of development of cognitive skills decreases throughout the study. To verify and confirm this statement it is necessary to conduct a longitudinal study and track the development of skills.

Graphically, the results of the study by the method "The reflexive skills (cognitive level)" are shown in Figure 1.

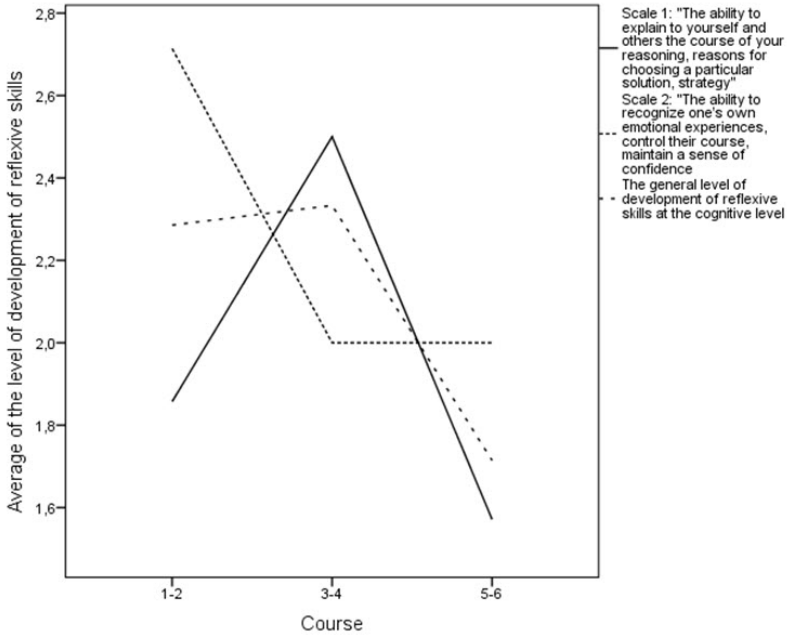

Figure 1. The results of the method "The reflexive skills (cognitive level)" (O. V. Savchenko) among students in accordance with the curriculum with the use of one-factor dispersion analysis of variance ANOVA

If we take into account the results of correlation analysis with the use of Spearmen's correlation coefficient, according to which the general level of development of reflexive skills at the cognitive level has a negative weak correlation with metacognitive involvement (r = -0.274, p=0.031), then we can say that with a higher focus on cognitive skills, students become less involved in metacognitive activity (Table 1). The results can be interpreted as follows: senior students have more automatic cognitive skills, students begin to focus more on metacognitive observations, that is, on the process of metacognitive monitoring.

It is worth noting that metacognitive activity does not correlate with any reflexive skill at the cognitive

level. As you can see, these skills do not relate to working with information and actually solving problems but are focused on observing and tracking emotional experiences, searching for the causes of failures, and the like. Thus, the hypothesis about the existence of a positive relationship between the metacognitive characteristics (knowledge) of the subject's activity and the formed reflexive skills of the cognitive level is partially confirmed; however, the metacognitive involvement has a negative relationship with reflexive skills.

Table 1

The results of correlation analysis with the use of Spearmen's correlation coefficient on the relation between metacognitive characteristics and reflexive skills at the cognitive level

	R	P
Metacognitive involvement * The ability to keep oneself in the plane of reflective reasoning, analyze the reasons for one's own actions, causes of failures	0,331	0,009
Metacognitive involvement * The ability to regulate the process of finding a solution, to verify one's assumptions	-0,268	0,035
Metacognitive involvement * The general level of development of reflexive skills at the cognitive level	-,0274	0,031
Metacognitive knowledge * The ability to recognize one's own emotional experiences, control their course, maintain a sense of confidence	0,342	0,007
Metacognitive knowledge * The ability to keep oneself in the plane of reflexive reasoning, to analyze the grounds of one's own actions, the causes of failures	0,374	0,003
Metacognitive knowledge * The ability to regulate the process of finding a solution, to verify one's assumptions	0,309	0,015

This is confirmed by the correlation results with the use of SpearmeFn's correlation coefficient, according to which metacognitive knowledge has a positive moderate relationship with the following reflexive skills: to be aware of one's own emotional experiences, control their course, maintain a sense of confidence (r=0.342, p=0.007), keep oneself in the plane of reflexive reasoning, analyze the grounds of one's own actions and the reasons of failures (r=0.374, p=0.003), as well as to regulate the process of finding a solution and verify one's own assumptions (r=0.309, p=0.015).

In addition, we investigated the level of development of reflexive skills at the metacognitive level according to the method of O. Savchenko in the context of the student's year of study with the use of one-factor dispersion analysis of variance ANOVA and the results of descriptive statistics. We found that students demonstrated a higher level of development of the ability to organize the process of solving the problem and direct efforts to achieve the goal [F (2, 56)=4.979, p=0.010] in the third/fourth years of study (M=2.33, SD=0.767), and the lowest rates are in the last years of study (M=1.86, SD=0.359). On a scale that measures the level of development of the ability to predict possible errors and difficulties and to analyze one's own capabilities, a gradual increase in indicators is observed [F (2, 56)=0.709, p=0.013] throughout the entire period of students' education: in the first years, the indicators are as follows: (M=2, 14 SD=0.359), in the third/fourth year (M=2.33, SD=0.485) and in the master's course (M=2.57, SD=0.507). The lowest indicators of the level of development of the ability to plan, evaluate and verify one's own actions, [F (2, 56)=4.979, p=0.010] are observed in the first years (M=1.71, SD=0.717), and the highest in third/fourth year (M=2.33, SD=0.485). Studying the general level of the development of reflexive skills at the metacognitive level study, with the use of one-factor dispersion analysis of variance ANOVA and the results of descriptive statistics, we found that the development rates of reflexive skills at the third / fourth year (M=2.33, SD= 0.767) are statistically significantly higher [F (2, 56)=7.410, p=0.001] than the last years of study (master's program) (M=2.29, SD=0.463). Informative is the observation that predominantly third- and fourth-year students showed better results than graduate students by the method. Thus, we confirm the hypothesis that senior students (master's program) have a higher level of formation of reflexive skills at the metacognitive level, compared with first- and second-year students. Graphically, the results of the study using the method "The reflexive skills (metacognitive level)" are shown in Figure 2.

If we take into account the results of correlation analysis by Spearmen's correlation coefficient, it is worth noting that the ability to predict possible mistakes and difficulties, analyze one's own capabilities (r=0.372, p=0.003), as well as the ability to create probabilistic models of solving the problem, to carry out self-analysis of one's own actions and behavioral characteristics (r=0.327, p=0.009) have a positive moderate connection with metacognitive activity. That is, the more active a student's metacognitive activity, the higher is the level of development of this skill.

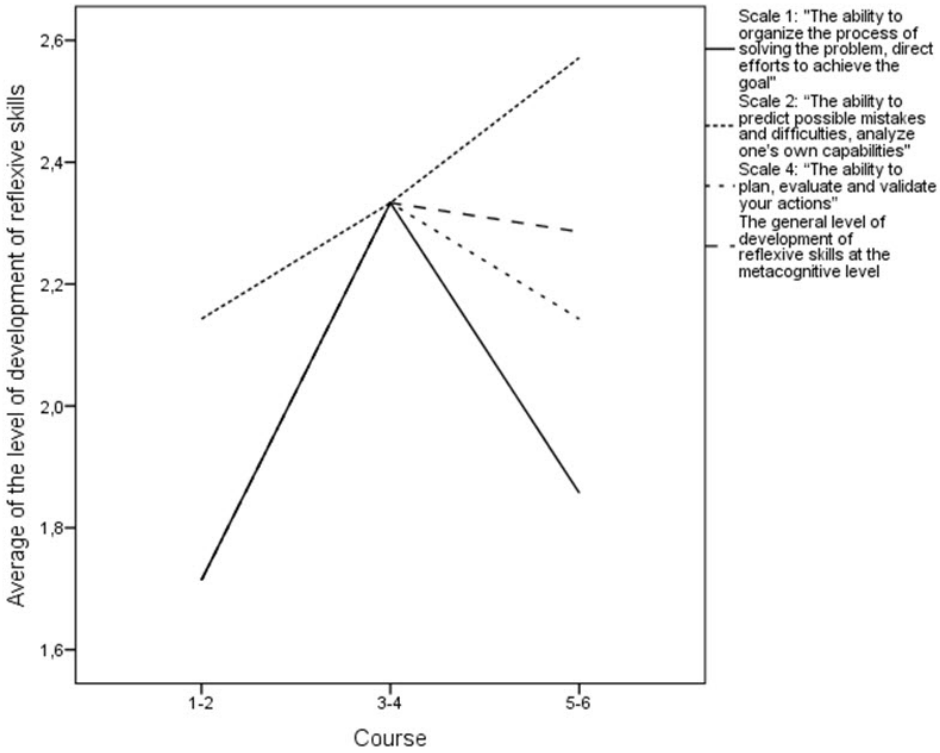

Figure 2. The results of the method "The reflexive skills (metacognitive level)" (O. V. Savchenko) among students in accordance with the curriculum study with the use of one-factor dispersion analysis of variance ANOVA

At the same time, the ability to regulate one's own emotional states and setting one's own mind to work has a negative weak link with metacognitive inclusion (r = -0.278, p = 0.029) and activity (r = -0.268, p=0.035), as well as between the general level of development of reflexive skills at a metacognitive level and metacognitive knowledge (r = -0.281, p=0.027) (see Tab. 2). That is, there is some probability that the more a student is involved in metacognitive activity, the less he can regulate his or her emotions. So, the hypothesis of the existence of a positive connection between the metacognitive characteristics (activity) of the subject's activity and the reflexive skills formed at the metacognitive level is partially confirmed. It is worth noting that such a metacognitive characteristic as metacognitive knowledge is associated only with the general level of the development of reflexive skills but does not correlate with any reflexive skills.

According to the results of the analysis of the method of diagnosis for self-assessment of metacognitive knowledge and metacognitive activity of M. M. Kashapov and Y. V. Skvortsova with the use of one-factor dispersion analysis of variance ANOVA, statistically significant differences were determined on the metacognitive activity scale [F=3,266, p=0,0,45]. Using the results of descriptive statistics, we can confirm that the lowest rates are among first- and second-year students (M=2.95, SD=0.203), and the highest are among third- and fourth-year students (M=3.50, SD=0.514).

Table 2

The results of the correlation analysis with the use of Spearmen's correlation coefficient on the connection between metacognitive characteristics and reflexive skills at the metacognitive level

	R	P
Metacognitive involvement * The ability to regulate one's own emotional states, set mind to work	-0,278	0,029
Metacognitive knowledge * The general level of development of reflexive skills at the metacognitive level	-0,281	0,027
Metacognitive activity * The ability to predict possible mistakes and difficulties, analyze one's own capabilities	0,372	0,003
Metacognitive activity * The ability to regulate one's own emotional states, set mind to work	-0,268	0,035
Metacognitive activity * The ability to create probabilistic models of solving a problem, to carry out self-analysis of one's actions, features of one's behavior	0,327	0,009

On the metacognitive knowledge scale, no statistically significant differences were found.

When studying reflexive problem-solving strategies with the use of one-factor dispersion analysis of variance ANOVA, we found that, in general, senior students have a higher plane of intelligence in particular on the scale of deep processing of information [F=7.563, p=0.001], where statistically significant high rates were found in third-, fourth-year students (M=2.33, SD=0.114), and the lowest among first- and second-year students (M=1.55, SD=0.157), which is confirmed by the indicator of descriptive statistics Indicators on the decision-making scale with a focus on internal standards [F=9.898, p=0.000] are also the highest among the third- and fourth-year students (M=2.17, SD=0.167), and the lowest among the first- and second-year students (M=1.86, SD=0.136). On a scale of in-depth information processing, the results are similar: indicators are statistically significantly higher [F=4,158, p=0,020] for the third- and fourth-year students (M=2.33, SD=0.181), and the lowest for the first- and second-year students (M=1.82, SD=0.142). Thus, we can note that senior students are more capable of evaluating their own strengths, they have prevailing ideas and views on certain events, ways of solving problems and making decisions, and they are less focused on the opinions and ideas of others, which confirms the hypothesis that senior students (master's program) have a higher level of formation of reflexive strategies of solving the problem, compared with the first- and second-year students. For senior students, there is great variability in the ways of solving the problem, and productivity is important for them, therefore they are more likely to analyze the causes of difficulties or failures. However, they may be negligent in the process of solving the problem at the stage of familiarization with the task conditions. They often take risks because they try to rely on their own strengths and act intuitively, but such behavior is not always justified. A graphical representation of the results is shown in Fig. 3.

If we observe the results of correlation analysis with the use of Spearmen's correlation coefficient, it is worth noting that most of the scales according to the method have a positive link with all metacognitive characteristics that we determined in the study; in particular, the comprehensive strategy, "A rational approach to solving problems with orientation to internal standards", correlates with all metacognitive characteristics. It has a positive moderate relationship with metacognitive activity (r=0.306, p=0.016), a positive weak link with metacognitive knowledge (r=02 53, p=0.048) and a positive strong link with metacognitive inclusion (r=0.722, p=0,000).

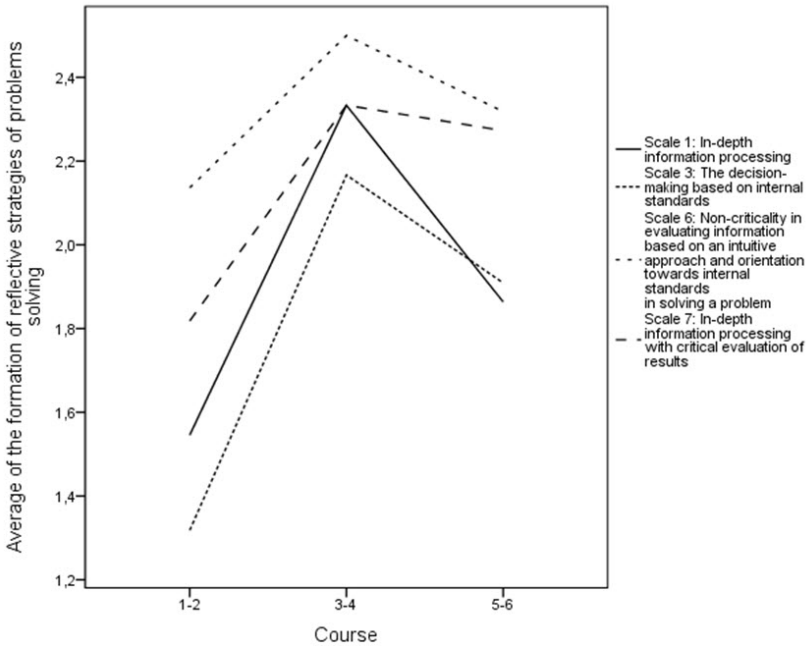

Figure 3. The results of the method "The reflexive strategies of problems solving" (O. Savchenko, M. Makiienko) in the development among students in accordance with the curriculum with the use of one-factor dispersion analysis of variance ANOVA

It is also worth noting that such a metacognitive characteristic as metacognitive knowledge correlates with the vast majority of reflexive strategies, in particular, a positive weak link with deep processing of information (r=0.286, p=0.024), criticality in the analysis and evaluation of information (r=0.277, p=0.029), a rational approach to solving a problem with an orientation towards internal standards (r=0253, p= 0.048), as well as a positive moderate link with decision-making with an orientation to internal standards (r=0.373, p=0.003), non-criticality in evaluating information based on an intuitive approach and focus on internal standards in solving the problem (r=0.450, p=0.000) (See Table 3).

This means that the more involved, active, and knowledgeable a person is about their own metacognitive activity and their ability to consciously monitor and change his or her actions, the more reflexive problem-solving strategies he or she has. Considering the most informative results of correlation analysis, we can state that such a component of reflexive strategies as the orientation towards internal standards in problem-solving has a close connection with metacognitive knowledge and involvement. That is, a student who possesses these metacognitive characteristics is inclined to solve problems based on his or her thoughts and strengths, and not the requirements and assessments of others.

Table 3

The results of the correlation analysis with the use of Spearmen's correlation coefficient on the connection between metacognitive characteristics and reflective strategies of problems solving

	R	P
Metacognitive activity * Non-criticality in evaluating information based on an intuitive approach and orientation towards internal standards in solving a problem	0,261	0,041
Metacognitive activity * Rational approach to solving a problem with an orientation towards internal standards	0,306	0,016
Metacognitive knowledge * In-depth information processing	0,286	0,024
Metacognitive knowledge * Criticality in the analysis and evaluation of information	0,277	0,029
Metacognitive knowledge * Decision-making based on internal standards	0,373	0,003
Metacognitive knowledge * Non-criticality in evaluating information based on an intuitive approach and orientation towards internal standards in solving a problem	0,450	0,000
Metacognitive knowledge * Rational approach to solving a problem with a focus on internal standards	0,253	0,048
Metacognitive involvement * Rational approach to finding a solution to a problem	0,347	0,006
Metacognitive involvement * Rational approach to solving a problem with a focus on internal standards	0,722	0,000

Students can evaluate and quickly correct their actions, anticipate possible failures, and change the way he or she accomplishes the task accordingly.

Discussion

In the light of the results of our theoretical analysis and empirical research, with the help of statistical analysis, we confirmed the hypothesis that there is a positive connection between the metacognitive characteristics of the subject's activity, namely metacognitive involvement, activity, and knowledge, and formed reflexive problem-solving strategies; that is, the more metacognitive characteristics the subject has developed, the more effective it is to use reflexive strategies to solve the problems. This result is consistent with some psychological studies about metacognitive involvement and monitoring (Avhustiuk, 2016; Balashov, 2019; Dotsevych, 2014; Flavell, 1979; Karpov, 2012; Nietfeld et al., 2005).

Reflexive competence is a mobilizing factor for triggering the operational and behavioral resources of the individual, through which the activity of the subject is ensured by the organization and regulation of intellectual activity. Enhanced operations and strategies reduce the ability to use poorly performing techniques to process information and to lose control over the course of one's thoughts and experiences. Reflexive competence at the metacognitive level is viewed as a system of formed reflexive abilities, which ensures high productivity of the intellectual activity of the subject by activating the metacognitive resources that are necessary and organizing reflexive actions aimed at eliminating the problem in the situation when it is necessary to solve a difficult task. The quality and content of a person's decision is largely mediated by the way, in which the subject evaluates his or her knowledge and intellectual skills in the process of completing a particular task. It is worth noting that most of the studies show that the actor is inclined to overestimate one's own competence. For this reason, student's overconfidence can cause mistakes in the evaluation of the results of the work on the task. Today, much of the research is focused on exploring the various factors that determine the quality of metacognitive monitoring and its potential for development. Thus, senior students have better indicators of reflexive skills at the metacognitive level, among which it is necessary to distinguish abilities: to organize the process of solving a problem, to direct efforts towards the goal, to predict possible mistakes and difficulties, to analyze one's own capabilities,

and to plan, evaluate and check one's own actions. Our study has proved that reflexive competence of students at the metacognitive level has been confirmed to be closely interconnected with the components of metacognitive learning activities of students, supporting the studies of Schunk (1987), Dunlosky and Metcalfe (2009), Winne (2010), Savchenko (2016).

At the same time, the indicators of the level of development of the reflexive skills at the cognitive level are lower, namely the following abilities: to comprehend one's own emotional experiences, to control their course, to maintain a sense of confidence, to explain to themselves and others the course of their own reasoning and reasons for choosing a certain solution or strategy. Master's students also have more sophisticated reflexive problem-solving strategies, such as in-depth information processing, internal standards-based decision-making, deep processing of information with critical evaluation of results, and more. Such results support the previous studies of Valdez (2013), Ryan and Deci (2017), Kitsantas and Dabbagh (2010), Leontyev and Averyna (2011) who emphasized the importance of reflexivity and self-determination in success of learning process.

Conclusions

The results of the presented study indicate that senior students (master's program) have a higher level of reflexive skills at the metacognitive and cognitive levels and, accordingly, have a higher level of reflexive problem-solving strategies than the first- and second-year students have. At the same time, the results of the comparison of the general level of development of the reflexive skills at the cognitive level revealed that the senior students (master's program) have the lowest indicators. However, such a result may be due to sample characteristics (our study is not a longitudinal one), rather than age differences or the dynamics of learning activity.

Positive correlation between the metacognitive characteristics of the student learning activity, namely metacognitive involvement, activity, and knowledge, and the formed reflexive problem-solving strategies have been confirmed. The more metacognitive characteristics a student develops, the more effective it is to use reflexive strategies to solve the learning problems. We have found out that reflexive cognitive skills do not have a positive link at both levels (metacognitive and cognitive) or not correlate with metacognitive activity, while reflexive metacognitive skills do not correlate with metacognitive knowledge.

Acknowledgments

Authors would like to express sincere words of gratitude to all participants of the research (students of the National University of Ostroh Academy) and to the editorial team members for their patience, kindness and professional assistance.

Conflict of interests

The authors declare no conflict of interest.

References

Andrade, H. L., & Heritage, M. (2017). *Using formative assessment to enhance learning, achievement, and academic self-regulation.* Routledge. https://doi.org/10.4324/9781315623856

Avhustiuk, M. (2016). Psychological Peculiarities of Objectivity of Metacognitive Monitoring. *Actual Issues of Development of Education and Science under Conditions of Globalization. Materials of All-Ukrainian Scientific Conference.* Dnipro: Royal Print, 35–37. Retrieved from http://www.dnu.dp.ua/docs/zbirniki/fsnm/program_5a1d359d68327.pdf

Babaian, Y. (2014). Structure of Reflexive Competence of Teacher of Higher School. *Scientific Bulletin of O. Sukhomlynskyi Mykolaiv National University. Series "Psychological Sciences", 2*(13), 22–26.

Balashov, E. (2019). Psychological characteristics of metacognitive monitoring in student learning activities. *Scientific Bulletin of Kherson State University. Series "Psychological Sciences", 4,* 64–71. https://doi.org/10.32999/ksu2312-3206/2019-4-8

Balashov, E., Pasichnyk, I., & Kalamazh, R. (2018). Self-Monitoring and Self-Regulation of University Students in Text Comprehension. *Psycholinguistics, 24*(1), 47-62. https://doi.org/10.31470/2309-1797-2018-24-1-47-62

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Bembenutty, H., Kitsantas, A., & Cleary, T. J. (Eds.). (2013). *Applications of selfregulated learning across diverse disciplines: A tribute to Barry J. Zimmerman*. IAP.

Dabbagh, N., & Kitsantas, A. (2013). The role of social media in self-regulated learning. *International Journal of Web Based Communities, 9*(2), 256-273. https://doi.org/10.1504/IJWBC.2013.053248

Dotsevych, T. I. (2014). Rozroblennia i aprobatsiia opytuvalnyka pedahohichnoi refleksyvnosti vykladacha vyshchoi shkoly

[Designing and approbation of questionnaire of reflexivity of a HEI teacher]. *Psykholohichni perspektyvy–Psychological Perspectives, 23*, 99-112.

Dovhaliuk, T. & Voloshyna, V. (2015). Poniattia myslennia yak metakohnityvnoho protsesu u psykholohichnii nautsi [Concept of Thinking as Metacognitive Process in Psychological Science]. *Molodyi vchenyi–Young Scientist, 10*(25), 184-188. Retrieved from http://molodyvcheny.in.ua/files/journal/2015/10/84.pdf

Dunlosky, J., & Metcalfe, J. (2009). *Metacognition: A Textbook for Cognitive, Educational, Life Span and Applied Psychology.* SAGE Publications.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American psychologist, 34*(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Fomin, A. Y. (2012). Evrystika dostupnosti i metakohnitivnyi monitorynh resheniia uchebnykh zadach studentami [Heuristics of availability and metacognitive monitoring of solving learning tasks by students]. *Psykhologiia: Vestnik Brianskogo hosuniveriteta, 1,* 175-180. [in Russian]. Retrieved from http://vestnik-brgu.ru/wp-content/numbers/v2012_12.pdf

Hrynkiv, A. (2016). Metacognitive Researches in Context of Educational Innovations. *Higher Education of Ukraine, 2*, 37–43. Retrieved from http://enpuir.npu.edu.ua/bitstream/123456789/19188/1/Grinkiv.pdf

Karpov, A. (2012). Interconnection of Learning and Metacognitive Characteristics of Personality. *Yaroslavl Pedagogical Bulletin, 2*(3) (Psychological and Pedagogical Sciences), 228–235. Retrieved from http://vestnik.yspu.org/releases/2012_3pp/51.pdf

Kholodnaya, M. (2002). *Psychology of Intellect: Paradoxes of Research.* Saint Petersburg: Piter.

Kitsantas, A., & Dabbagh, N. (2013). *Learning to Learn with Integrative Learning Technologies (ILT): A Practical Guide for Academic Success (Chinese Edition).* IAP.

Kitsantas, A. & Dabbagh, N. (2010). *Learning to learn with Integrative Learning Technologies (ILT); A Practical Guide for Academic Success.* Charlotte: NC: Information Age Publishing.

Koriat, A., & Bjork, R. A. (2005). Illusions of competence in monitoring one's knowledge during study. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*(2), 187–194. https://doi.org/10.1037/0278-7393.31.2.187

Leontyev, D., & Averyna, Z. (2011). Phenomenon of Reflexivity in Context of Issue of Self-Regulation [E-Resourse]. *Psychological Research: Electronic Scientific Journal, 2*(16). Retrieved from http://psystudy.ru/index.php/num/2011n2-16/463-leontiev-averina16.html

Maksymenko, S. (2017). *Genetic Psychology of Human Learning* [E-Resource]. Kyiv: Slovo. Retrieved from http://lib.iitta.gov.ua/id/eprint/709727.

Nelson, T.O. & Narens, L. (1990). Metamemory: A theoretical framework and some new findings. In G.H. Bower (Ed). *The Psychology of Learning and Motivation,* (Vol. 26, pp. 125–173). New York: Academic Press.

Nietfeld, J. L., Cao, L., & Osborne, J. W. (2005). Metacognitive monitoring accuracy and student performance in the postsecondary classroom. *The Journal of Experimental Educational, 74*(1), 7–28. https://www.jstor.org/stable/20157410

Pasichnyk, I., Kalamazh, R., & Avhustiuk, M. (2014). Metakohnityvnyi monitorynh yak rehuliatyvnyi aspect metapiznannia [Metacognitive experience as regulative aspect of metaknowledge]. Naukovi zapysky Natsionalnoho universytetu «Ostrozka akademiia»–Scientific Notes of the National University of Ostroh Academy. Series «Psychology and Pedagogy». *Thematic Issue «Actual Problems of Cognitive Psychology, 28*, 3-16. Retrieved from https://psj.oa.edu.ua/articles/2014/n28-ua/Pasisnik.pdf

Pasichnyk, I. & Dovhaliuk, T. (2016). Feedback as a Factor of Optimization of Metamemory under the Conditions of Proactive Interference. Scientific Notes of National University of Ostroh Academy. *Series "Psychology", 4,* 5-18. Retrieved from https://eprints.oa.edu.ua/7503/1/3.pdf

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* Guilford Publications.

Savchenko, O. (2016). *Reflexive Competence of Personality: monograph*. Kherson: Helvetyka.

Savin, E. & Fomin, A. (2011). Confidence in Knowledge as Aspect of Metacognitive Monitoring in Learning Activity. Scientific Works of K. Tsyolkovskiy Kaluga State University. *Series "Psychological and Pedagogical Sciences",* 244–248. Retrieved from http://evgenysavin.ru/_ld/0/61___-2011-_____.pdf

Schunk, D. (1987). Self-Efficacy and School Learning. *Psychology in Schools, 22*(2), 208-223. https://doi.org/10.1002/1520-6807(198504)22:2<208::AID-PITS2310220215>3.0.CO;2-7

Tytarenko, T. (2013). Individuality-Oriented Approach in Practical Psychology. *Psychology and Personality, 1*(3), 85-96. Access Mode: http://nbuv.gov.ua/UJRN/Psios_2013_1_9

Valdez, A. (2013). Student Metacognitive Monitoring: Predicting Test Achievement from Judgment Accuracy. *International Journal of Higher Education, 2*(2), 141-146. https://doi.org/10.5430/ijhe.v2n2p141

Winne, P. H. (2010). Bootstrapping learner's self-regulated learning. Psychological Test and Assessment Modeling, 52(4), 472.

Zabrucky, K. M. (2010). Knowing what we know and do not know: Educational and real world implications. *Procedia-Social and Behavioral Sciences, 2*(2), 1266-1269. https://doi.org/10.1016/j.sbspro.2010.03.185

Zimmerman, B. J., & Schunk, D. H. (2011). *Handbook of self-regulation of learning and performance*. Routledge/Taylor & Francis Group.

Original scientific paper

UDK: 159.955.075

Received: November, 01.2020.
Revised: November, 25.2020.
Accepted: December, 11.2020.

doi: 10.23947/2334-8496-2020-8-SI-29-36

Functions of Participants in the Collaborative Solution of Thinking Problems

Alla Belousova[1*]

[1]Don State Technical University, Faculty of Psychology, Pedagogy and Defectology, Rostov-on-Don, Russian Federation, e-mail: akbelousova@donstu.ru

Abstract: The article presents the results of an empirical study of the collaborative solution of thinking problems by groups of students. The study was conducted in the context of educational activities when students solve educational problems. The student group was divided into subgroups of four people; each subgroup was given a learning task. In accordance with the author's ideas, collaborative thinking is carried out through the implementation of the following functions: generation, selection, meaning transfer, implementation. These functions are distributed among participants in collaborative problem solving. The purpose of the study was to study the distribution of functions when students collaboratively solve thinking problems. To study the distribution of functions, the author used a questionnaire to determine the distribution of functions between students. The author has shown that in the process of collaborative problem solving, functions are distributed among the participants. It is revealed that in the processes of collaborative solution of thinking tasks, each group of students has a unique combination of functions, which the author defines as the group's thinking style.

Keywords: collaborative thinking, function, role, functional foundations, self-organization, regulation, thinking style, thinking, thinking tasks.

Introduction

Currently, in public practice, strategic guidelines have been identified, which include the development of collaboration, collaborative activities, and a culture of cooperation. The educational practice emphasizes the need to develop innovation competencies, the ability to think critically, the readiness to work in a team, creativity and entrepreneurship, the ability and willingness to take reasonable risks. This is evidenced, in particular, by the implementation and development of the Four Cs program (USA), the 21st century skills Assessment and training program (ATC21S) (Griffin, Care, and McGaw, 2012; Griffin, Care, and Harding, 2015). Collaborative problem solving and collaborative thinking skills have been classified as 21st-century skills (Griffin, Care, and McGaw, 2012). In cognitive science, the study of the interaction paradigm in thinking and cognitive processes is actively developing (Belousova, 2013).

Thus, in social practice, in education, science, business, and management, attention is focused and programs are formed aimed at developing the skills and competencies of collaborative thinking, or collaborative thinking activity.

Currently, in cognitive psychology, many psychologists are conducting research on the problems of collaborative thinking in the paradigm of embodied cognition (Calvo and Gomila, 2008).

There are studies aimed at studying different types of problems in the context of collaborative solution: collaborative crossword solving as a form of collaborative thinking (Szary and Dale, 2013), mathematical and physical problems (Ahonen and Harding, 2018; Belousova, 2010; Harding et al., 2017), various characteristics of the problem (Griffin, Care, and Harding, 2015).

Problem Solving addresses cognitive and social aspects (Ahonen and Harding, 2018; Burch, Burch, and Batchelor, 2019; Hesse et al., 2015; Yuan, Xiao, and Liu, 2019) of collaborative problem solving.

Researchers are looking at different ways to use collaborative problem solving in educational practice (Ahonen and Harding, 2018; Care, Scoular, and Griffin, 2016; Griffin, 2017; Lioe, Fai, and Hedberg, 2006; Yuan, Xiao, and Liu, 2019), based on STEM learning (Chen, et al.,2019), when using online learning (Ahonen and Harding, 2018; Harding et al., 2017; Lipponen, 2002).

Hesse et al. (2015) identified five main areas in the design of collaborative problem solving. Definite cognitive skills were assigned to them: participation in the production and transmission of information;

*Corresponding author: akbelousova@donstu.ru

considering and taking into account the points of view of others; understanding the strengths and weaknesses of group members; regulating the process of problem solving; knowledge formation in the process of group interaction. In addition to these skills, social skills are also highlighted, which involve the development of participant management skills (Hesse et al., 2015).

The social side of collaborative problem solving has long been noticed by researchers of collaborative solutions, collaborative activities, and group interaction in various fields of psychology.

Various socio-psychological studies emphasize the fact of functional role distribution when solving various tasks by a group. R. Schindler also identified group roles: alpha, beta, gamma, and omega, which differ in their behavior and functions in the group (Gellert M, and Nowak C., 2000).

Analysis of interaction processes in group problem solving, undertaken by R. Bales (Rudestam, 1982), led to the identification of two functions that underlie people's acceptance of certain roles: the task-solving function and the support function. Each function is represented by a specific set of roles. The task solving function is represented by the roles: initiator, developer, coordinator, evaluator, and motivator. Roles associated with group support: mastermind, harmonizer, mediator, dispatcher, surveyor, wingman (Rudestam, 1982).

Further research in various fields of psychology led to a refinement of the set of roles performed by group members in solving various tasks. In Russian psychology, within the framework of the program-role approach, M. G. Yaroshevsky identifies the main set of group roles in solving scientific problems: an idea generator, a polymath, and a critic (Yaroshevsky, Yurevich, and Allakhverdyan, 2000). Similar data can be found in other theories (Gadzhiev, CH. M., 1983-generator of ideas, critic, activator, resonator of ideas, problem finders).

In management psychology, the classification of roles is widespread. Belbin, R. M. (1993), who believes that effectively working groups include eight group roles: coordinator (leader), idea generator, organizer of collective work, critic (controlling and evaluating link), implementer (practitioner), mover (person who supports performance), resource scout (contact specialist), finalizer – closer (inspector).

The list goes on and there are many empirical studies and concepts that present different sets of roles for participants in collaborative problem-solving processes.

Concept of functional bases of collaborative thinking activity

It seems to us that the described facts of the role distribution of the processes of collaborative problem solving can be interpreted as a manifestation of a general pattern concerning the self-organization of collaborative thinking activity. We assume (Belousova, 2002) that the roles previously identified by various researchers (Bales, R. F.,1950; Belbin, R. M., 1993; Gadzhiev, CH. M., 1983; Schindler, R., 1968; Yaroshevsky, Yurevich, and Allakhverdyan, 2000, etc.) are not certain types of activities fixed in them, but reflect the contribution made by each participant to the formation of psychological neoplasms that are formed in the course of collaborative problem solving. In our opinion, the phenomena of functional-role distribution of participants represent real functional relationships that arise in the system of collaborative problem solving or tasks.

Theoretically, we distinguish four functions (Belousova, 2002) that integrate the empirical experience of researchers: idea generation, selection, meaning transfer, and implementation.

One of the criteria underlying the distribution of functions is the participation of a person in the initiation and development of thinking, which is manifested in the reflection of contradictions, entering new information into the consciousness, image of the world of participants, in the processes of forming psychological neoplasms (goals, ideas, hypotheses of meanings, assessments, motives, needs), leading to dynamization and self-organization of the participants ' thinking activity.

We believe that the first stage in the formation of a goal in collaborative thinking activity is to reflect the contradiction and form assumptions and hypotheses based on it. This stage marks the beginning of the initiation of thinking activity. From the point of view of the dynamics of activity development, the initiation of thinking is one of the most mobile poles of thinking activity. In this regard, the pole associated with the greatest mobility of collaborative thinking activity is provided by the function, the content of which is the ability to primarily reflect contradictions in the subject content of the task and form some assumptions and hypotheses based on them. It is this function that stands out in the literature when it comes to "idea generators", the role of "alpha" (Gadzhiev, CH. M., 1983; Yaroshevsky, Yurevich, and Allakhverdyan, 2000; Schindler, R., 1968, etc.).

The next step in the self-organization of collaborative thinking activity aimed at achieving the goal and characterized by the development of the necessary neoplasms is associated with the selection function, i.e., with the selection and evaluation of assumptions and hypotheses. This function is assumed by a person in the role of a critic: he considers the proposed assumptions, hypotheses, as if sifting through

information, selecting the necessary and cutting off the irrelevant. These operations assume that the critic has formed ideas about the main contradictions of the problem, i.e. a structured psychological situation (Tikhomirov, 2002).

The information selected and sorted out by the critic is the concrete basis that is transformed into a goal in the next steps. However, the stated assumptions, hypotheses, do not yet imply their mandatory acceptance by the other members of the group, or by the partner. The final verbalization and definition of the goal are necessary, bringing it to the partner. Therefore, in collaborative thinking activity, the following function is necessarily distinguished: transmitting hypotheses and assumptions that arise from the generator and selected by the critic to the rest of the group members, as well as organizing activities for their implementation. This function plays a very important role in goal formation in collaborative thinking activity. If we consider the main content of this function, its essence is the processes of the content transfer, that is, transferring of meanings of the purpose, meanings, psychological neoplasms, meanings of the information to other participants.

In individual thinking activity, meaning formation and meaning transfer are merged and form an integral part of goal formation (Tikhomirov, 2002). In collaborative thinking activity, while preserving for each participant the general laws of individual thinking activity, meaning formation as the formation of common meanings of objects looks somewhat different. In collaborative thinking activity, meaning formation, as we have shown (Belousova, 2002), is realized through the processes of meaning transfer. Thus, meaning transfer in collaborative thinking activity performs two tasks: meaning formation (formation of general meanings) and translation, or transfer of meanings, meaning transfer itself. In a group, to form a common goal, it is necessary for all participants to accept it, and for this purpose, the meaning of assumptions, hypotheses, is brought to everyone. This role is assumed by the coordinator, performing the functions of meaning transmission. Reflecting the meaning, value assumptions, hypotheses, coordinator of the dialogue conveys their meaning to other participants, thereby forming shared meanings, structured common understanding of the situation and make a general psychological situation. As a result of these processes, participants accept hypotheses, assumptions, goals, and then hypotheses, assumptions, and goals become common, since their meaning is included in the overall psychological situation.

In the general system of collaborative thinking activity, the function of meaning transfer is rather close to ensuring stability: goal formation, which begins with a generator that offers an idea, continued by a critic who selects the most relevant ideas, ends with a coordinator who brings the idea to everyone and turns it into a system - forming factor-a goal. Thus, the level of mobility of collaborative thinking activity from function to function decreases, but at the same time the level of stability increases. Therefore, the more mobile and less stable the generation, the less mobile and more stable the selection function, i.e., the selection and evaluation of ideas, the more the function of meaning transfer tends to the stability pole. The function of meaning transfer carries mobility (you have to follow the movement of the generator and the critic), but it is more stable, since in order to organize and implement activities, you need to stop, fix your choice on a certain idea.

So, it is possible to predict that the function of ensuring stability in collaborative thinking activity will be assumed by the one of the participants who implements its norms, namely, the one who more or less successfully performs this function. What does the sustainability function mean? In individual activities, this role is played by the set (Uznadze, 2001). The stability of collaborative thinking activity is mainly provided by the implementation function, which is one of the least mobile among other functions. Representing a pole of stability, it involves the implementation of the formed goals.

But this function is necessary, because it is the final link in the functional support of self-organization of collaborative thinking activity, one of the most important. Without it, the activity is unproductive, devoid of its result, since it involves the implementation of the formed actual neoplasms. In the self-organization of the system of collaborative thought activity, this function is more responsible for maintaining stability. Thus, self-organization of collaborative thought activity presupposes the presence of participants who take on the goal-realizing function and ensure the greatest stability of the system, its goal-preservation.

Thus, in functional terms, self-organization of collaborative thinking activity as goal achievement, or goal formation is represented as follows. The generation of suppositions, hypotheses, and goals begins, creating a substantive basis from which some hypotheses, goals, and assumptions are evaluated positively and selected, while others are evaluated negatively. Negative ratings are perceived by all participants, including the generator, which continues to generate other assumptions, hypotheses, and goals based on them. Selected by the critic of the assumptions hypothesis or targets are reflected by the coordinator, their meaning is communicated by the coordinator to other members of the group, and formed a common sense of purpose (hypothesis, assumptions), giving rise to the common goal of the participants, which determines their collaborative action. The coordinator's activity creates a certain emotional background,

which completes the integration of participants and the goal is realized.

At the same time, we emphasize that the distribution of these functions among the participants is free: each person performs the function that corresponds to him, and in relation to the intellectual and personal characteristics of the other partners in the solution. The fact of functional distribution is not rigidly fixed between the participants and at various stages of the decision, that is, movement and thinking, there is a redistribution of functions.

Summarizing, we can conclude that the selected functions are components of collaborative thinking activity and the formation of psychological neoplasms to solve problems and tasks. Moreover, and we want to emphasize this, it is not collaborative thinking activity that leads to the division of functions, but the self-organization of a system of collaborative thinking activity, i.e. a group of people who think together, in its functional plan is possible only when they are distributed. Thus, stability and mobility, selectivity and orientation, dynamics of emerging psychological neoplasms and self-organization of collaborative thinking activity are provided by the functional distribution of participants.

In our opinion, it is very important to understand the relationship between functions and roles, or between functions and participants who implement these roles. The functions of generation, selection, meaning transfer and implementation are among the permanent components, the interaction of which leads to self-organization and development of collaborative thinking activity, to the ability to form and develop common neoplasms for participants, to solve problems and tasks together. But this constancy of the functions that structure collaborative thought activity does not mean that they are permanently assigned to certain participants. Here, a different process is observed: the roles of the generator, critic, coordinator, and implementer are dynamic, they change, although they are limited by the development of personal qualities of each participant in a collaborative decision, its capabilities, goals, needs, and their relationship with partners.

So, the analysis of the functional support of collaborative thinking activity allows us to say that in the system of collaborative thinking activity there is a complex inter-individual formation of a functional nature, which performs the functions of self-organization. This mechanism of collaborative thinking activity is objectified in the form of distribution of functions between participants in collaborative problem solving.

It was interesting for us to see how functional support occurs when solving problems together in real life, in the course of students ' educational activities at the University. The process of solving educational problems is one of the spheres of students ' life reality, the main activity through which their professional development and formation takes place (Craig and Baucum, 2001).

Materials and Methods

To study and analyze the self-organization of collaborative thinking activity in the processes of collaborative solving professional problems, we conducted an experimental study in natural conditions. The study involved 180 students from various universities in Rostov-on-Don. The course of the study was as follows: students in the organization of classes in psychology were offered to solve the problem. Classes were conducted using the “small group” method, which involves dividing the student group into subgroups of four people. Each subgroup was solving a separate the task. At the end of the lesson, students of each subgroup were asked questions aimed at studying the functional distribution in groups (Belousova, 2002). The questions were formulated in such a way that each participant could evaluate the participation of partners in the performance of the function. Each function had two questions.

Based on the responses of group members, the frequency characteristics of each participant’s performance of certain functions were calculated. We used data obtained during 5 classes. The data obtained were processed based on two analysis plans: first, the analysis of the ratio of functions between participants in relation to collaborative thinking activity; second, the analysis of the ratio of functions characteristic of individual thinking activity. Primary quantitative data processing was based on taking into account the accumulated frequency of functions performed by each member of the subgroups.

Results and Discussions

The analysis made it possible to see that, indeed, there is selectivity in taking on certain functions by participants.

Table 1
Average values of functions in groups in the course of solving problems

Functions	Average values	Standard deviation	Standard error of the mean
Generation	23,00	19,66	3,42
Selections	20,52	19,36	3,37
Meaning transfers	18,88	18,57	3,23
Implementations	22,94	21,46	3,74

Analysis of the average values for each of the functions shows that the highest and almost identical average values are observed in the generation function (23.00) and the implementation function (22.94), followed by the selection function (20.52) and meaning transfer (18.88) (Table 1).

In the experimental groups, the functions of implementation (32.96 %) and generation (29.55%) are more pronounced, which are most often assumed by participants. In equal proportions, the roles of critic and coordinator related to the implementation of the functions of selection and meaning transfer are distinguished in the groups (12.50 %). And a fairly high percentage (12.50) falls on the share of students who do not have a pronounced dominance of certain functions.

The use of the Student's T-test for paired samples showed that there are significant differences between the generation and selection functions (t=2.466 with a confidence level of 0.019), between the generation and meaning transfer functions (t=3.995 with a confidence level of 0.000), and between the meaning transfer and implementation functions (t=2.662 with a confidence level of 0.012). The differences between the other functions were insignificant.

The obtained data allowed us to fix different functional relationships in the studied subgroups. If we consider the functional ratio as one of the indicators of dynamic processes of self-organization of collaborative thinking activity, we can say that the ratio of functions in a group in the course of collaborative problem solving creates a certain profile, which is manifested in the dynamics and direction of thinking.

In general, we can conclude that systems of collaborative thinking activity are self-organized in the process of solving problems due to the distribution of functions between participants. The distribution of functions between participants resembles a mechanism whose purpose is to regulate thinking activity. However, in collaborative thinking activity, this mechanism is associated with the dynamics of functions, the ratio of which differs in each group.

We can interpret the results obtained as evidence of an individually peculiar outline of the functions performed by a person when solving problems in a group, which brings us back To L. S. Vygotsky's ideas about the functional nature of the psyche (1983; 1986).

Since we have identified four functions through which the self-organization of collaborative thinking activity is carried out, the dominance of one of them in the structure of functions performed by the group, and created the basis for highlighting the originality of collaborative thinking of this group. We interpret this orientation of the originality of the group's collaborative thinking as a stylistic originality of collaborative thinking. Thus, the studied subgroups clearly differ in the level and ratio of functional support for collaborative problem solving, which is defined by us as the thinking style of each group.

We conducted a simple quantitative analysis aimed at calculating the percentage of the orientation of thinking in different subgroups. The results were distributed as follows in descending order: practical - (31 %), initiative - (17 %), critical - (15 %), managerial - (10%). At the same time, we can also observe groups that are dominated by two (21 %) or three (1%) or even four (5%) functions, which indicates an unexpressed style of thinking in these groups. Thus, we can see that there are pronounced differences in the orientation of the group solution, and these differences are related to the dominant type of functions in the functional support of the solution. In accordance with the kind of function, dominant among the rest, the following styles of thinking groups: a proactive style – the dominant function of generation; critical style is dominated by a function selection; management style – meaning transfer function dominates; practical style - the function implementation dominates.

The results obtained are consistent with the research of Dautov, D. F. (2009), aimed at studying the effectiveness of collaborative thinking activity in student groups that solve various types of problems. The research was based on theoretical ideas (Belousova, 2002) about the functions: generation, selection,

meaning transfer, implementation, providing collaborative thinking activity. Dautov found that when problem solving is organized, when roles are distributed among students, there is a higher efficiency of collaborative thinking activity in student groups (Dautov, 2009). His research also highlighted certain personal characteristics of participants that affect the distribution of functions in collaborative thinking. Our research echoes the results of T. Pavlova (Pavlova, 2015), who studied the ontogenetic aspect of the problem under study. In the study of collaborative problem solving by preschool children, vol. Pavlova found that the distribution of functions between preschoolers is associated with the characteristics of the personality type.

We believe that the results obtained indicate, first, a general interindividual psychological mechanism distributed among group participants and existing in the form of functions assumed by participants, as it was noted by many researchers (Bales, R. F.,1950; Belbin, R. M., 1993; Gellert M, and Nowak C., 2000; Gadzhiev, CH. M., 1983; Schindler, R, 1968; Rudestam, K. E., 1982; Yaroshevsky, Yurevich, and Allakhverdyan, 2000); secondly, that the very situation of cooperative interaction of various people with unique personal qualities leads to the dynamics of functions in the collaborative solution of thinking problems, generating a stylistic originality of collaborative thinking.

The results also allow us to speak about the presence of a kind of "contribution" of each participant to collaborative thinking activity. This "contribution" is expressed in the assumption by each participant of the primary performance of functions. We believe it is possible to interpret this fact, returning to the ideas of Vygotsky L. S. (2005), as exteriorization and resocialization of functions previously formed by man in ontogenesis. The performance of certain functions by each person, their correlation with the functions performed by other participants, and provides a unique vector and direction of collaborative thinking activity of each group, its stylistic originality.

Conclusions

1. Thus, the analysis of the processes of collaborative thinking activity processes in groups of students allows us to say that in the course of its implementation, a complex inter-individual education arises, which performs the functions of self-organization. This mechanism of collaborative thinking activity is objectified in the form of distribution of functions between group members. The functions that ensure the self-organization of the system of collaborative thinking activity include the following: generation, selection, meaning transfer, implementation.

2. The Presented results allow us to see a different ratio of functions in each group, which gives a peculiar character to the collaborative solution of problems by each group. This correlation of functions in the processes of collaborative problem solving is characterized as a style of collaborative thinking of the group.

3. In accordance with the type of function that dominates among the others in their combination, the following styles of group thinking were identified: initiative style-the generation function dominates; critical style-the selection function dominates; management style – the meaning transfer function dominates; practical style – the implementation function dominates.

Acknowledgments

The authors are grateful to all participants of the research – students of Don State Technical University and Southern Federal University.

Conflict of interests

The author declares no conflict of interest.

References

Ahonen, A., & Harding, S. M. (2018). Assessing online collaborative problem solving among school children in finland: a case study using ATC21S TM in a National Context. *International Journal of Learning, Teaching and Educational Research, 17*(2), 138-158. https://doi.org/10.26803/ijlter.17.2.9

Bales, R. F. (1950). *Interaction process analysis; a method for the study of small groups*. Cambridge, Mass: Addison-Wesley. Retrieved from https://ia902609.us.archive.org/32/items/interactionproce00bale/interactionproce00bale.pdf

Belbin, R. M. (1993). *Team Roles at Work* (London: Butterworth-Heinemann). Retrieved from https://www.belbin.com/resources/belbin-papers-and-reports/

Belousova A. K. (2002). *Самоорганизация совместной мыслительной деятельности* [Collaborative Thinking Activity Self-Organization]. Ростов-на-Дону: РГПУ. Retrieved from https://www.elibrary.ru/item.asp?id=23550556

Belousova A. K. (2010). *Initiation of Collaborative Thinking Activity Self-Organization: Basic conceptions and experimental research of collaborative thinking activity generation*. Saarbrücken: LAP LAMBERT. Retrieved from https://www.morebooks.de/store/gb/book/initiation-of-collaborative-thinking-activity-self-organization/isbn/978-3-8433-7190-2

Belousova A. K. (2013). *Editorial*. International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE), 2(1), Retrieved from https://www.ijcrsee.com/index.php/ijcrsee/issue/view/1/1

Burch, G. F., Burch, J. J., & Batchelor, J. H. (2019). Group Creative Problem Solving: The Role of Creative Personality, Process and Creative Ability. *Quality Innovation Prosperity, 23*(3), 38-54. https://doi.org/10.12776/QIP.V23I3.1286

Calvo, P., & Gomila, T. (Eds.). (2008). *Handbook of cognitive science: An embodied approach.* Elsevier. https://doi.org/10.1016/B978-0-08-046616-3.X0001-1

Care, E., Scoular, C., & Griffin, P. (2016). Assessment of collaborative problem solving in education environments. *Applied Measurement in Education, 29*(4), 250-264. https://doi.org/10.1080/08957347.2016.1209204

Chen, L., Yoshimatsu, N., Goda, Y., Okubo, F., Taniguchi, Y., Oi, M., ... & Yamada, M. (2019). Direction of collaborative problem solving-based STEM learning by learning analytics approach. *Research and Practice in Technology Enhanced Learning, 14*(1), 1-28. https://doi.org/10.1186/s41039-019-0119-y

Craig G. J., & Baucum, D. (2001). *Human Development.* New Jersey: Prentice Hall. Retrieved from https://books.google.ru/books/about/Human_Development.html?id=a9B9AAAAMAAJ&redir_esc=y

Dautov, D. F. (2009). Influence of creative abilities on group's functional and role structure. *Russian psychological journal, 6*(1), 84-86. https://doi.org/10.21702/rpj.2009.1.13

Gellert M, & Nowak C. (2000). *A practical book for working in and with teams*. Limmer Verlag, Retrieved from http://www.trainertreffen.de/tkb-news/literatur/050907%20limmer%20verlag.htm

Gadzhiev, CH. M. (1983). *Организация коллективного изобретательства. В книге: Исследование проблем психологии творчества* [Organization of collective invention. In the book: Research into the problems of the psychology of creativity]. Москва: Наука, 1983. С.266-279. Moscow: Nauka, pp. 266-279.

Griffin P. (2017) Assessing and Teaching 21st Century Skills: Collaborative Problem Solving as a Case Study. In: von Davier A., Zhu M., Kyllonen P. (eds) *Innovative Assessment of Collaboration. Methodology of Educational Measurement and Assessment*. Springer, Cham. https://doi.org/10.1007/978-3-319-33261-1_8

Griffin P., Care E., & Harding SM. (2015) Task Characteristics and Calibration. In: Griffin P., Care E. (eds) *Assessment and Teaching of 21st Century Skills. Educational Assessment in an Information Age.* Springer, Dordrecht. https://doi.org/10.1007/978-94-017-9395-7_7

Griffin, P., & Care, E. (Eds.). (2014). *Assessment and teaching of 21st century skills: Methods and approach*. Springer. https://doi.org/10.1007/978-94-017-9395-7

Griffin, P., Care, E., & McGaw, B. (2012). *The changing role of education and schools. In Assessment and teaching of 21st century skills* (pp. 1-15). Springer, Dordrecht. https://doi.org/10.1007/978-94-007-2324-5_1

Harding, S. M. E., Griffin, P. E., Awwal, N., Alom, B. M., & Scoular, C. (2017). Measuring collaborative problem solving using mathematics-based tasks. *AERA Open, 3*(3), 1–19. 2332858417728046. https://doi.org/10.1177/2332858417728046

Harding, S. M., & Griffin, P. E. (2016). Rasch Measurement of Collaborative Problem Solving in an Online Environment. *Journal of Applied Measurement, 17*(1), 35-53. Retrieved from https://pubmed.ncbi.nlm.nih.gov/26784377/

Hesse F., Care E., Buder J., Sassenberg K., Griffin P. (2015) A Framework for Teachable Collaborative Problem Solving Skills. In: Griffin P., Care E. (eds) *Assessment and Teaching of 21st Century Skills. Educational Assessment in an Information Age.* Springer, Dordrecht. https://doi.org/10.1007/978-94-017-9395-7_2

Lioe, L. T., Fai, H. K., & Hedberg, J. G. (2006). Students' Metacognitive Problem-Solving Strategies in Solving Openended Problems in Pairs. In *Redesigning Pedagogy* (pp. 243-259). Brill Sense. https://doi.org/10.1163/9789087900977_018

Lipponen, L. (2002, January). Exploring foundations for computer-supported collaborative learning. In *CSCL* (Vol. 2, pp. 72-81). https://doi.org/10.3115/1658616.1658627

Pavlova, T. V. (2015). Распределение функций в совместной мыслительной деятельности дошкольников с разным типом личности [Distribution of functions in the joint mental activity of preschoolers with different personality types]. *Вестник Саратовского областного института развития образования, 4*(4), 26-35. Retrieved from https://www.elibrary.ru/author_items.asp?authorid=222894&pubrole=100&show_refs=1&show_option=0

Rudestam, K. E. (1982). *Experiential groups in theory and practice*. Brooks/Cole Pub Co.

Schindler, R. (1968). Dynamische Prozesse in der Gruppenpsychotherapie [Dynamic processes in group psychotherapy]. *Z Gruppenpsychother Gruppendyn, 1,* 31-37.

Szary, J., & Dale, R. (2013). Dyadic cooperation enhances retrieval and recall of crossword solutions. In *Proceedings of the Annual Meeting of the Cognitive Science Society, 35*(35). Retrieved from https://escholarship.org/uc/item/5ck4z7p6

Tikhomirov, O. K. (2008). *Психология мышления* [The psychology of thinking]. Moscow: Academy. Retrieved from https://elibrary.ru/author_items.asp?authorid=71844&show_refs=1&show_option=1

Uznadze D. N. (2001). *Психология установки* [The Psychology of Set]. Санкт-Петербург: Питер. Retrieved from https://royallib.com/book/uznadze_dmitriy/psihologiya_ustanovki.html

Vygotsky L. S. (1983). *Проблемы развития психики* [Problems of the development of the psyche]. V.3. [In Collected works: In the 6 volumes]. Moscow: Pedagogy, Retrieved from http://elib.gnpbu.ru/text/vygotsky_ss-v-6tt_t3_1983/go,2;fs,1/

Vygotsky L. S. (1986). Конкретная психология человека. Вестн. *Моск. ун-та. Сер, 14*, 52-65. Retrieved from https://bookap.info/genpsy/vygotskiy_stati_konspekty_materialy_iz_lichnogo_arhiva_ls_vygotskogo/load/pdf.shtm

Vygotsky L. S. (2005). *Психология развития человека* [Human developmental psychology]. — Moscow: Smysl; Eksmo. Retrieved from http://lchc.ucsd.edu/mca/Mail/xmcamail.2008_07.dir/att-0052/problema_razvitiya_i_raspada_vysshih_psih_funkciy.pdf

Yaroshevsky M. G., Yurevich A. V., & Allakhverdyan A. G. (2000). Программно-ролевой подход и современная наука [Role-based approach and modern science. Psychology issues]. *Вопросы психологии, (6)*, 3-18. Retrieved from https://elibrary.ru/item.asp?id=20207733

Yuan, J., Xiao, Y., & Liu, H. (2019). Assessment of Collaborative Problem Solving Based on Process Stream Data: A New

Paradigm for Extracting Indicators and Modeling Dyad Data. *Frontiers in Psychology, 10*, 369. https://doi.org/10.3389/fpsyg.2019.00369

Original scientific paper

UDK: 159.953.3.072-057.875(532)

Received: August, 25.2020.
Revised: October, 30.2020.
Accepted: November, 09.2020.

doi: 10.23947/2334-8496-2020-8-SI-37-47

Mental Simulation Effects on Performance: Benefits of Outcome Versus Process Simulations in Online Courses

Runna Al Ghazo[1], Ibtisam Daqqa[1], Hanadi AbdelSalam[1], Maura A. E. Pilotti[1], and Huda Al Mulhem[1]*

[1]Prince Mohammad Bin Fahd University, Al Khobar, Kingdom of Saudi Arabia
e-mail: ralghazo@pmu.edu.sa; idaqqa@pmu.edu.sa; habdelsalam@pmu.edu.sa; mpilotti@pmu.edu.sa; halmulhem@pmu.edu.sa

Abstract: The present research compares the effects of mentally recreating the experience of realizing that a desirable goal had been achieved (outcome simulation exercise) with those of mentally recreating the actions that might lead to the desirable goal (process simulation exercise). It asked whether the performance benefits of process simulations over outcome simulations, which have been reported in students enrolled in face-to-face classes, would generalize to an online environment. The process simulation exercise was expected to foster attention to the antecedents of good grades, thereby improving class performance relative to the outcome simulation exercise which was intended to be merely motivational. College students from the Middle East, who were taking classes online due to the COVID-19 pandemic, participated. Type of simulation impacted students' performance on assignments, but differently depending on the timing of the assessment. It did not influence behavioral engagement, midterm test performance, or predictions of performance before or after the test. Instead, process simulation enhanced students' confidence in their predictions. These findings suggest that process simulation exercises may be useful learning props for activities that challenge students' problem-solving skills (e.g., assignments) rather than engage well-practiced study habits (e.g., tests).

Keywords: higher education; academic performance; mental simulation; performance forecast.

Introduction

During the COVID-19 pandemic, many educational institutions around the world have opted to cancel face-to-face classes, and have mandated that faculty move their courses online. As a result, a large number of students and instructors have been catapulted into the world of distance education (Hodges et al., 2020; Laplante, 2020; Williamson et al., 2020). For many college students, prior experience with either synchronous or asynchronous virtual classrooms may have been sporadic at best, including enrollment in an online course out of necessity, and/or use of an eLearning platform (e.g., Blackboard) in face-to-face classes to access and submit course materials. If the spring 2020 semester has forced upon such students and many instructors a drastic shift into the online world (Zimmerman, 2020), it has also given them the opportunity to adjust, thereby making online summer classes feel like a familiar ecosystem (Murray and Barnes, 1998; Wang et al., 2010). In summer courses, learning is usually packed into a shorter timeframe and is more likely to suffer from distractions promoted by clement weather. As such, academic success greatly relies on the students' motivation and timely execution of course activities. Thus, it is reasonable to ask whether educational interventions whose effectiveness as propellers of academic success has been put to the test in face-to-face courses bring forth similar outcomes when the courses are taught synchronously online during the more compacted timeframe of the summer term.

In the present research, we focus on mental simulations as capable of enhancing students' performance (Pham and Taylor, 1999). Specifically, we compare the effects of mental simulation instructions that require learners to envision the actions necessary to obtain the desired outcome (a good grade) with those of mental simulation instructions that require learners to imagine their reactions to having achieved the desired outcome. Synchronous online learning is defined as learning that happens in real-time (Richardson, 2020). Classes are scheduled in a virtual classroom at specific times, during which students and instructors are given the opportunity to interact through a particular online medium (e.g., Blackboard Collaborate). Before we discuss the purported impact of the two modes of envisioning the future on performance, the concept of mental simulation needs to be defined.

*Corresponding author: ralghazo@pmu.edu.sa

In essence, mental simulation is the "imitative representation of some event or series of events" which may pertain to the past, present, or future (Taylor et al., 1988, p. 430). If it involves the latter, the simulation offers the person who performs it a window into the future by enabling him/her to consider possibilities and the actions that are deemed suitable to realize those possibilities. Envisioning the future is consequential. For instance, running through a set of events in one's minds and imagining them in concrete and specific terms, constrained by what is plausible, has been shown to make events seem real, increasing the person's belief that such events will actually happen (Koehler, 1991). Furthermore, imagining an event has also been shown not to produce a dry cognitive representation but rather to evoke emotions with underlying physiological changes (e.g., alterations in heart rate, blood pressure, and electrodermal activity), which give the person experiencing them opportunities for self-regulation (Linden and Skottnik, 2019). Most importantly, it is thought of as providing information about those events (Druckman, 2004). As such, it can play an important role in how people solve problems in everyday life. Thus, it is not surprising that mental simulation has been characterized as capable of improving human performance by linking mental activity to action. References to the purported benefits of mental simulation of future events are plentiful in the literature on self-help advice (Fanning, 1994; Peale, 1982), clinical psychology, and sports (Marlatt and Gordon, 2005; Orlick and Partington, 1986).

Yet, not all mental simulations are viewed as equally effective when performance is concerned (Druckman, 2004). They may interfere with self-regulation if they are unrealistic, such as fantasies (Oettingen, 1995), or involve rumination of painful experiences (Horowitz, 1976; Silver et al., 1983). In the educational domain, even within the realm of realistic and emotionally restrained scenarios, the effectiveness of mental simulation of the future is a matter of debate. According to one viewpoint, the critical component of a successful mental simulation is its emphasis on mimicking the process needed to reach a given goal. The reason is that rehearsal of the process required to reach a desired end state forces the learner to identify and organize the steps involved in getting there, thereby inducing planning, enhancing the accessibility of required actions, and serving as a motivator. For example, students who desire to complete a college course successfully can increase their chances of doing so by mentally simulating the activities linked to each requirement of the selected course, such as reading the study guide of an upcoming test, reviewing the study materials, defining key concepts, developing examples of such concepts, practicing answering questions, etc. A contrasting point of view, mostly derived from the self-help literature, argues for a quite different form of mental simulation. This approach maintains that a person's attentional focus on the outcome to be achieved will help bring it about (Fanning, 1994; Peale, 1982) by motivating independent action. Accordingly, students who want to be successful in a course may be advised to envision themselves already at the end of a semester looking at an A or A+ on their transcript.

Despite the widespread popularity of outcome simulation, it remains unclear how a mere attentional focus on the desired outcome, without an articulation of the activities that lead to attainment, may enable people to achieve it. It can motivate students but does not inform them of the path to get there. Furthermore, although the stated purpose of formal education is to acquire general and specialized knowledge as well as a variety of information processing skills, a strong subtext that emphasizes the significance of grades is often present (Pollio and Beck, 2000). Thus, simulating a goal that is already relevant in students' minds may not add much of a drive to the activities that lead to the successful completion of a course.

Not surprisingly, evidence that one type of simulation is superior to the other in enhancing future performance is not decisive. Consider, for instance, the findings of experiments conducted by Pham, Taylor, and colleagues (1998; 1999) who, during the week before the administration of a midterm test, asked college students who were studying for the test to do one of two things. In the process simulation condition, students were told to visualize themselves studying for the test to obtain a high grade (or more explicitly an A). In the outcome simulation condition, they were told to imagine themselves having obtained a high grade (or more explicitly an A) on the test. Both groups of students were asked to perform the simulation for five minutes each day before the exam. Pham and colleagues found that students who had simulated the process of studying for the exam prior to their midterm merely displayed a trend towards superior performance. In a systematic replication of the experiment, however, they reported a significant difference in favor of process simulation. Interestingly, prior to the test, when asked about expected grades, students in the process simulation condition reported higher grades. Further evidence from self-reports of the activities preceding the test indicated that students who practiced outcome simulation rehearsed the delight they would experience from obtaining a good mark but failed to put more effort into achieving the good mark, thereby ultimately reducing their aspirations. Positive expectations motivate learning in students, leading to enhanced performance through behavioral engagement (Putwain et al., 2019). Behavioral engagement is an omnibus variable that includes effort, persistence, and exertion in

class activities (Appleton et al., 2006; Fredricks et al., 2004). Thus, lower aspirations may be considered counterproductive if the aim of mental simulation exercises is to motivate action.

The Present Study (in Brief)

Three predictions regarding mental simulation in the synchronous online classroom can be formulated, all stemming from the recognition that teaching and learning in the synchronous and face-to-face mode greatly resemble each other (Dennis, 2003). Like the exchanges in the face-to-face classroom, real-time interactions give students the feeling of immediate contact, as well as the opportunity to clarify uncertainties in a timely manner (Salmon, 2000; Steeples et al., 2002). Yet, the physical distance among participants inherent to synchronous technologies tends to yield slightly less interaction between students and among instructors and students inside and outside the classroom (Anderson, 2003; Ng, 2007). Faculty's self-reports at our university support this claim. Process simulation may be ideally effective in compensating for the physical distance imposed by the medium, through its focusing students' attention on the steps necessary to complete activities, making such steps more accessible, and thus ultimately enhancing self-regulating learning. Alternatively, the impact of process and outcome simulation instructions may not differ. Although both can be conceptualized as propellers of thought and action (i.e., sources of motivation), as they include references to performance attainment (e.g., grades), they may become redundant props in the students' environment where attainment is already emphasized. It is also possible though to predict that outcome simulation may reduce students' aspirations, and thus impair performance by diminishing exerted effort.

If indeed the process simulation instructions differentially shape students' cognition and action from those involving outcome simulation, then not only performance but also predictions of performance may differ. Consider that simulating the process of completing the requirements of a course may motivate students as well as inform them of the steps necessary to get to the desired goal. That is, it encourages learners to articulate informed expectations. Expectancy is defined as learners' belief about the probability of success in forthcoming activities (Locke and Latham, 1990). Thus, we hypothesize that if students are asked, before a test, about the expected grades, those who have performed a process simulation exercise will exhibit higher expectations and be more confident in their ability to fulfill such expectations than those who performed an outcome simulation exercise. Yet, higher expectations may be a double-edged sword. They can reflect an optimistic forecast that motivates preparation (Ng, 2007; Taylor and Brown, 1988) or be so inflated to encourage inertia with dire consequences on performance (Brookings and Serratelli, 2006; Yang et al., 2009). Because expectations are informed by the process simulation exercise, students exposed to this mental exercise are likely to yield estimates that are not only more confident, but also more accurate than those of students who perform the outcome simulation exercise. Furthermore, it is important to recognize that grade prediction is undeniably a tricky business, especially for students who are struggling. Not surprisingly, evidence suggests that grade prediction accuracy changes with performance level (Miller and Geraci, 2011; Pilotti et al., 2019, 2020; Yang et al., 2009). Although poor performers tend to be less accurate in their grade predictions than good performers, yielding inflated estimates of future performance, they are less confident in their inflated estimates. Thus, the benefits of process simulation exercises may be experienced primarily by poor performers. We test predictions of actual and forecast performance with the methodology described below.

Materials and Methods

Participants

The participants of the simulation exercises were 269 female undergraduate students (age range: 18-25) at a university located in the Eastern Province of the Kingdom of Saudi Arabia. They reported Arabic as their first language and English as their second language. For admission, English competency had to be demonstrated through standardized English proficiency tests (i.e., Aptis, IELTS, or TOEFL). At the university, English was the participants' primary vehicle of instruction. They were enrolled in one of eight courses of the Core curriculum offered during the summer semester (to be described below). The number of credit hours completed varied from 0 to 135. Students' prior experience with distance learning at the university was reported to be limited to courses completed during the previous spring semester and to the use of Blackboard in face-to-face classes. Participation complied with the guidelines of the Office for Human Research Protections of the USA Department of Health and Human Services and with the American Psychological Association's ethical standards in the treatment of human subjects. Sixteen additional students were excluded from the study for their failure to follow the instructions or complete

the course. Due to gender-segregation rules, a comparable sample of male students was unattainable. Because ethical considerations prevented us from randomly excluding students from exercises that could benefit academic performance, we identified a sample of students (n = 269) who could serve as a baseline (business-as-usual instruction). They had been enrolled in the same courses selected for the mental simulation exercises. The courses had been taught by the same instructors in the earlier semester. Two criteria were applied to match students assigned to the mental simulation exercises with baseline students: the number of credit hours completed (perfect match or 1 credit hour either above or below), which served as a measure of academic experience, and final class grades (perfect match or within a limited range of points of deviation: 0.25-2.15), which served as a measure of overall performance level.

Procedure and Materials

This field study was conducted during the summer 2020 semester. Eight courses of the Core Curriculum of the University were selected according to the following criteria: they (a) included students across the entire university, (b) offered the smallest likelihood of overlap of students, and (c) ensured adequate representation of the Core curriculum whose courses emphasize the practice of basic academic skills (e.g., writing, speaking, reasoning, etc.) across a variety of topics (e.g., Technical and Professional Communication, Writing and Research, and Oral Communication) or within a specific domain of knowledge (e.g., Introduction to Psychology). The curriculum of such courses relies on syllabi approved by the Texas International Education Consortium (TIEC) and textbooks published in the USA. The only exception is a sequence of 4 courses on Islamic and Arabic culture, which provides the Core curriculum with a culturally-appropriate foundation. As much as the courses approved by TIEC, they emphasize the practice of basic academic skills across a variety of topics (Introduction to Islamic Culture, Islamic Society, and Communication) or within a particular domain of knowledge (History of Prophet Mohammad). Another feature of the selected courses was the equivalence of students' outcome assessment protocols concerning the range of outcomes and the timing of assessment. Each course involved assignments to be completed during the first half of the semester (i.e., before the midterm) or the second half of the semester, a midterm exam, and a final exam. Test questions and assignments encompassed five of the six types of information processing highlighted by Bloom's taxonomy (Anderson and Krathwohl, 2001; Bloom, 1956, 1976; Krathwohl, 2002). Namely, assessment required remembering, understanding, application, analysis, and evaluation, but excluded synthesis/creation of work due to the introductory nature of the Core curriculum.

Three instructors, whose pedagogy was deemed student-centered and learning-oriented by students, colleagues, and administrators (Farias et al., 2010), volunteered to participate in the study. The instructors were described in peer evaluations, peer observations, and students' evaluations as underscoring partnership and mutual support in learning activities, offering developmental feedback, treating grades as opportunities for learning, and fostering the practice of critical thinking. The instructors' scores on the LOGO F questionnaire of Eison et al. (1993), along with peer observations and evaluations supported this pedagogical profile. The 20-item questionnaire assessed their attitudes towards grades and learning on a 5-point Likert scale from strongly disagree (1) to strongly agree (5), and their behaviors towards grades and learning on a five-point scale from never (1) to always (5). Instructors reported engaging in behaviors likely to support a learning-orientation in their students (M = 4.00) more often than behaviors likely to foster a grade-orientation (M = 2.13). Likewise, they endorsed more strongly learning-oriented attitudes (M = 4.13) than grade-oriented ones (M = 2.53). Each taught at least 2 of the 8 classes included in the study.

Table 1 describes the activities performed by the students assigned to the simulation exercises. At the start of the semester (after the instructor overviewed the requirements of the course in which students were enrolled) and prior to the midterm exam, 5 questions were asked under two randomly assigned between-subjects instructional conditions. The process simulation exercise asked participants (n = 139) to mentally simulate the process of effective studying, whereas the outcome simulation exercise required participants (n = 130) to mentally simulate the experience of realizing that a desirable goal (e.g., high mark) had been achieved. Specifically, in the process simulation exercise condition, students were instructed to picture themselves studying for an upcoming test or assignment in such a way that would lead them to obtain a high mark. Because a letter grade, such as an A or A+, was not a realistic goal for all the students, we chose to state the desirable goal vaguely. To ensure realism and compliance, their task was to describe 5 different actions they would perform to achieve a high mark. Instead, in the outcome simulation exercise condition, students were instructed to picture themselves realizing that they scored a high mark on a test or assignment in the class in which they were enrolled. Their task was to describe 5 actions they would perform after realizing that they obtained a high mark. To ensure comfort,

instructions were presented both in English and Arabic and students were free to use either language in their responses. In the mental simulation conditions, before starting the midterm test and after having completed it, students predicted their performance. For both prospective and retrospective estimates, students also expressed their confidence in the prediction made. Students predicted their grade (see Hacker et al., 2000) on a scale from 0 to 100 as well as expressed their confidence in the prediction made on a scale from 0 (not at all confident) to 4 (extremely confident). Estimates of grades, which were made both before and after the midterm test, illustrated students' accuracy of self-assessment by comparing estimates to actual grades, whereas reports of confidence indicated the extent to which such estimates were trusted by the students who made them (i.e., subjective confidence).

Table 1
Sequence of Activities

Timing	*Activity*
1st	Process or outcome simulation exercise
2nd	Assignments (1st half of the semester)
3rd	Process or outcome simulation exercise
4th	Grade prediction and subjective confidence rating
5th	Midterm test
6th	Grade prediction and subjective confidence rating
7th	Assignments (2nd half of the semester)
8th	Participation score and class grade

During the semester, grades and feedback regarding assignments and the midterm test were delivered to students within a few days from submission to ensure timely feedback. At the completion of the semester, participation scores were computed by the instructors. The participation score measured behavioral engagement estimated by the instructor based on the contribution that each student made to the online class (attendance, frequency, and quality of questions asked, answers given, and comments made during lectures or class discussions, etc.). Due to institutional restrictions, final test grades were not made available. All grades/scores were computed as percentages.

Because of the COVID-19 epidemic, all classes were taught online through the synchronous (in real-time) mode. As a result, the simulation exercises were performed through Blackboard and closely monitored by each instructor who served as a content facilitator (Williams and Peters, 1997). Pedagogically, the synchronous virtual space replicated many aspects of the face-to-face space. Blackboard Collaborate, which is a real-time video conferencing tool equipped with audio, video, and application-sharing tools, a text-chat box, and a whiteboard, allowed students to interact with the instructor during lectures and participate in class discussions. Blackboard gave them access to study materials and resources, such as study guides, textbooks, and videos. Each online course was characterized by the instructor's effort to maximize (a) learner-content interaction, (b) learner-instructor interaction, and (c) learner-learner interaction, which are the criteria set by Moore (1989) as necessary for successful distance education. There was an important difference though. Although interactions could occur through typed or spoken messages, the camera function was disabled for cultural and religious reasons. Thus, students and faculty could not see each other.

Results

The results reported below are significant at the .05 level. Results are organized by the question that they were intended to answer. Descriptive statistics are reported in Table 2. If an analysis of variance (ANOVA) is conducted, and results are significant, tests of simple effects are carried out. The sequentially rejective multiple test procedure is adopted to adjust the alpha of each test and thus determine significance while controlling for experiment-wise alpha (Chen et al., 2017). Before the analyses of performance measures, estimates, and confidence ratings were conducted, the students' written responses to the simulation instructions were examined. They offered evidence of compliance, as well as established that the two types of simulation instructions yielded qualitatively different responses. At the start of the field

experiment, the academic experience (as measured by credit hours completed) of students assigned to the three conditions did not differ, $F(1, 535) < 1$, ns (process simulation: M = 41.88, SEM = 2.49; outcome simulation: M = 41.02, SEM = 2.61; and baseline: M = 40.74, SEM = 1.88).

Table 2
Mean and Standard Error of the Mean (in Parentheses) of Main Dependent Variables

Measure	*Scale*	*Process Simulation*	*Outcome Simulation*	*Baseline*
Assignments (1st half of semester) [a c]	0-100	85.00 (1.35)	89.82 (1.16)	84.53 (0.90)
Test grade prediction	0-100	90.43 (0.70)	89.51 (1.03)	
Accuracy before the test	+, 0, -	+5.86 (1.43)	+6.59 (1.81)	
Subjective confidence in prediction	0-4	2.47 (0.08)	2.20 (0.09)	
Midterm test	0-100	84.57 (1.38)	82.92 (1.68)	82.55 (1.08)
Test grade prediction	0-100	86.21 (1.01)	85.15 (1.25)	
Accuracy after the test	+, 0, -	+1.64 (1.65)	+2.23 (1.50)	
Subjective confidence in prediction	0-4	2.31 (0.09)	2.00 (0.10)	
Assignments (2nd half of semester) [a b]	0-100	90.17 (1.04)	86.03 (1.30)	86.28 (0.82)
Participation score	0-100	92.17 (1.67)	95.57 (0.91)	93.80 (0.97)
Overall class grade	0-100	86.24 (1.01)	85.36 (1.10)	86.79 (0.66)

Note. [a] significant difference between simulation conditions; [b] significant difference between process simulation and baseline; [c] significant difference between outcome simulation and baseline.

Does the Type of Simulation Differentiate Performance?

The impact of mental simulation on grades may be immediate (1st half of the semester) or may take time (2nd half of the semester). Thus, a two-way ANOVA was conducted on assignment performance with timing (1st and 2nd half of the semester) and condition (process simulation, outcome simulation, and baseline) as the independent variables. This analysis yielded a significant interaction, $F(2, 535)=13.75$, $MSE = 102.06$, $p < .001$, $\eta p2= .049$ (main effects: $Fs \leq 2.74$, ns). Performance on assignments completed during the 1st half of the semester was higher for students who carried out the outcome simulation exercise, $t(267) = 2.74$, $p = .006$. Instead, performance on assignments completed during the 2nd half of the semester was higher for students who carried out the process simulation exercise, $t(267) = 2.50$, $p= .013$. Consistent with these results, in the 1st half of the semester, assignment performance following outcome simulation was superior to that of the baseline condition, $t(397) = 3.47$, $p = .001$. In the 2nd half of the semester, performance following process simulation was superior to that of the baseline condition, $t(406) = 2.84$, $p = .005$. Baseline performance was not different from performance in the process simulation condition during the 1st half of the semester, and in the outcome simulation condition during the 2nd half of the semester, $ts < 1$, ns. Furthermore, a one-way ANOVA on midterm test grades as well as behavioral engagement (as measured by participation scores) of the three conditions failed to reach significance, $Fs< 1.54$, ns.

It is important to note that if we had merely focused on midterm test grades, as Pham and Taylor (1999) did, we would have incorrectly concluded that type of simulation does not matter. Instead, the impact of this factor in our study was modulated by the task at hand and its timing. These findings can be understood by first taking into consideration the content of spontaneous comments made by students in class and during debriefings. According to such comments, assignments were much more likely to engage students' problem-solving skills than tests which tended to rely on well-developed study habits. That is, students saw assignments as novel artifacts that needed to be approached strategically, whereas tests tended to activate well-established routines for preparation. This difference in the way assignments and tests were perceived by the students may account for the sensitivity of assignment performance, and the insensitivity of test performance, to the type of mental simulation exercised by the learners. Yet, the timing of assessment may also be relevant as it suggests the existence of qualitatively different drives promoted by the two exercises: a feeling-good drive and a slow-acting one guided by information about the steps to perform, each capable of propelling action but impacting learners' activities sequentially. At least initially, simulating a desirable outcome may be more motivating than simulating the activities to obtain it, as the value of a realistic examination of the labor required by each assignment may sound

just more work. As a result, a feeling-good drive may be more effective in propelling effort and promoting higher levels of performance in activities perceived as novel problems to solve. However, as experience with the class requirements grows, the informational value of simulating such activities may begin to be recognized, such as the increased accessibility of the steps involved in each assignment, thereby ultimately benefitting performance.

In our study, it was not feasible to measure the expended effort, as measurement through questioning could change what learners would normally do if they were merely exposed to the simulation exercises. Thus, we asked students to engage in an activity that is habitually conducted in each class. Namely, we asked them to predict their grades on a midterm exam, thereby treating grade prediction as a measure of expectancy. We hypothesized that if a motivational gap between the two types of mental simulation exists, it may seep into grade predictions for the midterm test (as indices of students' expectations). The issue is whether a feeling-good drive propelling action versus one guided by information about the steps to perform may differentially shape midterm test predictions, as well as subjective confidence in such predictions. If a feeling-good drive propelling action is the hallmark of the outcome simulation exercise, the predictions of the students who performed such exercise will be more optimistic than those of students who performed the process simulation exercise. In contrast, the informed expectancy fostered by the process simulation exercise may give rise to more accurate predictions. Whether differences in the confidence learners place in such predictions will emerge may depend on whether subjective confidence rests on a feeling-good drive, which can foster overconfidence, or an informed expectancy, which can promote restrained confidence. We examine these issues next.

Does the Type of Simulation Differentiate Grade Estimates and Subjective Confidence?

The midterm grade obtained by each student was subtracted from the estimated one to determine whether the student's performance expectation was optimistic (+), accurate (0), or pessimistic (-). A two-way ANOVA on students' predictions of midterm grades with timing (1st and 2nd half of the semester) and condition (process simulation and outcome simulation) as the independent variables yielded a main effect of timing, $F(1, 267) = 33.74$, $MSE = 73.23$, $p < .001$, $\eta p2 = .112$, indicating that optimism merely declined after the test (other $Fs < 1$, ns). Thus, test experience gave rise to restrained optimism irrespective of the simulation exercise to which one submitted.

Did participants' optimism reflect inflated estimates? We analyzed the extent to which students' estimates deviated from 0 (accuracy) in each exercise group. Before the test, both outcome and process simulation participants made inflated estimates, $t(129) = 3.64$, $p < .001$, and $t(138) = 4.09$, $p < .001$, respectively. After the test, estimates were rather accurate, $ts \leq 1.49$, ns.

The same two-way ANOVA on subjective confidence indicated that predictions were also made with less confidence after the test, $F(1, 267) = 8.95$, $MSE = .482$, $p < .003$, $\eta p2 = .032$. Although type of mental simulation did not affect learners' expectations, subjective confidence in such expectations was higher among those who performed the process simulation exercise, $F(1, 267) = 7.03$, $MSE = 1.590$, $p=.008$, $\eta p2 = .026$ (other $F < 1$, ns).

In sum, the informed expectancy fostered by the process simulation exercise did not affect the optimism with which estimates were made, but made participants more confident in such estimates. Yet, contrary to the hypothesized effect of the process simulation exercise, its estimates were as inflated before the midterm test and as realistic afterward as those of the outcome simulation condition.

Does Performance Level Modulate the Impact of Type of Simulation on Estimates and Subjective Confidence?

Regression analyses with class performance (i.e., grade at the end of the semester) and simulation type as the predictors were conducted on the accuracy of estimates and subjective confidence (see Table 3a). These analyses indicated that performance was an important contributor to the accuracy of the estimates made by students. That is, the higher was the performance of a student, the less inaccurate her predictions were. Instead, the type of simulation was an important contributor to the confidence with which estimates were made. That is, the process simulation exercise yielded greater subjective confidence overall than the outcome simulation exercise. Table 3b illustrates these differential contributions. In it, class grades were used to classify students into poor (C or below), average performers (B), or high performers (A) for ease of illustration.

Table 3a

Regression Analysis with Estimates or Subjective Confidence as the Outcome Variable and Simulation Exercise (Outcome Versus Process) and Class Performance as the Predictors

Accuracy Before the Midterm	*B*	*SE*	*Beta*	*t*	*Sign.*
(Constant)	93.980	6.173			
Simulation Exercise	.177	1.722	.005	.103	*ns*
*Class performance**	-1.024	.071	-.663	-14.451	<.001
Confidence Before the Midterm					
(Constant)	1.698	.423			
*Simulation Exercise**	.262	.118	.135	2.226	.027
Class performance	.006	.005	.073	1.211	*ns*
Accuracy Before the Midterm					
(Constant)	74.899	6.648			
Simulation Exercise	.166	1.854	.005	.089	*ns*
*Class performance**	-.851	.076	-.565	-11.158	<.001
Confidence Before the Midterm					
(Constant)	1.490	.467			
*Simulation Exercise**	.304	.130	.142	2.336	.020
Class performance	.006	.005	.068	1.116	*ns*

Note. * Significant contribution. Accuracy before the Midterm test: R = .663; confidence before the Midterm test: R = .156; accuracy after the Midterm test: R = .565; confidence after the Midterm test: R = 1.59

Table 3b

Mean and Standard Error of the Mean (in Parentheses) of Accuracy of Estimates and Subjective Confidence as a Function of Performance Level and Condition

Measure	*Performance Level*	*Process Simulation*	*Outcome simulation*
Before the midterm test			
Accuracy	Poor	+23.95 (6.14)	+29.29 (4.48)
	Average	+5.69 (1.71)	+4.87 (2.76)
	Good	+0.05 (1.10)	-2.16 (1.52)
Subjective confidence	Poor	2.32 (0.18)	2.03 (0.18)
	Average	2.52 (0.13)	2.19 (0.17)
	Good	2.48 (0.11)	2.28 (0.14)
After the midterm test			
Accuracy	Poor	+19.66 (6.45)	+19.24 (3.69)
	Average	+2.93 (2.05)	-2.16 (3.05)
	Good	-5.24 (1.69)	-2.89 (1.18)
Subjective confidence	Poor	2.23 (.17)	1.90 (0.20)
	Average	2.38 (.16)	1.91 (0.20)
	Good	2.28 (.13)	2.09 (0.13)

Discussions

The results of the present field study can be summarized in two points. First, outcome and process simulation exercises had a different impact on assignment performance and no impact on midterm test performance. Outcome simulation promoted performance during the 1st half of the term, whereas process simulation enhanced performance during the 2nd half of the term. Second, the type of mental simulation did not affect future estimates of test performance, but the confidence with which such estimates were made. Process simulation, which was assumed to inform learners of the steps necessary to complete a task, made learners more confident in their estimates. Irrespective of the type of simulation, estimates were generally more realistic after having experienced the test.

The impact of the outcome simulation exercise was expected to resemble that obtained by Sherman et al. (1981) who asked participants to envision and then explain a desirable or undesirable outcome of an upcoming task before estimating the probability of completing the task. Participants who explained a desirable outcome not only had higher expectations of performance but also performed at a higher level than control participants who did not imagine and explain outcomes. In our study, the benefits of simulating a desirable outcome were fleeting (limited to the 1st half of the term) and relegated to tasks that participants approached as novel problems to solve (assignments). However, simulating outcomes neither affected participants' predictions of performance in an upcoming test nor their subjective confidence in such predictions. Thus, in our study, feeling-good drives were found to have a time-limited impact and be task-specific. Oettingen (1995) argued that outcome simulation might be counterproductive. It can reduce expended effort because it anticipates the attainment of success, thereby preventing one's appreciation of the amount and quality of the effort required for the envisioned success to become reality. In support of Oettingen's proposal, Pham and Taylor (1999) found that outcome simulation reduced the number of hours spent preparing for an upcoming midterm test and lowered learners' expectations of performance. We did not find evidence of this pattern of effects. During the debriefing, we asked students about their test preparation activities. There was no evidence from the students' self-reports that they studied less or differently in the outcome simulation condition.

Of particular relevance to educators are the results of the process simulation exercise which demonstrated its effectiveness towards the 2nd half of the semester when students experienced more intense fatigue. It is important to note that process simulation resembles scenario construction whereby a script-like description of a future event, such as an upcoming test, is broken down into components, thereby helping people not only identify the cluster of activities that are critical to successful performance but also envision activities along a timeline that connects the point of origin to the desired end-point (Healey and Hodgkinson, 2008; Schoemaker, 1991). Process simulation is an informative exercise as it provides concreteness to the actions to be performed in an upcoming task, defines uncertainty, and highlights causal connections.

Our findings are also different from those of Taylor and Pham (1999) who asked participants, prior to writing an essay, to simulate the outcome of writing the essay, simulate preparing the essay, or do neither (baseline condition). They found that both types of simulation improved the quality of an essay written on an expected topic. If the assignments that our students had to complete are equated to the problem-solving activity of writing essays on expected topics, our results appear to be inconsistent with those of Taylor and Pham. However, their assessment did not cover performance across an entire semester, but rather it was a one-time affair. If we were to combine the assignments of the 1st half and 2nd half of the semester, then our results would resemble those obtained by Taylor and Pham. The latter also reported that outcome simulation enhanced motivation and self-efficacy, whereas process simulation facilitated essay-writing planning. We found, instead, that process simulation enhanced subjective confidence on the estimated outcome of a midterm test, which may be related to the facilitation that process simulation is assumed to exercise on planning.

Conclusions

Although the present findings give educators practical information on the nature and boundaries of the impact of different types of mental simulation, some limitations need to be considered in future research. The sample assessed included only female students, thereby questioning whether gender differences could be observed. In compliance with ethical considerations, the students in the baseline group were merely matched with those of the simulation group, rather than being randomly selected. Matching, albeit successful, does not entail identity, thereby leaving factors for which matching was not

exercised free to exert their influence on participants' cognition and action.

Repeated practice with process simulation may help poor-performing students to not only engage in behaviors that maximize their chances of success but also feel that they have a role to play in doing well. Yet, the quality of the simulation, its frequency, timing, and the extent to which it requires instructor's supervision are factors that need to be explored in future research. As many students struggle to succeed in higher education, understanding the effectiveness of exercises whose goal is to enhance performance can guide students who are failing to behaviors that increase their chances of success. This study adds to a growing body of literature that empowers students to take charge of their learning by considering different strategies to attain academic success.

Acknowledgments

The authors are grateful to the members of the Cognitive Science Research Cluster at Prince Mohammad Bin Fahd University (PMU) as well as the members of the PMU Undergraduate Research Society for their assistance and feedback, and to the students who participated in the study.

Conflict of interests

The authors declare no conflict of interest.

References

Anderson, L. W., & Bloom, B. S. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* Longman. https://eduq.info/xmlui/handle/11515/18345

Anderson, T. (2003). Getting the mix right again: An updated and theoretical rationale for interaction. *International Review of Research in Open and Distance Learning, 4*(2), 9–14. https://doi.org/10.19173/irrodl.v4i2.149

Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the student engagement instrument. *Journal of School Psychology, 44*(5), 427–445. https://doi.org/10.1016/j.jsp.2006.04.002

Bloom, B. S. (1976). *Human characteristics and school learning*. McGraw Hill. https://psycnet.apa.org/record/1977-22073-000

Bloom, B. S. (Ed.). (1956). *Taxonomy of educational objectives. Cognitive domain*. McKay.

Brookings, J. B., & Serratelli, A. J. (2006). Positive illusions: Positively correlated with subjective well-being, negatively correlated with a measure of personal growth. *Psychological Reports, 98*(2), 407–413. https://doi.org/10.2466/pr0.98.2.407-413

Chen, S. Y., Feng, Z., & Yi, X. (2017). A general introduction to adjustment for multiple comparisons. *Journal of Thoracic Disease, 9*(6), 1725–1729. https://doi.org/10.21037/jtd.2017.05.34

Dennis, J. (2003). Problem-based learning in online vs. face-to-face environments. *Education for Health: Change in Learning & Practice, 16*(2), 198–209. https://doi-org.library.pmu.edu.sa/10.1080/1357628031000116907

Druckman, D. (2004). Be all that you can be: Enhancing human performance. *Journal of Applied Social Psychology, 34*(11), 2234–2260. https://doi.org/10.1111/j.1559-1816.2004.tb01975.x

Eison, J., Janzow, F., & Pollio, H. R. (1993). Assessing faculty orientations towards grades and learning: Some initial results. *Psychological Reports, 73*(2), 643–656. https://doi.org/10.2466/pr0.1993.73.2.643

Fanning, P. (1994). Visualization for change (2nd ed.). New Harbinger Publications Incorporated.

Farias, G., Farias, C. M., & Fairfield, K. D. (2010). Teacher as judge or partner: The dilemma of grades versus learning. *Journal of Education for Business, 85*(6), 336–342. https://doi.org/10.1080/08832321003604961

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of educational research, 74*(1), 59-109. https://doi.org/10.3102/00346543074001059

Hacker, D. J., Bol, L., Horgan, D. D., & Rakow, E. A. (2000). Test prediction and performance in a classroom context. *Journal of Educational Psychology, 92*(1), 160–170. https://doi.org/10.1037/0022-0663.92.1.160

Healey, M. P., & Hodgkinson, G. P. (2008). Troubling futures: Scenarios and scenario planning for organizational decision making. In G. P. Hodgkinson, & W. H. Starbuck (Eds.), *The Oxford Hand-book of Organizational Decision Making* (pp. 565-585). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199290468.003.0030

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educause Review, 27*. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-andonline-learning

Horowitz, M. J. (1976). *Stress response syndromes.* Aronson.

Koehler, D. J. (1991). Explanation, imagination, and confidence in judgment. *Psychological Bulletin, 110*(3), 499–519. https://doi.org/10.1037/0033-2909.110.3.499

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2

Laplante, P. (2020). Contactless U: Higher education in the postcoronavirus world. *IEEE Annals of the History of Computing, 53*(07), 76–79. https://doi.org/10.1109/MC.2020.2990360

Linden, D. E., & Skottnik, L. (2019). Mental imagery and brain regulation–New links between psychotherapy and neuroscience. *Frontiers in Psychiatry, 10*, 779. https://doi.org/10.3389/fpsyt.2019.00779

Locke, E. A. (1996). Motivation through conscious goal setting. *Applied and preventive psychology, 5*(2), 117-124. https://doi.org/10.1016/S0962-1849(96)80005-9

Locke, E. A., & Latham, G. P. (1990). Work motivation and satisfaction: Light at the end of the tunnel. *Psychological Science, 1*(4), 240–246. https://doi.org/10.1111/j.1467-9280.1990.tb00207.x

Marlatt, G. A., & Donovan, D. M. (Eds.). (2005). *Relapse prevention: Maintenance strategies in the treatment of addictive behaviors.* Guilford press.

Miller, T. M., & Geraci, L. (2011). Unskilled but aware: Reinterpreting overconfidence in low-performing students. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*(2), 502–506. https://doi.org/10.1037/a0021802

Moore, M. G. (1989). Three types of interaction. *The American Journal of Distance Education, 3*(2), 1–6. https://doi.org/10.1080/08923648909526659

Murray, L., & Barnes, A. (1998). Beyond the "wow" factor – evaluating multimedia language learning software from a pedagogical viewpoint. *System, 26*(2), 249–259. https://doi.org/10.1016/S0346-251X(98)00008-6

Ng, K. C. (2007). Replacing face-to-face tutorials by synchronous online technologies: Challenges and pedagogical implications. *The International Review of Research in Open and Distributed Learning, 8*(1), 1–15. https://doi.org/10.19173/irrodl.v8i1.335

Oettingen, G. (1995). Positive fantasy and motivation. In P. M. Gollwitzer & J. A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 219–235). Guilford Press.

Orlick, T., & Partington, J. T. (1986). *Psyched: Inner views of winning.* Coaching Association of Canada.

Peale, N. V. (1982). Positive imaging: *The powerful way to change your life*. Fawcett Crest.

Pham, L. B., & Taylor, S. E. (1999). From thought to action: Effects of process-versus outcome-based mental simulations on performance. *Personality and Social Psychology Bulletin, 25*(2), 250-260. https://doi.org/10.1177/0146167299025002010

Pilotti, M. A., Alaoui, K. E., Mulhem, H. A., & Salameh, M. H. (2020). A close-up on a predictive moment: Illusion of knowing or lack of confidence in self-assessment?. *Journal of Education*, 0022057420944843 https://doi.org/10.1177/0022057420944843

Pilotti, M., El Alaoui, K., Mulhem, H., & Al Kuhayli, H. (2019). The Illusion of knowing in college. *Europe's Journal of Psychology, 15*(4), 789-807. https://doi.org/10.5964/ejop.v15i4.1921

Pollio, H. R., & Beck, H. P. (2000). When the tail wags the dog: Perceptions of learning and grade orientation in, and by, contemporary college students and faculty. *The Journal of Higher Education, 71*(1), 84-102. https://doi.org/10.1080/00221546.2000.11780817

Putwain, D. W., Nicholson, L. J., Pekrun, R., Becker, S., & Symes, W. (2019). Expectancy of success, attainment value, engagement, and achievement: A moderated mediation analysis. *Learning and Instruction, 60*, 117-125. https://doi.org/10.1016/j.learninstruc.2018.11.005

Richardson, K. (2020). Online tools with synchronous learning environments. In P. Wachira & J. Keengwe (Eds.), *Handbook of research on online pedagogical models for mathematics teacher education* (pp. 68–78). IGI Global. https://www.igi-global.com/chapter/online-tools-with-synchronous-learning-environments/243500

Salmon, G. (2000). *E-moderating: The key to teaching and learning online Kogan Page*.

Schoemaker, P. J. (1991). When and how to use scenario planning: A heuristic approach with illustration. *Journal of Forecasting, 10*(6), 549–564. https://doi.org/10.1002/for.3980100602

Sherman, S. J., Skov, R. B., Hervitz, E. F., & Stock, C. B. (1981). The effects of explaining hypothetical future events: From possibility to probability to actuality and beyond. *Journal of Experimental Social Psychology, 17*(2), 142-158. https://doi.org/10.1016/0022-1031(81)90011-1

Silver, R. L., Boon, C., & Stones, M. H. (1983). Searching for meaning in misfortune: Making sense of incest. *Journal of Social issues, 39*(2), 81-101. https://doi.org/10.1111/j.1540-4560.1983.tb00142.x

Steeples, C., Jones, C., & Goodyear, P. (2002). Beyond e-Learning: A future for networked learning. In C. Steeples & C. Jones (Eds.) *Networked Learning: Perspectives and issues* (pp. 323–341). Springer-Verlag. https://doi.org/10.1007/978-1-4471-0181-9_19

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin, 103*(2), 193–210. https://doi.org/10.1037/0033-2909.103.2.193

Taylor, S. E., Pham, L. B., Rivkin, I. D., & Armor, D. A. (1998). Harnessing the imagination: Mental simulation, self-regulation, and coping. *American Psychologist, 53*(4), 429–439. https://doi.org/10.1037/0003-066X.53.4.429

Taylor, S. E., & Pham, L. B. (1999). The effect of mental simulation on goal-directed performance. *Imagination, cognition and personality, 18*(4), 253-268. https://doi.org/10.2190/VG7L-T6HK-264H-7XJY

Wang, Y., Chen, N. S., & Levy, M. (2010). Teacher training in a synchronous cyber face-to-face classroom: Characterizing and supporting the online teachers' learning process. *Computer Assisted Language Learning, 23*(4), 277-293. https://doi.org/10.1080/09588221.2010.493523

Williams, V. & Peters, K. (1997). Faculty incentives for the preparations of web-based instruction. In B. H. Kahn (Ed.), *Web-based instruction* (pp. 107–110). Educational Technology Publications.

Williamson, B., Eynon, R. & Potter, J. (2020). Pandemic politics, pedagogies and practices: Digital technologies and distance education during the coronavirus emergency. *Learning, Media and Technology, 45*(2), 107–114. https://doi.org/10.1080/17439884.2020.1761641

Yang, M. L., Chuang, H. H., & Chiou, W. B. (2009). Long-term costs of inflated self-estimate on academic performance among adolescent students: A case of second-language achievements. *Psychological Reports, 105*(3), 727–737. https://doi.org/10.2466/PR0.105.3.727-737

Zimmerman, J. (2020, March 10). Coronavirus and the great online-learning experiment. *Chronicle of Higher Education*. https://www.chronicle.com/article/Coronavirusthe-Great/248216

Malik, A. & Ubaidillah, M. (2020). Students critical-creative thinking skill: A multivariate analysis of experiments and gender, *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE), (8),* Special issue of Current Research and Trends in Cognitive Sciences 2020, 49-58.

Original scientific paper

UDK: 159.955.072-057.875(594)

Received: September, 17.2020.
Revised: November, 27.2020.
Accepted: November, 02.2020.

doi: 10.23947/2334-8496-2020-8-SI-49-58

Students Critical-Creative Thinking Skill: A Multivariate Analysis of Experiments and Gender

Adam Malik[1], Mujib Ubaidillah[2]*

[1]Department of Physics Education, UIN Sunan Gunung Djati Bandung, Indonesia, e-mail: adammalik@uinsgd.ac.id
[2]Department of Biology Tadris, IAIN Syekh Nurjati Cirebon, Indonesia, e-mail: mujib_ubaidillah@syekhnurjati.ac.id

Abstract: Students' ability to practice several thinking skills is one of the problems common in today's learning. Therefore, this research aims to describe the improvement of students' critical-creative thinking skills through a multivariate analysis of the experiment model and gender. The experiment models used in this research are the Multiple Skill Laboratory Activity Model (MSLAM) and Higher Order Thinking Laboratory (HOT Lab), with gender, considered as a factor influencing a successful learning process. Research method was a quasi-experiment with data obtained from 328 respondents from five different universities in Indonesia and analyzed using the multivariate tests. The results showed that the experiment model affected the learning outcomes more than genders. Furthermore, the Multiple Skill Laboratory Activity Module proved to improve students' critical and creative thinking skills better than the Higher Order Thinking Laboratory. This study expected to provide a comparison in determining the types of suitable experiments for learning at colleges and schools.

Keywords: critical, creative, MSLAM model, HOT Lab.

Introduction

The critical thinking skills (CrTS) and creative thinking skills (CvTS) are important abilities associated with education in this 21st century. Several studies carried out in accordance with these skills showed that they were essential to students achievement (Bean, 2011; Pantiwati, 2013; Quieng et al., 2015; Seymour et al., 2003). CrTS and CvTS are also used in civil society, with students adopting to the new norms of global information.

Furthermore, studies have also been carried out on the learning process that practiced the use of CrTS and CvTS. According to these studies, these skills are practiced using a specific related model of teaching (Bustami and Corebima, 2017; Fuad et al., 2017; Hadi et al., 2018; Malik et al., 2020; Malik et al., 2019; Martaida et al., 2017; Muhlisin et al., 2016; Nasir, 2018; Nugraha et al., 2016; Saputri et al., 2019; Sari et al., 2018; Seranica et al., 2018; Suardana et al., 2018; Wang et al., 2015; Zaini et al., 2018). In these studies, students' ability increased significantly with the design of specific activities and purposive tasks for effective learning. The studies carried out by (Hastuti et al., 2018; Nugraha et al., 2016; Saputri et al., 2019; Weatherspoon et al., 2015) showed an increase in CrTS and CvTS by using the learning media. This result also showed that student whose used learning media have higher CrTS and CvTS compared to those that did not use it, because it made them more active while following the process. Besides, learning media was more interesting, which increased their interest and focus. However, another research showed that student achievement of CrTS and CvTS can be optimized using the laboratory activity or an experiment learning (Lisdiani et al., 2019; Malik et al., 2018; Setiawan et al., 2018).

However, few studies combined the CrTS and CvTS due to their differing basic approaches (Pantiwati, 2013; Seymour et al., 2003). According to Cottrell (2017), CrTS needed students to think deductive, realistic, systematic, and rational which have several aspects such as disposition, criteria, argument, reasoning, point of view, and procedures for applying criteria (Cottrell, 2017). These aspects were different from the CvTS approach, which comprises originality, elaboration, fluency, and flexibility (Lince, 2016). Lince (2016) CvTS approaches comprises of divergence, autistic, emotional, and natural and divergence thinking patterns. However, students' ability to participate in experiment activity is used to solve mixed approaches (Lince, 2016).

The Higher Order Thinking Laboratory (HOT Lab) has implemented the experiment model in the colleges and schools. HOT Lab model showed good results in students' achievement after using it as a

*Corresponding author: adammalik@uinsgd.ac.id

learning activity. The research indicated that the practice of competences building is good when used in more than once (Setiawan et al., 2018). However, it had several limitations associated with the steps and evaluations, therefore the HOT Lab model needs improvement, which can be carried out using the Multiple Skill Laboratory Activity Module (MSLAM).

MSLAM is a module developed to modify the various HOT Lab steps by adding two steps to increase CrTS and CvTS. The CrTS and CvTS were practiced using MSLAM with the effect analysed by carrying out a Multivariate test in accordance with Models and Gender. Analysis by gender is used to provide information on gender contribution in laboratory activity. This study aims to describe the improvement of students' critical-creative thinking skills after using MSLAM as a HOT Lab refinement module. Therefore, teachers in college or schools need to carry out learning more optimally.

Research Question

1. How do the experimental models of students' critical-creative thinking skills simultaneously contribute to their knowledge?
2. Does gender affect student's critical-creative thinking skills, which are simultaneously practiced?

Materials and Methods

This is a quantitative and experimental research with data consisting of students' critical and creative thinking skills in two groups. The physics contents taught in this study are electric current (El-Cr) and elasticity (Elc). The respondents in this study were 328 students divided into 10 subject groups. The first five groups also are known as the control groups, carried out the HOT Lab model, while the remaining five, which utilized the MSLAM model were in the experimental class. Groups A, B, C, D, and E comprises of students from the UIN Sunan Gunung Djati Bandung (Java), UIN Imam Bonjol Padang (Sumatra), UIN Alauddin Makasar (Sulawesi), IAIN Palangka Raya (Kalimantan), and IAIN Syech Nurjati Cirebon (Java), respectively. Each selected group subject has heterogeneous academic abilities with different habits and learning experience.

Data were collected using an essay test-form, which includes CvTS and CrTS. The CvTS test consists of four indicators modified through creative thinking from Almaeida (Almeida et al., 2008) and Alrubaie (Alrubaie and Daniel, 2014). Research techniques that are flexible, elaborating, and innovating. The CrTS test consists of seven indicators modified from Binkley (Binkley et al., 2012) and Tiruneh's (Tiruneh et al., 2017) research techniques: reasoning, interpreting, explaining, synthesizing, evaluating, and inferencing. Furthermore, all of the results were analysed using the normalized gain result of each subject's groups <g> (Hake, 1999).

N-gain scores are then used as the data source for multivariate tests, which consist of three parts that analyzed the experiments, gender, and combination between the experiments and gender. The experiment was used to analyze the influence of added syntax to the critical and creative thinking skills of students. While gender analysis aimed at seeing the contribution of gender in experiment-based learning.

Results

The results of this study consist of the Manova analysis, which influences each independent variable (experiment model, gender, and combination of both) and the dependent (CrTS and CvTS) in all subjects.

Analysis of the experiment learning model

The first analysis is used to determine how the experiment model influences students' CrTS and CvTS, which are simultaneously trained through different experimental activities, such as HOT-Lab for the control class and MSLAM for the experiment. Table 1, 2 and 3 show the results of Manova analysis presented in the form of a multivariate test, Levene's Test of Equality of Error Variances, and Test of Between-Subject Effects.

Table 1
Multivariate test by Pillai's Trace method

Subjects	Group A	Group B	Group C	Group D	Group E
Value	0.305	0.395	0.275	0.352	0.521
F	15.81	8.973	5.487	7.46	19.047
sig.	0.000	0.000	0.001	0.000	0.000

Based on Table 1, it can be concluded that the experimental models have a significant influence on CrTS and CvTS. This result is expressed by a p-value smaller than 0.05 in each test, which gives the overall conclusion that experimental model has a significant effect on CrTS and CvTS.

Table 2
Levene's Test of Equality of Error Variances

Contents	El-Cr					Elc				
Group	A	B	C	D	E	A	B	C	D	E
CvTS	0.026	0.113	0.175	0.175	0.105	-	0.048	0.135	0.048	0.000
CrTS	0.000	0.297	0.003	0.003	0.026	-	0.003	0.008	0.195	0.195

Table 2 showed that students in the control and experiment classes are in an inhomogeneous group. Most of the scores are higher than 0.05, in accordance with the score and significance values, therefore the data are homogeneous. This result showed that the student's score of CrTS and CvTS are in the control class using HOTs Lab model, while the experiment class produced different results using the MSLAM (Stichter et al., 2019). Meanwhile, the data classified in each competence, can improve CvTS using the MSLAM, because the average significance score is 0.091. This result showed that the group's variant is relatively different, with an average CrTS significance score of 0.081 (Mertler and Reinhart, 2016). Table 3 shows the Test of Between-Subject Effects analysis, which was carried out to provide a detailed answer.

Table 3
Test of Between-Subject Effects

Skills	Group	A		B		C		D		E	
	Contents	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc
CvTS	Intercept	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Experiment	0.000	-	0.622	0.000	0.331	0.000	0.013	0.000	0.009	0.004
	Error	0.057	-	0.115	0.074	0.104	0.051	0.082	0.064	0.06	0.07
CrTS	Intercept	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Experiment	0.009	-	0.033	0.042	0.025	0.013	0.033	0.042	0.012	0.000
	Error	0.060	-	0.057	0.082	0.078	0.055	0.057	0.082	0.083	0.079

This test was used to determine the contribution of each experiment model that improved students' CrTS and CvTS. Table 3 shows an intercept value on each variable, which is less than 0.05, which means that it is significant. Therefore, the experimental model, HOT Lab, and MSLAM contributed differently with a significant value of student achievement in each group (Cronk, 2017; Mertler and Vannatta, 2002).

In addition, there is a significant value that specifically illustrated the effect of the experiment model on the dependent variable. Furthermore, the significant value of the model, which is less than 0.05, positively improved the CvTS in the Elc content. This result is different from the increase in CvTS on El-Cr

content with a significance value greater than 0.05 in two groups.

Gender analysis

This was carried out to acquire an overview of gender effect in increasing students' CvTS and CrTS. A total of 328 students comprising 61 males and 267 females were used to carry out this research. The first analysis is multivariate test significance, as shown in Table 4.

Table 4
Multivariate test by Pillai's Trace method

Subjects	Group A	Group B	Group C	Group D	Group E
Value	0.065	0.038	0.048	0.019	0.127
F	2.522	0.547	0.735	0.265	2.537
sig.	0.087	0.702	0.572	0.899	0.048

Table 4 shows that the overall independent variable, or gender, did not affect the values of CvTS and CrTS at a significance value above 0.05 in each group. Therefore, this indicates that gender does not influence the significant increase of CvTS and CrTS. Meanwhile, the differences in student scores can be analysed by their gender, as shown in Table 5.

Table 5
Levene's Test of Equality of Error Variances

Contents				El-Cr					Elc	
Group	A	B	C	D	E	A	B	C	D	E
CvTS	0.097	0.641	0.641	0.591	0.186	-	0.05	0.05	0.698	0.153
CrTS	0.309	0.157	0.157	0.328	0.904	-	0.362	0.362	0.75	0.361

Table 5 shows that the most significant value is higher than 0.05, which means that the scores of CvTS and CrTS are definitely different (Stichter et al., 2019) due to students' efficacy and anxiety in the learning process (Assan and Sarfo, 2015). This is similar to the studies carried out by (Chang, S., and Cho, 2013; Hill et al., 2016), which stated that female students are more anxious than males, especially in math.

Table 6
Test of Between-Subject Effects

Skills	Group	A		B		C		D		E	
	Contents	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc
CvTS	Intercept	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Gender	0.799	-	0.565	0.222	0.564	0.187	0.729	0.968	0.026	0.052
	Error	0.073	-	0.115	0.061	0.105	0.066	0.091	0.061	0.061	0.075
CrTS	Intercept	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Gender	0.029	-	0.923	0.616	0.779	0.748	0.534	0.501	0.552	0.783
	Error	0.060	-	0.110	0.087	0.059	0.085	0.083	0.087	0.090	0.132

Table 6 shows that the intercept value on each variable is less than a significance of 0.05. (Bergold et al., 2017) stated that gender contribution is insignificant because the average score is 0.457 for CvTS and 0.607 for CrTS. According to (Cronk, 2017; Mertler and Vannatta, 2002), gender contribution is significant when the score is less than 0.05. This result is particularly accurate at average errors of 8.81% and 7.87% for CrTS and CvTS, respectively. This is in accordance with the socio-scientific research and principles of correctness which amounted to 91.19% and 92.13% for critical and creative thinking skills.

Combined analysis of experiment types and gender

The last analysis reviews the simultaneous contributions of the experimental and gender models to improve CrTS and CvTS.

Table 7
Multivariate test by Pillai's Trace method

Group	A		B		C		D		E	
d-factor*	exp	gen	Exp	gen	exp	gen	exp	gen	exp	gen
Value	0.316	0.081	0.397	0.042	0.49	0.275	0.351	0.018	0.522	0.128
F	16.430	3.110	8.898	0.592	0.738	5.412	7.312	0.253	18.828	2.530
sig.	32.867	0.051	0.000	0.670	0.570	0.001	0.000	0.907	0.000	0.048

**d-factor is different factors that used in analyse, exp = experiment type, gen = gender*

Table 7 shows a variety of spreads with significant values in the experiment and gender models of group A higher than 0.05. In group B, the experiment and gender models are significant and insignificant at values of 0.00 and 0.67. Furthermore, in group C, the experiment and gender models are insignificant and significant at values of 0.57 and 0.001. In group D, the experiment model provides a significant influence, as opposed to gender. The last group shows a significant influence on both aspects. Therefore, it can be concluded that the analyzed student competencies are separately carried out due to the varying basic point of view (Berglund and Gericke, 2016; Garcia and Mayorga, 2018; Kottorp et al., 2019).

Table 8
Levene's Test of Equality of Error Variances

Content	El-Cr					Elc				
Group	A	B	C	D	E	A	B	C	D	E
CvTS	0.000	0.311	0.387	0.200	0.042	-	0.050	0.076	0.493	0.189
CrTS	0.025	0.039	0.069	0.465	0.259	-	0.123	0.070	0.188	0.000

The analysis of homogeneity indicates that there are differences in CrTS and CvTS of the experimental and control classes. In CvTS, Levene's Test's average score is significant because it is 0.194 greater than 0.05. This means, that the experimental and gender models are different in accordance with students' scores. The same result is also shown by CrTS average score with 0.138 above 0.05 and different from their experiment and gender models (Stichter et al., 2019).

Table 9
Test of Between-Subject Effects

Skills	Group	A		B		C		D		E	
	Contents	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc	El-Cr	Elc
CvTS	Intercept	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Experiment	0.968	-	0.575	0.169	0.644	0.282	0.762	0.545	0.013	0.061
	Error	0.000	-	0.633	0.000	0.366	0.019	0.014	0	0.005	0.005
CrTS	Intercept	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Experiment	0.015	-	0.882	0.575	0.411	0.54	0.926	0.459	0.634	0.976
	Error	0.005	-	0.035	0.042	0.000	0.022	0.035	0.042	0.013	0.000

Table 9 shows an explicit analysis of the contributions of two independent variables against two dependent variables simultaneously. It provides the same intercept value in each group indicating that the experiment and gender models are capable of significantly changing each subject group's value for the improvement of CrTS, and CvTS.

Furthermore, the overall data on Table 9 shows that gender does not significantly improve CrTS and CvTS, as opposed to the experiment model. Lastly, the data error, of the combination analysis provides a relatively small error with an average error of 7.01% and 7.53% for CrTS and CvTS. This shows that the method used in this research has an acceptance rate of 92.99% and 92.47% for increasing CrTS and CvTS.

Discussion

The research results showed that experimental model has significant affect to improve student's CrTS dan CvTS simultaneously. This is unique because these two competencies have different characteristics from one another. CrTS are convergent thinking skills, meaning that if they are trained students must be able to carry out various analyzes of facts and draw conclusions from the multiple facts found. In contrast to CvTS which have divergent characteristics where students are trained to have high curiosity, elaboration, flexibility and tend to rely on imagination. Even though these two abilities do not collide with each other in a cognitive context, in carrying out practicum activities using the MSLAM model, these two abilities can be trained simultaneously. Refer to the model syntax and practicum steps in the MSLAM model, which can develop CrTS and CvTS.

The development of creative and critical thinking skills through elasticity and electricity practicum activities using MSLAM can be viewed from several stages. The stages of practicum activities that can train and develop aspects of critical thinking skills include real-world problems, experimental questions, brainstorming, conceptual questions, prediction, analysis, evaluation, and reflection. Creative thinking skills that can be developed through various stages of MSLAM practicum include brainstorming, proposing alternative ideas, exploration, and measurement. Critical and creative thinking skills can be developed through brainstorming (Chang et al., 2015). The activity of proposing alternative ideas as part of divergent thinking can give birth to new methodologies, generate new ideas, and students' scientific practice. (Abraham, 2013; Antink-Meyer and Lederman, 2015).

The explanation of these findings is due to the habits of students while carrying out experiments. Based on a study conducted by Lin et al. (2004), another aspect related to the scientific process is the logic of science as a form of logical thinking. Therefore, laboratory activities also provide a rich context for using shared logical thinking between CvTS and CrTS (Koray and Köksal, 2009). Thus, from the point of view of activity steps, it can be stated that MSLAM can train CrTS and CvTS.

The other side, Elc is part of the mechanical content where students carried out mechanical experiments more often than electronica experiments since middle school. It is different from the implementation of El-Cr experiment, which is often ignored, and made them possess less level of their CvTS. This finding is consistent with the studies carried out by (Harris and de Bruin, 2018; Irjayanti and

Azis, 2017; Lucas, 2016). In the review of the CrTS, it is apparent that all the subject groups in each content have a significance value of less than 0.05, with MSLAM providing more effect to CrTS than HOTs Lab. When the results were reviewed, this study obtained the average error rate for CvTS 7.52% and CrTS 7.03% which is relatively small for the research group socio-scientific (Nuijten et al., 2016; Rahman et al., 2017; Vázquez-Cano et al., 2017). Therefore, it can be concluded that the addition of HOT Lab model's several steps has succeeded in increasing students CvTS and CrTS simultaneously.

In other side, gender analysis showed an insignificant influence on improving CvTS and CrTS. According to previous studies, students' syntax, level of difficulty, habit, and motivation are also some of the reasons for the insignificant values. In the performance process, male students tend to perform better than their female counterparts. However, in the data processing, analysing and reporting stages, the reverse was the case. This finding is also reinforced by the results of previous studies which show that generallly there is no difference in ability between male and female students, but only in a few conditions (Adolphus and Omeodu, 2016; Aeschlimann et al., 2016; Bećirović, 2017; Brodahl et al., 2011; Crymble, 2016; Master et al., 2017; Putri et al., 2018; Sayed and Mohamed, 2013). This result is different from previous research in that male students tend to have better analytical thinking skills than female students. Lin et al. (2004) stated that CvTS and CrTS as higher-order thinking skills are related to other variables such as age, cognitive level and field of study. The results also contradict the statement that female students have higher levels of CvTs than male students at the university level (Matud, Rodríguez, and Grande, 2007); female students performed better on divergent thinking tests, while male abilities were superior in insightful problem-solving tasks (Lin et al., 2012); In divergent thinking, men have a stronger declarative memory, while women have advantages in the theory of mind, social perception, speech processing and reference processing (Abraham et al., 2014); male students have higher creativity than female students when they produce the same output (Proudfoot, Kay, and Koval, 2015).

These findings have a relatively high level of accuracy based on the error value that provide a relatively small error value of 7.52% and 7.03% for the experimental models of CvTS, and CrTS. Meanwhile, using the gender model, it produced 7.87% and 8.81% for CvTS, and CrTS, with 7.53% and 7.01 for the simultaneous models of experiment and gender to CvTS, and CrTS (Nuijten et al., 2016; Rahman et al., 2017; Vázquez-Cano et al., 2017). Therefore, in conclusion, MSLAM has the ability to adapt two thinking skills at once. Therefore, efforts are needed to take a wider implementation to determine the effectiveness of this model.

The limitation found in this study is in combination analysis methods, which were carried out by combining the experiment and gender models, which are the external and internal factors of students. These results are biased because gender influences students' learning interests, especially their experimental activities. Therefore, subsequent studies need to be carried out for students' tendency factors based on gender, to obtain more accurate measurement results.

Conclusions

The results showed that experimental learning using MSLAM can improve CrTS and CvTS simultaneously. MANOVA test suggests that the MSLAM contributes more significantly to the HOT Lab. Besides, gender analysis showed an insignificant influence on improving CvTS and CrTS. These contributions provide a relatively small error value of 7.52% and 7.03% for the experimental models of CvTS, and CrTS. Meanwhile, using the gender model, it produced 7.87% and 8.81% for CvTS, and CrTS, with 7.53% and 7.01 for the simultaneous models of experiment and gender to CvTS, and CrTS. Therefore, in conclusion, MSLAM can adapt two thinking skills at once. Therefore, efforts are needed to take a broader implementation to determine the effectiveness of this model.

Acknowledgments

This research was financially supported by the Ministry of Religious Affairs of the Republic Indonesia via Directorate General of Islamic Education through grant 1967 in 2019 regarding recipients of global/ international applied research assistance in fiscal 2019 for facilitating and financing this research.

Conflict of interests

The authors declare no conflict of interest.

References

Abraham, A. (2013). The promises and perils of the neuroscience of creativity. *Frontiers in Human Neuroscience, 7*(246), 1–9. https://doi.org/10.3389/fnhum.2013.00246

Abraham, A., Thybusch, K., Pieritz, K., & Hermann, C. (2014). Gender differences in creative thinking: behavioral and fMRI findings. *Brain imaging and behavior, 8*(1), 39-51. https://doi.org/10.1007/s11682-013-9241-4

Adolphus, T., & Omeodu, D. (2016). Effects of gender and collaborative learning approach on students' conceptual understanding of electromagnetic induction. *Journal of Curriculum and Teaching, 5*(1), 78–86. https://doi.org/10.5430/jct.v5n1p78

Aeschlimann, B., Herzog, W., & Makarova, E. (2016). How to foster students' motivation in mathematics and science classes and promote students' STEM career choice. A study in Swiss high schools. *International Journal of Educational Research, 79*, 31–41. https://doi.org/10.1016/j.ijer.2016.06.004

Almeida, L. S., Prieto, L. P., Ferrando, M., Oliveira, E., & Ferrandiz, C. (2008). Torrance Test of Creative Thinking: The question of its construct validity. *Thinking Skills and Creativity, 3*(1), 53–58. https://doi.org/https://doi.org/10.1016/j.tsc.2008.03.003

Alrubaie, F., & Daniel, E. G. (2014). Developing a creative thinking test for Iraqi physics students. *International Journal of Mathematics and Physical Sciences Research, 2*(1), 80–84. Retrieved from https://researchpublish.com/issue/IJMPSR/Issue-1-April-2014-September-2014

Antink-Meyer, A., & Lederman, N. G. (2015). Creative Cognition in Secondary Science: An exploration of divergent thinking in science among adolescents. *International Journal of Science Education, 37*(10), 1547–1563. https://doi.org/10.1080/09500693.2015.1043599

Assan, E. A., & Sarfo, J. O. (2015). Piagetian Conservation Tasks in Ghanaian Children: the Role of Geographical Location, Gender and Age Differences. *European Journal of Contemporary Education, 12*(2), 137–149. https://doi.org/10.13187/ejced.2015.12.137

Bean, J. C. (2011). *Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Thinking, and Active Learning in the Classroom.* In Jossey-Bass. John Wiley & Son.

Bećirović, S. (2017). The relationship between gender, motivation and achievement in learning english as a foreign language. *European Journal of Contemporary Education, 6*(2), 210–220. https://doi.org/10.13187/ejced.2017.2.210

Berglund, T., & Gericke, N. (2016). Separated and integrated perspectives on environmental, economic, and social dimensions – an investigation of student views on sustainable development. *Environmental Education Research, 22*(8), 1115–1138. https://doi.org/10.1080/13504622.2015.1063589

Bergold, S., Wendt, H., Kasper, D., & Steinmayr, R. (2017). Academic competencies: Their interrelatedness and gender differences at their high end. *Journal of Educational Psychology, 109*(3), 439–449. https://doi.org/10.1037/edu0000140

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first century skills. In Assessment and teaching of 21st century skills (pp. 17-66). *Springer*, Dordrecht. https://doi.org/10.1007/978-94-007-2324-5_2

Brodahl, C., Hadjerrouit, S., & Kristian Hansen, N. (2011). Collaborative writing with web 2.0 technologies: Education students' perceptions. *Journal of Information Technology Education: Innovations in Practice, 10*, 073–103. https://doi.org/10.28945/1384

Bustami, Y., & Corebima, A. D. (2017). The Effect of JiRQA Learning Strategy on Critical Thinking Skills of Multiethnic Students in Higher Education , Indonesia. *International Journal of Humanities Social Sciences and Education, 4*(3), 13–22. https://doi.org/http://dx.doi.org/10.20431/2349-0381.0403003

Chang, S., & Cho, S. (2013). Development and validation of the Korean mathematics anxiety rating scale for college students. *Journal Of the Korean Data Analysis Society, 15*(4), 1955–1969.

Chang, Y., Li, B. Di, Chen, H. C., & Chiu, F. C. (2015). Investigating the synergy of critical thinking and creative thinking in the course of integrated activity in Taiwan. *Educational Psychology, 35*(3), 341–360. https://doi.org/10.1080/01443410.2014.920079

Cottrell, S. (2017). *Critical thinking skills: Effective analysis, argument and reflection*. Macmillan International Higher Education.

Cronk, B. C. (2017). *How to Use SPSS®: A Step-By-Step Guide to Analysis and Interpretation* (10th ed.). Routledge.

Crymble, A. (2016). Identifying and removing gender barriers in open learning communities: The programming historian. *Blended Learning in Practice,* 2016 (July 2012), 49–60.

Fuad, N. M., Zubaidah, S., Mahanal, S., & Suarsini, E. (2017). Improving Junior High Schools' Critical Thinking Skills Based on Test Three Different Models of Learning. *International Journal of Instruction, 10*(1), 101-116. https://doi.org/10.12973/iji.2017.1017a

Garcia, N. M., & Mayorga, O. J. (2018). The threat of unexamined secondary data: A critical race transformative convergent mixed methods. *Race Ethnicity and Education, 21*(2), 231-252. https://doi.org/10.1080/13613324.2017.1377415

Hadi, S. A., Susantini, E., & Agustini, R. (2018). Training of Students' Critical Thinking Skills through the implementation of a Modified Free Inquiry Model. *Journal of Physics: Conference Series, 947*(1), 012063. https://doi.org/10.1088/1742-6596/947/1/012063

Hake, R.R., & Reece, J. (1999). A*nalyzing Change/Gain Scores*. American Eduational Research Asociation's Divisions, Measurement and Reseacrh Methoology, 1–4. Retreived from https://www.semanticscholar.org/paper/ANALYZING-CHANGE%2FGAIN-SCORES*%E2%80%A0-Hake-Reece/ee433f272764045eede29180e06f62c963dcc4a2

Harris, A., & de Bruin, L. R. (2018). Training teachers for twenty-first century creative and critical thinking: Australian implications from an international study. *Teaching Education, 29*(3), 234-250. https://doi.org/10.1080/10476210.2017.1384802

Hastuti, P. W., Nurohman, S., & Setianingsih, W. (2018). The Development of Science Worksheet Based on Inquiry Science Issues to Improve Critical Thinking and Scientific Attitude. *Journal of Physics: Conference Series, 1097*(1), 012004. https://doi.org/10.1088/1742-6596/1097/1/012004

Hill, F., Mammarella, I. C., Devine, A., Caviola, S., Passolunghi, M. C., & Szűcs, D. (2016). Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. *Learning and Individual Differences, 48*, 45-53. https://doi.org/10.1016/j.lindif.2016.02.006

Irjayanti, M., & Azis, A. M. (2017). Implementing technology in creative industry (Benchmarking study in developed countries).

Advanced Science Letters, 23(9), 8113-8118. https://doi.org/10.1166/asl.2017.9845

Koray, Ö., & Köksal, M. S. (2009). The effect of creative and critical thinking based laboratory applications on creative and logical thinking abilities of prospective teachers. In *Asia-Pacific Forum on Science Learning & Teaching, 10*(1), 1.

Kottorp, A., Keehn, M., Hasnain, M., Gruss, V., & Peterson, E. (2019). Instrument Refinement for Measuring Self-Efficacy for Competence in Interprofessional Collaborative Practice: Development and Psychometric Analysis of IPECC-SET 27 and IPECC-SET 9. *Journal of Interprofessional Care, 33*(1), 47-56. https://doi.org/10.1080/13561820.2018.1513916

Lin, W. L., Hsu, K. Y., Chen, H. C., & Wang, J. W. (2012). The relations of gender and personality traits on different creativities: A dual-process theory account. *Psychology of Aesthetics, Creativity, and the Arts, 6*(2), 112–123. https://doi.org/10.1037/a002624

Lince, R. (2016). Creative thinking ability to increase student mathematical of junior high school by applying models numbered heads together. *Journal of Education and Practice, 7*(6), 206-212. Retrieved from https://files.eric.ed.gov/fulltext/EJ1092494.pdf

Lisdiani, Sahidah, S. A., Setiawan, A., Suhandi, A., Malik, A., & Safitri, D. (2019). The Implementation of HOT Lab Activity to Improve Students Critical Thinking Skills. *Journal of Physics Conference Series, 1204*(1), 012033. Retrieved from https://iopscience.iop.org/article/10.1088/1742-6596/1204/1/012033/meta

Lucas, B. (2016). A five-dimensional model of creativity and its assessment in schools. *Applied Measurement in Education, 29*(4), 278-290. https://doi.org/10.1080/08957347.2016.1209206

Malik, A., Yuliani, Y., Rochman, C., Zakwandi, R., Ismail, A., & Ubaidillah, M. (2020). Optimizing students critical thinking skills related to heat topics through the model of content, context, connection, researching, reasoning, reflecting (3C3R). *Journal of Physics: Conference Series, 1521*(2), 022001. https://doi.org/10.1088/1742-6596/1521/2/022001

Malik, A, Setiawan, A., Suhandi, A., Permanasari, A., Samsudin, A., Safitri, D., Lisdiani, S. A. S., Sapriadil, S., & Hermita, N. (2018). Using hot lab to increase pre-service physics teacher's critical thinking skills related to the topic of RLC circuit. *Journal of Physics: Conference Series, 1013*(1), 012023. https://doi.org/10.1088/1742-6596/1013/1/012023

Malik, A., Nuraeni, Y., Samsudin, A., & Sutarno. (2019). Creative thinking skills of students on harmonic vibration using model Student Facilitator And Explaining (SFAE). *Jurnal Ilmiah Penidikan Fisika Al-BiRuNi, 08*(1), 77–88. https://doi.org/10.24042/jipfalbiruni.v8i1.3056

Martaida, T., Bukit, N., & Ginting, E. M. (2017). The effect of discovery learning model on student's critical thinking and cognitive ability in junior high school. *IOSR Journal of Research & Method in Education (IOSR-JRME), 7*(6), 1-8. https://doi.org/10.9790/7388-0706010108

Master, A., Cheryan, S., Moscatelli, A., & Meltzoff, A. N. (2017). Programming experience promotes higher STEM motivation among first-grade girls. *Journal of experimental child psychology, 160*, 92-106. https://doi.org/10.1016/j.jecp.2017.03.013

Matud, M. P., Rodríguez, C., & Grande, J. (2007). Gender differences in creative thinking. *Personality and individual differences, 43*(5), 1137-1147. https://doi.org/10.1016/j.paid.2007.03.006

Mertler, C. A., & Reinhart, R. V. (2016). Advanced and multivariate statistical methods: Practical application and interpretation. *Taylor & Francis*. Retrieved from http://bayes.acs.unt.edu:8083/BayesContent/class/Jon/ResourcesWkshp/DecisionTree_MertlerVannatta.pdf

Mertler, C. A., & Vannatta, R. A. (2002). *A guide to multivariate techniques. Advanced and Multivariate Statistical Methods*. 2nd ed. Los Angeles, CA: Pyrczak Publishing.

Muhlisin, A., Susilo, H., Amin, M., & Rohman, F. (2016). Improving critical thinking skills of college students through RMS model for learning basic concepts in science. *Asia-Pacific Forum on Science Learning and Teaching, 17*(1), 1–24.

Nasir, M. (2018). Influence of Project-Based Learning Model that Aided Matrix Laboratory toward Creative Thinking Skills Viewed from College Student's Science Generic Skills. *Indonesian Journal of Science and Education, 2*(2), 100-106, 161–167. https://doi.org/10.31002/ijose.v2i2.779

Nugraha, M. G., Kaniawati, I., Rusdiana, D., & Kirana, K. H. (2016, February). Combination of inquiry learning model and computer simulation to improve mastery concept and the correlation with critical thinking skills (CTS). In *AIP Conference Proceedings* (Vol. 1708, No. 1, p. 070008). AIP Publishing LLC. https://doi.org/10.1063/1.4941181

Nuijten, M. B., Hartgerink, C. H., van Assen, M. A., Epskamp, S., & Wicherts, J. M. (2016). The prevalence of statistical reporting errors in psychology (1985–2013). *Behavior research methods, 48*(4), 1205-1226. https://doi.org/10.3758/s13428-015-0664-2

Pantiwati, Y. (2013). Authentic assessment for improving cognitive skill, critical-creative thinking and meta-cognitive awareness. *Journal of Education and Practice, 4*(14), 1-9. Retrieved from https://www.iiste.org/Journals/index.php/JEP/article/view/6790

Proudfoot, D., Kay, A. C., & Koval, C. Z. (2015). A gender bias in the attribution of creativity: Archival and experimental evidence for the perceived association between masculinity and creative thinking. *Psychological Science, 26*(11), 1751-1761. https://doi.org/10.1177/095679761559873

Putri, A. U., Rusyati, L., & Rochintaniawati, D. (2018). The Impact of Problem-Solving Model on Students' Concept Mastery and Motivation in Learning Heat Based on Gender. *Journal of Science Learning, 1*(2), 71-76. https://doi.org/10.17509/jsl.v1i2.9793

Quieng, M. C., Lim, P. P., & Lucas, M. R. D. (2015). 21st Century-Based Soft Skills: Spotlight on Non-Cognitive Skills in a Cognitive-Laden Dentistry Program. *European Journal of Contemporary Education, 11*(1), 72-81. https://doi.org/10.13187/ejced.2015.11.72

Rahman, M. A., Sainu, M. N., & Asfah, I. (2017, September). Revisiting the Linguistic Errors in the Writing of the Students Majoring in English. In *2nd International Conference on Education, Science, and Technology (ICEST 2017)*. Atlantis Press. https://doi.org/10.2991/icest-17.2017.53

Saputri, A. C., SAjidan, Rinanto, Y., Afandi, & Prasetyanti, N. M. (2019). Improving Students' Critical Thinking Skills in Cell-Metabolism Learning Using Stimulating Higher Order Thinking Skills Model. *International Journal of Instruction, 12*(1), 327-342. Retrieved from https://files.eric.ed.gov/fulltext/EJ1201357.pdf

Sari, D. M., Ikhsan, M., & Abidin, Z. (2018, September). The development of learning instruments using the creative problem-solving learning model to improve students' creative thinking skills in mathematics. In *Journal of Physics: Conference Series* (Vol. 1088, p. 012018). https://doi.org/10.1088/1742-6596/1088/1/012018

Sayed, E. M., & Mohamed, A. H. H. (2013). Gender Differences in Divergent Thinking: Use of the Test of Creative Thinking-Drawing Production on an Egyptian Sample. *Creativity Research Journal, 25*(2), 222–227. https://doi.org/10.1080/10400419.2013.783760

Seranica, C., Purwoko, A. A., & Hakim, A. (2018). Influence of Guided Inquiry Learning Model to Critical Thinking Skills. *IOSR Journal of Research & Method in Education, 8*(1), 28–31. https://doi.org/10.9790/7388-0801022831

Setiawan, A., Malik, A., Suhandi, A., & Permanasari, A. (2018, February). Effect of higher order thinking laboratory on the improvement of critical and creative thinking skills. In *IOP Conference Series: Materials Science and Engineering, 306*(1), pp. 1-7. https://doi.org/10.1088/1757-899X/306/1/012008

Seymour, B., Kinn, S., & Sutherland, N. (2003). Valuing both critical and creative thinking in clinical practice: narrowing the research–practice gap?. *Journal of Advanced Nursing, 42*(3), 288-296. https://doi.org/10.1046/j.1365-2648.2003.02618.x

Stichter, J. P., Herzog, M. J., Malugen, E., & Schoemann, A. M. (2019). Influence of homogeneity of student characteristics in a group-based social competence intervention. *School Psychology, 34*(1), 64. https://doi.org/10.1037/spq0000261

Suardana, I. N., Redhana, I. W., Sudiatmika, A. A., & Selamat, I. N. (2018). Students' Critical Thinking Skills in Chemistry Learning Using Local Culture-Based 7E Learning Cycle Model. *International Journal of Instruction, 11*(2), 399-412. https://doi.org/10.12973/iji.2018.11227a

Tiruneh, D. T., Cock, M. De, Weldeslassie, A. G., Elen, J., & Janssen, R. (2017). Measuring Critical Thinking in Physics : Development and Validation of a Critical Thinking Test in Electricity and Magnetism. *International Journal of Science and Mathematics Education, 15*, 663–682. https://doi.org/10.1007/s10763-016-9723-0

Vázquez-Cano, E., González, A. I. H., & Sáez-López, J. M. (2017). An analysis of the orthographic errors found in university students' asynchronous digital writing. *Journal of Computing in Higher Education, 31*(1), 1–20.

Wang, J., Guo, D., & Jou, M. (2015). A study on the effects of model-based inquiry pedagogy on students' inquiry skills in a virtual physics lab. *Computers in Human Behavior, 49*, 658-669. https://doi.org/10.1016/j.chb.2015.01.043

Weatherspoon, D. L., Phillips, K., & Wyatt, T. H. (2015). Effect of electronic interactive simulation on senior bachelor of science in nursing students' critical thinking and clinical judgment skills. *Clinical Simulation in Nursing, 11*(2), 126-133, 126–133. https://doi.org/10.1016/J.ECNS.2014.11.006

Yang, S. C., & Lin, W. C. (2004). The relationship among creative, critical thinking and thinking styles in Taiwan high school students. *Journal of Instructional Psychology, 31*(1), 33–45.

Zaini, M., Kaspul, & Rezeki, A. (2018). Hasil Belajar dan Keterampilan Berpikir Kritis Siswa SMA pada Pembelajaran Biologi menggunakan Model Inkuiri. [Learning Results and Critical Thinking Skills SMA On Biology Learning Using Inquiry Model]. *BIOEDUKASI: Jurnal Pendidikan Biologi, 11*(1), 17–22. https://jurnal.uns.ac.id/bioedukasi/article/view/19732

Original scientific paper

UDK: 59.944.4.072-057.875:[616.98:578.834(470)

Received: November, 13.2020.
Revised: December, 01.2020.
Accepted: December, 06.2020.

doi: 10.23947/2334-8496-2020-8-SI-59-67

Informational Behavior in the COVID-19 Pandemic: Psychological Predictors

Grishina Anastasia Vasilievna[1], Abakumova Irina Vladimirovna[2]*

[1]Department of General and Counseling psychology, "Psychology, pedagogy and defectology" faculty, Don State Technical University, Rostov-on-Don, Russian Federation, e-mail: abakira@mail.ru
[2]Corresponding Member of Russian Academy of Education, Dean of "Psychology, pedagogy and defectology" faculty, Don State Technical University, Rostov-on-Don, Russian Federation, e-mail: abakira@mail.ru

Abstract: The core problem of the COVID-19 pandemic for psychologists is to find out how people cope with the stress of isolation and the threat of fatal disease. The scale of the pandemical impact on the psychological well-being of an individual has still no knowledge and psychological predictors which the impact depends on need to be identified. This paper presents an empirical study of informational behavior and its psychological predictors in the pandemic. The research was held online in April-May 2020. The total amount of 165 participants, aged from 18 to 66. The subjects were chosen from a randomly selected sample. The participants were asked to estimate their informational consumption in pandemic. Tolerance to ambiguity, hardiness and anxiety was studied in groups distinguished according to changes in informational consumption. The findings of this study indicate a significant correlation between informational behavior and psychological characteristics related to coping with stress. Besides the analysis proved a negative correlation between reactive and personal anxiety and tolerance to ambiguity, hardiness and its components. We have confirmed that increased informational comsumption can be considered as a coping strategy for overcoming the pandemic social isolation among respondents with low hardiness and tolerance to ambiguity. Stable and decreased informational consumption indicates that respondents with high hardiness and tolerance to ambiguity and low state and trait anxiety don't need to consume information for coping with difficulties of pandemic self-isolation. Future work will concentrate on expanding the list of psychological predictors of informational behavior and studying the features of their interaction in different situations.

Keywords: pandemic, informational behavior, tolerance to ambiguity, hardiness, anxiety.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has had a significant impact on people's psychological health and wellbeing. The behavior of a person in the pandemic situation is still poorly understood as this is the first time when the mankind faces such a global and unknown threat and takes such measures to prevent its spread. Besides, the uniqueness of this situation lies in the fact that the pandemic has affected all spheres of human life - work, leisure, nutrition, sports (Våpenstad, 2010). One of the main issues in our knowledge of COVID-19 is a lack of facts about its real origin and effects. This led all social situations to the highest level of ambiguity, causing great psychological effects both on the level of a personality and of the society.

Tolerance to ambiguity is increasingly becoming a vital factor in psychological health of a modern man. The first studies of tolerance to ambiguity considered it to be an emotional and perceptual personal variable (Frenkel-Brunswik, 1948). E. Frenkel-Brunswik describes a personality type with a high level of intolerance to uncertainty, characterized by a tendency to make decisions on the principle of black - white; to draw hasty conclusions without taking into account significant factors and the real situation; strive for unconditional acceptance or rejection irelationships with other people.

The further studies proposed a new definition of tolerance to ambiguity considering it a basic personality trait. It was included in the theory of authoritarian personality (Adorno et al., 1950) as one of the typical characteristics of an authoritarian personality, explaining its behavior.

S. Budner has put forward the psychological content of this construct and understands intolerance to ambiguity as a tendency to interpret uncertain situations as a source of threat (Budner, 1962).

*Corresponding author: avgrishina.donstu@gmail.com

He identified the following signs of an uncertain situation:

• novelty (a completely new situation not previously encountered in experience);
• complexity (a difficult situation with a large number of variables);
• unsolvability (different elements of the situation give rise to conflicting interpretations).

Budner S. (1962) identified four indicators of individual threat perception, acting as threat experiences (phenomenological reactions) or behavior in a threat situation (operational reactions):

• phenomenological submission (discomfort),
• phenomenological denial (repression, suppression),
• operational submission (avoidant behavior)
• operational denial (destructive or reconstructive behavior).

After the ideas of first researchers, tolerance to ambiguity was understood as a tendency to interpret uncertain situations as desired. It is studied by the this group of researchers as a stable personality trait: from works of MacDonald, A. P. (1970), Hazen et al. (2012), Norton R. W. (1975), to latest researches of Herman et al. (2010), Litman (2010), Zhu, D., Xie, X., and Xie, J. (2012).

Other authors consider tolerance to ambiguity as a dynamic personal characterictic, that can advance during professional education (DeRoma, Martin and Kessler, 2003) and psychotherapy (Våpenstad, 2010). Kajs L. T. and McCollum D. L. point out that tolerance to ambiguity can increase with extension of life experience and age (Kajs and McCollum, 2010).

Tolerance to ambiguity has received much attention from scientists in the last 20 years. It has become a significant value for a modern man, helping to adapt to the constantly changing world.

The ideas of S. Maddi can be used as a starting point in studying COVID-19 pandemic as a situation of revealing hardiness. S. Maddi has proposed a new definition of personality hardiness as the personality pattern of attitudes and strategies that helps people turn stressful circumstances from potential disasters into growth opportunities. It's a composite of the interrelated attitudes of commitment, control and challenge that together provide the existential courage (Maddi, 2015).

People who are strong in commitment attitude get involved with what is happening, regardless of how stressful it may seem, perceiving this as the best way to learn from their experiences. People who are strong in the controlling attitude believe that trying to influence outcomes by the decisions they make is more likely to lead to meaningful outcomes then sinking into powerlessness in the face of stress. People who are strong in the challenging attitude believe that stress is normal and fulfillment is not to be found in easy comfort, security, and routine but rather in the continual growth in wisdom through what is learned from the negative and positive experiences of an active, changing life (Maddi et al., 2011).

D.A.Leontiev considers the phenomenon of hardiness in the context of personal potential and defines hardiness as an integrative characteristic of a person responsible for success in overcoming a person's various life difficulties (Leontiev et al., 2011; Leontiev, 2019).

Further researchers have focused on place of hardiness in personality structure and its correlation with other psychological constructs: the connection of hardiness with an identity crisis (Kuzmin, Gusev, and Konopak, 2010), with personal-situational interaction, with psychological content of the students' personality vitality (Loginova, 2010; Soboleva and Shumakova, 2014).

The phenomenon of anxiety is the subject of comprehensive psychological research. In this work we rely on K. Spilberger's approach to anxiety. He distinguishes anxiety as a state (reactive anxiety) and anxiety as a trait (personal anxiety). Reactive anxiety is temporary emotional state caused by the action of real or imaginary danger to the individual. Personal anxiety is a stable individual property, determined by the tendency of the subject to perceive a threat to his own personality and the willingness to respond to the threat with an increase in reactive anxiety in situation of even a small danger or stress (Spielberger, 1972).

Cognitive psychology focuses on anxiety influence on cognitive processes. It was found that high level of anxiety makes the person focus his attention on objects and facts related to the reason of anxiety or on information that can help to overcome stress and reestablish the psychological well-being.

Materials and Methods

Our research aimed to analyze the psychological predictors of infromational behaviour in the pandemic situation. This paper calls into a question if the informational behavior strategies can be considered as a coping strategies in the situation of social isolation.

Subjects were chosen from a randomly selected sample of working and not-working citizens of Rostov-on-Don aged from 18 to 66. The research was held online in April-May 2020 (from 48 to 60 days

of lockdown mode in Rostov-on-Don, Russia). All study participants were asked to fill out identical forms for testing and questioning. The total amount of 165 participants included 55 men and 110 women.

The hypothesis of the study: informational behavior in pandemic situation can have psyhological predictors.

To the group of such predictors the following psychological characteristics were chosen:

- hardiness
- tolerance to ambiguity
- anxiety as a state
- anxiety as a trait

To prove our hypothesis the following methods were chosen:

• MacLane's Uncertainty Tolerance Scale (MSTAT-I) (adapted by E. G. Lukovitskaya)

•The Personal Views Survey III-R by S. R. Maddi (adapted by D. A. Leontiev, E. I. Rasskazova)

• State-Trait Anxiety Inventory (STAI) by Ch. D. Spielberger (adapted by Yu. L. Khanin)

• Authors' questionnaire on studying changes in informational behavior of respondents during COVID-19 social isolation.

The questionnaire contained questions about how many hours a day respondents were consuming different types of content (news, political TV-shows, Internet blogs, documentaries, movies, serials, social networks) before the pandemic situation, how many hours a day they where planning to consume the described content in the pandemic isolation (when it only began) and how it turned up in the reality of social isolation.

Statistical methods of data processing: to identify the probabilistic relationship of indicators, we used the Spearman rank order correlation coefficient; to determine the significance of differences in the subgroups, we used the non-parametric Kruskal-Wallis test.

Results

Our aim was to get a general picture of psychological predictors of informational behavior. To define different informational behavior strategies we used our questionnaire. In response to the question «Has your informational consumption changed in COVID-19 pandemic?» the respondents estimated the time they had been spending on the listed types of content before the pandemic, in plans for pandemic and over the course of the pandemic. It allowed us to devide all respondents into 3 groups:

Group 1. Increased informational consumption – 80 respondents

Group 2. Stable informational consumption – 65 respondents

Group 3. Decreased informational consumption- 20 respondents.

The next step was therefore to investigate the differences in the psychological characteristics of the distinguished groups.

The level of tolerance to uncertainty has significant differences in the groups (Fig.1).

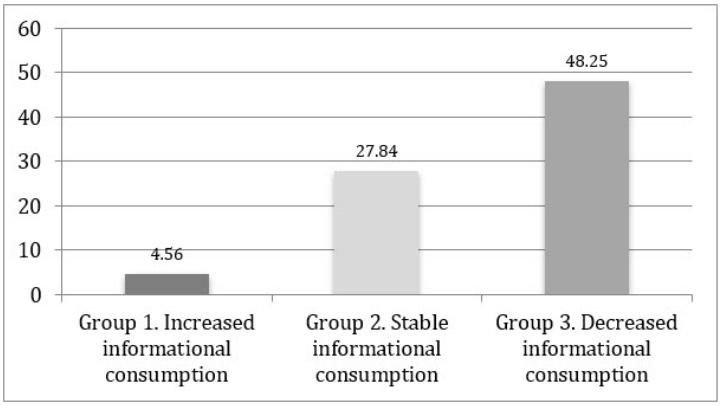

Figure 1. Tolerance to ambiguity in groups with different informational consumption

The average score of tolerance to ambiguity for the Group 1 Increased Informational Consumption is the lowest for the sample. Many respondents of this group showed even negative scores. It indicates that these respondents feel uncomfortable in ambiguous situations. They feel afraid of uncertainty and

usually hide from solving serious problems. The respondents from Group 3 Decreased Informational Consumption showed the highest level of tolerance to ambiguity. They can be characterized as creative people aware of the complexity and unpredictability of the world and are ready to adapt to it. Group 2 Stable Informational Consumption has medium positive scores of tolerance to ambiguity.

Thus, the increased informational consumption can be defined as a strategy of overcoming uncertainty in the COVID-19 pandemic for Group 1. The qualitative analysis of answers on the authors' questionnaire in this group showed the increase of the consumption of the content, primarily related to the cause of the pandemic: news, political TV-shows, and documentaries. Probably, finding the latest information on pandemic and social isolation allowed these respondents to feel more confident and to understand better the prospects for the development of the social situation.

The level of hardiness and its components has also differences in the groups (Fig. 2).

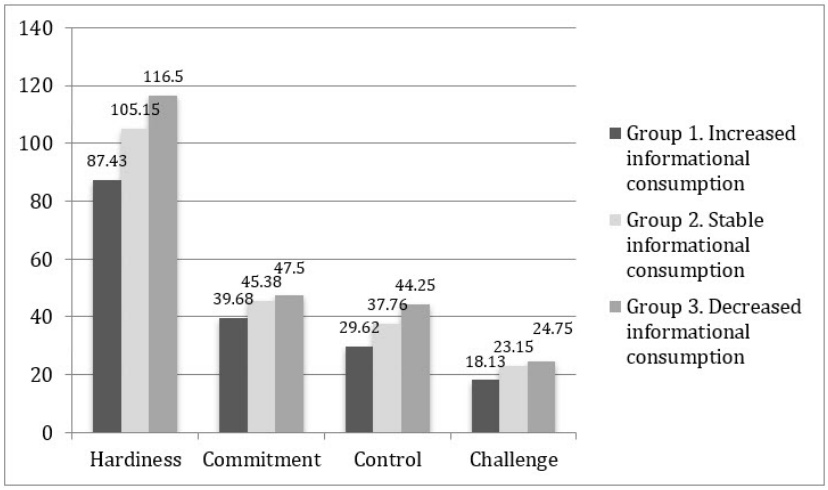

Figure 2. Hardiness and its components in groups with different informational consumption

The average score in hardiness and its components (commitment, control, challenge) for the Group 1 Increased Informational Consumption is also lowest for the sample, but can be rated as standard compared to regulatory values. The respondents from Group 3 Decreased Informational Consumption showed the highest level of hardiness, commitment, control and challenge.

Hardiness is a system of personal beliefs that allows personality to overcome anxiety in situations of uncertainty and to be independent of situational emotional reactions. In this context the highest level of hardiness in Group 3 reveals their psychological and behavior skills in difficult situations such as social exclusion and pandemic:

• high scores on Commitment scale indicate the belief that involvement in what is happening in pandemic gives the maximum chance of finding worthwhile information and making the right decisions;

• high level of Control reflects the confidence that one's actions can influence the outcome of what is happening in the pandemic;

• high scores in Challenge scale shows a willingness to accept the positive and negative experience of social isolation, finding a source of new knowledge and experience in it.

These results correlate with answers of Group 3 about positive and negative experiences of self-isolation in the pandemic: "I pay more attention to the family", "I do sports at home", "I can just relax", "I study new courses and webinars".

The level of anxiety has also differences in the groups (Fig. 3).

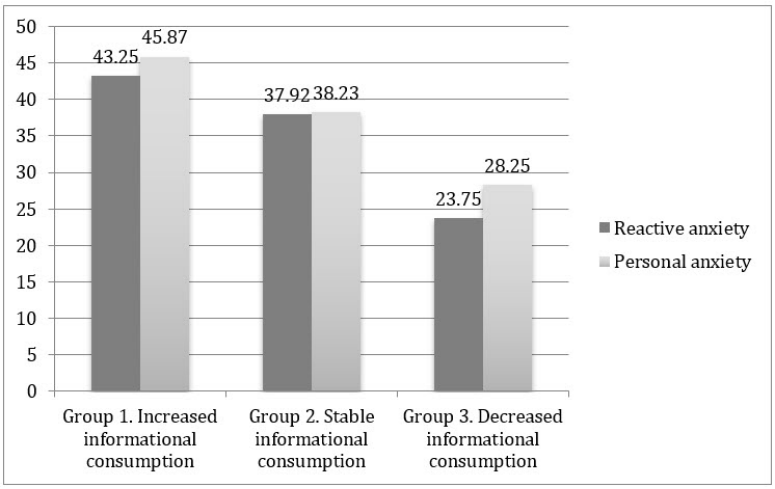

Figure 3. Level of reactive and personal anxiety in groups with different informational consumption

The level of anxiety is the highest in Group 1. The average scores in Group 3 are the lowest in the sample. Group 2 showed medium results. In all experimental groups the level of personal anxiety is insignificantly higher than situational anxiety.

In order to identify the relationship between studied indicators, we used the Spearman rank correlation coefficient (Table 1).

Table 1

Results of statistical analysys by Spearman rank order correlation coefficient

Psychological predictors	Spearman rank order correlation	p-value
Tolerance to ambiguity & reactive anxiety	-0,550	0,001
Tolerance to ambiguity & personal anxiety	-0,675	0,000
Hardiness & reactive anxiety	-0,520	0,002
Hardiness & personal anxiety	-0,780	0,000
Commitment & reactive anxiety	-0,427	0,013
Commitment & personal anxiety	-0,732	0,000
Control & reactive anxiety	-0,397	0,022
Control & personal anxiety	-0,865	0,000
Challenge & reactive anxiety	-0,506	0,003
Challenge & personal anxiety	-0,516	0,002

The analysis proved a negative correlation between reactive and personal anxiety and tolerance to ambiguity, hardiness and its components (commitment, control, challenge): in all studied groups the higher is anxiety the lower are the levels of other studied characteristics.

The next step was to determine the significance of differences in the subgroups, using non-parametric Kruskal-Wallis test (Table 2).

Table 2

Differences in the components of hardiness, the level of tolerance to ambiguity and anxiety in groups with different informational consumption

Variables	Changes in informational behavior (Mean Rank)			Significance of Differences (Kruskal-Wallis test)	
	Increased N = 80	Stable N = 65	Decreased N = 20	H	p
Ambiguity Tolerance Scale					
Tolerance to ambiguity	10,96875	20,69231	29,12500	14,41695	0,0007
The Personal Views Survey III-R					
Hardiness	11,00	21,15385	27,50	13,29157	0, 0013
Commitment	11,34375	21,65385	24,50	10,94187	0,0042
Control	11,71875	20,34615	27,25	10,87155	0,0044
Challenge	10,96875	21,57692	26,25	13,14260	0,0014
Scale for assessing the level of reactive and personal anxiety					
Reactive anxiety	21,93750	15,38462	2,50	13,59286	0,0011

Note: H- Kruskal-Wallis H-test (one-way ANOVA on ranks), p=probability value

The analysis showed significant differences between groups with different informational consumption on all psychological charactiristics, except personal anxiety. This supports the idea that personal anxiety is a more stable personal trait. It's a stable tendency to perceive a large range of situations as threatening, that is not changing in pandemic situation, while reactive anxiety essentially depends on the specific situation that causes it.

Discussions

One of the main goals of this empirical research was to show that informational behavior can be considered as a stress management strategy and a way to adapt to changing or uncertain situations. There was a significant positive correlation between Informational consumption and levels of Tolerance to Ambiguity, Hardiness, Commintment, Control and Challenge and negative correlation with Reactive and Personal Anxiety.

This is in good agreement with the findings of A. Sh. Tkhostov, E. I. Rasskazova, who have studied the correlation of the different types of anxiety of in the pandemic situation with the search for information about coronavirus and with protective actions (Tkhostov and Rasskazova, 2020). The authors identified two aspects in the structure of anxiety about the coronavirus: the fear of the infection and anxiety about negative consequences. Tracking pandemic information is considered a defensive reaction (clarifying information, searching for what reassures or concretizes the threat, giving an action plan) (Tkhostov and Rasskazova, 2020). Described informational behavior strategy has a significant correlation with high level of anxiety (Huang and Zhao, 2020).

Our results have a number of similarities with D. A.Leontiev, E. I. Rasskazova results of studying the connection between subjective well-being with coping strategies and anxiety about coronavirus in the pandemic situation. Emotionally oriented coping strategies associated with a higher level of pandemic anxiety. Problem-oriented and active coping strategies are weakly associated with lower anxiety that could be explained by the lack of effective methods of resolving this new and uncertain situation (Leontiev et all., 2011). In this context, our strategies of informational consumption can be attributed to emotionally oriented coping strategies that assume involving mental avoidance of the problem and finding ways to distract.

This idea supports the previous findings in the literature (Liu, 2020), that COVID-19 information consumption on the Internet and social media during the infectious disease outbreak could elicit intense worry, and in turn increase preventive behaviors by engagement in the COVID-19 preventive actions.

Tull and others examined the impact of COVID-19 and stay-at-home orders on psychological outcomes. The authors have shown that the perceived impact of COVID-19 on daily life was positively

associated with health anxiety, financial worry, and social support, but negatively associated with loneliness (Tull et al., 2020).

Our results can be supplemented by the findings of some foreign scientists in the field of psychological predictors. Traunmüller et al., (2020) have evaluated the psychological distress in Austria during the initial stage of the COVID-19 outbreak and highlighted the factors making a personality psychologically vulnerable or psychologically protected. Being a female, higher age, lower levels of education, concern about family members, the internet as the main source of information, student or pupil status, poor self-rated health, and the attitude that "there is too much unnecessary worry" were significantly associated with higher psychologically vulnerability. Protective factors were the possibility to work in home office, frequent (indirect) contact with family or friends, the availability of virus-specific information, confidence in the diagnosis capability, and physical activity during the crisis (Traunmüller et al., 2020). Remarkably that informational behavior (the internet as the main source of information) is distinguished as a factor of negative influence on coping the stress. Our results do not support this suggestion, as our respondents indicated increased anxiety after consuming TV-content. Internet content was considered as a more objective and giving more confidence and decreasing the ambiguity of situation.

The findings of C.Traunmüller, R.Stefitz, et al, correlate well with the results of the survey, conducted in China in January-February 2020, studying the levels of psychological impact, anxiety, depression, and stress during the initial stage of the COVID-19 outbreak. Wang et al., (2020) showed that female gender, student status, specific physical symptoms, and poor self-rated health status were significantly associated with a greater psychological impact of the outbreak and higher levels of stress, anxiety, and depression. Specific up-to-date and accurate health information (e.g., treatment, local outbreak situation) and particular precautionary measures (e.g., hand hygiene, wearing a mask) were associated with a lower psychological impact of the outbreak and lower levels of stress, anxiety, and depression (Wang et al., 2020). Getting up-to-date information is highlighted as a factor of decreasing stress and anxiety.

Thus, most researchers agree that the regulation of information consumption and communication can be an effective way to overcome the stress of ambiguity and anxiety in a pandemic situation.

Conclusions

We have described empirical research of psychological reasons for informational consumption in the COVID-19 pandemic. The findings of this study indicate a significant correlation between informational behavior and psychological characteristics related to coping with stress: tolerance to ambiguity, hardiness, anxiety. We have demonstrated that respondents with increased informational consumption have low or negative scores in Tolerance to Ambiguity, average (but lowest in the sample) values in Hardiness, Commitment, Control, Challenge, and the highest in the sample of Reactive and Personal Anxiety. Respondents with stable informational consumption have average positive scores in Tolerance to Ambiguity, high values in Hardiness, Commitment, Control, and Challenge and a moderate level of Reactive and Personal Anxiety. Respondents with decreased informational consumption showed high levels of Tolerance to Ambiguity, Hardiness, Commitment, Control, and Challenge and low levels of Reactive and Personal Anxiety.

Taken together, these findings suggest that increased informational consumption can be considered as a coping strategy of overcoming the pandemic social isolation for respondents with low hardiness and tolerance to ambiguity: searching different types of information (in particular the latest news about the COVID-19 pandemic) helps such people to overcome the ambiguity of the situation, makes their life more understandable and predictable, thereby giving confidence in the future and making today's interesting. Stable informational consumption indicates that these respondents are stable and confident in their interests, in their need for the information necessary to feel safe. Decreased informational shows that for feeling calm and enjoy the opportunity to spend time on social isolation, these respondents do not need outside information.

Limitations

Our research has some limitations. We didn't take into account the age and gender characteristics of the respondents, but obviously, informational consumption among representatives of different generations may vary due to different reasons.

Acknowledgments

The research was supported by the Russian Foundation for Fundamental Research (Project No. 18-29-22004) (2018) «Psychological and genetic studies of users' behavior predictors that determine the perception of Internet content of various informational orientation».

Conflict of interests

The authors declare no conflict of interest.

References

Adorno T. W., Frenkel-Brunswik E., Levinson D. J., & Sanford R. N. (1950). *The Authoritarian Personality.* New York: Harper & Brothers. Retrieved from http://www.ajcarchives.org/main.php?GroupingId=6490

Budner, N. Y. (1962). Intolerance of ambiguity as a personality variable. *Journal of personality, 30*(1), 29-50. https://doi.org/10.1111/j.1467-6494.1962.tb02303.x

DeRoma, V. M., Martin, K. M., & Kessler, M. L. (2003). The relationship between tolerance for ambiguity and need for course structure. *Journal of instructional psychology, 30*(2), 104. Retrieved from https://www.questia.com/library/journal/1G1-105478978/the-relationship-between-tolerance-for-ambiguity-and

Enikolopov, S. N., Boyko, O. M., Medvedeva, T. I., Vorontsova, O. U., & Kazmina, O. Y. (2020). Dynamics of psychopathological reaction at the first stage of COVID-19 pandemics. *Psychological-Educational Studies, 12*(2), 108-126. Retrieved from https://psyjournals.ru/en/psyedu_ej/2020/n2/Enikolopov_et_al.shtml

Enikolopov S. N., & Kaz'mina O. Yu. (2020). Dynamics of psychopathological reaction at the first stage of COVID-19 pandemics. *Psikhologicheskaya gazeta* [Psychological Newspaper]. Retrieved from https://www.psy.su/feed/8182/

Freeston, M. H., Tiplady, A., Mawn, L., Bottesi, G., & Thwaites, S. (2020). Towards a model of uncertainty distress in the context of Coronavirus (Covid-19). *The Cognitive Behaviour Therapist, 13, E31.* https://doi.org/10.1017/S1754470X2000029X

Frenkel-Brunswik, E. (1948). Tolerance toward ambiguity as a personality variable. *American Psychologist, 3*(268), 385-401.

Hazen, B. T., Overstreet, R. E., Jones-Farmer, L. A., & Field, H. S. (2012). The role of ambiguity tolerance in consumer perception of remanufactured products. I*nternational Journal of Production Economics, 135*(2), 781-790. https://doi.org/10.1016/j.ijpe.2011.10.011

Herman, J. L., Stevens, M. J., Bird, A., Mendenhall, M., & Oddou, G. (2010). The tolerance for am-biguity scale: Towards a more refined measure for international management research. *International Journal of Intercultural Relations, 34*(1), 58-65. https://doi.org/10.1016/J.IJINTREL.2009.09.004

Huang Y., & Zhao N. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: a web-based cross-sectional survey. *Psychiatry Research,* 288. https://doi.org/10.1016/j.psychres.2020.112954

Kajs, L. T., & McCollum, D. L. (2010). Dealing with ambiguity: Assessment of tolerance for ambiguity in the context of school leadership. *Academy of Educational Leadership Journal, 14*, 77. Retrived from https://www.questia.com/library/journal/1G1-241861824/dealing-with-ambiguity-assessment-of-tolerance-for

Kharlamenkova N. E., Bykhovets Yu. V., Dan M. V., & Nikitina, D. A. (2020). *Perezhivanie neopredelennosti, trevogi, bespokoistva v usloviyakh COVID-19* [Experiences of uncertainty, anxiety and unrest during COVID-19] [Elektronnyi resurs]. IP RAS, 2020. Retrieved from http://ipras.ru/cntnt/rus/institut_p/covid-19/kommentarii-eksp/har-1.html?fbclid=IwAR2oJC9T6N8XvicF7wz4neKQ8r8Yc3POe8bqmOzG%20NFaBJqWO77L6FBUNnok

Kuzmin M. Yu., Gusev A. N., & Konopak I. A. (2011). The relationship between gender identity and resilience among female students studying at a university. *Bulletin of ZabGU, 11*, 58-62. Retrived from https://cyberleninka.ru/article/n/svyaz-gendernoy-identichnosti-i-zhiznestoykosti-u-studentok-obuchayuschihsya-v-vuze

Leontiev, D. (2019). Happiness and subjective well-being: towards the construction of a conceptual field. *The monitoring of public opinion economic & social changes 1.* Retrieved from https://doi.org/10.14515/monitoring.2020.1.02

Leontiev, D., Mandrikova, E., Rasskazova, E., & Fam, A. (2011). *Hardiness as a component of personal potential. Lichnostniy potencial: stryktyra I diagnostika* [Personal potential: structure and diagnosis]. Moscow, Meaning. Retrieved from https://www.hse.ru/data/2013/03/10/1293613146/Леонтьев%20Мандрикова%20Рассказова%20Фам%202011%20..уации%20неопределенности%20и%20выбора.pdf

Litman, J. A. (2010). Relationships between measures of I-and D-type curiosity, ambiguity toler-ance, and need for closure: An initial test of the wanting-liking model of information-seeking. *Personality and Individual Differences, 48*(4), 397-402. https://doi.org/10.1016/j.paid.2009.11.005

Loginova M. V. (2010) Psychological maintenance of viability of the identity of students [Psikho-logicheskoe soderzhanie zhiznestoikosti lichnosti studentov]. *Cand. Diss., 225.* Retrived from http://nauka-pedagogika.com/viewer/311197/a?#?page=1

Liu, P. L. (2020). COVID-19 Information Seeking on Digital Media and Preventive Behaviors: The Mediation Role of Worry. *Cyberpsychology, Behavior, and Social Networking 23*(10), 677-682. https://doi.org/10.1089/cyber.2020.0250

Mac Donald, A. P. (1970). Revised Scale for Ambiguity Tolerance: Reliability and Validity. *Psychological Reports, 26*(3), 791–798. https://doi.org/10.2466/pr0.1970.26.3.791

Maddi, S. R. (2015). Hardiness. *The Encyclopedia of Adulthood and Aging*, 1-4. https://doi.org/10.1002/9781118521373.wbeaa002

Maddi, S. R., Khoshaba, D. M., Harvey, R. H., Fazel, M., & Resurreccion, N. (2011). The personality construct of hardiness, V: Relationships with the construction of existential meaning in life. *Journal of Humanistic Psychology, 51*(3), 369-388. https://doi.org/10.1177/0022167810388941

Norton, R. W. (1975). Measurement of ambiguity tolerance. *Journal of personality assessment, 39*(6), 607-619. https://doi.

org/10.1207/s15327752jpa3906_11

Odintsova M. A. (2015). *The psychology of resilience*. Moscow: Flint Nauka. Retrieved from http://ppms.edu-penza.ru/documents/Психология%20жизнестойкости%20Учебное%20пособие.pdf

Rasskazova, E. I., Leontiev, D. A., & Lebedeva, A. A. (2020). Pandemic as a challenge to subjective well-being: anxiety and coping. *Counseling Psychology and Psychotherapy, 28*(2). 90-108. https://doi.org/10.17759/cpp.2020280205

Soboleva E. V., & Shumakova O. A. (2014). *The phenomenon of resilience in foreign and domestic research. Sovremennie naychnie issledovania i innovacii* [Modern scientific research and innovation]. Retrieved from: http://web.snauka.ru/issues/2014/05/34519

Spielberger C. D. (1972). Current trends in theory and research. *Anxiety-Current trends and theory*, 3-19. https://doi.org/10.1016/B978-0-12-657401-2.50008-3

Stankovska G., Memedi I., & Dimitrovski, D. (2020). Coronavirus COVID-19 disease, mental health and psychosocial support. *Society Register, 4*(2), 33-48. https://doi.org/10.14746/sr.2020.4.2.03

Tkhostov A. Sh., & Rasskazova, E. I. (2020). Psychological Contents of Anxiety and the Prevention in an Infodemic Situation: Protection against Coronavirus or the "Vicious Circle" of Anxiety?. *Counseling Psychology and Psychotherapy, 28*(2), 70-89. https://doi.org/10.17759/cpp.2020280204

Traunmüller, C., Stefitz, R., Gaisbachgrabner, K., & Schwerdtfeger, A. (2020). *Psychological correlates of COVID-19 pandemic in the Austrian population*. PREPRINT (Version 1) available at Research Square https://doi.org/10.21203/rs.3.rs-23337/v1

Trottier, Magan, Wendy Roberts, Irene Drmic, Stephen W. Scherer, Rosanna Weksberg, Cheryl Cytrynbaum, David Chitayat, Cheryl Shuman, and Fiona A. Miller (2013). Parents' perspectives on participating in genetic research in autism. *Journal of Autism and Developmental Disorders 43*(3), 556-568. https://doi.org/10.1007/s10803-012-1592-y

Tull, M. T., Edmonds, K. A., Scamaldo, K., Richmond, J. R., Rose, J. P., & Gratz, K. L. (2020). Psychological outcomes associated with stay-at-home orders and the perceived impact of covid-19 on daily life. *Psychiatry research,* 289, 112098. https://doi.org/10.1016/j.psychres.2020.113098

Våpenstad, E. V. (2010). The ambiguity of the psychoanalytic situation and its relation to the analyst's reverie. *Psychoanalytic psychology, 27*(4), 513-535. https://doi.org/10.1037/a0020454

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International journal of environmental research and public health, 17*(5), 1729. https://doi.org/10.3390/ijerph17051729

Zhu, D., Xie, X., & Xie, J. (2012). When do people feel more risk? The effect of ambiguity tolerance and message source on purchasing intention of earthquake insurance. *Journal of Risk Research, 15*(8), 951-965. https://doi.org/10.1080/13669877.2012.686051

Original scientific paper

UDK: 159.922.72.072-057.875

Received: October, 06.2020.
Revised: November, 06.2020.
Accepted: November, 11.2020.

doi: 10.23947/2334-8496-2020-8-SI-69-77

Cognitive-Conceptual Model for Developing Foreign Language Communicative Competence in Non-Linguistic University Students

Alla Evtyugina[1], Aizhanna Zhuminova[2], Elena Grishina[3], Irina Kondyurina[4], Marina Sturikova[4]*

[1]Department of Russian and Foreign Languages, Russian State Vocational Pedagogical University, Ekaterinburg, Russian Federation, e-mail: alla.evtyugina@rambler.ru
[2]Department of Journalism and Translation, "Turan" University, Almaty, Kazakhstan, Russian Federation, e-mail: aktobedrp@mail.ru
[3]Department of Foreign Languages, Ural Institute of State Fire Service of EMERCOM of Russia, Ekaterinburg, Russian Federation, e-mail: GrishinaLena18@yandex.ru
[4]Department of Russian and Foreign Languages, Russian State Vocational Pedagogical University, Ekaterinburg, Russian Federation, e-mail: im.kon@mail.ru; Sturikova_marina@mail.ru

Abstract: This study is devoted to the foreign language communicative competence development among non-linguistic universities under-graduate students. This research covered the issue of foreign language education based on the cognitive-conceptual model for teaching English to non-linguistic university students. As the main research method, pedagogical modelling was chosen. The experiment was conducted at Russian State Vocational Pedagogical University, Ural Federal University named after the first President of Russia B.N. Yeltsin, and Ural Institute of State Fire Service of EMERCOM of Russia among 72 undergraduate students. The results of several curriculum-based tests showed that the percentage of correct determination of expressions with the context available increased from 54% to 93.2% in EG1, and from 41.9 to 85.5% in EG2. The overall students' understanding of lexical units increased by 39.2% and 43.6%, respectively. The ratio of misunderstanding/understanding of speech utterances increased from 15/7 to 6/16, while the proportion of students who do not use/use various interpretation strategies changed from 8/14 to 3/19. The developed cognitive-conceptual methodology effectiveness for teaching foreign language communicative competence was proven. It can be applied to train students of various specialisations at different university degree levels.

Keywords: pedagogical modelling, professional activity, intercultural communication, teaching method, competence.

Introduction

Today, globalisation and informatisation are rapidly changing the world and human life. Such transformations have led to considerable shifts in the organisation of world education, changes in the educational paradigm, and in particular, in teaching a foreign language (Sinkus, 2019).

The central goal of foreign language teaching in our newly created educational environment is not just mastering the communicative skills, but the development of readiness and ability to interact with representatives of other cultures. This goal necessitates the creation of a new methodological system that takes into account the current sociocultural and educational background (Dudeney and Hockly, 2016; Kosareva et al., 2019). As a result, there is a need for the learning process to focus on an in-depth awareness of foreign cultural phenomena, as well as perception, understanding and interpretation of a foreign language message in the aggregate with linguistic and extralinguistic characteristics. Modern linguistic education should be concentrated on the formation of strategies to overcome various difficulties in foreign language communication and provide the ability to analyse and evaluate the received information, interlocutors' actions and opinions (Kuprina et al., 2019). The emergence of post-non-classical education, characterising the current educational system in Russia, is taking place against the backdrop of changes in the educational paradigm and in the way of providing educational services (Vujičić and Tambolaš, 2019). As a consequence, one may note the emergence of an educational society based on integrity, fundamentality, evolutionism, self-organisation, and human-centric ideas. The learning process is now viewed not only as preparation for a certain future activity but also as an adaptation to social life (Biserova and Shagivaleeva, 2019).

*Corresponding author: alla.evtyugina@rambler.ru

The current study introduces the concept of 'cognitive-conceptual model.' Throughout this paper, this term will refer to an integral model focused on the formation of the multicultural personality of a student as a subject of foreign language communication. In addition, the cognitive-conceptual model is aimed at teaching students how to adequately interpret sociocultural realities in a foreign language context and communicate with a representative of another culture, while bearing in mind the peculiarities of his/her perception of the world. The novelty of this study lies in an attempt to solve complex issues of the synergy of functional characteristics of foreign language communication in connection with the development of educational paradigm, based on the perception of speech as a process carried out by neurophysiological structures (Ud Din and Akhlaq, 2019).

Literature review

In recent years, most of foreign language teaching models applied in higher educational institutions are aimed at developing certain competencies required by university curricula or education levels (bachelor's degree, master's degree, postgraduate studies) (Li and He, 2019).

Today's professionally-oriented methodologies of foreign language teaching are focused on the development of a set of skills related to the achievement of one's individual objectives (Sinkus, 2019). In the current multilingual environment, language teaching methods are responsible for delivering a particular linguistic picture of the world. This fact emphasises the importance of not just learning a language, but the formation of communicative competence (Lasekan, 2020). In the rapidly developing information society, apart from the ability to receive and process a large amount of data, a person should also possess the skills of highly organised non-linear thinking. Such thinking is characterised as a holistic and alternative vision of reality which can offer a variety of possible solutions. It provides a possibility to express doubts about the truth of the available knowledge by improving the ability to analyse, interpret, and correct one's own thoughts (Resnick, 1987).

Currently, a growing body of literature examines theoretical and practical aspects of language competence (Celce-Murcia, 2008). In the educational field, language competence is predominantly understood as the ability to carry out communication in accordance with the study program requirements, based on a set of knowledge, skills and abilities, necessary for successful interaction (Jacobson, 2020; Sergeeva, 2014).

A considerable number of research papers also investigates the structure of the language competence. In particular, Lynch (2011) describes language competence as a combination of various components. He believes that this concept includes the understanding of the peculiarities of foreign thinking patterns, awareness of various communicative scenarios, and knowledge of strategies that can help to overcome the communication difficulties. At the same time, Kecskes (2014) argues that language competence also includes such an element as the ability to correlate and interpret the events of another culture and critically assess one's own activity.

Another area of research is devoted to identifying the relationship between communicative and intercultural competences. The analysis of scientific works on this issue has revealed that many scholars tend to single out communicative competence as a separate type of intercultural competence (Deardorff, 2009; Lasekan, 2020). Communicative competence is often referred to as the ability that allows an individual to realise him/herself within the framework of a cross-cultural dialogue (Li, et al., 2017; Jacobson, 2020) and successfully communicate in the environment with different cultural context (Entwistle, 2017; Biserova and Shagivaleeva, 2019). In the meantime, intercultural competence is defined as the ability to effectively and adequately implement communicative behaviour and achieve the desired conversation outcome in the light of the specific nature of the communicative situation (Goh and Aryadoust, 2016).

The thorough analysis of various interpretations of the intercultural competence enables identifying its important characteristics. In particular, it becomes clear that intercultural competence is much broader than communicative competence. It takes into account factors that act as intermediaries in the dialogue between different linguistic consciousnesses. This difference creates a conflicting linguocultural background that requires awareness and consideration of communicants' cultural features as various strategies of communicative behaviour of representatives of different cultures are manifested the most clearly exactly in the intercultural dialogue. For this reason, the immersion into the socio- and ethnocultural context of communication is necessary for the formation of intercultural competence (Marsh, 2002).

Materials and Methods

The experiment was based at Russian State Vocational Pedagogical University (Ekaterinburg, Russia), Ural Federal University named after the first President of Russia B.N. Yeltsin (Ekaterinburg, Russia), and Ural Institute of State Fire Service of EMERCOM of Russia (Ekaterinburg, Russia). The sample population included 72 undergraduate students (39 women and 33 men) in the first and second years of study majoring in:

- Ecology and Nature Management (Ural Federal University named after the first President of Russia B.N. Yeltsin);
- Technosphere safety (Ural Institute of State Fire Service of EMERCOM of Russia);
- High-tech welding (Russian State Vocational Pedagogical University).

The selection of study participants was conducted by means of placement test (Placement Test, Upstream, Enterprise), which was offered on the pre-experimental stage. The test was aimed at selecting students with minimum sufficient level of foreign language proficiency which would enable them to take part in this study. This level was recognised as B1 (Intermediate) according to the Common European Framework of Reference for Languages. However, individuals with A2 English (Pre-Intermediate) were also allowed to participate since they represent a fairly large proportion of students in non-linguistic faculties (almost half).

Since a new method and even a new teaching methodology is proposed, it was necessary that it did not overlap with the teaching methods already known to the participants, which were used in their training earlier. At the same time, the cognitive approach to learning manifests itself most effectively if the student has basic knowledge, on the basis of which he can embed new knowledge into his model of cognizable knowledge (Warner and Dupuy, 2018). The optimal choice was the participants with the minimum basic level of foreign language proficiency. For the same reason, cutting off the impact of other influences from other teaching methods and previously obtained higher knowledge in the field of English, it was decided to exclude from the sample students of specialized linguistic faculties or those who had an in-depth study of English from the beginning of their studies.

In the course of the study, the participants were offered a set of tests, which are sequentially described below in the Results section, which are included in the research group of cognitive activity in the course of applying language skills of recognition, translation, combinatorics, determination of lexical and semantic units of text, assumption that idiomatic expressions, analysis of deep understanding of phrases and expressions (Kecskes, 2014; Li and He, 2019). Specific methods of processing statistical results for every step of research and their presentation for the convenience of the reader are sequentially presented in the Results section.

During the experiment, no personal information that could be used to identify the study participants was collected, stored or used. All respondents were aware of the experiment's goal and voluntarily agreed to be involved. The statistical processing and visualisation of data were performed via Microsoft Excel spreadsheet program.

The research object was represented by the fragments of English culture-specific discourse because they reveal the sociocultural and cognitive-conceptual specifics of speech activity. As the study material, fragments of oral and speech polemics in English that contain sociocultural and contextual lexical units were used.

The study material was sampled from the Corpus of Contemporary American English. As noted by Maxom (2010), this electronic resource is a 'synchronic model' of the national language, since it reflects various manifestations of cognitive-conceptual and sociocultural characteristics of the language as well as the frequency of the use of lexical units.

The Corpus was used as a bank of examples that represent oral linguistic material of modern American English. The creation of a database of texts in the form of oral cognitive-conceptual fragments made it possible to select target lexical units based on the criteria of their frequency of use. Thus, the list of chosen lexical items comprised of ten sociocultural and contextual expressions (Soboleva and Obdalova, 2015).

The collection of empirical data included the results of students' cognitive-conceptual activity. Respondents had to categorise speech phrases by types, translate target lexical units into Russian without and with the context available, analyse a communicative situation using the cognitive-conceptual analysis method, interpret a communicative situation and compare it with similar ones in the Russian discourse.

As for the research methodology, the authors used the interview in the form of narrative communication. Such interviews were conducted after university classes in the process of the experimental

training and during the classes after its end. As data collection tools, specially designed tasks, data of pedagogical observations, results of the surveying of involved students and teachers, and content analysis were used.

Results

First of all, study participants were offered a categorisation task based on the visual perception of target lexical units in a text fragment. It allowed determining the manifestation of students' cognitive abilities while classifying English phrases. The pie chart in Figure 1 exposes that the greatest difficulty was in categorising situation-bound utterances (SBUs). The percentage of incorrect determination of SBUs constituted 60%; fixed semantic units (FU) – 24%; and idiomatic expressions (ID) – 17%.

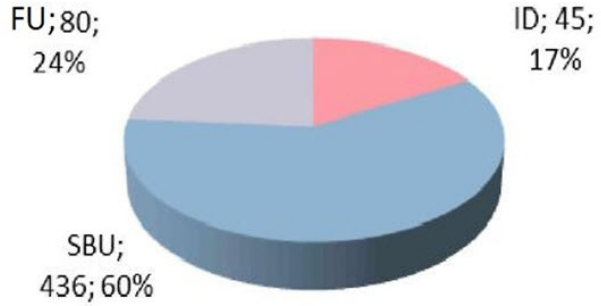

Figure 1. Percentage of errors in the categorisation of lexical units

The obtained empirical data confirmed the assumption that idiomatic expressions, as bright and emotionally coloured phrases, are easier to remember and identify among other lexical units. Tasks 2 and 3 were carried out on the basis of an authentic foreign language context and supposed its auditory perception. In the second test, students were required to understand the meanings of ten situational expressions. In the third test task, the cognitive-conceptual and intercultural-communicative aspects of students' activities were assessed according to the parameters of understanding/misunderstanding, depth of understanding, and management of individual speech-thinking activity (the ability to link a concept to native culture and personal life experience).

In order to examine the cognitive-conceptual aspect of students' speech and thinking activity, this study compared the frequency of the use of strategies to interpret the meanings of lexical units and communicative situations on the example of expressions under consideration. The investigation revealed that the percentage of correct determination of expressions with the context available increased significantly – from 54% to 93.2% in EG1, and from 41.9 to 85.5% in EG2. Thus, the overall students' understanding of lexical units increased by 39.2% and 43.6%, respectively. As a consequence, it can be asserted that the provision of situational context increased the quality of perception, thereby contributing to the analysis and synthesis of all the semantic properties of a linguistic unit (Figure 2).

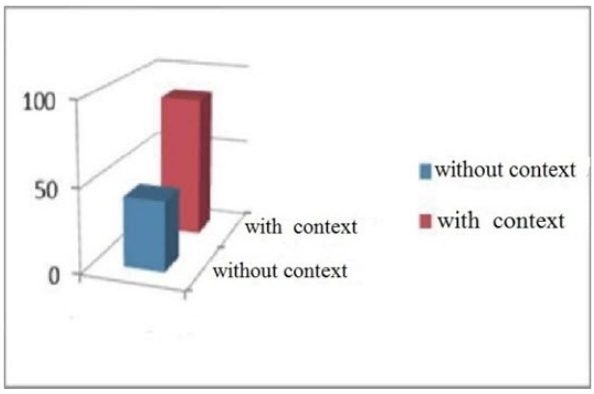

Figure 2. Improvement in understanding a lexical unit depending on the context availability

The analysis of the depth of understanding parameter showed that students' application of the strategy of meaning extraction based on literal translation did not allow revealing the implicit meaning of a

holistic phrase (Goswami and Bryant, 2007). Such individuals failed to realise the meaning of the phrase even though they could translate all the words in it.

As the study showed, most respondents had no idea about the different characteristics of the context and diverse ways of expressing standard speech formulae in English. The analysis of students' notes showed that the majority of examination participants relied predominantly on the literal meanings of words. Figures 3 and 4 show the ratio of students' correct and incorrect interlingual translations of situational expressions with and without the context available.

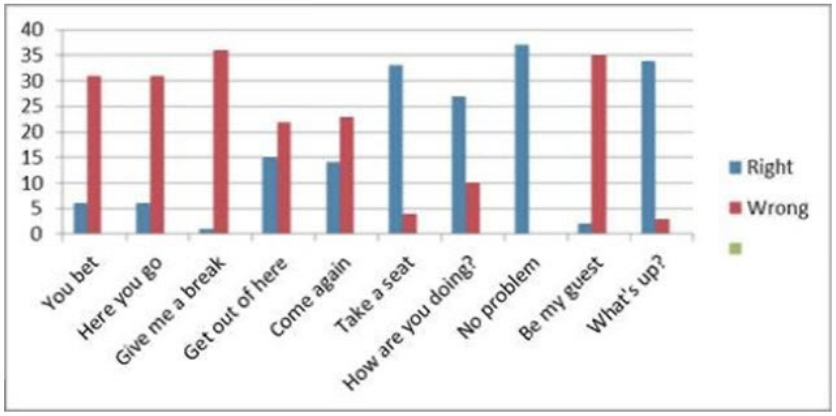

Figure 3. Correlation between correct and incorrect interpretations of situational expressions without the context available (for EG2)

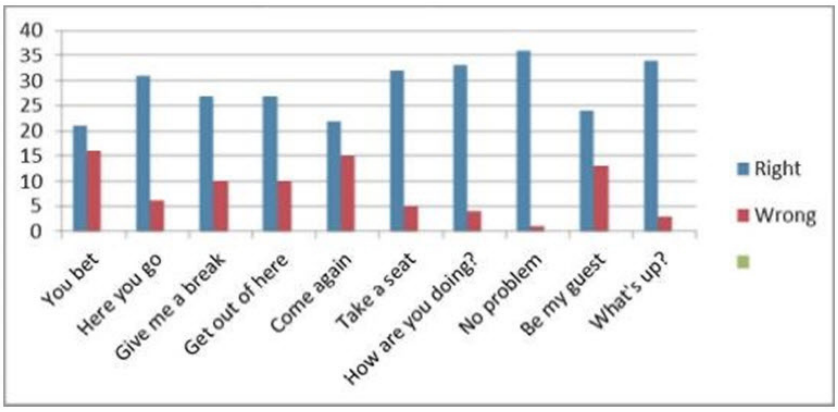

Figure 4. Correlation of correct and incorrect interpretations of situationally conditioned expressions with the context available (for EG2)

For a comprehensive assessment of the formation of foreign language communicative competence according to the cognitive-conceptual aspect of foreign language activity, the method of complex assessment was applied (modified methodology of Tobias and Everson (2002)).

Based on the formula for calculating the coefficient of communicative competence (E), one can get the value E = 1 when the student is successful in all the selected parameters of foreign language activity (indicators a and b have a '+' sign). This indicates that the one understands the context at the semantic level and relies on a set of effective strategies for foreign language speech interpretation. The value E = –1 is obtained when the student does not demonstrate the understanding of the text and flexibility in the use of speech strategies (indicators c and d have a '–' sign). The value E = 0 can be achieved only in case of equal numbers of successful and unsuccessful manifestations of the parameters of communicative and cognitive-conceptual activity (c and d).

To demonstrate the technique of complex assessment of the formation of foreign language communicative competence in terms of the cognitive-conceptual aspect, the authors of the current study applied it on 22 individuals from EG1. The corresponding data were based on the analysis of students' test results and were collected at the beginning and at the end of the experimental work. In such a manner, at the beginning of the training, 5 students out of 22 had a 'zero' level of competence – they neither understood the content of the utterances nor used meaning extraction strategies. In the meantime, by the end of the experiment, only one person was described as such. Furthermore, at the beginning of

the experimental work, 10 students out of 22 did not achieve an understanding of the implicit meaning of the lexical unit but understood the general meaning of the communicative situation without the use of interpretation strategies. In this respect, it was noted that only 5 students had such a result after the experiment finished. As for those who managed to extract the meaning of a speech utterance, but did not use various interpretation strategies, only 3 such students were noted before the experimental training, and 2 after its end. A situation, when one of the considered skills was not developed, designates a low level of language competency. Out of 22 individuals, 14 successfully interpreted the meaning of a lexical unit and demonstrated good discourse analysis skills (compared to 4 students before the experiment started). As a result, the given data indicate that the performed experimental training provided the possibility to increase the level of English language competence.

The ratio of misunderstanding/understanding of speech utterances increased from 15/7 to 6/16, and the ratio of non-using/using various interpretation strategies increased from 8/14 to 3/19.

Figure 5 depicts the dynamics of the formation of foreign language communicative competence among undergraduate students from EGs as a result of the approbation of the cognitive-conceptual model of teaching. The radial diagram demonstrates a significant improvement in students' language competence according to the five parameters. The external figure, reflecting their values at the end of the experiment, is much larger than the internal one corresponding to the beginning of training, showing increments of up to 80% or more.

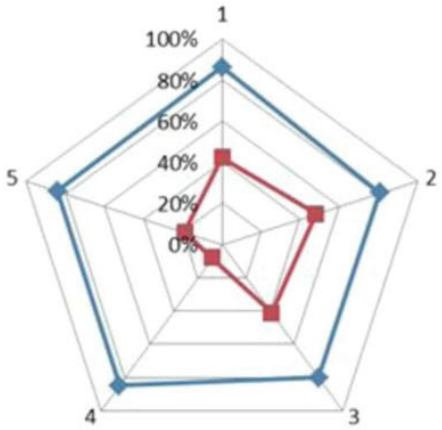

Figure 5. Dynamics of the formation of foreign language communicative competence (%)

Diagnostic parameters:
1 – understanding of professionally-oriented texts;
2 – use of professional vocabulary;
3 – speech activity;
4 – understanding of socio-culturally marked realities;
5 – variability of the strategies used for foreign speech interpretation.

At the final stage of the experiment, students' levels of formation of the foreign language communicative competence were assessed based on the results of the control task fulfilment. The interpretation of the results obtained made it possible to draw a conclusion about the positive dynamics of the development of foreign language communicative competence in the experimental and control groups. The level of understanding culturally marked lexical units changed from 62% and 68% to 92% and 94% in the EG1 and EG2, respectively, and from 64% to 68% in the CG. In the meantime, the level of competence in professionally-oriented discourse increased from 82% and 77% to 92% and 94% in EG1 and EG2, respectively, and from 86% to 88% in CG. Given the collected data, it may be argued that the observed positive dynamics resulted from the application of the developed cognitive-conceptual training model.

Discussion

Modelling as a research method came to pedagogy from mathematics and cybernetics and significantly expanded the ability of teachers to obtain better representations of examined objects (Celce-Murcia, 2008; Jacobson, 2020). Researchers identify many ways of modelling depending on the object itself and the level of its abstraction (macro- or micro-level) (Jacobson, 2020). The model of the education

system is represented in the macro-level as it sets learning goals and trajectories depending on social needs and principles of adopted state policy. The model of the learning process can be presented in the micro-level as a theoretical structure described by means of didactic and methodological categories (Vujičić and Tambolaš, 2019). Pedagogical modelling is believed to reflect the characteristics of the 'existing education system' (Traxler, 2018). Its most critical characteristics include the integrity of the processes, availability of information describing them, and structural interconnection of the elements of the model (Oudeyer et al., 2016).

In the course of research activities, scholars have identified four types of learning models based on the prevailing components of the course content and student's learning objectives: linguistic, communicative, professionally-oriented, and competence-oriented (Dudeney and Hockly, 2016). Linguistic models are also divided into two types – models aimed at teaching the lexical or grammatical aspect of language (Lewis et al, 1997). The emphasis on the lexical side of training correspondingly develops student's lexical competence. This modelling type touches upon the way of presenting material, describes the desired result of a conversation 'in the form of blocks of lexical units,' and concentrates on verbal language. Correspondingly, grammatically-centred models of students' training focus on grammar. Nowadays, in the modern language learning models, the study of lexical and grammatical aspects is combined and corresponds to changes in students' educational goals, future professional orientation, and learning strategies.

The study of the structure of understanding a foreign language and the formation of language competence as the ability of its contextual use is especially relevant for South and South-East Asia. Historically, in these regions, English and other European languages have become the basis for cultural and economic modernisation as well as a means of everyday communication (Ud Din and Akhlaq, 2019). The communication model of this region is traditionally based on studying a significant amount of texts and other paper materials to accumulate a large number of lexical units before coming into direct contact with a native speaker (Srinivasan, 2018).

In a number of regions of the world, foreign language teachers act as central communicators and authoritative sources in linguistic matters. They have the same features of professional foreign language communicative competence, as identified in the current study (first of all, the understanding of foreign language texts and fluent use of professional vocabulary) (Suryani et al., 2020). In most countries of Western Europe and the USA, according to research results, the domestic and personal cultural aspects of communication competence prevail (Li et al., 2017).

Modern communication models are focused on satisfying student's needs for foreign language activity. Their aim is to teach how to express one's thoughts and provide an understanding of the original foreign-language message. Among foreign methodologists, one of the most accurate descriptions of the communicative approach principles is given by Rivers (1983). She has formulated the task of teaching a foreign language as the ability to apply the acquired communication skills by means of the target language. Such a communication-oriented approach presupposes the use of the principles of personal involvement, meaningful communication, and students' interaction in the process of educational activity.

In accordance with the communicative approach, the language learning process should take into account the peculiarities of real conversation. New models of teaching students are guided by the correspondence of the course material to the real interaction between specialists in a certain area of activity. Such models of teaching, being built on the cognitive-conceptual approach, are implemented in the form known as '(English) language for specific purposes' in various modifications (LSP, ESP, CLIL, etc.) (Daokuan, 2016).

The latest professionally-oriented models of language learning imply the formation of students' ability to communicate in a foreign language against the background of their occupation and through language immersion and content-based instruction (Evdokimova, 2017; Li et al., 2017). A good example of such a methodology can be Content and Language Integrated Learning (CLIL). The term CLIL was created by Marsh (2002) to denote a set of methods for studying the non-linguistic discipline, for instance, Math, using language as the means of education. His methodology is built with reference to the needs of students, based on which the content and methods of teaching are determined. Consequently, CLIL learning methodology pursues a double goal – the simultaneous study of the discipline and the foreign language (Marsh, 2002).

Conclusions

The results of the conducted experiment showed that the indicators of the level of formation of foreign

language communicative competence among the EG respondents, trained according to the cognitive-conceptual model, were higher than those of CG students. The percentage of correct determination of expressions with the context available increased significantly – from 54% to 93.2% in EG1, and from 41.9 to 85.5% in EG2. Thus, the overall students' understanding of lexical units enhanced by 39.2% and 43.6%, respectively. The ratio of misunderstanding/understanding of speech utterances increased from 15/7 to 6/16, while the proportion of students who do not use/use various interpretation strategies changed from 8/14 to 3/19. An increase in the number of strategies used and an increase in the flexibility of thinking lags somewhat behind the level of success in solving practical problems of language understanding.

Within the framework of the present study, it was proved that the positive dynamics in the development of foreign language communicative competence resulted from the enhancement and upgrade of the learning process and training content. The developed methodological system was based on three unique elements: cognitive-conceptual learning, personal learning model, and newly-created teaching methodology. Their synergy laid down a didactic base that contributes to the effective achievement of a new goal of teaching undergraduate students – fluent foreign language communication. The focus of a new teaching methodology, the effectiveness of which has been demonstrated by the results of the experiment, is based not only on the individualization of the learning path, but on cognitive rather than memorizing and repetitive activities during the course of learning.

Based on the analysis of criteria and indicators of training success, this research experimentally confirmed the effectiveness of the cognitive-conceptual learning model. In addition, it was uncovered that the introduction of the proposed training methodology facilitates the formation of a basic level of intercultural competence among students.

The practical significance of this study lies in the possibility of introducing the developed cognitive-conceptual model of teaching foreign language communicative competence into the higher educational institutions' pedagogical practice. Further research in this field will be concentrated on the more detailed development of the methodological provisions of cognitive-conceptual approach and their sub-sequent implementation in scientific, methodological and practical activities.

The results of the research are suggested to be used as a basis for the development of new curricula for the development of the communicative competence of foreign languages. It is also proposed to expand research on the application of the cognitive-conceptual approach to other fields of education.

Acknowledgments

The authors are grateful to the reviewers' and editors' valuable comments that improved the manuscript.

Conflict of interests

The authors declare no conflict of interest.

References

Biserova, G. K., & Shagivaleeva, G. R. (2019). Socio-psychological adaptation of international students to learning and professional activities. *Space and Culture, India, 6*(5), 99-114. https://doi.org/10.20896/saci.v6i5.411

Celce-Murcia, M. (2008). Rethinking the role of communicative competence in language teaching. In *Intercultural language use and language learning* (pp. 41-57). Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-5639-0_3

Daokuan, H. (2016). Jieshao yimen xinxing kexue — kuawenhua de jiaoji. *Waiguo yuyan yu wenxue,* 2, 70-73.

Deardorff, D. K. (2009). *The Sage handbook of intercultural competence*. Sage.

Dudeney, G., & Hockly, N. (2016). *How to Teach English with Technology*. Pearson Education Limited.

Dunn, J. (2016). Computational learning of construction grammars. *Language and cognition, 9*(2), 254-292. https://doi.org/10.1017/langcog.2016.7

Entwistle, J. (2017). Emotional labour. In D. Richardson (Ed.), *The International Encyclopedia of Geography: People, the Earth, Environment and Technology* (pp. 1-3). Wiley-Blackwell. https://doi.org/10.1002/9781118786352.wbieg0313

Entwistle, N., & Ramsden, P. (2015). *Understanding student learning* (Routledge revivals). Routledge.

Evdokimova, M. G. (2017). *Innovative system of professionally oriented foreign language teaching in a non-linguistic university*. Biblio-Globus Publ.

Goh, C. M., & Aryadoust, V. (2016). Learner listening: New insights and directions from empirical studies. *International Journal of Listening, 30*(1-2), 1-7. https://doi.org/10.1080/10904018.2016.1138689

Goswami, U., & Bryant, P. (2007). *Children's cognitive development and learning*. University of Cambridge.

Jacobson, M. J. (2020). Complexity conceptual perspectives for research about educational complex systems. *The Journal of Experimental Education, 88*(3), 375-381. https://doi.org/10.1080/00220973.2019.1652138

Kecskes, I. (2014). Evaluative function of situation-bound utterances. In G. Thompsom & L. Alba-Juez (Eds.), Evaluation in Context (pp. 137-150). John Benjamins Publishing Company. Retrieved from https://languageofevaluation.info/seminar1/wp-content/uploads/2019/03/Thompson-Alba-Juez_ed.-Evaluation-in-Context.pdf#page=150

Kosareva, L., Evreeva, O., & Zakirova, O. (2019). Formation of language competence: Modern issues and strategies in the area of cross-cultural communication. *Space and Culture, India, 7*(3), 149-159. https://doi.org/10.20896/saci.v7i3.525

Kuprina, T. V., Beketova, A. P., & Minasyan, S. M. (2019). Self-organising systems in the context of academic environment. *The Education and Science Journal, 21*(1), 150-166. https://doi.org/10.17853/1994-5639-2019-1-150-169

Lasekan, O. (2020). Using the Interpersonal Relationship Communication Approach to Assess Language Dominance in both Written and Oral Communication among Multilinguals. *Space and Culture, India, 8*(1), 164-176. https://doi.org/10.20896/saci.v8i1.623

Lewis, M., Gough, C., Martínez, R., Powell, M., Marks, J., Woolard, G. C., & Ribisch, K. H. (1997). *Implementing the lexical approach: Putting theory into practice, 3*(1), 223-232. Hove: Language Teaching Publications. Retrieved from http://www.tesl-ej.org/wordpress/issues/volume3/ej09/ej09r10/?wscr

Li, Y., & He, Z. (2019). Environmental Adaptation Theory and application in Standard Language Competence Model. *Ekoloji, 28*(107), 2779-2782. http://ekolojidergisi.com/download/environmental-adaptation-theory-and-application-in-standard-language-competence-model-5910.pdf

Li, Y., Yang, X., & Cheng, L. (2017). The enlightenment of specialised foreign language talents training in the US to our country. *Journal of Anshan Normal University, 1*, 11. http://en.cnki.com.cn/Article_en/CJFDTotal-ASSF201701011.htm

Lynch, T. (2011). Academic listening in the 21st century: Reviewing a decade of research. *Journal of English for Academic Purposes, 10*(2), 79-88. https://doi.org/10.1016/j.jeap.2011.03.001

Marsh D. (2002). *Content and Language Integrated Learning: The European Dimension - Actions, Trends and Foresight Potentia*l. Oxford Univ. Press.

Maxom, M. (2010). *Teaching English as a foreign language for dummies*. John Wiley & Sons.

Oudeyer, P. Y., Gottlieb, J. & Lopes, M. (2016). Intrinsic motivation, curiosity, and learning: Theory and applications in educational technologies. *Progress in brain research, 229*, 257-284. https://doi.org/10.1016/bs.pbr.2016.05.005

Resnick, L. B., & Science National Research Council (US). Committee on Research in Mathematics. (1987). *Education and learning to think*. National Academy Press.

Rivers, W. M. (1983). *Communicating naturally in a second language: Theory and practice in language teaching*. Cambridge University Press.

Sergeeva, N. N. (2014). Foreign language communicative competence in the field of professional activity: Model and method development. *Procedia-Social and Behavioral Sciences, 154*, 250-253. https://doi.org/10.1016/j.sbspro.2014.10.145

Sinkus, T. (2019). The Development of Professional English Language Competence in Business Administration Studies. *Rural Environment. Education. Personality. (REEP), 12*, 173-181. https://doi.org/10.22616/REEP.2019.022

Soboleva, A. V., & Obdalova, O. A. (2015). Strategies in interpretation of culture-specific units by Russian EFL students. *Procedia-Social and Behavioral Sciences, 200*, 69-76. https://doi.org/10.1016/j.sbspro.2015.08.016

Srinivasan, R. T. (2018). Introduction: South Asia from Postcolonial to World Anglophone. *Interventions, 20*(3), 309-316. https://doi.org/10.1080/1369801X.2018.1446840

Suryani, A., Soedarso, S., Diani, K. T. & Rosmawati, R. (2020). English teaching in social and cultural contexts: Language teachers as cultural managers. *LLT Journal: A Journal on Language and Language Teaching, 23*(2), 273-292. http://dx.doi.org/10.24071/llt.v23i2.2470

Tobias, S., & Everson, H. T. (2002). *Knowing what you know and what you don't: further research on metacognitive knowledge monitoring: research report 2002-3.* College Entrance Examination Board. https://files.eric.ed.gov/fulltext/ED562778.pdf

Traxler, J. (2018). Current State of Mobile Learning. In M. Ally (Ed.), *Mobile Learning: Transforming the Delivery of Education and Training* (pp. 9-25). AU Press.

Vujičić, L., & Tambolaš, A. Č. (2019). Educational Paradigm and Professional Development: Dimensions of the Culture of Educational Institution. In J. Lepičnik Vodopivec, L. Jančec, & T. Štemberger (Eds.), *Implicit Pedagogy for Optimised Learning in Contemporary Education* (pp. 77-103). IGI Global. https://doi.org/10.4018/978-1-5225-5799-9.ch005

Ud Din, K., & Akhlaq, M. W. (2019). Influence of English Language in Political Awareness of South Asian Societies: A Comparative Study of India, Pakistan and Bangladesh. *South Asian Studies, 34*(1), 213-225. Retrieved from http://111.68.103.26/journals/index.php/IJSAS/article/view/3236

Warner, C., & Dupuy, B. (2018). Moving toward multiliteracies in foreign language teaching: Past and present perspectives… and beyond. *Foreign Language Annals, 51*(1), 116-128. https://doi.org/10.1111/flan.12316

Original scientific paper

UDK: 159.954.072-053.2

Received: October, 09.2020.
Revised: November, 11.2020.
Accepted: November, 20.2020.

doi: 10.23947/2334-8496-2020-8-SI-79-91

Creativity Formation in the Context of Social and Psychological Adaptation of Preschoolers Aged 5-6 Years

Larysa V. Zdanevych[1], Galyna V. Buchkivska[2], Valentyna V. Greskova[2], Borys M. Andriievskyi[3], Liudmyla A. Perminova[3]*

[1]Department of Pre-School Pedagogy, Psychology and Professional Methods, Faculty of Pre-School Education and Psychology, Khmelnytskyi Humanitarian-Pedagogical Academy, Khmelnytskyi, Ukraine, e-mail: larysazdanevych@gmail.com
[2]Department of Decorative-Applied Arts and Labor Training, Humanitarian Faculty, Khmelnytskyi Humanitarian-Pedagogical Academy, Khmelnytskyi, Ukraine, e-mail: buchkivska181@gmail.com; valiagreskova@gmail.com
[3]Department of Pedagogy of Preschool and Primary Education, Faculty Pedagogical, Kherson State University, Kherson, Ukraine, e-mail: boris1938and@gmail.com; lperminova@gmail.com

Abstract: The aim of the research is to analyze the creativity manifestation in the early stages of ontogenesis; to verify the relationship between creative abilities and social adaptation of preschoolers. The importance of the topic under consideration is determined by the fact that preschoolers' childhood is the main sensitive period for the formation of creativity as the person's adaptive re-source. The deficiency of development during this period cannot be compensated later. The examination of the creative abilities of 115 children aged 5-6 years has been conducted. Based on the total result of seven subtests Torrance Tests of Creative Thinking, three groups of children have been distinguished. They include children with high (N=20), medium (N=79), and low (N=16) creative potential. Data on behavior have been collected from 142 parents and 24 teachers who supervised children during communication situations. The adaptation of preschoolers have been analyzed on three sides: as a set of individual be-havioral reactions conditioning cooperation with the environment (A questionnaire of children's temperament Thomas and Chess); as a social competency – skills in communication with children and adults (expert assessments of teachers based on the open structured supervision), and as an emotional adaptation to life situations (the projective technique of anxiety diagnostics "Choose a face"). In all cases, children with high creative potential demonstrated particular differences. The positive reaction of "approaching" in response to new stimuli, a low sensory threshold, and high speed of adaptation to the change of external terms are a typological profile of a "creative" temperament. Related problems of emotional reaction and the increased anxiety of pre-schoolers have been detected. The development of skills for social competence lags significantly in the group with a low level of creativity. The factorial structure of creative abilities, which presents three types of creativity (subject, verbal, and figurative), and three leading abilities (productivity, originality, and fluency) have been suggested. The particular parameters of creativity corre-late in different ways with the adaptability of preschoolers: the readiness is more successful, and originality is associated with disturbances of emotional regulation. In conclusion, creativity is presented as a natural condition for a child's adaptation.

Keywords: creative potential, intelligence, creativity diagnostics, productivity, originality, readiness, social competences, temperament, anxiety.

Introduction

Understanding creativity evolves with society and its needs. At different times, the ability to be creative was considered as the highest manifestation of the human mind, as a rare talent that contributes to achievements in the sphere of arts and sciences, as a competitive advantage in business, as an attribute of self-actualization, and, finally, as a necessary quality that needs development from an early age (Veldbrekht, 2009). The increased interest in this phenomenon is caused by the growing need for unconventional approaches and innovative products, as well as for cognitive adaptation to social and cultural diversity (Crisp and Turner, 2011). The instability, turbulence of the environment is constantly updating the demands for a person and elevates creativity to the rank of a renewable resource that ensures effective daily adaptation.

The disengagement of convergent thinking bound to a single correct answer and divergent thinking as generating a variety of various ideas in situations where there are no correct answers played a key role in the conceptualization of creativity (Guilford, 1967). The theory of the intellectual threshold was soon

*Corresponding author: larysazdanevych@gmail.com

formulated, proving that intelligence is necessary but not sufficient for creativity (Torrance, 1980). Although discussions on the mutual influence of cognitive abilities are still ongoing (Burlatchuk and Veldbrekht, 2011; Ilagan and Patungan, 2018; Karwowski and Gralewski, 2013); the studies are mainly focused on finding the personal and social prerequisites for creativity. Today, creativity is understood as a set of personal and cognitive qualities contributing to going beyond the things that are known, creating ideas that are novel and, at the same time, correspond to the context (Runco and Jaeger, 2012). The "Four C" model assumes that the results of creativity may have no social value, but be subjectively significant: to educate and transform a personality, to help express oneself, or to solve daily problems (Kaufman and Beghetto, 2009).

Despite the accumulated material, explaining the mechanisms of cognitive processes, their cognitive and personal basis, as well as the social context in which this ability is manifested, the problem of the role of creativity in the formation of adaptive potential is still far from the final decision. The main contradiction is that clear benefits (a possibility to make decisions and act in situations of uncertainty) are combined with problematic aspects. There is a stable idea that creative talent is accompanied by pathologization of the personality, at best, by emotional impertinence and expressed weirdness of behavior. The advantages and disadvantages of creative individuals have been repeatedly confirmed by empirical data (Acar and Runco, 2012; Simonton, 2005; Veldbrekht, 2005; Winston et al., 2014). This inconsistency has led to the creation of a dialectical theory, where creativity appears as a dynamic interaction of order and chaos: creation and destruction, coherence and inconsistency, disinhibition, and restraint (Holm-Hadulla, 2013).

The age-related dynamics of creativity has been studied relatively insufficiently, although it itself can clarify its adaptive nature (Restrepo et al., 2019). In this context, the age of 4-6 is of particular importance, when the first peak of creativity is observed: spontaneous, unconscious, and therefore, the most organic. It is not necessary to teach children creativity - they have a natural bent to explore the world around, wonder, experiment, and fantasize (Hadani and Jaeger, 2015).

We assume that a unique combination of internal and external factors occurs during this short period. On the one hand, the cognitive basis for the development of creative processes is maturing the complication of subject-manipulative operations, speech development, the activation of social interaction, the impetuous development of expertise, and so on. On the other hand, terms of socialization enable a child to demonstrate his/her creativity without special demands and restrictions, as an element of play activity. Then, in the course of socialization, along with the system of rules and means of activity, the child also learns the system of restrictions. It is known that with the beginning of formal schooling, the creativity of children is noticeably reduced and manifests again itself in adolescence, suggesting a critical attitude to the results of their creativity, as well as their conscious opposition to generally accepted rules, stereotypes, and modes of actions (Lilly, 2020). The phase titled "striving for conformity" is necessary for mastering culturally fixed ways of creative activity; at the same time, the psychological mechanisms of mature creativity are based on the abilities developed in early childhood (Druzhinin, 2019; Harrington et al., 1983). Since the preschool age is sensitive for the formation of the creative potential of a personality, the study of creativity in connection with adaptability will help solve important theoretical contradictions, as well as to determine the practical trends of work on developing the necessary qualities in children.

The aim of the research is to analyze the manifestations of creativity at the early stages of ontogenesis, and to find out the relationship between the creative abilities and social adaptation of preschoolers.

The content of research hypotheses determined the following research objectives:

1) to structure the manifestations of creativity in preschoolers, to determine the leading and additional components - we assumed that there is an uneven development of creative processes at this age, which reflects the basic adaptive processes.

2) to clarify the conditions for the formation of creativity on the basis of general cognitive abilities - we assumed that the allocation of creative abilities is due to specific development tasks in certain social conditions.

3) show and prove the differences in the mechanisms of socio-psychological adaptation in preschoolchildren with high and low levels of creativity - we assumed that there are both positive and negative (as well as nonlinear) relationships between creativity and adaptive abilities.

Our study is one of the few that takes a balanced position in the interpretation of creativity as a predictor of socio-psychological adaptation / maladjustment. Separate aspects of creativity have been studied in the context of different aspects of children's adaptation. We consider different sides of this phenomenon in great detail, taking into account the complex action of cognitive, personal and social factors.

Materials and Methods

Procedures and measurement

The diagnostic of psychological peculiarities of preschoolers included five courses of action to collect data from different sources:

1. Torrance Tests of Creative Thinking (TTCT, 1966-1998) reflects the ideas of J. Guildford's concept of divergent thinking. It is a powerful diagnostic tool enabling to measure the classic characteristics of creative potential, starting from the age of 5: fluency – the ability to generate a large number of meaningful ideas; flexibility – the ability to view information at different angles and apply different strategies for solving problems; originality – the ability to introduce unusual, unique answers going beyond the obvious; elaboration – the ability to elaborate on ideas (Torrance, 1998). Tunick (1998) carried out adaptation and standardization of TTCT in Russian. The coherence, validity, and reliability of the adapted version in samples of different ages have been proved. The guide contains lists of typical responses as well as normative data of representative age groups from 5 to 17 years. We used subtests of the figurative battery "Unfinished figures", "Repeated lines" and the verbal battery: "Questions," "Reasons," "Consequences," "Objects improvement," and "Unusual implementation."

The diagnostic procedure for preschoolers was carried out individually and lasted about an hour (taking into account the time required to provide instructions). Verbal and figurative subtests were performed on different days. When processing the results, the raw scores of the four criteria of creativity were calculated for each subtest, as well as the total indicator of overall creativity.

2. The questionnaire for determining the temperament of children aged 3–7 years (Thomas and Chess, 1977) is designed to be filled in by parents. This is a reliable and informative method for diagnosing the psychodynamic characteristics of the children's behavior. The children can be both healthy and with disorders of development. The methodology contains 72 statements describing the child's behavior in various situations of everyday life. Parents evaluate them using the options "never," "rarely," "often", and "always"; there is also an option for a "don't know" answer and an opportunity to comment on the given grades. The parents received forms with questions and standard instructions, which they fill in individually at home. The experimenter asked both parents, if it was possible, to participate in the study, and provide an overall assessment through a collaborative discussion of the child's typical behavior.

The methodology is based on the theoretical foundation, which states that the style of behavior and individuality of the child is the result of the relationship between his/her natural characteristics (temperament traits) and the response of the environment to these traits. The authors highlighted nine components of children's temperament that exist in different cultures and are already noticeable at the age of two-three months. Each scale is represented by 8 statements of the questionnaire: *activity* – the motor component of behavior, mobility/passivity of the child during games, eating, walking, etc.; *rhythmicity* – regularity or unpredictability of reactions associated with physiological needs; *approach/withdrawal* – the reaction to new stimuli (the resulting function of child's fear and exploratory reflex); *adaptability* – ease of getting used to new conditions; the time, which the child needs to adapt after the initial reaction to a new stimulus (food, daily routine, rules, people); *intensity* – the energy level of reactions, regardless of their positive or negative orientation; *threshold* – sensitivity to external stimuli, intensity of the influence necessary for the reaction manifestation; the quality of mood, the predominance of a joyful and satisfied state; *distractibility* – the degree of influence of external stimuli on behavior, the speed of transition from one type of activity to another; *attention/persistence* – the child's ability to concentrate and persistence during activities when difficulties arise. The Russian-language standardized version of the questionnaire was developed by V. Kolpakov and V. Makarov (1993) and has proven validity and reliability. A wide range of parameters makes it possible to build a profile of the child's individual properties and highlight its typological characteristics.

3. The methodology of the expert assessment of the social competences of children aged 5–7 years was developed under the guidance of Krivtsova (2013) and is targeted at being filled in by kindergarten teachers based on the open and structured monitoring of children in a kindergarten group. The structure of basic social competences is a list of 45 skills and abilities, united into groups and reflecting crucial aspects of a child's life:

- *Skills of adapting to an educational institution* (11 points): the ability to listen, to be engaged in discussion, ask questions, declare one's needs, seek help from an adult, express gratitude, follow the instruction, finish an activity, etc.

- *Communication skills with peers* (10 points): openness to contacts, the ability to join children, who are playing, play by the rules, ask for a favor, offer help, express sympathy, receive praise, take initiative, share, and apologize.

- *Skills of dealing with feelings* (8 points): the ability to experience and express adequately both positive feelings (joy, pleasure) and those that are negatively assessed by society (sadness, anger, and envy); to recognize the feelings of the other person, empathize, deal with own anger and respond to another person's anger, deal with fears, and experience sadness.

- *Alternatives to aggression* (9 points): the ability to promote one's interests calmly and adequately, express dissatisfaction, respond to undeserved accusations, demonstrate tolerance, admit the guilt, accept the consequences of own mistakes, and so on.

- **Skills of coping with stress** (7 points): the ability to deal with failure (loss), to react to rejection, to say "no", to cope with a situation of ignorance, embarrassment, etc.

These qualities represent the model behavior of a socially competent preschooler. Regarding each item of the list, the content of the competence and a situation in which it can emerge, as well as the examples of immaturity and the steps representing the path of this skill's formation have also been described in detail. The methodology does not have standardized indicators; the competency profile obtained during the study should be considered not as a diagnosis, but as a preliminary basis for building psychological and pedagogical interaction with a child. The first two blocks reflect basic communication skills, which are developed spontaneously during everyday interaction with adults and children. The lack of them may indicate the child's disadvantage, significant problems of social adaptation, and even personality disorders. The rest of the blocks reflect existential and humanistic ideas on mental health and emotional intelligence; they are often developed insufficiently even among adults because other ideas related to addressing feelings that exist in the society for a long time (Krivtsova, 2013).

The kindergarten teachers were trained preliminary in a step-by-step methodology of the open monitoring of a child in the process of communication. The observation was held for 5 days, every time the skills and problematic aspects demonstrated by the child were recorded in the protocol. On the basis of five measurement protocols, the average grades of 45 competences were provided – whether the child demonstrates this skill always, often, sometimes, rarely, or never (points from 5 to 1), which then were summed up as the final scales. For each preschooler, grades were collected from three independent adult experts, at least.

4. Projective technique for studying children's anxiety was created by Dorkey and Amen (1947) to identify the degree of emotional adaptation among children aged 3-7 years. Experts show alternately 14 cards depicting plots that simulate typical life situations of preschoolers and provoke anxiety reactions (independent options for boys and girls) to children. They do not have a child's face – a test subject must determine the character's mood by choosing a picture with a sad or joyful face. We used a modified modern version of the methodology (Mykhaylov and Kolesnik, 2016), updated to study anxiety in interaction in the information virtual space. The anxiety index is calculated as the percentage ratio of emotionally negative choices in the total number of drawings; the average rate is 20-50%. The manifestation of anxiety is associated with the negative experience in certain situations. The qualitative analysis of the results is focused on the relationship between positive and negative experiences in three types of situations: relationships between children, "child-adult" relationships, and daily activities.

5. Diagnostics of intelligence. Since intelligence is one of the basic resources of adaptability, its consideration was mandatory. The children's version of the Weksler WISC test was used (the diagnosis was conducted earlier by a staff psychologist as part of the mandatory diagnostic minimum in a preschool educational institution). The markers of verbal and non-verbal intelligence were taken into account, as well as the overall IQ.

Characterization of the sample

Individual diagnostics of 115 children aged 5-6 years was conducted. The sample consisted of 56 boys and 59 girls who attend municipal and private preschool educational institutions (hereinafter referred to as PEI) in Khmelnytskyi and Kherson. Parents participated in collecting data on typical children's behavior: 107 mothers and 35 fathers. Pedagogical employees (kindergarten teachers, teachers of creative studios, sport trainers, and other specialists) of seven preschool educational institutions (further PEI) provided information on the social adaptation of preschoolers. The total number is 24 experts.

Based on the overall rate of creativity in the sample of preschoolers, three groups were identified: with low, medium (interval M ± SD), and high creative potential. The low-creative group included 16 respondents, the highly creative group – 20 ones, and the most numerous was the "medium" group – 79 children.

Research ethics

The study was conducted in accordance with the standards provided in the Ethical Principles of

Psychologists and Code of Conduct. Diagnostic tools are approved by the Ministry of Education and Science of Ukraine to be used in educational institutions. The research program was approved by the management staff of preschool educational institutions.

The invitation was announced at parent-teacher meetings in kindergartens. Families were provided with the necessary information on the goals and stages of work. They were motivated to participate voluntary in the study. The work began after the parents signed informed consent. In addition, the oral consent of the children was also obtained. The personal information collected during the study is strictly confidential.

Data analysis

The verification of the properties of the primary parameters distribution has showed compliance with the normal form. This allowed to use parametric criteria for further calculations. The data were processed by using correlation and factor analysis. One-way variance analysis (ANOVA) was used to compare the average values of three groups. Mathematical processing of the material was conducted using the IBM SPSS Statistics program (version 17).

Results

Creativity manifestations among preschoolers

Some observations that are important for understanding the manifestations of children's creative abilities and methods of their diagnostics should be mentioned in psychological and pedagogical research.

Based on the results of seven TTCT subtests, more than 74.8% of preschoolers demonstrated one or more parameters of creativity which is above the normative (average) level. Most of the children with high indicators were concentrated in preschool groups belonging to creative studios (art school and art lyceum) – Table 1. A preliminary selection of students, as well as focused development and encouragement of creativity, are happening there. In private PEIs, quite a lot of attention is paid to the development of the children's general gifts: cognitive, physical, social, and so on. Municipal kindergartens with the largest data variability got the last place. Due to a large number of children in groups (25-30 people), it is difficult for them to receive the focused attention of teachers of kindergarten. It complicates the development of the cognitive sphere.

Table 1

Average values and standard deviations of raw creativity indicators of children aged 5-6 years

Types of socialized environment:	fluency	Flexibility	originality	readiness
Preschool groups in creative studios (14 children)	38.2±16.6	19.1±5.4	17.0±7.4	45.6±10.1
Private kindergartens (45 children)	36.1±17.3	18.8±8.3	15.8±8.8	34.2±8.6
Municipal PEI (56 children)	33.5±18.5	18.2±8.5	15.4±9.2	31.4±7.4

The divergent thinking test sufficiently reveals the creative abilities of children; however, the results of certain subtests may not coincide. The tasks completion requires preliminary involvement in the work. It also depends on the emotional contact between the child and the host. Therefore, the one-stage test may not provide reliable information; rather long-term complex diagnostics is required.

Children took tasks of TTCT positively more like a game rather than a test of their abilities. At the same time, the motivation and behavior of preschoolers during the testing process can be regarded as an additional marker of abilities: children who received high grades became quickly involved in the activity. They also reacted on additional instructions and demonstrated vivid positive emotions. They almost did not need external support and approval (although they were glad to hear the experimenter's praise). Besides, they enjoyed the creative process. Such manifestations were recorded in 80% of the highly creative group. They indicate that even in preschool age, creativity includes an emotional and motivational (personal) component.

The irrelevance of the preschoolers' answers (inadequacy concerning the given task) remains a methodological problem. Children are uncritical in assessing their own results; it is especially difficult for them to recognize obvious answers and to understand how other children could respond.

Comparison of groups with a different level of creativity

Having divided the sample into three groups based on the general indicator of creativity, we found distinct differences in the mechanisms of social and psychological adaptation – Table 2.

Table 2

The comparative analysis of the average adaptation indicators in groups of preschoolers with different creative potential

Adaptation parameters	A group with low level of creative potential (N=16)	A group with medium level of creative potential (N=79)	A group with high-level of creative potential (N=20)	F (ANOVA)	The significance of differences (sig.)
Questionnaire to determine children's temperament:					
Activity	3.72	4.03	3.96	1.190	0.308
Rhythmicity	4.16	4.25	4.04	0.801	0.452
approach/withdrawal	3.44	3.98	4.75	7.816	0.001
Adaptability	3.38	4.15	4.18	3.521	0.033
Intensity	4.09	4.17	4.22	0.309	0.735
Threshold	3.12	4.27	5.03	9.784	0.000
Mood	4.47	4.35	4.39	0.281	0.755
Distractability	4.15	3.77	4.45	1.332	0.074
attention/persistence	4.76	5.05	4.61	0.778	0.462
The expert assessment of preschoolers' social competences:					
Adaptation skills to PEI	3.15	4.02	3.46	4.334	0.015
Communication skills with peers	2.71	3.85	3.30	10.354	0.000
Skills to treat feelings	2.02	2.25	1.64	2.788	0.066
Alternatives for aggression	1.55	1.67	1.68	0.132	0.876
Skills to overcome stress	1.88	2.00	1.94	0.087	0.917
Projective technique to study child anxiety:					
General level of anxiety	46.08	38.39	43.49	2.026	0.137
Negative experience in communication situations among children	50.25	42.55	38.70	5.537	0.005
Negative experience in communication situations "a child – an adult"	43.18	38.46	35.63	2.355	0.100
Anxiety in everyday actions	44.81	34.15	56.14	13.277	0.000
Wechsler's test for children WISC:					
Verbal intelligence	96.8	104.2	106.4	4.107	0.019
Nonverbal intelligence	102.5	116.4	111.5	4.934	0.009
General indicator of IQ	100.7	111.3	109.9	4.391	0.015

The adaptability of preschoolers is studied on three sides: as a temperament trait that characterizes how quickly or slowly the child adapts to new conditions; as social competence – communication skills with children and adults in terms of PEI, as well as emotional adaptation to standard life situations. In all cases, preschoolers with high creative potential demonstrated specific differences.

Temperament traits: The main feature that differentiates the highly creative group was a significant reaction of "approach" in response to new stimuli and situations. Along with the growth of creativity in groups, the threshold of sensitivity, which determines the level of external stimulation required to change behavior, is slowly decreasing. These qualities are combined with increased distractibility and fast switching when exposed to new stimuli, which are of great interest for the child (however, the significance of the differences does not reach the level of 0.05). The readiness to react defines "sensitivity to the world" as the basis of creativity. However, at the same time, it can function as a source of problems and discomfort for the child. Such children are predisposed to complaining about too loud sounds or unpleasant odors. They pay attention to the color of objects, the temperature in the house or outside. In addition, they are sensitive to uncomfortable clothes, etc.

The important result addresses the significantly reduced adaptability of children with a low level of creative potential; at the same time, the groups with medium and high levels of creativity have similar ratings. It means that a decrease in creativity below a certain threshold value determines a long and difficult adaptation to changes of external conditions, the inability to change the initial reaction in the direction

required by the situation. It should be remembered that at a low level, creativity skills are associated with an indicator of general intelligence – Table 2.

Intelligence. All children with a level of intelligence below the average (12.2% in the sample) demonstrated simultaneously low levels of creativity, which confirms the threshold hypothesis. Having an average and high IQ level in accordance with the Wechsler test, preschoolers usually have creativity – in the form of the corresponding verbal or non-verbal abilities.

Social competence. Relatively low grades of communication skills with peers and adaptation to the conditions in PEI among low-creative children were confirmed. In this case, the highest grades were given to the group with an average level of creativity. Teachers noted the problematic character of dealing with feelings in highly creative children ($p = 0.066$).

Emotional adaptation. The general level of anxiety in the groups does not differ significantly. However, distinct differences were found at the qualitative level. The level of creativity determines the specific perception of positive and negative experiences in different life situations. Low-creative preschoolers are characterized by an increased level of anxiety in situations of communication among children. Highly creative children experience negative emotions in situations of habituation to daily rituals and activities. The last result was unexpected for us and required clarification.

A qualitative analysis of the choices showed that highly creative preschoolers are characterized by anxiety in such situations which children with low and medium creative potential usually take positively. In this group, more than half of the respondents chose a sad mood in situations modeling everyday activities and compliance with the daily routine: the need to pick up toys (12 children), going to bed and eating alone (8 children each), dressing (6 children). In unambiguous situations, which provoke negative emotions among the majority of children (isolation, aggression from another child, or conflict because of a toy), some children chose a cheerful face, interpreting events in their own way: as expected, favorable or playful actions. In general, there were ten such observations (8.7% of the sample), eight of which were representatives of the creative group.

The factor structure of the creative and intellectual abilities of preschoolers

The 23 indicators of creativity, measured by TTCT, required grouping. Factor analysis allowed to determine the necessary minimum of informative variables, as well as to clarify the structure of the cognitive abilities of preschoolers.

During factorization conducted by the method of principal components, five factors, which explain 73.7% of the features variance, were discovered. The first three are the most significant (Table 3).

Table 3

Factor analysis of creativity and intelligence indicators in a sample of 115 preschoolers

Variables:		Factor decision without rotation			Factor decision with Varimax rotation				
		F 1	F 2	F 3	F 1	F 2	F 3	F 4	F5
Subtest 1. «Questions»	fluency	0.799				0.803			
	flexibility	0.682				0.518			
	originality		0.792			0.656			
Subtest 2. «Causes»	fluency	0.721		0.482		0.779			
	flexibility	0.704				0.578			
	originality		0.820			0.691			
Subtest 3. «Consequences»	fluency	0.811				0.754			
	flexibility	0.635							
	originality		0.744			0.733			
Subtest 4. «Objects improvement»	fluency	0.943	-0.360	0.516	0.806				
	flexibility	0.716			0.713				
	originality		0.750		0.845				
Subtest 5. «Unusual research»	fluency	0.878	-0.318	0.538	0.947				
	flexibility	0.713			0.705				
	originality		0.733		0.800				
Subtest 6. «Unfinished figures»	fluency	0.429					0.670		
	flexibility	0.751					0.584		
	originality		0.788				0.739		
	readiness			0.756					0.627
Subtest 7. «Repeated lines»	fluency	0.783					0.866		
	flexibility	0.636					0.723		
	originality		0.719				0.760		
	readiness		-0.404	0.782					0.517
General assessment of creativity		0.921	0.547		0.615		0.485		
Wechsler's test for children	verbal	0.717	0.505			0.442		0.771	
	nonverbal	0.650		0.438				0.734	
	General IQ	0.897		0.451				0.840	

The first factor (34.4% of the explained variance) included the fluency and flexibility of all TTCT subtests, that is, the productivity of putting forward diverse ideas that meet the requirements of the situation. These qualities, in particular, correlate the most with the general assessment as well with preschoolers' IQ.

The second factor (15.6% of the variance) united indicators of the performance originality of both verbal and non-verbal tasks. It is noteworthy that in some subtests the factor has weak negative correlations with the indicators of fluency and readiness of answers (they are in italics in Table 1). This factor reflects meaningfully our practical observation on the high level of productivity in tasks on divergent thinking, which is often achieved through trivial and obvious answers. Originality in preschool age is achieved mainly through the instruction to invent something unusual, "to answer in a way children did not answer before." For many children, this request causes difficulty and even misunderstanding because they do not know which answers are generally accepted. Only five of the respondents answered without additional stimulation by the experimenter; in all cases, they were students from creative studios, whom the teachers characterized as talented (which would combine innate abilities with early experience of their development in a suitable social environment). Thus, originality is formed based on the productivity of ideas generation as the ability to reject generally accepted decisions at a certain stage.

The third factor, explaining 11.07% of the variance, united elaboration parameters of figurative subtests. It correlates positively with scores of fluency for verbal subtests and intellectual abilities.

The factorial solution with Varimax-rotation reveals the orthogonal factors that are most distant from each other. In this case, the filling of the factors was changed and the variables reflecting the solution of cognitive tasks of various types came to the fore. The subtests of the TTCT verbal battery created two independent factors. Although the tasks "Objects Improvement" and "Unusual Use" are verbal in form, they are related mostly to the object activity (children were asked to think of as many unusual uses of cardboard boxes as possible as well as of ways to improve the toy elephant to make it more interesting for a game). Among other subtests, these tasks are associated the most with the practical experience of children and tackling with everyday life issues. The significant correlation of factor 1 with the general test grade suggests that this particular type of creativity is dominant in preschool age. This enables us to distinguish three types of creativity in the structure of the creative abilities of preschoolers – subject (practical), verbal, and figurative. Readiness was again presented as a separate factor.

As a result of factor analysis we reduced 23 particular indicators of creativity to eight integral parameters: productivity (the sum of fluency and flexibility) and originality, which were considered independently for three informative blocks of tasks: verbal (1-3), subject (4-5), and figurative (6-7); in addition, we calculated the total indicator of the readiness of figurative subtests and the total score based on the results of the seven TTCT subtests.

Correlations of certain parameters of creativity and adaptation aspects

Considering the general indicator of creativity in the context of relationships with preschoolers' temperament traits, significant correlations with a positive reaction to new things, reactivity, and quick adaptation should be noted. The indicator of general intelligence also correlates with adaptability, but mostly with the ability to concentrate as well as with engagement, and intensity of reactions. It is reasonable to assume that these qualities are the natural basis for the development of cognitive abilities. Creativity is also associated with low anxiety (lack of negative experience) in situations of communication with children and adults. The correlations obtained reflect various prerequisites for the formation of intelligence and creativity.

The connections between creativity and the child's adaptive abilities become clearer at the level of certain abilities – Table 4.

Table 4

Correlations of indicators for cognitive abilities and adaptation measures in a sample of 115 preschoolers

Adaptation parameters:	Subject (practical) creativity		Verbal creativity		Figurative creativity		The level of readiness	General creativity	General intelligence
	productivity	originality	productivity	originality	productivity	originality			
The questionnaire to determine temperament of children aged 3-7 years:									
Activity	0.077	0.060	0.066	0.057	0.094	0.123	0.151	0.149	0.231
Rhythmicity	0.055	-0.019	0.125	-0.019	0.110	-0.004	0.188	0.096	0.141
approach/withdrawal	0.194	0.196	0.214	0.257	0.138	0.166	0.186	0.304	0.156
Adaptability	0.187	0.085	0.258	0.057	0.164	0.102	0.225	0.216	0.227
Intensity	0.152	0.145	0.087	0.101	0.074	0.119	0.209	0.125	0.203
Threshold	0.202	0. 269	0.109	0.203	0.192	0.243	0.108	0.251	0.112
Mood	0.038	-0.071	0.040	0.049	0.011	0.065	0.025	0.063	0.046
Distractability	0.015	0.105	0.140	0.209	0.101	0.236	-0.188	0.155	-0.071
attention/persistence	0.189	0.140	0.192	0.108	0.002	-0.021	0.202	0.115	0.270
The expert assessment of preschoolers' social competences:									
Adaptation to PEI	0.186	0.113	0.184	0.103	0.126	0.113	0.213	0.151	0.185
Communication skills with peers	0.191	0.134	0.312	0.036	0.082	0.044	0.139	0.117	0.158
Skills to treat feelings	-0.064	-0.184	-0.047	-0.119	-0.163	-0.234	0.061	-0.141	0.066
Alternatives to aggression	-0.005	0.027	-0.010	0.063	-0.014	0.163	0.105	0.078	0.212
Skills to overcome stress	0.081	0.104	0.058	0.041	-0.018	0.098	0.065	0.069	0.089
Negative experience and anxiety manifestation:									
During the communication among children	-0.212	-0.166	-0.200	-0.199	-0.085	-0.051	-0.043	-0.235	-0.141
During the communication situations "a child – an adult"	-0.206	-0.187	-0.172	-0.246	-0.106	0.066	-0.203	-0.208	-0.224
During everyday activities	0.170	0.192	-0.086	0.072	0.180	0.217	0.007	0.174	-0.080
Anxiety degree	-0.105	-0.122	-0.105	-0.154	0.024	-0.027	-0.187	-0.100	-0.188

Note: the critical value of the Pearson correlation coefficient is 0.184 at p≤0.05; 0.240 at p≤0.01; 0.298 at p≤0.001.

We see that the originality of the performance of objective and figurative tasks, to some extend, is the opposite of adaptability: it is associated with the child's anxiety in everyday actions and a low assessment of emotional control. Elaboration, on the other hand, is a favorable criterion associated with adaptive capacity, emotional well-being, and social competence.

The performance effectiveness of verbal and subject tasks is directly related to social competencies: probably, children with these abilities really adapt better to social conditions, therefore kindergarten teachers rate them higher.

Discussions

Prerequisites for the creativity formation at the early stages of ontogenesis

Preschoolers aged 5-6 years have demonstrated high and sufficient productivity while solving creative problems. When interpreting the results, it should be remembered that children's creativity is largely conditioned by a lack of knowledge, experience, and low thinking criticality. This stimulates the imagination; however, it also complicates the application of traditional criteria to the results of the preschoolers' creativity. The diagnostic methodology of creativity at the early stages of ontogenesis still

requires improvement.

We justified the appropriateness of creativity types division based on the material for generating ideas: verbal, figurative, and subject-practical. Verbal and practical abilities are a strategic factor, and they are closely related to the general level of cognitive development. Previous researchers have pointed out that "subject" subtests are central in Torrance's test battery (Tunick, 1998); the existence of the so-called "everyday" creativity in student samples was distinguished on their basis (Veldbrekht, 2005; Yakymchuk et al., 2020). Our results clarify that this type of creativity plays a leading role in preschool age.

The results obtained also testify that the creativity and intelligence development of preschoolers creates a single factor. There is a holistic mechanism for the development of cognitive abilities as a result of gaining experience in interaction with the world around, both subject and social. At the same time, creativity should not be considered as something integrated into the structure of intellectual abilities. It is formed by the age of 5-6 based on general intelligence and shortly becomes a separate ability supported by personal prerequisites and favorable social conditions. This is confirmed by the different roles of intellectual and creative resources in the processes of children's social adaptation (it was demonstrated convincingly by Wallach and Kogan (1965)).

Creativity at the early stages of ontogenesis performs purely pragmatic functions: cognitive and adaptive. This is a special way of processing and using the information received, which expands the adaptive capabilities of the child in situations where the capabilities of intelligence and thinking are insufficient (Vygotsky, 1997).

Creativity is formed in the direction from the basic ability to generate ideas adequate to the given task to the ability to detail and refine these ideas, and then to produce original content. The leading role of game activity in the development of creativity, as well as in the formation of social skills and regulation of children's emotions should be noted (Hoffmann and Russ, 2012). The speech development (verbal productivity) and the ability to adapt the features of typical objects to one's own needs play an important role here. Children's creativity determines the development of personal qualities, and it itself is determined by them.

The profile of individual traits of a creative personality

Although at the age of 5-6, it is still too early to talk about the completed formation of personality, we can analyze the inclinations of individuality acquired in the process of socialization based on innate qualities. It is known that the temperament features create ontogenetically stable syndromes; earlier, based on the parameters of the Thomas and Chess (1977) test, such types of temperament as "easy,". "slowtowarmup," and "difficult"; "Home child" (Makarova, 1998) were empirically identified. Guided by this logic, we describe the typological profile of a creative child: high level of sensitivity and readiness to respond, openness to new stimuli, and quick adaptability. In addition to these general features, the ability to concentrate or to switch attention quickly determines the development of certain components of creativity: productivity and originality.

It is known from previous studies that the adaptive abilities of a child aged 3-5 years depend on the parameters of approaching and mood. Then the temperament profile changes – the predictability and intensity of reactions become a key feature (Kolpakov and Makarov, 1993). In our case, the indicator of approaching correlates with general creativity, which determines the inclusion of this variable in the structure of the adaptive abilities of preschoolers.

Special attention should be paid to cases of a negative relationship between abilities for creativity and adaptability parameters: an increase of anxiety during everyday activities and a decrease of control over feelings. The literature noted the same peculiarities earlier. The prime example is the increase of the neuroticism level and the activation of the psychological defenses of preschoolers during the experiment on the development of creative abilities (Druzhinin, 2019). Consequently, the optimal (sufficient) level of creativity is crucial in the resilience system and social adaptation.

Social competences and the influence of the environment on the development of creative potential

Social and psychological adaptation includes the assimilation of norms, values, rules of society in general, and the inner social circle: family and kindergarten. The acquisition of social norms and sanctions occurs while interaction of preschoolers with other people and the corresponding vigorous activity. The study showed that the advantage in the possibilities of social adaptation does not relate to highly creative children. It belongs to preschoolers with a sufficiently developed (average) creative potential. This confirms the dialectical contradiction between the concept of "social norm" and the concept of "creativity" as a way to go beyond limitations of existing rules.

The study by Gryazeva-Dobshinskaya et al. (2020) identified the adaptation resources of preschoolers with the various structures of creative abilities (the ratio of readiness and originality). A direct link between creativity and personal adaptive resources was only found in the group of children with a high level of both abilities; at a low level of answers readiness, originality acquires negative correlations with the resources of adaptability. Our results represent a different research methodology. However, they show a similar result – the readiness is a marker of adaptation. The productivity of solving practical and verbal problems has a similar effect, too. As a result, creativity has a number of certain cognitive and personal characteristics that have an influence on the quality of adaptation both positively and negatively.

The creativity study always occurs in the context of a certain social environment, stereotypes, and requirements for creativity products (Lilly, 2014; 2020). Within a particular culture, the creativity of children and adults is manifested and encouraged in different ways. For example, representatives of Western culture demonstrate advantages in the ability to solve innovative problems, but in general, children are flexible in implementing the tools provided by using alternative methods (Neldner et al., 2019).

According to Makarova (1998), social culture is also "imprinted" in temperament by 8-12 years, creating stereotypical behavioral patterns. When studying the early formation of temperament features in children under 7 years, no population differences were found: gender, age, and ethnicity. The unstable functioning of the nervous system in preschoolers hampers the full assimilation of generally accepted norms and rules. This feature makes this age sensitive for creativity formation both at the cognitive and personal levels. Later, the mechanisms of the creative qualities development are transformed due to the inclusion of critical thinking and self-censorship.

Conclusions

The creativity of preschoolers is manifested at the level of individual abilities in the subject, verbal, and/or imaginative sphere: the production of a large number of ideas, originality, and the ability to elaborate ideas in detail. These abilities are gradually formed in the process of gaining experience in different spheres of life by developing in the direction from spontaneous "game" creativity to its socially significant forms. In the process of creativity development, its cognitive and personal components are significantly transformed.

The dialectical nature of creativity is manifested at the early stages of the socialization formation – manifestations of creativity can both contribute to and hamper social and psychological adaptation. Adaptive creativity is associated with an open perception of the world around in its changing and diverse manifestations. Creativity contributes to the assimilation of social competencies, it allows to expand significantly the interpretation of stressful situations and implement coping according to the principle of "positive reassessment." On the other hand, increased anxiety in everyday situations can tip the balance of positive and negative experiences, leading to disturbances in the emotional regulation of behavior. The relationship between creativity and adaptability is largely determined not by high, but by low values (in the zone of relationship with general intelligence). Thus, creativity in preschool age is a part of the child's normal cognitive development and a natural condition for personality adaptation.

Implications and Recommendations

Based on the obtained results, a number of important recommendations for psychological and pedagogical support of creativity were formulated. The support of the child's creative abilities in the family and in the PEI creates the basis for his/her further development. The lack of creative potential readiness of children under 5 cannot be compensated at a later age. This is an important argument for the implementation of creativity in programs of educational establishments.

The main task of preschool age is to teach a child to produce easily a large number of various ideas, which are adequate for the task. This quality is basic for the creation of other creative abilities. Development programs should be comprehensive in nature. Besides, they should include the integration of creativity and related cognitive, emotional, communicative, and regulatory resources. When working with preschoolers, it is important to find a fundamental cognitive ability in the area of actual development (intelligence or creativity in the figurative, verbal, and practical spheres) and develop it, providing appropriate stimuli for deepening and expanding skills.

In parallel, the processes of emotional regulation should be improved; the child should be taught effective and safe ways to find solutions in difficult life situations. In addition, it is necessary to detect timely factors that are unfavorable for social adaptation. Besides, the child should be taught effective and

safe ways to find solutions in difficult life situations.

It is important for adults to understand the diversity of creativity – for example, that emotional regulation problems are caused by sensitivity to environmental stimuli. In preschool age, many behavioral reactions, including increased vulnerability, are assessed as manifestations of the age norm and do not cause wariness. Only with the beginning of schooling, when such behavior creates problems for both children themselves and those who are around, they draw parents and teachers' attention. Early identification and correction of maladaptive manifestations will help the child to adapt successfully at the next stages of development. But rigid attempts to "redesign" the child lead to the loss of early formed adaptive and creative abilities.

Limitations

The results obtained reflect the regularities of the formation of creativity in children under 5-6 years who are studying in preschool educational institutions. Due to the rapid development of personality and cognitive properties in other age groups, other internal mechanisms are probable. The correlation study leaves open the question of the cause-and-effect direction of the relationships detected.

Acknowledgments

We would like to thank all those who have contributed to this research, i.e. parents and pedagogical employees of the municipal and private preschool educational institutions in Khmelnytskyi and Kherson, as well as editorial team for their patience, kind and professional assistance.

Conflict of interests

The authors declare no conflict of interest

References

Acar, S., & Runco, M. A. (2012). Psychoticism and creativity: A meta-analytic review. *Psychology of Aesthetics, Creativity, and the Arts, 6*(4), 341-350. https://doi.org/10.1037/a0027497

Burlatchuk, L., & Veldbrekht, O. (2011). Зв'язок креативності з інтелектом в структурі загальної обдарованості [The relationship between creativity and intelligence in the structure of general skills]. Вісник Київського національного університету імені Тараса Шевченка. *Психологія. Педагогіка. Соціальна робота, 1*, 15-18.

Crisp, R. J., & Turner, R. N. (2011). Cognitive adaptation to the experience of social and cultural diversity. *Psychological Bulletin, 137*(2), 242-266. https://doi.org/10.1037/a0021840

Dorkey, M., & Amen, E. W. (1947). A continuation study of anxiety reactions in young children by means of a projective technique. *Genetic Psychology Monographs, 35*, 139-183.

Druzhinin, V. N. (2019). *Психология общих способностей*, 3-е изд [General ability psychology, 3th ed.]. Москва: Юрайт.

González Restrepo, K., Arias-Castro, C., & López-Fernández, V. (2019). A theoretical review of creativity based on age. *Psychologist Papers, 40*(2), 125-132. https://doi.org/10.23923/pap.psicol2019.2901

Gryazeva-Dobshinskaya, V. G., Dmitrieva, Y. A., Korobova, S. Y., & Glukhova, V. A. (2020). Children's creativity and personal adaptation resources. *Behavioral Sciences, 10*(2), 49. https://doi.org/10.3390/bs10020049

Guilford, J. P. (1967). The nature of human intelligence. New York, NY: McGraw-Hill.

Hadani, H., & Jaeger, G. J. (2015). *Inspiring a generation to create: 7 critical components of creativity in children*. Sausalito, CA: Center for Childhood Creativity.

Harrington, D., Block, J., & Block, J. H. (1983). Predicting creativity in preadolescence from divergent thinking in early childhood. *Journal of Personality and Social Psychology, 45*(3), 609-623. https://doi.org/10.1037/0022-3514.45.3.609

Hoffmann, J., & Russ, S. (2012). Pretend play, creativity, and emotion regulation in children. *Psychology of Aesthetics, Creativity, and the Arts, 6*(2), 175-184. https://doi.org/10.1037/a0026299

Holm-Hadulla, R. M. (2013). The dialectic of creativity: A synthesis of neurobiological, psychological, cultural and practical aspects of the creative process. *Creativity Research Journal, 25*(3), 293-299. https://doi.org/10.1080/10400419.2013.813792

Ilagan, M. J., & Patungan, W. (2018). The relationship between intelligence and creativity: On methodology for necessity and sufficiency. *Archives of Scientific Psychology, 6*(1), 193-204. http://dx.doi.org/10.1037/arc0000050

Karwowski, M., & Gralewski, J. (2013). Threshold hypothesis: Fact or artifact? *Thinking Skills and Creativity, 8*, 25-33. https://doi.org/10.1016/j.tsc.2012.05.003

Kaufman, J. C., & Beghetto, R. A. (2009). Beyond big and little: The four C model of creativity. *Review of General Psychology, 13*(1), 1-12. https://doi.org/10.1037/a0013688

Kolpakov, V. G., & Makarov, V. V. (1993). *Опросники для определения темперамента* [Questionnaires for determining temperament]. Красноярск: Фонд ментального здоровья.

Krivtsova, S. V. (Ed.) (2013). *Развитие социальных компетенций у старших дошкольников в системе ДОУ* [The development of social competences in older preschoolers in the preschool educational system]. Москва: Академия социального управления.

Lilly, F. R. (2014). 'Creativity in early childhood'. In T. P. Gullotta & M. Bloom (Eds.), Encyclopedia of Primary Prevention and Health Promotion. Boston, MA: Springer. https://doi.org/10.1007/978-1-4614-5999-6_160

Lilly, F. R. (2020). 'Creativity and cognitive development in adolescence'. In The *Encyclopedia of Child and Adolescent Development*. https://doi.org/10.1002/9781119171492.wecad371

Makarova, G. A. (1998). Особенности темперамента детей и подростков здоровых и с резидуально-органическими психическими нарушениями [Features of temperament of healthy children and teenagers and with residual organic mental disorders] [*диссертация кандидата психол.*] наук, Психоневрологический институт им. В. М. Бехтерева, Санкт-Петербург.

Mykhaylov, B. V., & Kolesnik, N. M (2016). Модификация теста тревожности Р. Теммл, М. Дорки, В. Амен (методика «выбери нужное лицо») для углублённого исследования тревожности у детей дошкольного возраста [Modification of the anxiety test R. Temml, M. Dorki, V. Amen (method "Choose the right person") for an in-depth study of anxiety in preschool children]. *Men's health, gender and psichosomatic medicine, 2*(4), 41-48. http://ujmh.org/?op=1&z=46&i=6

Neldner, K., Redshaw, J., Murphy, S., Tomaselli, K., Davis, J., & Nielsen, M. (2019). Creation across culture: Children's tool innovation is influenced by cultural and developmental factors. *Developmental Psychology, 55*(4), 877-889. https://doi.org/10.1037/dev0000672

Restrepo, K., Arias-Castro, C., & López-Fernández, V. (2019). A theoretical review of creativity based on age. *Psychologist Papers, 40*(2), 125-132. https://doi.org/10.23923/pap.psicol2019.2901

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity research journal, 24*(1), 92-96. https://doi.org/10.1080/10400419.2012.650092

Simonton, D. K. (2005). Are genius and madness related? Contemporary answers to an ancient question. *Psychiatric Times. 22*(7), 21–23. https://www.psychiatrictimes.com/view/are-genius-and-madness-related-contemporary-answers-ancient-question

Thomas, A., & Chess, S. (1977). *Temperament and development.* New York, NY: Brunner/Mazel Publisher.

Torrance, E. P. (1980). Growing up creatively gifted: A 22-yr longitudinal study. *Creative Child & Adult Quarterly, 5*(3), 148-158.

Torrance, E. P. (1998). 'The Torrance tests of creative thinking norms'. *Figural (Streamlined) Forms A & B*. Bensenville, IL: Scholastic Testing Service.

Tunick, E. E. (1998). *Диагностика креативности. Тест Торренса* [Diagnostics of creativity. Torrance test]. Санкт-Петербург: Иматон.

Veldbrekht, O. O. (2005). Соціально-психологічна адаптація та психологічне благополуччя творчих особистостей: результати експериментального дослідження [Socio-psychological adaptation and psychological well-being of creative individuals: Results of experimental research]. *Проблеми загальної та педагогічної психології: зб. наук. праць Інституту психології ім. Г.С.Костюка АПН України, 7*(3), 44-55. https://www.academia.edu/39819438

Veldbrekht, O. O. (2009). Культурно-історична еволюція уявлення про творчу особистість [Cultural and historical evolution of ideas about the creative personality]. *Практична психологія та соціальна робота, 10*, 67-71.

Vygotsky, L. S. (1997). *Воображение и творчество в детском возрасте* [Imagination and creativity in childhood]. Санкт-Петербург: Союз.

Wallach, M. A., & Kogan, N. (1965). A new look at the creativity-intelligence distinction. *Journal of Personality, 33*(3), 348-369. https://doi.org/10.1111/j.1467-6494.1965.tb01391.x

Winston, C. N., Tarkas, N. J., & Maher, H. (2014). Eccentric or egocentric? Preoperational features in schizotypic and creative adults. *Psychology of Aesthetics, Creativity, and the Arts, 8*(4), 413-422. https://doi.org/10.1037/a0037442

Yakymchuk, B. A., Yakymchuk, I. P., Vakhotska, I. O., Sundukova, I. V., & Lohvinova, Y. O. (2019). The impact of creativity and intelligence on the social adaptation of the students of the faculty of physical education. *Journal of Intellectual Disability Diagnosis and Treatment, 7*(3), 188-199. https://doi.org/10.6000/2292-2598.2019.07.03.17

Mingaleva, Z. A., & Vukovic N. A. (2020). Development of engineering students competencies based on cognitive technologies in conditions of industry 4.0 , *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE), (8),* Special issue of Current Research and Trends in Cognitive Sciences 2020, 93-101.

Original scientific paper

UDK: 377.014.5:331.1

Received: October, 30.2020.
Revised: November, 17.2020.
Accepted: November, 25.2020.

doi: 10.23947/2334-8496-2020-8-SI-93-101

Development of Engineering Students Competencies Based on Cognitive Technologies in Conditions of Industry 4.0

Zhanna A. Mingaleva[1], Nataliia A. Vukovic[2]*

[1]Perm National Research Polytechnic University, Perm, Russian Federation; e-mail: mingal.psu@gmail.com
[2]Department of World Economy, National Research University Higher School of Economics, Moscow, Russian Federation; e-mail: shpak17121978@gmail.com

Abstract: Industry 4.0 and Society 5.0 concepts are actively developing all over the world. The accelerating transition to Industry 4.0 and Society 5.0 sets new requirements for the university education system in qualifications and competencies of engineering universities graduates. The article reveals the possibilities of using cognitive models in the professional training of research engineers for new industries. Authors used the modeling method for creating a cognitive and metacognitive model of the process. It can be used for the development of forming the optimal structure of higher professional engineering education. The article substantiates that the main tasks of modernization of pedagogical approaches in modern education, is to establish the compliance of educational products with the labor market requirements and transform the structure of vocational education, providing training for professional specialists required by specific employers. Conclusions are drawn about the important role of soft skills for engineering education in Industry 4.0. The results obtained in the study can be used for the engineering category of students.

Keywords: Industry 4.0, engineering education, cognitive abilities, metacognitive competencies, reflection, individual's self-development.

Introduction

The 21st century has fundamentally changed the traditional models of learning, communication, and work in Engineering Science, due to the development of modern concepts of Industry 4.0 (Oztemel and Gursev, 2020) and Society 5.0 (Onday, 2019). New industries of these concepts need new competencies from engineers (Subheesh and Sethy, 2020).

Due to the framework of Industry 4.0 and Society 5.0, industries and enterprises are developing when their activities are largely based on research and innovation, as well as a project-based approach to the implementation of search and innovation activities. Industries such as aircraft and automobile manufacturing, chemical and pharmaceutical industries, production of new composite materials, and a number of others, work on the basis of the project and "they are all notable for technological developments that have changed the way we live and work "(Dinsmore and PMP, 2014). The development of cognitive abilities starts to be one of the first criteria for engineering education (Peng and Kievit, 2020).

At the same time, project work requires special qualifications and special competencies of specialists involved in projects (Mingaleva, 2018). Also it should be noted that the term "cognitive engineer" appeared in modern Russian scientific and managerial science several years ago (Sheketa, Bestylny and Khrabatyn, 2006).

The concept of Society 5.0 is considered as one of the models of sustainable development. The main idea of the concepts of Industry 5.0 and Society 5.0 is the following: digital technologies for the development of society. The fourth industrial revolution and the concept of Industry 4.0 "should not consider promising technologies as simple tools that are completely under our conscious control…. Instead, we should try to understand how and where human values are embedded in new technologies and how technologies can be applied for the common good, environmental protection and human rights" (Schwab and Davis, 2018). Considering the increasing importance of sustainability and the role of engineers in society: "the key criteria that should be considered in models to evaluate the insertion level of sustainability into engineering education" (Rampasso et al., 2020). Generally the role of human resources on the economy is significant as it is presented in case study of Balkan EU member states Vukovic et al.

*Corresponding author: shpak17121978@gmail.com

(2015) and it is the same for all world.

Also many scientists pointed that role of university in transformation to Industry 5.0 and Society 5.0 is very important, Kochetkov, Larionova, and Vukovic, (2017) noticed in their paper that: "..historically, it is possible to allocate four types of the university by analogy to four industrial revolutions. In the conditions of the fourth industrial revolution, there is a radical shift in the university model. From research and development and technology transfer, the university moves to the creation of the intellectual capital". Their proved this by case studies of the most successful Russian technological entrepreneurs university, Novosibirsk and Tomsk universities.

So obtaining new competencies is possible both in the process of professional activity and at the stage of studying at university. However, in this case, the use of the old "classical" methods and teaching models is no longer suitable. The main emphasis in the requirements of employers in modern industries is increasingly placed on the formation of cognitive skills and cognitive competencies in future specialists. This, in turn, presupposes a wider application of various cognitive educational models in the process of teaching and training specialists. The wider application of cognitive models in education is also facilitated by the digitalization of all aspects of society (Siarova, Sternadel, and Mašidlauskaitė, 2017), which provides students and teachers with effective tools for monitoring and checking the process of students' intellectual activity. In this regard, research and generalization of positive practical experience in the application of cognitive models in education in Russia and abroad is highly relevant.

Literacy discussion

Turning to the history of the application of various educational models and approaches in the higher education system, we note that in this study, under the term cognition (lat. "cognitio", cognition, study, awareness) we mean the ability to learn, and under cognitive technologies - ways and algorithms for achieving the goals of subjects, based on the processes of cognition, learning, and information processing.

A cognitive model, in a broad sense, "can be considered as an interpretive information structure intended for cognitive analysis and especially effective for analyzing complex or unstructured information" (Tsvetkov, 2016). A cognitive model in education is a structured description of the process of achieving a result (forming the necessary competencies) based on the use of cognitive technologies and the development of cognitive abilities (Matsuo and Tsukube, 2020). A similar approach is followed in the research of Bogavac and Đukić, 2017; Cosgrove and O'Reilly, 2020; Laguador and Dotong, 2014 and Patil and Codner, 2007.

One feature of learning based on the use of cognitive technologies is the emphasis on the development of creative abilities. However, with this approach, the differences between people in mental and creative abilities naturally appear. This leads to the fact that intellectual inequality is clearly manifested among students, which leads to a complication of the communication process within student groups. In addition, when training is focused on the development of creative abilities, it is difficult to find a single criterion for assessing such training. This, as well as a number of other features of cognitive learning, contributed to the fact that, until recently, this approach has been applied in higher education systems to a rather limited extent.

Earlier we built a 5-component model of modern specialists' competence (Figure 1). As it was proved earlier, the most difficult to assess are the competences from the group of cognitive (cognitive) competences.

These competences are closely related to such notions as "intellect" and "cognition". Cognition is a general term applied to any process, basic structure, procedure, action, which allows a person to know and be aware of the environment, the tasks ahead of him/her and the ways to solve them (a way out of a difficult situation). Intellect is a hypothetical construct underlying a person's ability to cope with abstractions, learning and effective behavior in new situations (the ability to judge, understand and reason). Collectively, cognitive competences include actions such as perception, learning, memorizing, reasoning, thinking, speaking, and evaluation.

As it was proved earlier, the most difficult to assess are the competences from the group of cognitive (cognitive) competences. These competences are closely related to such notions as "intellect" and "cognition". Cognition is a general term applied to any process, basic structure, procedure, action, which allows a person to know and be aware of the environment, the tasks ahead of him/her and the ways to solve them (a way out of a difficult situation). Intellect is a hypothetical construct underlying a person's ability to cope with abstractions, learning and effective behavior in new situations (the ability to judge, understand and reason). Collectively, cognitive competences include actions such as perception, learning, memorizing, reasoning, thinking, speaking, and evaluation.

An important methodological peculiarity of building a cognitive model of learning and formation

of modern competencies is the need to identify, account for and reflect the interrelationships between competencies from all groups. The analysis has shown that the majority of competencies from the group of cognitive competencies complements and enhances the competencies from other groups, as well as experiences their impact. In particular, such element of cognitive competencies as “ability to discover” is closely related to such metacompetencies as “self-development” and “creativity”. This includes “skills/ skills”, which in most models is understood in a narrower context as the ability to perform complex motor and/or cognitive actions with ease, accuracy, and adaptability to changing conditions or in a broader context all acquired abilities.

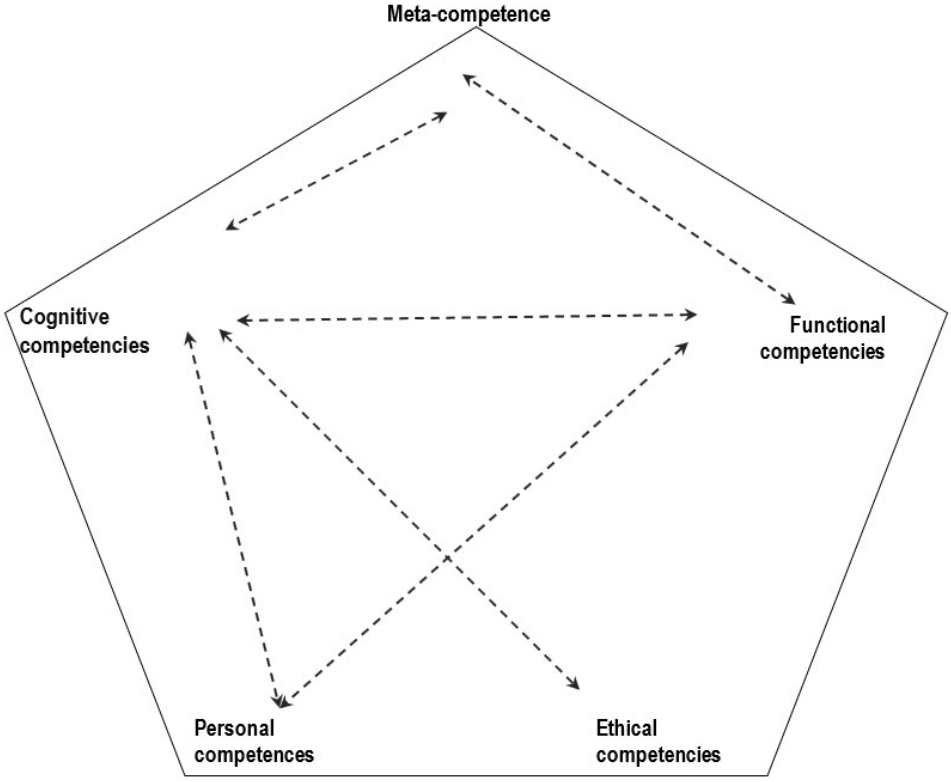

Figure 1. Model of 5-component specialist competency

There is also a very interconnection between groups of functional and cognitive competencies, especially those specialists who are engaged in scientific research, development, search for new materials, products, methods of their production (design engineers, employees of research laboratories of enterprises, etc.). In particular, many studies emphasize that the cognitive ability of individuals and/or members of social groups to learn (knowledge, skills, etc.) that they acquire, in turn, should be used to solve complex problems, i.e., ensure the implementation of functional competencies (Mingaleva, 2018) . Mental and psychomotor competencies from the group of functional competencies are closely related to individual competencies, while social competencies are closely related to indicative notions, skills and abilities, as well as theoretical knowledge that allow employees to understand their place and role in society, responsibility to society as a whole, the need to comply with social standards and rules of responsible behavior, including the development of new products and materials.

Competencies necessary for future cognitive engineers are formed in the process of training through the use of new pedagogical methods and tools, including the use of cognitive technologies. The study of modern educational practice has shown that nowadays cognitive models (Figure 1) and technologies are applied mainly in three directions of educational activity:

- in the process of full-time education (classical or project-based),
- in the process of distance education,
- in the process of testing.

Each of the selected areas is characterized by its own technologies and end results. In the framework of previous studies, it was noted that the method of “competency interview”, applied in personnel management, was tested during testing of students in terms of determining their cognitive abilities. This method allows students to evaluate cognitive actions such as reasoning, thinking, speech, and evaluation, as well as cognitive ability to find a solution, which are manifested by students in the

course of solving a problem academic situation.

Based on a study of scientific literature and the practice of using cognitive models in education, we identified the following differences in approaches to organizing the educational process based on the classical approach and the cognitive approach. The results are shown in Table 1.

Table 1

Comparative analysis of classical learning and cognitive learning

Learning element	Classical learning	Cognitive learning
Final goal	Formation of formalized and personal knowledge	Development of creative abilities
Control	Checking the result	Checking the process of obtaining the result
Criteria for assessing learning outcomes	The same for all	Individual, based on mental and cognitive abilities
Peculiarities of the interpretation of criteria	Obtaining the highest score in the framework of the point grading system к	Manifestation of a non-standard approach to solving the problem
Learning tools	Traditional lectures, workshops, laboratory work	Cognitive graphics based on modern ICT (Vlasov, Juravleva, Shakhnov, 2019)
The optimal group size for training	20-30 students	5-7 students

As it is presented in Table 1, the educational approach based on the use of cognitive technologies differs significantly from the traditional approach, even if the latter widely uses ICT, virtual learning, distance learning and other modern technologies.

Changing the requirements for the qualification characteristics of specialists in the direction of expanding intellectual and communication competencies naturally presupposes a transition to cognitive learning models, and the widespread use of digital technologies makes it possible to reduce differences in students' cognitive abilities.

We investigated the possibility of using cognitive models in the training of students of engineering specialties (chemical-technological and aerospace faculties), focused on research and design work in the framework of progressive directions of creating new structural materials and products from them.

Engineering education is under strong pressure from manufacturing to transition to Industry 4.0 (Kiel et al., 2017). Also on the way to sustainable development, cognitive technologies have an important role in engineering education (Potočan, Mulej and Nedelko, 2020). Table 2 is presenting groups of criteria for the evaluation of engineering education for sustainable development (EESD) (Rampasso et al., 2020).

Grouping results of criteria for evaluating engineering education for sustainable development (EESD) from Table 2 could be presented like it is in Figure 2, by blocks. The same vision is proved in researches of Yakymchuk et al., 2020.

Table 2

Criteria for the evaluation of engineering university education for sustainable development (EESD)

№	Group of criterion	Criteria to evaluate engineering education for sustainable development (EESD) (Rampasso et al., 2020)
1	Courses Content	C1 Use of transdisciplinarity in teaching C13 Availability of adequate and constantly updated teaching material to include sustainability in the course C14 Proper training of professors to insert sustainability into their disciplines
2	Teaching Methods	C6 Development of critical thinking in students throughout the course C7 Development of holistic and systemic thinking in students throughout the course to enable them to make decisions responsibly C9 Use of active learning approaches to problem solving to teach aspects related to sustainability
3	Networking	C2 Establishment of global partnerships C4 Encouraging students to volunteer through extracurricular activities C8 Discussion of issues related to values and ethics with students throughout the course C10 Use of service-learning towards the local community for educational purposes C11 Constant discussion, throughout the course, about industrial applications of technical knowledge for sustainability (for example, life cycle assessment, cleaner production, ecologically efficient strategies for resources use, etc. C12 Development of communication skills in students to enable them to work within multidisciplinary groups
4	University Infrastructure	C3 Alignment between sustainability insertion and institutional strategy, with top management support for needed adjustments C5 Balanced focus among environmental, social, and economic aspects of sustainability C15 Use of sustainability concepts in university installations

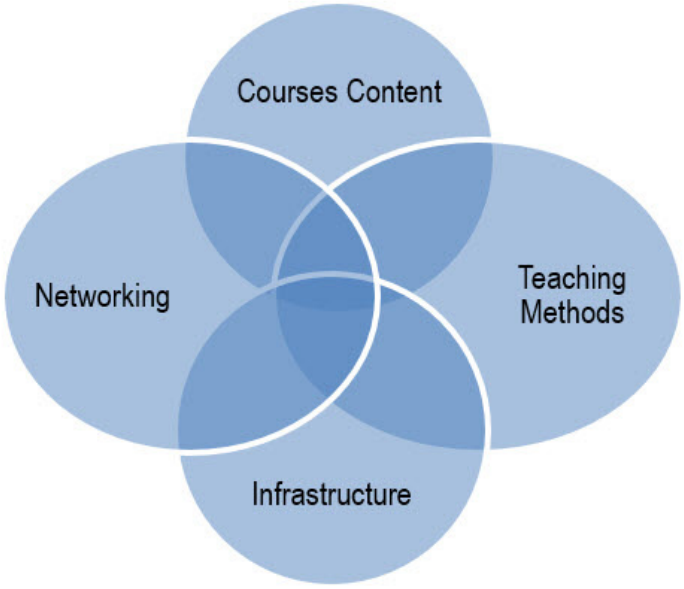

Figure 2. Main group of tools for cognitive engineering education

Due to analyses of modern researches, which are presented bellow we formulate 2 hypothesis about modern engineering education and cognitive approach in it.

Hypothesis 1.

The modern system of engineering education in Russia is not yet fully capable of forming the entire set of cognitive competencies required by modern cognitive engineers.

Hypothesis 2.

To form the necessary set of cognitive competencies, it is necessary to use cognitive learning technologies based on the creation of cognitive learning models.

For testing Hypothesis 1 and Hypothesis 2 we implemented survey in Perm National Research Polytechnic University in September 2020.

Materials and Methods

Sample description

The empirical study involved 263 volunteers – students of 4nd-5th years of study, and master's programs (5th-6th years of study) in the engineering specialties (chemistry and mashing building), balanced distribution by gender (41.2% of women, 58.8% of men). Senior students (4-5) were not randomly selected. On the 3rd year students of engineering specialties undergo practical training, and many starts working at enterprises. At this time students already get the first idea about the place of future work, about features and character of work, functional responsibilities, specific scientific and research activities. This allows senior students to more clearly and consciously define the competencies and skills they will need in their future work. This also applies to cognitive competencies.

Data collection methodology

The study was held in September 2020. Despite the scientific urgency and practical relevance of the topic, there are still no reliable diagnostic methods for diagnosing cognitive competencies.

There are some modern researches in the same fields. Assessment of programme outcomes through exit surveys of Engineering students was implemented previously by many scientists (Othman et al., 2011).

The results of our previous research «The practice of using digital technologies of practice-oriented educational technologies in Perm National Research Polytechnic University (PNRPU)» were also used for design of the content of the research survey Mingaleva (2018).

We also implemented short survey of students of engineering universities. A survey of the quality of cognitive skills and competencies was conducted among 4-5 year students. For this purpose, a list of cognitive competencies was compiled, which includes: list of competencies from groups "Cognitive strategies" and "Cognitive abilities", developed by proposed ones Robinson et al., 2005. This is the sum of main cognitive competences: «Judges importance" (Q1), «Analyses tasks»(Q2), «Identifies factors», «Learns from mistakes», «Seeks simplest solutions», « Makes effective decisions», «Thinks intuitively»(Q3), «Thinks 'outside the box»(Q4), « Is able to learn»(Q5), «Thinks quickly»(Q6). The results of our previous research «The practice of using digital technologies of practice-oriented educational technologies in Perm National Research Polytechnic University (PNRPU)» were also used for design of the content of the research survey.

In total, students were offered a list of 10 competencies (Robinson et al., 2005), closely correlated with content of Table 2. In the course of the survey, students were asked the following questions characterizing their specific cognitive competencies:

1. Which of the following competencies were formed in your previous training in the basic program?
2. Which of the competences listed below were formed in your self-study process?
3. Which of the competences listed below have been formed in the course of your internship and work at the enterprise?
4. Which of the competences listed below will you need for your future work?
5. Which of the following competencies do you need to develop during your remaining time at the university?

Results

By answering these questions, students were able to choose several competencies. In answering these questions, students expressed their personal subjective opinion about the existence of specific competencies and the need for such competencies for their work. The results of questionnaires processing are presented in Table 3. The matrix cells present the total number of positive answers with regard to each of the listed competences.

Table 3
Survey Results, number of positive answers

N	Survey questions	Competences									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	Which of the following competencies were formed in your previous training in the basic program?	201	167	207	115	15	58	46	15	37	15
2	Which of the competences listed below were formed in your self-study process?	153	174	216	212	24	19	26	37	9	198
3	Which of the competences listed below have been formed in the course of your internship and work at the enterprise?	182	196	241	237	36	16	31	42	11	162
4	Which of the competences listed below will you need for your future work?	210	202	253	241	231	206	212	252	181	235
5	Which of the following competencies do you need to develop during your remaining time at the university?	254	198	175	198	18	41	37	28	12	174

Table 3 presents that among 10 main cognitive competences: «Judges importance" (Q1), «Analyses tasks»(Q2), «Identifies factors»(Q3), «Learns from mistakes»(Q4), «Seeks simplest solutions»(Q5), «Makes effective decisions»(Q6), «Thinks intuitively»(Q7), «Thinks 'outside the box»(Q8), «Is able to learn»(Q9), «Thinks quickly»(Q10) the most important by students opinion are Q1,Q2 and Q3.

Table 4
Survey Results, % of positive answers

N	Survey questions	Competences									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	Which of the following competencies were formed in your previous training in the basic program?	76,4	63,5	78,7	43,7	5,7	22,1	17,5	5,7	14,1	5,7
2	Which of the competences listed below were formed in your self-study process?	58,2	66,2	82,1	80,6	9,1	7,2	9,9	14,1	3,4	75,3
3	Which of the competences listed below have been formed in the course of your internship and work at the enterprise?	69,2	74,5	91,6	90,1	13,7	6,1	11,8	16,0	4,2	61,6
4	Which of the competences listed below will you need for your future work?	79,8	76,8	96,2	91,6	87,8	78,3	80,6	95,8	68,8	89,4
5	Which of the following competencies do you need to develop during your remaining time at the university?	96,6	75,3	66,5	75,3	6,8	15,6	14,1	10,6	4,6	66,2

In the course of the research it was established that in Russian universities a part of cognitive competence is formed and fixed in the skills of students already in the first years of study. These are such competences as the ability to assess the importance of a problem (Q1) or a task, the ability to analyze tasks (Q2), the ability to determine the factors (Q3) affecting the situation, problem, task. The presence of these competences in general was pointed out by the interviewed students.

Discussion

The current requirements of Industry 4.0 require employees to have new skills, knowledge and competencies focused on the SDG. This requires the expansion of cognitive competencies of university

graduates.

The cognitive strategy revealed by the survey results is called by its content as “Looking for the simplest solutions” (Q5) is very attractive for students in their future work (87.8% of positive answers to question 4), but in the process of learning it is not formed fully enough (5.1% of positive answers to question 1).

There is the similar situation with cognitive ability assessment “Makes effective decisions” (Q6). According to respondents, this cognitive ability is needed in future work (78.3% of respondents answered 4 questions positively), but is not fully developed in the learning process (22.1% of respondents answered 1 question positively).

Competences such as “Thinks outside the box” (Q8), and “Thinks fast” (Q10) are very attractive to students (95.8% and 89.4%), but most of them have not formed with any form of training (face-to-face, on their own, in the process of industrial practice.

Such cognitive ability as “Intuitive Thinking” (Q7), according to the majority of respondents, is poorly developed (17.5%), although in terms of the success of future work, especially its scientific and research part of design engineers, this ability is of great importance (80.6% of positive answers to question 4). Only a very small number of students consider this competence to be innate and undeveloped.

At the same time, the cognitive ability “Knows how to learn” (Q9) and the cognitive strategy “Learns from mistakes” (Q4) are considered by many students to be developable. Moreover, quite a few students (80.6% of the total number of students enrolled) noted that they were able to develop these competencies independently through self-learning.

Conclusions

It is obvious that classical education is not enough for transition to Industry 4.0 and it is very important to have soft skills for career success. Modern trends of Industry 4.0 need workers to acquire new skills, knowledge, and competencies, focused on the SDGs. This implies the expansion of the cognitive competencies of university graduates.

Implementing cognitive education in engineering education meets a lot of different challenges (Rajaee et al., 2013) like not standard business situations, international multi-linguistic team and etc. In the course of the study, it was found that in Russian universities, part of the cognitive competencies are formed and consolidated in the skills of students already, and are formed in the first years of study. Also, some of the competencies are developed during the process of self-training and in the course of industrial practice within a business. At the same time, modern students expect more progression from the education system, to develop cognitive competencies among specialists and engineers, which will allow them, in the future, to more effectively carry out scientific research (experimental), generate ideas, find solutions faster, and work more effectively in a team. Students expect new teaching methods from universities and are eager to accept them.

Especially important for students of engineering specialties, are such cognitive abilities and cognitive strategies “not received” in the learning process, such as the ability to find the simplest solutions, the ability to make effective decisions, the ability to think outside the box, and to think quickly.

An education system that meets the requirements of the market must develop and introduce pedagogical methods into the educational process that allow for the comprehensive development of the professional competencies necessary for cognitive engineers. Future research will focus on the development and adaptation of such progressive pedagogical methodologies to suit different engineering specialties.

Acknowledgment

The work is a part of base portion of the state task of the Ministry of Education and Science of the Russian Federation to Perm National Research Polytechnic University (topic №FSNM-2020-0026).

Conflict of interests

The authors declare no conflict of interest.

References

Bogavac, D., & Đukić, T. M. (2017). Non-formal education within the function of responsible parenting. *International Journal of Cognitive Research in Science, Engineering and Education, 5*(1), 31. https://doi:10.5937/IJCRSEE1701031B

Cosgrove, T., & O'Reilly, J. (2020). Theory, practice and interiority: an extended epistemology for engineering education. *European Journal of Engineering Education, 45*(1), 38-54. https://doi.org/10.1080/03043797.2018.1544226

Dinsmore, P. C., & PMP, D. (2014). Team Building and Interpersonal Skills for Dynamic Times. *The AMA Handbook of Project Management.* Retrieved from http://dl.booktolearn.com/ebooks2/management/9780814433393_the_ama_handbook_of_project_management_8c7c.pdf#page=424

Kiel, D., Müller, J. M., Arnold, C., & Voigt, K. I. (2017). Sustainable industrial value creation: Benefits and challenges of industry 4.0. *International Journal of Innovation Management, 21*(08), 1740015. https:doi.org/10.1142/S1363919617400151

Kochetkov, D. M., Larionova, V. A., & Vukovic, D. B. (2017). Entrepreneurial capacity of universities and its impact on regional economic growth. *Economy of Region/Ekonomika Regiona,* (2). 477-488. https:doi.org/10.17059/2017-2-13

Laguador, J. M., & Dotong, C. I. (2014). Knowledge versus practice on the outcomes-based education implementation of the engineering faculty members in LPU. *International Journal of Academic Research in Progressive Education and Development, 3*(1), 63-74. http://dx.doi.org/10.6007/IJARPED/v3-i1/640

Matsuo, M., & Tsukube, T. (2020). A review on cognitive apprenticeship in educational research: Application for management education. *The International Journal of Management Education, 18*(3), 100417. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1472811720301841

Mingaleva, Z. (2018). Peculiarities of the formation of communication competences within the framework of project training in a polytechnic university. *Rhetoric and Communications E-journal, 36*, Retrieved from http://journal.rhetoric.bg/?p=2141

Onday, O. (2019). Japan's society 5.0: Going beyond Industry 4.0. *Business and Economics Journal, 10*(2), 1-6. https://10.4172/2151-6219.1000389

Othman, N. T. A., Misnon, R., Abdullah, S. R. S., Kofli, N. T., Kamarudin, S. K., & Mohamad, A. B. (2011). Assessment of programme outcomes through exit survey of Chemical/Biochemical Engineering students. *Procedia-Social and Behavioral Sciences, 18*, 39-48. http://dx.doi.org/10.1016/j.sbspro.2011.05.007

Oztemel, E., & Gursev, S. (2020). Literature review of Industry 4.0 and related technologies. *Journal of Intelligent Manufacturing, 31*(1), 127-182. https://10.1007/s10845-018-1433-8

Patil, A., & Codner, G. (2007). Accreditation of engineering education: review, observations and proposal for global accreditation. *European journal of engineering education, 32*(6), 639-651. http://dx.doi.org/10.1080/03043790701520594

Peng, P., & Kievit, R. A. (2020). The development of academic achievement and cognitive abilities: A bidirectional perspective. *Child Development Perspectives, 14*(1), 15-20. https://doi.org/10.1111/cdep.12352

Potočan, V., Mulej, M., & Nedelko, Z. (2020). Society 5.0: balancing of Industry 4.0, economic advancement and social problems. Kybernetes. Retrieved from https://www.emerald.com/insight/content/doi/10.1108/K-12-2019-0858/full/html

Rajaee, N., Junaidi, E., Taib, S. N. L., Salleh, S. F., & Munot, M. A. (2013). Issues and challenges in implementing outcome based education in engineering education. International Journal for Innovation Education and Research, 1(4), 1-9. http://ir.unimas.my/id/eprint/1168

Rampasso, I. S., Quelhas, O. L., Anholon, R., Pereira, M. B., Miranda, J. D., & Alvarenga, W. S. (2020). Engineering Education for Sustainable Development: Evaluation Criteria for Brazilian Context. *Sustainability, 12*(10), 3947. https://doi.org/10.3390/su12103947

Robinson, M. A., Sparrow, P. R., Clegg, C., & Birdi, K. (2005). Design engineering competencies: future requirements and predicted changes in the forthcoming decade. *Design Studies, 26*(2), 123-153. http://dx.doi:10.1016/j.destud.2004.09.004

Schwab, K., & Davis, N. (2018). *Shaping the future of the fourth industrial revolution.* Currency. Retrieved from https://dl.acm.org/doi/book/10.5555/3312394

Sheketa, V., Bestylny, M., & Khrabatyn, R. (2006, February). Applicable scaling of user predicate queries in given categorical strategy and restrictions system. In *2006 International Conference-Modern Problems of Radio Engineering, Telecommunications, and Computer Science* (pp. 34-37). IEEE. Retrieved from https://ieeexplore.ieee.org/document/4404436

Siarova, H., Sternadel, D., & Mašidlauskaitė, R. (2017). Assessment practices for 21st century learning: review of evidence. *NESET II report.* https://doi.org/10.2766/71491

Subheesh, N. P., & Sethy, S. S. (2020). Learning through assessment and feedback practices: A critical review of engineering education settings. *EURASIA Journal of Mathematics, Science and Technology Education, 16*(3), em1829. https://doi.org/10.29333/ejmste/114157

Tsvetkov V.Ya.(2016). Cognitive model stratification. *International Journal of Applied and Basic Research. 2*(1). 136. http://www.applied-research.ru/pdf/2016/2-1/8456.pdf

Vlasov, A. I., Juravleva, L. V., & Shakhnov, V. A. (2019). Visual environment of cognitive graphics for end-to-end engineering project-based education. *Journal of Applied Engineering Science, 17*(1), 99-106. https://doi.org/10.5937/jaes17-20262

Vuković, D. B., Shpak, N. A., Radovanović, M. M., Portugal Duarte, A., & Radulović, D. (2015). The role of human resources on the economy: a study of the balkan eu member states. J*ournal of the Geographical Institute'Jovan Cvijic'SASA, 65*(2). https://doi.org/10.2298/IJGI1502123V

Yakymchuk, B. A., Chystiak, O. V., Padalka, R. G., Moskalyk, H. F., & Denha, N. M. (2020). Fostering Cognitive and Creative Thinking Styles Using Educational Tools Aimed at the "Creative Economy" Model in the Process of Vocational Education and Training. Psychology and education, 57(1), 01-07. Retrieved from http://www.psychologyandeducation.net/Article/fostering-cognitive-and-creative-thinking-styles-using-educational-tools-aimed-at-the-creative-economy-model-in-the-process-of-vocational-education-and-training.pdf

Original scientific paper

UDK: 159.928.072-057.875

Received: October, 10.2020.
Revised: November, 27.2020.
Accepted: December, 02.2020.

doi: 10.23947/2334-8496-2020-8-SI-103-112

Features of Social-Perceptual Properties of Mathematically Gifted Students

Tushnova A. Yuliya[1*]

[1]Department of educational psychology and organizational psychology, Don State Technical University, Russian Federation, e-mail: trubulya@yandex.ru

Abstract: The attention of modern society to intellectual potential makes the problem of studying mathematically gifted youth at the stage of self-determination in higher education relevant. Practical problems related to the psychological features of social adaptation of mathematically gifted youth require solving. The main goal of the research is to study the social and perceptual abilities of mathematically gifted students. The study sample consisted of 76 natural science students aged 17-23 years (M=19.8, SD=3.2 (58% men). The research methods were: testing (test of analytical mathematical abilities, test of the structure of intelligence (TSI) of R. Amthauer), expert assessment, survey (questionnaire of V. A. Krutetsky, questionnaires aimed at diagnosing socio-perceptual abilities), statistical methods. Self-assessment of intelligence, composite assessment, and some components of social intelligence and some components of empathy are significantly different. The ability of mathematical generalization and practical mathematical thinking have a greater number of relationships with social and perceptual properties. Here we found relationships not only with empathy, but also the ability to recognize verbal expression and the General ability to understand and manage their own and other people's emotions. The ability to operate images in two-dimensional space is related only to the level and components of emotional intelligence. According to the results of the study, the features of socio-perceptual properties of students with different levels of analytical mathematical abilities are described. The conclusions can be used in the development of a program of psychological support for this category of students.

Keywords: mathematical abilities, social-perceptual abilities, giftedness, student age.

Introduction

Research of abilities is closely related to the problem of giftedness, which is relevant today not only for science, but also for the economic and social spheres. Describing current trends, Yurkevich (2009) notes that the technological approach, which understands gifted people as economic capital, arose long ago, where giftedness is associated with innovation, the creation of an economically valuable product, the sum of achievements. This explains the growth of requirements to the intellectual potential of a person, the social order for specialists with individually expressed professional abilities in different types of professions.

Modern researchers describe giftedness as a holistic, multi-level, multi-component and dynamic phenomenon (Bogoyavlenskaya, 2004; Bogoyavlenskaya, 2010; Davidson, 2009; Druzhinin, 2000; Kholodnaya, 2011; Leites, 2008; Ushakov, 2011; Renzulli, 2002, 2005; Ridetskaya, 2011; Sternberg, 2000). Mathematical giftedness, as a type of special intellectual giftedness, is considered in different approaches: research in mathematical giftedness of particular abilities (Krutetsky, 1998), research of the General factor of mathematical giftedness. Namely, the General factor of mathematical giftedness is considered to be the General factor of intelligence, the speed factor of information processing, the level of thinking and mathematical intuition (Kryukova, 2001). Kolmogorov (2001) defines mathematical abilities as integral qualities of the mind. Mathematical abilities, according to the scientist, arise spontaneously in childhood, are specific (analytical, synthetic) and require pedagogical support in social adaptation (Kolmogorov, 2001). In the mod-Delhi of the V. N. intelligent range. Druzhinin the top is a formally-sign object, which is formed last and provides productivity of mathematical activity (Khertanova and Kondaurova, 2006). Krasnoryadtseva (2013) considers the phenomenon of mathematical giftedness as a systemic quality of a person in the context of creative life fulfillment, an individual measure that characterizes the implementation of the translation of their capabilities into reality at specific stages of self-development.

[*]Corresponding author: trubulya@yandex.ru

The study of the formation of mathematical abilities is considered from different sides: the role of cognitive, emotional and motivational processes of self-regulation in learning and performing mathematical tasks (Hanin and Van Nieuwenhoven, 2020), mathematical productivity and mathematical anxiety (Ashcraft and Krause, 2007; Ayres, 2001; Sari Faradba et al., 2019), procedural strategies for solving simple and complex problems in different cultures (Campbell et al, 2001), mathematical creativity and mathematical abilities (Schoevers et al, 2020), and much more. Most of the research is devoted directly to mathematical skills and the factors that influence them, as well as describing techniques for improving the effectiveness of teaching mathematics.

In General, research on the problem of mathematical abilities is inextricably linked to the concepts of intelligence, General and special abilities (Bogoyavlenskaya, 2004; Bogoyavlenskaya, 2010; Bogoyavlenskaya and Nizovtsova, 2017; Krutetsky, 1998; Leites, 2008; Ushakov, 2011; Kholodnaya, 2011). Some approaches consider abilities in the structure of General intelligence as a single ability, while others identify specific abilities that are responsible for the successful solution of test problems (Shadrikov, 2019). Describing abilities and talent, scientists say, not only to their complex composition, but also from personal characteristics of value-semantic sphere, creative ispossibly, environmental conditions (Krasnoryadtseva, 2013; Shadrikov, 2019; Yurkevich, 2009).

Shadrikov (2019) notes that giftedness is a dynamic education and can exist at the initial stages of mastering professional activity. Based on the theory that abilities are properties of functional systems that implement individual mental functions, Shadrikov (2019) speaks about the natural giftedness of the individual, the giftedness of the subject of activity and the giftedness of the individual. This understanding allows us to consider mathematical giftedness at the stage of mastering professional activity in higher education. Also, the Kolmogorov (2001) regulation on reducing the effectiveness of social adaptation of mathematically gifted students actualizes practical tasks related to the psychological features of social adaptation of gifted youth. In the process of adaptation, the individual is a participant in communication, an important characteristic of which are social-perceptual properties. Andreeva (2000) understands social perception as an integral process of reflecting the personal properties of another person, the process of knowing the other in terms of communication and joint activities. Kunitsyna, Kazarinova, and Pogol'sha (2001) defines social perception as a process that occurs in interpersonal interaction based on natural communication and occurs in the form of perception and understanding by one person of another. Ryzhov (1981), considering social-perceptual properties from the position of the activity approach, notes that they are associated with the processes of integration of individual participants of joint activity into its aggregate subject.

The explanation of the limits of the level of mathematical abilities associated with the features of social and perceptual properties of students requires generalization of the above views. According to Khinchin (1961), the mathematical orientation of the mind contributes to the formation of a special style of thinking, which is characterized by a formal logical scheme of reasoning, brevity, fragmentation of reasoning, accuracy of symbols (cited in Kanin, 2013). It is important to keep in mind that General intelligence does not indicate mathematical abilities (Kanin, 2013; Shadrikov, 2019). General intelligence is more related to stereotype thinking, and mathematical abilities are more related to creative thinking (Kanin, 2013; Krasnoryadtseva, 2013). That is, the process of social perception itself can be associated with the peculiarities of the type of thinking of people with developed mathematical abilities. The special style of thinking of mathematically gifted people can build the process of knowing another person and working together in a special way.

Ideas about the decrease in the effectiveness of social adaptation of mathematically gifted students (Kolmogorov, 2001), about the possibility of studying giftedness at the early stages of mastering professional activity (Shadrikov, 2019), justify the research interest in the problem of mathematical abilities of students. Ideas about the need to create an environment for developing the abilities of gifted students (Bogoyavlenskaya, 2004; Bogoyavlenskaya, 2010), in this context, requires attention not only to the organization of the learning process in mathematics, but also to the social environment in which students are located. In the process of constructing a social environment for mathematically gifted students, the psychologist will be interested in the features of the socio-perceptual properties of this target category.

Given the idea that mathematical giftedness is associated with personal properties and life fulfillment, in General, the study of the social and perceptual properties of mathematically gifted students will clarify the peculiarities of their communication, not only in the context of adaptation, but also professionalization, professional self-determination, in General. This research is aimed at solving this problem, which is aimed at studying the features of socio-perceptual properties of students with different levels of mathematical abilities.

Materials and Methods

The study sample consisted of 76 students of natural science majors aged 17 to 23 years (M=19.8; SD=3.2 (58% male)).

The research methods were: testing, expert evaluation, survey method, statistical methods (W-Kendall, tay-b Kendall, Mann Whitney U test, Chi-squared test, Spearman rank correlation coefficient). The methodological tools are presented by the following methods: 1) to diagnose mathematical abilities, a test of analytical mathematical abilities was used (Abakumova and Babiyants, 2012); subtests of the "Intellect structure Test (TSI)" were used. Amthauer, namely: subtest 5 "Arithmetic problems" (assessment of the level of development of practical mathematical thinking, mathematical generalization abilities), subtest 6 "Numerical series" (analysis of inductive thinking, the ability to operate numbers, analytical and synthetic mathematical abilities), subtest 7 "Spatial imagination" (research of combinatorial abilities, the ability to operate images in two-dimensional space), subtest 8 "Spatial generalization" (assessment of the ability to operate spatial images and generalize relations between them); 2) the diagnosis of subjective variables was carried out using the procedure of self-assessment of intelligence; a questionnaire to identify giftedness in a particular area (Krutetskiy, 1998); 3) for the diagnosis of social-perceptual properties, the method of social intelligence research by J. Guilford and M. Sullivan, adapted by Mikhailova (1996); the questionnaire of emotional intelligence by D. V. Lyusin (Belova, 2004) was used.

The study assumed the following tasks: to form a representative sample of the study, including expert evaluation of mathematical ability; undertake a comparative analysis of the characteristics of concepts about their cognitive interest, self-evaluations of intelligence and socio-perceptional properties of students with different levels of mathematical ability; to perform the relationship of mathematical ability and social-perceptual properties; to determine the location of findings in the system of modern scientific knowledge. Two assumptions were made: 1) students with different levels of mathematical abilities may have different features of subjective ideas about their cognitive interests, self-assessment of intelligence and socio-perceptual properties; 2) mathematical abilities may be interrelated with socio-perceptual properties (for example, student age).

The indicated failure of the test approach in the identification of abilities (including mathematical) (Bogoyavlenskaya, 2010; Kolmogorov, 2001; Shadrikov, 2019; Yurkevich, 2009: Al-meida et al, 2016), brought the inclusion of the procedure of expert evaluation in the study. The experts were employees of the University teaching of disciplines of a mathematical cycle IC in study groups of students. In total, three employees with academic degrees were involved. The Working concept of giftedness indicates that in the process of identifying giftedness, an expert assessment of activities is necessary, where experts must have high qualifications in the field of activity under study, and the assessment must take into account not only the current level of development of the property, but also the zone of nearest development (Bogoyavlenskaya, 2004). Therefore, the involvement of experts who lead the learning process of the studied students is justified.

Experts were asked to evaluate the students ' abilities on a 5-point scale: 1) the ability to generalize mathematical material, isolate the main thing, distracting from the unimportant, to see the General in externally different; 2) the ability to operate with numerical and symbolic symbols (Krutetskiy, 1998). Further, the degree of consistency of experts 'opinions was revealed (W-Kendall), which showed that a high degree of consistency of experts' opinions was found in the average assessment of respondents' mathematical abilities (W=0.219; X^2=54.672, p=0.000). The Confidence interval of generalized expert assessments was 4.08>M>2.7, which allowed us to divide the sample into three groups (high (7.1%), medium (22.9%), and low (70%) level of mathematical abilities).

The results of the test "Analytical mathematical abilities" showed that 26.3% of the surveyed students have an average level of analytical mathematical abilities, while 73.7% have a low level. Thus, the results of expert evaluation and testing are generally the same, which is confirmed by correlation analysis (tay-b Kendall; r=0.561, p=0.000). In the further analysis, the test results were selected as the basis for dividing the sample into groups based on the level of mathematical abilities: group 1 (average level of analytical mathematical abilities), group 2 (low level of analytical mathematical abilities).

The ability to conduct a comparative analysis of non-numerical groups is due to the calculation of the confidence zone of expert assessment values, in which the mathematical expectation of the process is located with a certain probability (Sukhodolsky, 2008). In addition, statistical studies indicate that the sample size depends on the rarity of objects (Sukhodolsky, 2008). Data on the parameters of the ideal General population of mathematically gifted students is not provided, so an expert assessment was additionally used, which showed a shift in the distribution to the left. Given the size of one of the subgroups, only nonparametric criteria and correlation coefficients were used in the analysis, the calculation of which

is based on ranks.

Data analysis was performed as follows: 1) selection of experts and criteria for expert evaluation, statistical analysis of the results of expert evaluation, comparison of the results of expert evaluation and testing results, and making a decision on the basis of dividing the empirical group into samples; 2) analysis of differences in the characteristics of subjective representations about their cognitive interests, self-assessment of intelligence and socio-perceptual properties in students with different levels of analytical mathematical abilities: 3) analysis of the relationship between mathematical abilities and socio-perceptual properties. The study can be described as an empirical one, carried out in the concept of the cross-section method.

Results

First, a comparative analysis of the self-assessment of intelligence was conducted. It was found (Chi-squared test) that the self-assessment of intelligence differs in students with average and low levels of analytical mathematical abilities (X^2=8.671, p=0.013). Obtained the following frequency distribution: 1) respondents group 1 your intelligence at a high level (25%, n=5), average (50%, n=10), low (25%, n=5); 2) respondents of group 2 rate your intelligence on a high level (26.8%, n=15) and average (17.9 percent, n=10), high (55.4 per cent, n=31). Students with an average level of analytical mathematical abilities are more likely to rate their intelligence as average, students with a low level of analytical mathematical abilities are more likely to rate their intelligence as high.

The analysis of subjective ideas about their cognitive interests (Chi-squared test) showed that there is a tendency to show differences in students with different levels of analytical mathematical abilities (χ^2=14.157, p=0.028). The frequency distribution of the group 1 respondents ' choices is represented by a sequence: artistic activity (30%, n=6), mathematics and mechanics (25%, n=5), Humanities (25%, n=5), nature (20%, n=4). The sequence of respondents in group 2 is as follows: Humanities (33.9%, n=19), art (25%, n=14), sports (14.3%, n=8), communication interests (10.7%, n=6), mathematics and mechanics (8.9%, n=5), nature (3.6%, n=2), labor (3.6%, n=2).

Subjective ideas about students ' own cognitive interests with an average level of analytical mathematical abilities have a less differentiated structure. Students with a low level of analytical mathematical abilities have more differentiated subjective perceptions of their own cognitive interests and have preferred fields of activity.

Statistical analysis of component and composite assessment of social intelligence (table 1) showed that students with different levels of mathematical ability composite assessment of social intelligence and the ability to recognize the structure of interpersonal situations in dynamics, the ability to correctly estimate the state, feelings, people's intentions for their non-verbal manifestations. The ability to correctly assess people's States, feelings, and intentions based on their nonverbal expressions tends to show differences. All these scales of social intelligence are more pronounced in students with an average level of analytical mathematical abilities.

Statistical analysis of the ability to empathize (Table 1) showed that students with different levels of mathematical abilities have differences in the emotional channel of empathy, intuitive channel of empathy, and there is a tendency to show differences in the overall level of empathy. All these empathy scales are more pronounced in students with a low level of analytical mathematical abilities.

There were no differences in the components of emotional intelligence among students with different levels of mathematical abilities.

Table 1

Comparative analysis of social intelligence and empathy of students with different levels of mathematical abilities

Variables	Group 1	Group 2	Mann Whitney U	p-Value
	M (SD)	M (SD)		
Ability to anticipate the consequences of behavior	8,5 (2,4)	8,2 (3,1)	556	0,962
The ability to properly evaluate the condition on the non-verbal manifestations	8,8 (1,5)	7,7 (1,9)	370,5	0,023
Verbal expression	8,4 (1,7)	7,8 (1,9)	458,5	0,224
Ability to recognize the structure of interpersonal situations in dynamics	8,1 (1,9)	5,98 (2,1)	245	0,000
Comprehensive assessment of social intelligence	34,1 (3,7)	29,7 (5,2)	258,5	0,000
Rational channel of empathy	4,2 (1,3)	4,1 (1,1)	522	0,643
Emotional channel of empathy	2,6 (1,4)	4,1 (1,3)	239	0,000
Intuitive channel of empathy	2,6 (1,8)	4 (1,5)	335	0,007
Attitudes to empathy	3,2 (1,6)	3,2 (1,6)	559,5	0,995
Penetrating power in empathy	3,4 (1,98)	3,3 (1,89)	545	0,858
Identification in empathy	3,5 (2,2)	3,5 (1,95)	555	0,952
General level of empathy	19,3 (5,2)	22,7 (4,1)	380,5	0,034

To test the hypothesis of the relationship between mathematical abilities and social-perceptual properties (on the example of student age), a correlation analysis (r-Spearman) was conducted, the results of which allowed us to identify significant relationships between mathematical abilities and components of social intelligence, types and channels of empathy, as well as components of emotional intelligence (Table 2).

Table 2

Results of correlation analysis of mathematical abilities and socio-perceptual properties

Variables		r-Spearman	p-Value
Mathematical skills	Socio-perceptual properties		
Subtest 5 (TSI) "Arithmetic tasks" (assessment of the level of development of practical mathematical thinking, mathematical generalization abilities)	Verbal expression (SI 1)	0,252	0,028
	General level of empathy	0,308	0,007
	Overall level of emotional intelligence	0,337	0,003
Subtest 6 (TSI) "Numerical series "(analysis of inductive thinking, the ability to operate with numbers, analytical-synthetic mathematical abilities)	Emotional channel of empathy	0,254	0,027
	Expression control (EI2)	0,239	0,038
Subtest 7 (TSI) "Spatial imagination" (the study of combinatorial abilities, the ability to operate images in two-dimensional space)	Understanding emotions (EI2)	0,257	0,025
	Overall level of emotional intelligence	0,341	0,003
Subtest 8 (TSI) "Spatial generalization" (assessment of the ability to operate with spatial images and generalize the relationships between them)	Verbal expression (SI 1)	0,278	0,015
	Intuitive channel of empathy	0,223	0,053

Notation: 1 – SI – social intelligence, 2 – EI – emotional intelligence. * is the significance level of 0,01, ** a significance level of 0.05.

Based on the results of correlation analysis, we can conclude that all identified correlations are positive. Subtest 5 (TSI) has the relationships with socio-perceptual properties, namely, verbal expression (p=0.05), General level of empathy (p=0.01), General level of emotional intelligence (p=0.01).. We see that the higher the level of practical mathematical thinking and mathematical generalization ability, the higher the ability to understand speech expression in the context of specific relationships, the greater the repertoire of role behavior. The overall level of empathy is also higher. It is shown that the ability of mathematical generalization is associated with the General level of emotional intelligence, that is, the ability to understand and manage their own and other people's emotions.

Analytical and synthetic mathematical abilities (Subtest 6 (TSI)) they tend to show a relationship with the emotional channel of empathy (p=0.05). That is, the higher the analytical and synthetic mathematical abilities are developed (the process from the particular to the General), the higher the ability to emotionally tune in to the other, to participate and empathize with the other.

Subtest 7 (TSI) is related to the overall level (p=0.01) and components of emotional intelligence (expression control (p=0.05), emotion understanding (p=0.01)). High indicators of combinatorial abilities, the ability to operate images in two-dimensional space are associated with a high level of ability to understand and manage emotions, namely, the ability to understand their own and others' emotions and the ability to control the external manifestations of their emotions. In other words, the development of the ability to accurately perceive the shape and size of planar figures (linear eye), mental operation of images is associated with the development of the ability to understand and control emotions. Understanding includes individual and interpersonal aspects, while control is only individual.

Subtest 8 (TSI) "Spatial generalization" is related to the social intelligence component verbal expression (p=0.01) and the intuitive empathy channel (p=0.05). This ability is closely related to visual-imaginative thinking and involves operating images in three-dimensional space. The higher the ability to operate with spatial images and generalize the relationship between them, the more developed the ability to understand speech expression in the context of specific relationships, the greater the use of emotional responsiveness as a means of "adjustment" to the partner, in General, the higher the emotional responsiveness.

Discussions

Summarizing the results of an empirical analysis aimed at testing the hypothesis that students with different levels of analytical mathematical abilities may have different features of subjective representations of their cognitive interests, self-assessment of intelligence and socio-perceptual properties, we can conclude that it is partially confirmed. The study shows that students with average and low levels of analytical mathematical abilities have differences in the subjective variables "self-assessment of intelligence" and "subjective ideas about their cognitive interests". Students with an average level of analytical mathematical abilities are characterized by an average self-esteem of intelligence, and equal shares of high and low self-esteem of intelligence. Subjective ideas about their own cognitive interests of this group have a small degree of differentiation and are represented by artistic activities, mathematics and mechanics, the Humanities and nature. Students with a low level of analytical mathematical abilities are characterized by a predominance of low self-esteem of intelligence. Subjective ideas about their own cognitive interests in this group are more differentiated, but the most preferred are the humanitarian sphere and artistic activities.

The literature presents research on the self-esteem of the gifted teens. So, Tsoi and Scheblanova (2013) we described the age and gender characteristics of self-assessment of intelligence by older teenagers (grade 8 and 9). It is shown that the self-assessment of intelligence students 8th grade higher than students of grade 9 girls higher rate of verbal-linguistic skills, intra - and interpersonal, boys, mathematics and natural science (Tsoi and Scheblanova, 2013). In descriptions of General characteristics of self-esteem of gifted children, it is noted that low self-esteem can hinder the implementation of abilities and adaptation of gifted children depends on the level of intelligence (Bogoyavlenskaya, 2004; Leites, 2008; Yurkevich, 2011). In this regard, the average self-assessment of intelligence by students with an average level of mathematical abilities can be designated as realistic, contributing to effective social adaptation.

The composite assessment of social intelligence and the ability to recognize the structure of interpersonal situations in dynamics in students with an average level of analytical mathematical abilities is higher than in group 2. Also, in this group, there is a tendency to have the ability to assess the state of people by non-verbal manifestations. It should be noted that according to the test norms (Belova, 2004),

the values in both groups are characterized as the average sample norm. Analyzing the above results, it is necessary to take into account the idea of a small relationship between general and social intelligence (Belova, 2004), that mathematical abilities are not intelligence in total (Khertanova and Kondaurova, 2006), as well as the fact that the realization of the potential of giftedness is associated with successful interpersonal interaction (Bogoyavlenskaya, 2004; Davidson, 2009; Kolmogorov, 2001; Renzulli, 2002, 2005). Higher values of social intelligence in students with a higher level of mathematical abilities indicate the prospects for research, namely, the study of the relationship of social intelligence with objective and subjective assessments of mathematical giftedness. Detailing the results allows us to note that verbal expression (a component of social intelligence) is associated with practical mathematical thinking, the ability of mathematical and spatial generalization.

There are differences in the emotional channel of empathy, the intuitive channel of empathy in students with different levels of mathematical abilities, and there is a tendency to show differences in the overall level of empathy. The quantitative values of these indicators are higher for group 2 respondents. That is, students with a low level of analytical mathematical abilities have more emotional responsiveness and the ability to make a forecast of behavior on this basis, as well as they have a more developed ability to predict the behavior of a partner in conditions of lack of objective information, based on their own experience. The overall level of empathy is also higher for students with low math abilities. At the same time, according to the test standards, this group corresponds to the average sample rate (Boyko, 1996). At the same time, students with an average level of mathematical ability showed an understated level of empathy.

Bovina (2020) points out that empathy is considered more often as a personal construct, but understanding empathy as a mechanism of social perception would allow resolving conceptual contradictions in the study of this phenomenon. Batson (2009) systematizing research on empathy in the fourth model of conceptualization of empathy speaks about projecting oneself into the situation of another person. Bovina (2020) notes that in imitation theory, empathy involves understanding the thoughts and feelings of another, based on one's own mental model. According to Rimé (2009) the emergence of empathy is based on cognitive processes (Bovina, 2020, p. 91). in other words, the identified relationships of empathy and analytical-synthetic mathematical abilities, mathematical and spatial generalization abilities, in the prospects of the study set the task of studying models and determinants of the process of understanding the other.

The revealed relationships of emotional intelligence with practical mathematical thinking, mathematical generalization and combinatorial abilities make it relevant to address modern research on emotional intelligence. It is shown that a high level of emotional intelligence increases the level of subjective well-being (Por et al, 2011), is positively associated with life satisfaction, self-esteem and self-acceptance (Carmeli et al, 2009), and readiness for online learning (Alenezi, 2020). Djermanov and Marić Jurišin (2018) point out the importance of emotional literacy in education and the need for pedagogical monitoring of the emotional development of young people, the development of their emotional competence directly in the system of education. We can assume that mathematical abilities will positively influence the subjective well-being of students, which coincides with the thesis described above about the relationship of mathematical giftedness with life fulfillment (Krasnoryadtseva, 2013). The current format of online education and its connection with emotional intelligence in this study allows us to make a primary assumption about the greater readiness of mathematically gifted students for this format of education.

Conclusions

The results of the study showed that: 1) students with different levels of mathematical abilities have differences in the features of subjective ideas about their cognitive interests, self-assessment of intelligence, composite assessment of social intelligence, the ability to recognize the structure of interpersonal relationships in dynamics, emotional and intuitive channel of empathy; 2) students with different levels of mathematical abilities have tendencies to show differences in the ability to correctly assess States based on non-verbal manifestations and the General level of empathy; 3) discovered a positive relationship with different levels of significance practical mathematical thinking, and math skills generalization with verbal expression, overall level of empathy, the overall level of emotional intelligence; analytic-synthetic mathematical abilities and emotional channel of empathy; combinatorial abilities, ability to handle images in two-dimensional space with the overall level and components of emotional intelligence (control of expression, understanding emotions); ability to operate with spatial images and generalize relationships between them with verbal expression and intuitive channel of empathy.

In summary, we can generalize the features of socio-perceptual properties of students with different levels of mathematical abilities. Students with an average level of analytical mathematical ability have a more realistic self-assessment of intelligence. Their subjective ideas about their own cognitive interests are little differentiated and are distributed among three spheres, where the mathematical has an equal percentage with the humanitarian. The higher expression of the General indicator of social intelligence than in the group with a low level of mathematical abilities is explained by high indicators of the ability to recognize the structure of interpersonal situations in dynamics and assess States by non-verbal manifestations.

The greater severity of the overall indicator of social intelligence than in group 2 is justified by indicators of the ability to recognize the structure of interpersonal situations in dynamics and evaluate States by non-verbal manifestations. Conditionally, these results can be described as a more pronounced ability to predict behavior based on a cognitive analysis of dynamic and nonverbal characteristics. This may be due in a certain way to the fact that students with an average level of analytical mathematical abilities have an underestimated level of empathy. When building programs of psychological and pedagogical support for this category of students, it is necessary to take into account the dominance of the cognitive component of forecasting over the emotional one. Since the unspoken ability to predict the partner's behavior through emotional responsiveness may be a factor of impaired social adaptation in the educational and professional group.

Students with low analytical math skills are more likely to show low self-esteem of intelligence. At the same time, they have a more differentiated field of subjective ideas about cognitive interests, where the leading ones are the humanitarian and artistic spheres. The social intelligence of this group corresponds to the average sample rate. When organizing psychological and pedagogical support for this category of students, it is recommended to include a module on the development of social intelligence in the program. This observation is also true for the group with an average level of analytical mathematical abilities.

The found relationships between mathematical abilities and social-perceptual properties indicate that a greater number of relationships with social-perceptual properties have the ability of mathematical generalization and practical mathematical thinking. Here, we found relationships not only with empathy, but also the ability to recognize verbal expression and the General ability to understand and manage their own and others ' emotions. The ability to operate images in two-dimensional space is related only to the level and components of emotional intelligence. This is significant in comparison with the ability to operate images in three-dimensional space, which are interconnected with social intelligence and empathy, but are formed earlier in ontogenesis. It can be assumed that in this way, the recognition and control of emotions is associated with more complex forms of mathematical thinking.

The prospects of this research are: improving the procedure for expert evaluation of mathematical giftedness; studying the components of mathematical abilities that determine socio-perceptual features; expanding the repertoire of socio-perceptual properties in the study; creating and testing a program of psychological and pedagogical support for mathematically gifted students.

Acknowledgments

The authors are grateful to all participants in the research and to the editorial team for their kind and professional assistance.

Conflict of interests

The author declares no conflict of interest.

References

Abakumova, I. V. & Babiyants, K.A. (2012). *Диагностика математической одаренности* [Diagnostics of mathematical giftedness]. Southern Federal University, Rostov-on-don. Retrieved from https://talant-portal.sfedu.ru/sites/default/files/diagnostika_matematicheskoy_odarennosti_abakumova_babiyanc.pdf

Alenezi, A. M. (2020). The relationship of students' emotional intelligence and the level of their readiness for online education: A contextual study on the example of university training in Saudi Arabia. *The Education and Science Journal, 22*(4), 89–109. http://dx.doi.org/10.17853/1994-5639-2020-4-89-109

Almeida, L. S., Araújo, A. M., Sainz-Gómez, M., & Prieto, M. D. (2016). Challenges in the identification of giftedness: Issues related to psychological assessment. *Anales de psicología, 32*(3), 621-627. http://dx.doi.org/10.6018/analesps.32.3.259311

Andreyeva, G.M. (2000). *Психология социального познания* [The psychology of social cognition]. Aspekt press, Moscow. Retrieved from https://search.rsl.ru/ru/record/01002568601

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic bulletin & review, 14*(2), 243-248. https://doi.org/10.3758/BF03194059

Ayres, P. L. (2001). Systematic mathematical errors and cognitive load. *Contemporary Educational Psychology, 26*(2), 227-248.

Batson, C. D. (2009). These things called empathy: Eight related but distinct phenomena. In J. Decety & W. Ickes (Eds.), *Social neuroscience. The social neuroscience of empathy* (p. 3–15). MIT Press. https://doi.org/10.7551/mitpress/9780262012973.003.0002

Belova, S.S. (2004). Социальный интеллект: сравнительный анализ методик измерения [Social intelligence: a comparative analysis of measurement techniques]. In D. V. Lyusin & D. V. Ushakov (Eds.), *Social intelligence: theory, measurement, research* (pp. 109-119). Institute of psychology of the Russian Academy of Sciences, Moscow. Retrieved from https://elibrary.ru/item.asp?id=21688471

Bogoyavlenskaya, D.B. & Nizovtsova, A.N. (2017). К проблеме соотнесения общих, специальных и творческих способностей (на примере математической одаренности) [To the problem of correlation of General, special and creative abilities (on the example of mathematical giftedness)]. Psychology. *Journal of the higher school of Economics, 14*(2), 277-297. https://doi.org/10.17323 / 1813-8918-2017-2-277-297

Bogoyavlenskaya, D.B. (2004). Рабочая концепция одаренности [Working concept of giftedness]. *Education issues, (2)*, 46-68. https://doi.org/10.24412/FhFzuzYI9AA 4

Bogoyavlenskaya, D.B. (2010). Одаренность: ответ через полтора столетия [Giftedness: the answer in a century and a half]. *Vestnik of Moscow state University Psychology, (3),* 3-18. URL: https://cyberleninka.ru/article/n/odarennost-otvet-cherez-poltora-stoletiya.

Bovina, I. B. (2020). Empathy: Critical Analysis and New Research Perspectives. *Cultural-Historical Psychology, 16*(1), 88-95. https://doi.org/10.17759/chp.2020160109

Boyko, V.V. (1996). *Энергия эмоций в общении: взгляд на себя и на других* [Emotional energy in communication: looking at yourself and others]. Informational-publishing house “Filin”, Moscow. Retrieved from https://search.rsl.ru/ru/record/01001756600

Campbell, J. I., & Xue, Q. (2001). Cognitive arithmetic across cultures. *Journal of Experimental Psychology: General, 130*(2), 299–315. https://doi.org/10.1037/0096-3445.130.2.299

Carmeli, A., Yitzhak-Halevy, M., & Weisberg, J. (2009). The relationship between emotional intelligence and psychological wellbeing. *Journal of Managerial Psychology, 24*(1), 66-78. https://doi.org/10.12691/rpbs-2-4-2

Davidson, J. E. (2009). Contemporary models of giftedness. In *International handbook on giftedness* (pp. 81-97). Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-6162-2_4

Djermanov, J., & Marić Jurišin, S. (2018). Students’ emotional literacy in the discourse of the contemporary school in Serbia. *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE), 6*(2), 1–10. https://doi.org/10.5937/ijcrsee1802001D

Druzhinin, V.N. (2000). Природа одаренности [Nature of giftedness]. In D. V. Ushakov (Eds.), *Psychology of giftedness from theory to practice* (issue 2, pp. 15-25). Institute of psychology of the Russian Academy of Sciences, Moscow.

Hanin, V. & Van Nieuwenhoven, C. (2020). An Exploration of the Cognitive, Motivational, Emotional and Regulatory Behaviours of Elementary-School Novice and Expert Problem Solvers. *Canadian Journal of Science, Mathematics and Technology Education, 20*, 312–341. https://doi.org/10.1007/s42330-020-00092-9

Kanin, E. S. (2013). Математические способности учащихся и их развитие. [Students‘ mathematical abilities and their Development]. *Bulletin of Vyatka state University,* (2-1), 152-158. Retrieved from https://cyberleninka.ru/article/n/matematicheskie-sposobnosti-uchaschihsya-i-ih-razvitie

Khertanova, V. V., & Kondaurova, I. K. (2006). Развитие математических способностей и познавательной самостоятельности студентов в контексте их будущей профессиональной деятельности [Development of mathematical abilities and cognitive independence of students in the context of their future professional activity]. *Bulletin of the Saratov state technical University, 3*(2), 260-264. Retrieved from https://elibrary.ru/author_items.asp?authorid=555978&pubrole=100&show_refs=1&show_option=0

Kholodnaya, M. A. (2011). Эволюция интеллектуальной одаренности от детства к взрослости: эффект инверсии развития [The evolution of intellectual giftedness from childhood to adulthood: the effect of inversion development]. *Psychological journal, 32*(5), 69-78. Retrieved from http://www.ipras.ru/engine/documents/document3358.pdf

Khinchin, A. Ya. (1961). О воспитательном эффекте уроков математики [On the educational effect of math lessons]. Mathematical education, 6, 7–28. Retrieved from http://www.mathnet.ru/links/f69d82f69f09afcfd78726a710ca3b20/mp676.pdf

Kolmogorov, A. N. (2001). О развитии математических способностей (письмо В.А.Крутецкому) [On the development of mathematical abilities (letter to V. A. Krutetsky)]. *Questions of psychology, 3*, 103-106. Retrieved from https://elibrary.ru/item.asp?id=15499930

Krasnoryadtseva, O. M. (2013). Актуализация потенциала одаренности подростков с выраженным интересом к математике: возможности психолого-образовательных технологий [Actualization of the potential of gifted adolescents with a pronounced interest in mathematics: the possibilities of psychological and educational technologies]. *Siberian psychological journal, 48*, 39-47. Retrieved from https://cyberleninka.ru/article/n/aktualizatsiya-potentsiala-odarennosti-podrostkov-s-vyrazhennym-interesom-k-matematike-vozmozhnosti-psihologo-obrazovatelnyh

Krutetskiy, V. A. (1998). *Психология математических способностей школьников* [Psychology of mathematical abilities of schoolchildren]. Institute of practical psychology, Moscow. Retrieved from https://search.rsl.ru/ru/record/01000581254

Kryukova, E. A. (2001). Математическая одаренность: индивидуальные, гендерные и возрастные особенности: дис. ... канд. психол. наук: 19.00.01. [Mathematical giftedness: individual, gender and age characteristics: dis. ... Cand. the course of studies. Sciences: 19.00.01.]. (*Doctoral dissertation*, Пермский государственный гуманитарно-педагогический университет). Perm. Retrieved from https://search.rsl.ru/ru/record/01002308503

Kunitsyna, V. N. & Kazarinova, N. V. & Pogol’sha, V. M. (2001). *Межличностное общение* [Interpersonal communication]. Peter, Saint Petersburg. Retrieved from https://search.rsl.ru/ru/record/01000707877

Leites, N. S. (2008). *Возрастная одаренность и индивидуальные различия* [Age-related giftedness and individual

differences]. Moscow psychological and social Institute, Moscow. Retrieved from https://search.rsl.ru/ru/record/01004244555

Mikhailova, E.S. (1996). *Методика исследования социального интеллекта: Адаптация теста Дж. Гилфорда и М. Салливена: Руководство по использованию* [Social intelligence research methodology: Adapting the J. Guilford and M. Sullivan test: A guide to use]. Imaton, Saint Petersburg.

Por, J., Barriball, L., Fitzpatrick, J., & Roberts, J. (2011). Emotional intelligence: Its relationship to stress, coping, well-being and professional performance in nursing students. *Nurse education today, 31*(8), 855-860. https://doi.org/10.1016/j.nedt.2010.12.023

Renzulli, J. S. (2002). Expanding the conception of giftedness to include co-cognitive traits and to promote social capital. *Phi Delta Kappan, 84*(1), 33-58. https://doi.org/10.1177/003172170208400109

Renzulli, J. S. (2005). The three-ring conception of giftedness. In R. J. Sternberg & J. E. Davidson (Eds.), *Conceptions of giftedness* (2nd ed., pp. 246–279). New York: Cambridge University Press. https://doi.org/10.1017/CBO9780511610455.015

Ridetskaya, O. G. (2011). *Психология одаренности* [Psychology of giftedness]. Publishing center of the Eurasian open Institute, Moscow. Retrieved from https://search.rsl.ru/ru/record/01005418330

Rimé, B. (2009). Le partage social des émotions [Social sharing of emotions]. Presses Universitaires de France, Paris. https://doi.org/10.1016 / j.jtcc.2011.01.003

Рыжов, В. В. (1981). О взаимосвязи особенностей общения личности и ее социально-перцептивных характеристик [On the relationship between personality communication features and its socio-perceptual characteristics]. *Вопросы психологии, (2)*, 58-67. Retrieved from http://www.voppsy.ru/issues/1981/812/812058.htm

Sari Faradiba, S., Sa'dijah, C., Parta, N., & Rahardjo, S. . (2019). Looking without seeing: the role of metacognitive blindness of student with high math anxiety. *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE), 7*(2), 53–65. https://doi.org/10.5937/IJCRSEE1902053F

Schoevers, E. M., Kroesbergen, E. H., & Kattou, M. (2020). Mathematical creativity: A combination of domain-general creative and domain-specific mathematical skills. *The Journal of Creative Behavior, 54*(2), 242-252. https://doi.org/10.1002/jocb.361

Shadrikov, V. D. (2019). К новой психологической теории способностей и одаренности [To a new psychological theory of ability and giftedness]. *Психологический журнал, 40*(2), 15-26, https://doi.org/10.31857/S020595920002981-5

Sternberg, R. J. (2000). Giftedness as developing expertise. In K. A. Heller, F. J. Monks, R. J. Sternberg, & R. F. Subotnik (Eds.), *International handbook of giftedness and talent* (2nd ed., pp. 55–66). New York, Elsevier. https://doi.org/10.1016/B978-008043796-5/50004-8

Sukhodolsky, G. V. (2008). *Математические методы в психологии* [Mathematical methods in psychology]. Publishing house of the Humanitarian center (3nd ed.), Moscow.

Tsoi, A.B. & Scheblanova, Е.И. (2013). Самооценка интеллекта одарённых учащихся разного возраста и пола [Self-assessment of the intelligence of gifted students of different ages and genders]. *Начальная школа плюс До и После, (5)*, 19-23. Retrieved from http://www.school2100.ru/upload/iblock/d1c/Tsoj.pdf

Ushakov, D. V. (2011). *Психология интеллекта и одаренности* [Psychology of intelligence and giftedness]. Institute of Psychology, Russian Academy of Education, Academy of Sciences, Moscow. Retrieved from https://search.rsl.ru/ru/record/01005369428

Yurkevich, V.S. (2009). Одаренные дети и интеллектуально-творческий потенциал общества [Gifted children and the intellectual and creative potential of society]. *Psychological Science & Education, (4)*, 74-86. Retrieved from https://psyjournals.ru/psyedu/2009/n4/24496.shtml

Yurkevich, V.S. (2011). Одаренные дети: сегодняшние тенденции и завтрашние вызовы [Gifted children: today's trends and tomorrow's challenges]. *Psychological Science & Education, (4),* 99-108. Retrieved from https://psyjournals.ru/files/48678/psyedu_2011_n4_Yurkevich.pdf

Original scientific paper

UDK: 005.31:519.816

Received: November, 20.2020.
Revised: December, 05.2020.
Accepted: December, 10.2020.

doi: 10.23947/2334-8496-2020-8-SI-113-120

Field Dependence / Field Independence as a Factor of Financial Decision Making With Varying Degrees of Risk Among Students

Belykh Tatiana Viktorovna[1], Zinchenko Ekaterina Mikhailovna[1]*

[1]Department of Psychology, Saratov National Research University named after N.G. Chernyshevsky, Russian Federation, e-mail: tvbelih@mail.ru; Odonata1108@yandex.ru

Abstract: Currently, a new interdisciplinary field of research – financial behaviour-is rapidly developing. Psychological characteristics of the subject of financial behaviour can have a significant impact on the decision-making process in this field. Cognitive style, as an individual way of processing the information perceived by the subject, is one of the factors determining such procedural features of financial decision-making as: the time spent on decision – making, the speed of decision-making, the emotional state of the individual during decision-making, the nature of perceptual information processing (especially oculomotor activity), as well as the type of decision strategy - rational, irrational or marginal.

Keywords: decision-making, risk, field dependence / field independence, oculomotor activity.

Introduction

The problem of research of psychological features and multi-factor determination of the decisions made by the person remains relevant today. For the first time this question was raised by Kahneman, D., and Tversky, A. (1979) in their work on the Theory of Prospects. They suggested that a person's choice is not always rational. On the contrary, we often make mistakes and act irrationally when making financial decisions. With the help of a series of experiments they managed to show and prove that a person is governed by psychological patterns at the time of making financial decisions. The problem of studying the decision-making process and its psychological components remains relevant to modern scientific knowledge. In the works of Neumann, J., and Morgenstein, O. (1970) in the framework of game theory and optimal control theory the first approaches to its study were formulated and the main stages of decision-making (construction of alternatives, their evaluation and selection of the optimal alternative) were identified. American psychologists Petty, R. E., and Cacioppo, J. T. (1986) developed an elaboration likelihood mode (ELM) of conscious information processing that describes the effect of persuasive message on the recipient from the point of view of its relationship to the subject of the message that can be used in understanding of the decision-making process.

A great contribution to the solution of this problem on the part of the Russian scientists was made by Kornilova, T. V. (2010) and her students who developed a theory that reveals the unity of the intellectual and personal potential of a person in decision-making. At the same time gender, age and individual-personal differences in decision-making processes were found (Zaguzova T. A., 2009), cognitive-style determination of decision-making was revealed (Semicheva N. V., 2010), the adoption of innovative solutions in terms of managerial competence of the individual was investigated (Ponomarev V. P., 2011), the specifics of decision-making processes in the situation of advertising exposure was revealed (Gladkih N. Yu, 2011), data on the psychological conditions of managerial decision-making by managers in stressful situations were obtained (Akhtamov V. S., 2013). Age aspect of decision-making has become the subject of study in the works of Bryukhova, N. G. (2007), who concentrated attention on the impact of self-reflection on decision-making process among young girls and boys, Rumyantseva, A. V. (2008), who studied the peculiarities of decision-making of high school students in situations of risk, which are manifested in the subjective representations of risk and decision-making, in the predominance of a particular type of risk, the characteristics of the flow of the decision-making process, in greater "riskiness" and less rationality than adults, Krivosheeva, N. W. (2008), who studied socio-psychological readiness of students-future managers to take managerial decisions, which includes motivational, value-orientation, assessment, operational, ethical-volitional and individual components.

*Corresponding author: tvbelih@mail.ru

At present, a new interdisciplinary field of knowledge - behavioural finance is developing. "Behavioural Finance is the direction of the financial theory that arose more than 30 years ago, whose distinctive feature is the use of the construction of financial models of the irrational component of individual cognitive processes" (Goretskaya V. A., 2014, p. 28). In this direction, within the framework of Economics and economic psychology, researches are conducted by such scientists as: Grishina N. P., 2012; Mordashkina Yu., 2013; Goretskaya V. A., 2014; Korshunova G. V., Nemtsev A. D., and Romanova L. E., 2017; Cechin V. V., 2017, etc.). As for foreign researchers, it is worthwhile mentioning such researchers as Loewenstcin, 1996; Carmon, Z. and Ariely, D. 2000; Ariely, D. and Wertenbroch, K. 2002, Ariely, Loewenstein, and Prelec, 2003; Ariely, D., Bracha, A., and L'Huillier, J.-P. 2010; Shiv B., Carmon Z., and Ariely D., 2005; Samson, A., 2015.

Individual cognitive features along with perception, memory and thinking (Kornilova, 2002; Vavilov, 2005; Nenasheva, 2009), which influence the financial decision-making process, include cognitive style as well. Cognitive style reflects the enduring characteristics of how different people think, perceive and remember information, as well as their preferred way of solving problems (Shkuratova, 1994, 1999; Kholodnaya, 1997).

Currently, there is a large number of works on the study of cognitive styles. Field dependence / field independence (FD / FID) is one of the parameters of cognitive style, described for the first time by G. Witkin, who considered it as one of the manifestations of psychological differentiation of a personality (Witkin, 1997). Depending on the person, the factor of influence of the field (subject and social environment) reveals itself in different measure. Thus, the behaviour of some people is more subordinated to the field (field dependent type of behaviour), while the behaviour of others is aimed at internal activity (field independent type of behaviour) (Kholodnaya, 1992, 1997). In a number of studies the impact of this style on mental abilities, on peculiarities of perception are examined, the issue of the development of style in the process of growing up, as well as the impact of gender on the manifestation of perceptual style are considered (Tikhomirova, 1988; The Style of the Person, 1998; Kholodnaya, 1990, 2002; Predein, 2012). So, Semyashkin, A. A. (2010) found out gender differences in the interrelations of cognitive styles (field dependence/field independence, narrowness-width of the range of equivalence) and temperament; Osokina, K. A. (2016) revealed the connection of the field of dependence/ field of independence with such stable characteristics of the personality as stress resistance, anxiety, procedural components of thinking.

The process of financial decision-making is multi-factor determination, which includes the impact of a biologically-determined psychological properties, for example, neuro - and psycho-dynamic individual differences (Belykh T. V., 2016) and socially-determined factors, which, in particular, consider the rationality/irrationality of decision-making (Belykh T., Grishina N., and Zinchenko E., 2018).

The aim of the present study is to identify the features of financial decision-making in simulated conditions with varying degrees of risk among field dependent/field independent students.

Materials and Methods

The study was conducted in a higher educational establishment on the basis of the educational laboratory "Cognitive Psychology". The experiment involved 77 people (85% of girls, 15% of boys), studying at the psychological, biological and mechanical-mathematical faculties.

The experiment consisted of several stages. In the first stage, the Gottschaldt Figure test was used to diagnose the cognitive style of FD / FID students (Gottschaldt, 1926).The test consists of thirty tasks in which it is proposed to find one masked element among the five reference ones. One complex figure and 5 reference elements, coded with the letters A, B, C, D, E, were shown on the Eye Tracker screen.

At the second stage the test "Coin Lottery" was used to assess the risk (Belykh T., Grishina N., and Zinchenko E., 2018). This test consists of 2 groups of financial tasks: 1 group – winning problems, 2 group – losing ones. Each group includes 2 types of questions depending on the degree of risk: 0.99 and 0.01. Financial tasks were presented one by one on the Eye Tracker screen and the participant of the experiment had to choose between two answers: to take a risk or to choose a guaranteed win or loss.

The experiment was carried out with the use of a hardware method for detection of oculomotor activity by video recording of the participant's gaze movements, carried out by a stationary binocular eye tracking system Eye Tracker (model RED 500 System, produced by SMI (SensoMotorikInstruments GmbH, Germany). Initial processing of the basic characteristics of eye movements was produced by the BeGaze program of the Eye Tracker installation. During the test, various parameters of oculomotor activity were recorded, including indicators of blinking, fixation and saccades.

Upon presentation of two alternatives, the experimenter has the information about previously

calculated mathematical expectation and dispersion (as a risk measure) for this choice, which allowed assessing the degree of manifestation of rationality in the decision-making of each participant. The results were carefully analyzed and subdivided into groups with varying degrees of rationality of the decisions made. The following definitions of specific solutions are used in the conducted analysis: rational (+); risk avoiding (RA); risk seeking (RS); loss avoiding (LA); irrational (-).

To determine membership in a particular group, the expectation and dispersion (risk measure) of the risk option are compared with the same parameters of the guaranteed outcome. After detailed analysis of the decisions of each participant, the entire study sample should be divided into groups depending on the rationality of the decisions taken. According to Markowitz, (1952), a rational investor prefers more to less and certainty to uncertainty. Thus, we believe that the percentage of rationality is a sum total of rational and risk-avoiding decisions in the total number of proposed choices (+ and RA).

The rationality of risk behaviour was determined depending on the number of risk responses given by the respondent, as well as taking into account the mathematical expectation and sigma for each task.

So 3 groups of personalities were singled out:

- strictly rational (>60% of rationality);
- marginal (60-40% of rationality);
- strictly irrational (<40% of rationality).

The same procedure is used to determine the rationality of decisions in subgroups of financial situations of choice: wins with a probability of 0.99, wins with a probability of 0.01, losses with a probability of 0.99, losses with a probability of 0.01

The obtained data were processed by SPSS program. The Kolmogorov-Smirnov criterion was used to determine the nature of the distribution of the data obtained. Further, in accordance with the result, non-parametric analysis methods were used: Mann-Whitney statistical criterion and Spirmen correlation analysis.

Results

In the course of the experiment, according to the results of the "Gottschaldt Figures" test, which determines the cognitive style, 2 groups of respondents were identified: group 1 – field independent students (24%), group 2 – field dependent students (76%) (Figure 1).

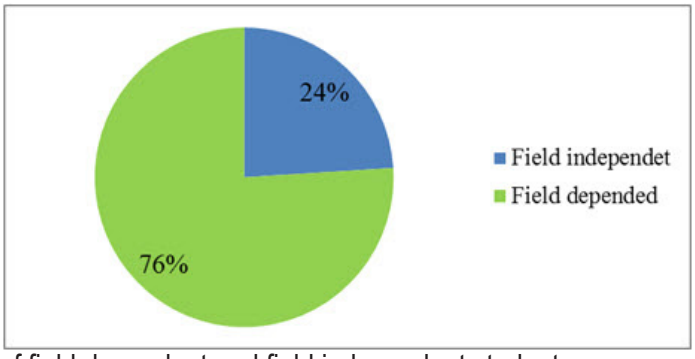

Figure 1. Ratio of field dependent and field independent students

Thus, the majority of respondents have low articulated experience. This is probably due to the fact that most of the test participants are girls. Field dependence is more typical for female representatives in all age groups, while field independence – for males (Shkuratova, 1994).

According to the results of the analysis of respondents' answers while solving financial problems in each group, depending on the rationality of the choice, rational, marginal and irrational students were identified (Figure 2).

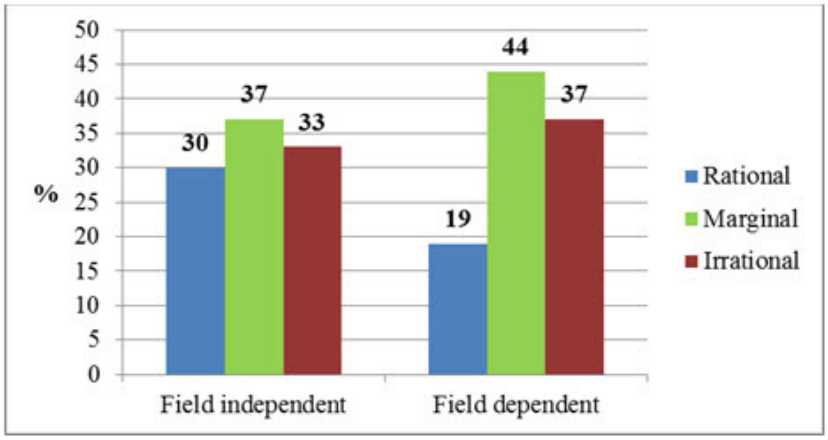

Figure 2. Distribution of field independent / field dependent students taking into account the rationality of choice

Both the field-independent and the field-dependent groups are dominated by representatives who are inclined to make decisions using both rational and irrational strategies, and their number is 37% and 44% respectively. The distribution based on rationality / irrationality among field-dependent students was approximately equal: 30% and 33% respectively. But among the field-dependent students the use of rational decision-making strategy is typical for 19% of respondents. The remaining 37% of respondents used an irrational strategy when making a financial decision.

Thus, the least amount of use of rational decision-making strategy among students is found in the group with a field-dependent perceptual style.

The correlation between the field dependence index and the level of rationality was not revealed by the results of the correlation analysis as for FID and FD students.

The percentage ratio of students was also revealed, taking into account the index of field-dependency by the number of risk-related responses in solving financial problems with different probability of win / loss (Figure 3).

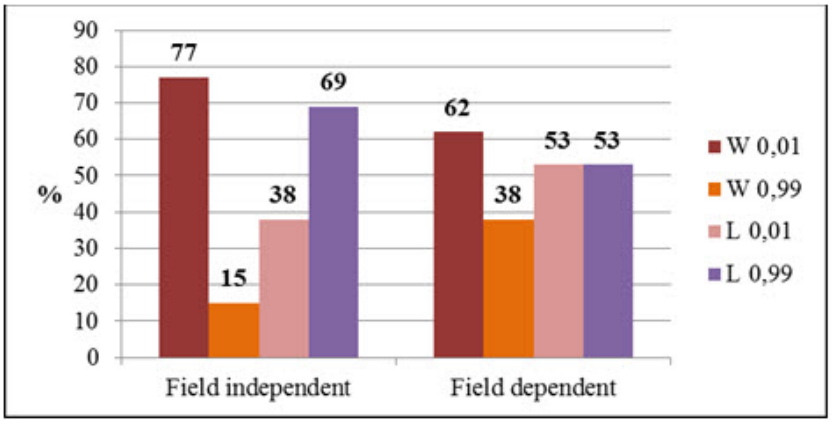

Figure 3. Distribution of students, taking into account the field dependency index by the number of risky answers.

Note: W 0.01 - tasks with winning probability of 1%, W 0.99 - tasks with winning probability of 99%, L 0.01 - tasks with lossing probability of 1%, L 0.99 - tasks with losing probability of 99 %.

Thus, students are more likely to risk in winning situations with a probability of 1%. It is worth noting that for FD students probability of loss does not matter, and for FID students the choice of risk increases with a probability of loss of 99%.

Further, a correlation analysis was performed, during which FD students were found to have a negative correlation relationship between number of risk responses and field dependence index when solving winning tasks with a probability of 1 % ($r = -0.402$, $p \leq 0.05$) and excluding probability ($r = -0.415$, $p \leq 0.05$). Thus, the more significant the cognitive style – field dependence is, the less risk-related responses are given by respondents.

At the next stage, the analysis of oculomotor activity (OMA) of students in the simulated conditions

of financial decision-making was carried out.

The results of the Kolmogorov-Smirnov test showed that the variables of OMA have significant deviations from the normal distribution ($p<0.05$). According to the results of the statistical analysis by the Mann-Whitney criterion, significant differences in oculomotor activity were found in students with different cognitive styles. But taking into consideration the fact that similar differences in OMA were found while solving problems with different degrees of probability of winning and losing, the description of the results will be the same on the example of winning problems with a probability of 0.99 (Table 1).

Table 1

OMA indicators for students with different cognitive styles in solving financial tasks with a probability of winning 0.99

	Options	FID	FD	
1	End Time [ms]	7266±897	8699±736	*
2	Blink Count	2.99±4.05	3.30±3.04	
3	Blink Frequency [count / s]	0.355±0.40	0.334±0.37	
4	Blink Duration Total [ms]	854±1325	753 ±989	
5	Blink Duration Average [ms]	241±151	207±54	
6	Blink Duration Maximum [ms]	597±57	190±137	*
7	Blink Duration Minimum [ms]	91.2±17.1	105.4±37.3	
8	Fixation Count	21.5±2.01	26.0±1,71	*
9	Fixation Frequency [count / s]	2.99±0.51	3.00±0.72	
10	Fixation Duration Total [ms]	3941±125	4567±134	*
11	Fixation Duration Average [ms]	207±19	167±12	*
12	Fixation Duration Maximum [ms]	546±115	333±87	*
13	Fixation Duration Minimum [ms]	58.8±12.2	58.8±16,6	
14	Fixation Dispersion Total [px]	1627±115	1905±163	*
15	Fixation Dispersion Average [px]	109±35,4	70.82±19,5	
16	Fixation DispersionMaximum [px]	425±53.9	347±63,9	
17	Fixation Dispersion Minimum[px]	11.52±2,45	24.19±4,13	*
18	Scanpath Length [px]	4941±225	5941±327	*
19	Saccade Count	37.3±3.29	50.5±7.61	*
20	Saccade Frequency [count / s]	5.13±0.25	5.69±0.23	*
21	Saccade Duration Total [ms]	1705±134	2290±226	*
22	Saccade Duration Average [ms]	48.0±2.69	46.4±3.17	
23	Saccade Duration Maximum [ms]	111±7.52	107±12.7	
24	Saccade Duration Minimum [ms]	23.3±6.87	22.9±4.35	
25	Saccade Amplitude Total [°]	203±7.05	227±9.12	*
26	Saccade Amplitude Average[°]	6.65±1.03	5.19±2.04	
27	Saccade Amplitude Maximum[°]	31.5±3.87	30.0±7.50	
28	Saccade Amplitude Minimum[°]	1.36±0.89	1.00±0.92	
29	Saccade Velocity Total [° / s]	3666±119	4199±224	*
30	Saccade Velocity Average [° / s]	99.4±9.17	87.7±11.25	
31	Saccade Velocity Maximum [° / s]	409±115	349±57	
32	Saccade Velocity Minimum [° / s]	31.5±3.99	28.0±2.75	
33	Saccade Latency Average [ms]	159±31.6	143±24.8	

Note: * - in comparison with field independent, $p \leq 0.05$.

So, significantly more time is spent by field-dependent students to solve financial problems, this suggests that they take decisions longer. Regarding blinking, it should be noted that significant differences were found in the maximum duration of blinking only when solving winning problems with a probability of 99% and losing – 1%. Thus, this factor is significantly higher for field-independent people, which indicates their greater emotionality in case of significant success and small losses. Significant differences in the parameters of fixations were also revealed. Thus, a greater number of fixations is typical for people with a field-dependent perceptual style. Field-independent individuals are characterized by low values of the total duration and maximum values of the average duration of fixations compared to individuals of group 2. The general and minimal dispersion of fixations is significantly higher among field-dependent students. Also, the maximum values of the length of the path travelled was identified, this confirms once again that

they spend more time to solve this kind of problems.

The analysis of saccade parameters revealed that individuals with high articulated experience are characterized by lower values of the number, frequency and total duration of saccades in comparison with the representatives of the group. Field-dependent students showed the highest values of the total amplitude and total velocity of saccades compared to field-independent ones. It is interesting to note that the values of such saccade parameters as the minimum duration, amplitude and speed are significantly higher among people with a more independent perceptual style only when solving losing problems regardless of probability. When solving losing problems with a probability of 99%, the latent period was longer for the field-independent students, that is, in such a situation, these people think longer. Consequently, the increase in the FD/FID index is associated with a decrease in the number of fixations, their duration and a decrease in the number and speed of saccades, which leads to a reduction in time, required for solving such tasks.

The obtained results indicate the presence of significant individual differences in OMA. A higher articulated perception among field independent students means both greater detailed elaboration and better organization of the perceptual field.

Discussion

According to the results of the study, it was established that the majority of students are on the border of rational and irrational financial behaviour, that is, in some cases, the risk is justified, and in some cases it is not. In winning situations, students take risk more often, regardless of cognitive style, but it is important to note that in situations with a high probability of losing more frequently the risk is taken by field independent persons. Various indicators of blinking, fixation and saccades allow us to conclude that students with a more independent perceptual style cope with such tasks faster. The increase in the FD / FID index is associated with a decrease in the number of fixations, their duration and a decrease in the number and speed of saccades, which leads to a reduction in the time required for solving financial problems. According to the number of blinking we can say that irrational students are more emotional. Financial decisions are made faster by rational individuals, based on the value of time spent and various indicators of fixations and saccades.

Conclusion

Cognitive style (field dependence / field independence) can be considered as a factor of financial decision-making. At the same time, cognitive style is interrelated with the degree of risk preference of the subject of financial decision-making, the type of decision–making strategy - rational, irrational or marginal, as well as the strategy of perceptual processing of information reflected in the features of oculomotor activity in the decision-making process, which determines its procedural features such as: the time spent on decision-making, the speed of decision-making, the emotional state of the individual during decision-making.

Acknowledgments

We thank students of Saratov National Research University named after N.G. Chernyshevsky for participation in our empirical experiments. We also would like to thank our colleagues from Economical Department for support and for comments that greatly improved the manuscript.

Conflict of interests

The authors declare no conflict of interest.

References

Akhtyamov, V. S. (2013). Psychological Conditions for Making Managerial Decisions by Managers in Stressful Situations. *Dissertation abstract* Candidate of Psychological Sciences, Moscow,24. Retrieved from http://nauka-pedagogika.com/psihologiya-19-00-03/dissertaciya-psihologicheskie-usloviya-prinyatiya-upravlencheskih-resheniy-rukovoditelyami-v-stressogennyh-situatsiyah

Ariely, D., Bracha, A., & L'Huillier, J.-P. (2015). Public and Private Values. J*ournal of Behavioral Decision Making, 29*(5), https://

doi.org/10.1002/bdm.1919
Ariely, D., Loewenstein, G., & Prelec, D. (2003). "Coherent arbitrariness": Stable demand curves without stable preferences. *The Quarterly journal of economics, 118*(1), 73-106. https://doi.org/10.1162/00335530360535153
Ariely, D., & Wertenbroch, K. (2002). Procrastination, deadlines, and performance: Self-control by precommitment. *Psychological science, 13*(3), 219-224. https://doi.org/10.1111/1467-9280.00441
Belykh, T. V. (2016). Making financial decisions with different degrees of risk: the neuro-and psychodynamic differences in the structure of individuality. *Economic Psychology: Past, Present, Future, 3*(2), 74-79. Retrieved from https://elibrary.ru/item.asp?id=27213371
Belykh, T., Grishina, N., & Zinchenko, E. (2018). Decision-making at different levels of rationality: subjects´s cognitive, neural and psycho-dynamic characteristic. *International journal of cognitive research in science, engineering and education, 6*(1), 39-44. https://doi.org/10.5937/ijcrsee1801039B
Bryukhova, N. G. (2007). Influence of self-understanding on decision-making by young men and girls. *Dissertation abstract* Candidate of Psychological Sciences, Astrakhan, 22. Retrieved from http://www.dissercat.com/content/vliyanie-samoponimaniya-na-prinyatie-reshenii-yunoshami-i-devushkami
Carmon, Z., & Ariely, D. (2000). Focusing on the forgone: How value can appear so different to buyers and sellers. *Journal of consumer research, 27*(3), 360-370. https://doi.org/10.1086/317590
Chechin, V. V. (2017). Objective conditions for the creation of a modern methodical approach to decision making on the securities market. *PUF*, 25. 28-33. Retrieved from https://cyberleninka.ru/article/v/obektivnye-usloviya-sozdaniya-sovremennogo-metodicheskogo-podhoda-prinyatiya-resheniya-na-rynke-tsennyh-bumag
Gladkikh, N. Yu. (2011). Specificity of decision-making processes in a situation of advertising influence. *Dissertation abstract* Candidate of Psychological Sciences,Yaroslavl, 24. Retrieved from http://www.dissercat.com/content/spetsifika-protsessov-prinyatiya-reshenii-v-situatsii-reklamnogo-vozdeistviya
Goretskaya, V. A. (2014). Behavioral finance: the application of the theory of prospects in financial management. *Finance and credit, 4*(580). Retrieved from https://www.fin-izdat.com/journal/fc/detail.php?ID=60427
Gottschaldt, K. (1926) Uber den Einfluss der Erfahrung auf die Wahrnehmung von Figuren. *Psychol. Forsch, 8,* 261–317. https://doi.org/10.1007/BF02411523
Grishina, N. P. (2012). The problem of making investment decisions from the point of view of the practice of behavioral finance. *Bulletin of the Saratov State Socio-Economic University, 1*(40). Retrieved from https://cyberleninka.ru/article/n/problema-prinyatiya-investitsionnyh-resheniy-s-tochki-zreniya-praktiki-povedencheskih-finansov
Kahneman, D., & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica, 47,* 263–291. Retrieved from https://www.uzh.ch/cmsssl/suz/dam/jcr:00000000-64a0-5b1c-0000-00003b7ec704/10.05-kahneman-tversky-79.pdf
Kholodnaya, M. A. (1997). Psychology of intelligence: research paradoxes, *Tomsk*, 392. Retrieved from https://gigabaza.ru/doc/14089-pall.html
Kholodnaya, M. A. (2002). *Cognitive styles: the nature of the individual mind* / MA Cold M.: PER SE, 304 pp.
Kholodnaya, M. A. (1990). *Cognitive styles as a manifestation of the uniqueness of individual intelligence*. UMK VO Kiev, 73.
Kholodnaya, MA (1992). Cognitive styles and intellectual abilities. *Psychol. Journal, 13*(3), 84–93. Retrieved from https://elibrary.ru/item.asp?id=20193930
Kornilova, T. V. (2010). Intellectual and personal potential of a person in coping strategies. *Moscow University Bulletin. Psychology, 14*(1), 46-57. Retrieved from https://cyberleninka.ru/article/v/intellektualno-lichnostnyy-potentsial-cheloveka-v-strategiyah-sovladaniya
Kornilova, T. V. (2002). *Motivational regulation of decision-making: modern views. Modern psychology of motivation* / Edited by DA. Leontiev, Moscow, Meaning, 172-213. Retrieved from http://world-psychology.ru/wp-content/uploads/2014/06/0100574_B1910_leontev_d_a_sovremennaya_psihologiya_motivacii.pdf#page=173
Korshunova, G. S., Nemtsev, A. D., & Romanova, L. E. (2017). Behavioral finance: the laws of financial decision-making. *Vestnik of the Volga University named after Tatishcheva, 2*(2), 1-10. Retrieved from https://cyberleninka.ru/article/v/povedencheskie-finansy-zakonomernosti-prinyatiya-resheniy-finansovogo-haraktera
Krivosheeva, N. W. (2008). The study of the socio-psychological readiness of students and future managers to make management decisions. *Dissertation abstract* Candidate of Psychological Sciences, Moscow, 22. Retrieved from http://www.dissercat.com/content/issledovanie-sotsialno-psikhologicheskoi-gotovnosti-studentov-budushchikh-rukovoditelei-k-p-0
Loewenstein, G. (1996). Out of control: Visceral influences on behavior. *Organizational behavior and human decision processes, 65*(3), 272-292. https://doi.org/10.1006/obhd.1996.0028
Markowitz, H. (1952). Portfolio selection. *The Journal of Finance, 7*(1), 77-91. https://doi.org/10.2307/2975974
Mordashkina, Yu. (2013). Psychological Aspects of Forming an Investment Decision Making Mechanism. *Russian Journal of Entrepreneurship, 9*(231). Retrieved from https://cyberleninka.ru/article/v/psihologicheskie-aspekty-formirovaniya-mehanizma-prinyatiya-investitsionnyh-resheniy
Nenasheva, E. V. (2009). Forecasting the profitability of financial assets in the capital markets, taking into account the behavioral characteristics of investors. *Dissertation abstract* Candidate of Economic Sciences, Moscow, 33. Retrieved from https://www.econ.msu.ru/cmt2/lib/a/1571/file/Nenasheva.pdf
Neumann, J., & Morgenstein, O. (1970). Game theory and economic behavior. Moscow, *Progress*, 103. Retrieved from http://bourabai.kz/dm/gamestheory1.htm
Osokina, K. A. (2016). Interrelation of cognitive style (field-dependence-field independence) and some personality traits. *Vestnik KSPU after V. P. Astafieva, 4*(38), 255-257. Retrieved from https://cyberleninka.ru/article/v/vzaimosvyaz-kognitivnogo-stilya-polezavisimost-polenezavisimost-i-nekotoryh-svoystv-lichnosti
Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 19, pp. 123-205). New York: Academic Press. https://doi.org/10.1016/S0065-2601(08)60214-2
Ponomarev, V. P. (2011). The adoption of innovative solutions as managerial competence on the example: of a high school leader. *Dissertation abstract* Candidate of Psychological Sciences, Moscow, 21. Retrieved from http://www.dissercat.

com/content/prinyatie-innovatsionnykh-reshenii-kak-upravlencheskaya-kompetentnost
Predein, E. V. (2012). *Cognitive style "field dependence - field independence"* / E. V. Predein. Published at the site: January 13, Retrieved from http://www.b17.ru/article/4203/ [electronic resource].
Rumyantseva, A. V. (2008). Features of decision-making by high school students in risk situations. *Dissertation abstract* Candidate of Psychological Sciences, St. Petersburg, 24. Retrieved from http://www.dslib.net/psixologia-razvitja/osobennosti-prinjatija-reshenij-starsheklassnikami-v-situacijah-riska.html
Samson, A. (2015). *The Behavioral Economics Guide 2015* (with an introduction by Dan Ariely introduction). Retrieved from http://eprints.lse.ac.uk/64439/1/BEGuide2015.pdf
Semicheva, N. V. (2010). Cognitive-stylistic decision-making determination. *Dissertation abstract* Candidate of Psychological Sciences, Moscow, 24. Retrieved from http://www.dissercat.com/content/kognitivno-stilevaya-determinatsiya-prinyatiya-reshenii
Semyashkin, A. A. (2010). Gender differences in the relationship of cognitive styles and temperament. *Vestnik TSPU, 2*(92), 130-134. Retrieved from https://cyberleninka.ru/article/v/gendernye-razlichiya-vo-vzaimosvyazyah-kognitivnyh-stiley-i-temperamenta
Shiv B., Carmon Z., & Ariely D. Placebo (2005). Effects of Marketing Actions: Consumers May Get What They Pay For. *Journal of Marketing Research., XLII,* 383–393 Retrieved from http://people.duke.edu/~dandan/webfiles/PapersPI/Placebo%20Marketing%20Actions.pdf
Shkuratova, I. P. (1994). *Cognitive style and communication,* Rostov-on-Don, RSPU, 156.
Shkuratova, I. P. (1999). *Cognitive styles and their impact on the success of communication and learning. Methodical manual for the course "Psychology of cognitive processes"*, Rostov-on-Don. 95. Retrieved from https://irshkuratova.ru/kog_stili_uspeshnost_obshenija-obuchenija.html
The style of man. Psychological analysis (1998). (Ed. A.V. Libin). M.: Meaning, 310.
Tikhomirova, I. V. (1988). Style and productive characteristics of abilities: a typological approach. *Questions of psychology, 3,* 106-115.
Vavilov, S. V. (2006). Psychological management space. *Sociological research, 5*, 93-102. Retrieved from http://ecsocman.hse.ru/data/770/662/1216/Sotsis_5_06_p93-102.pdf
Witkin, H., Goodenough, D. (1981). Cognitive styles, essence and origins: field dependence and field independence, N.Y., 135. Retrieved from https://catalogue.nla.gov.au/Record/1474010
Witkin, H. & Others (1977). *A Longitudinal Study of the Role of Cognitive Styles in Academic Evolution During the College Years* (microform] [Washington, D.C.)): Distributed by ERIC Clearinghouse, 131. Retrieved from https://eric.ed.gov/?id=ED165613
Zaguzova, T. A. (2009). Gender, age and individual-personality differences in decision-making processes. *Dissertation abstract* Candidate of Psychological Sciences, Moscow, 21. Retrieved from http://www.dissercat.com/content/gendernye-vozrastnye-i-individualno-lichnostnye-razlichiya-v-protsessakh-prinyatiya-reshenii

AUTHORS` GUIDELINES

Types of contributions

Original Research, Review Articles, Studies and articles, Book Reviews, Case Studies and Monographic studies.

BEFORE YOU BEGIN

Authorship of the Paper

Authorship should be limited to those who have made a significant contribution to the conception, design, execution, or interpretation of the reported study. All those who have made significant contributions should be listed as co-authors. Where there are others who have participated in certain substantive aspects of the research project, they should be acknowledged or listed as contributors. The corresponding author should ensure that all appropriate co-authors and no inappropriate co-authors are included on the paper and that all co-authors have seen and approved the final version of the paper and have agreed to its submission for publication.

Authors of work

The author of the paper should be the person who made the greatest contribution to the creation of the work. All those who contributed to the making of the work should be listed in the paper and as co-authors. If there are other contributors who took part in the preparation of making the same work should be listed or admitted as associates.

Before accepting a final version of the paper for publication is necessary that the author and all co-authors approved the final version.

Changes in authorship

Privacy change in authorship relates to the addition, deletion, or rearrangement of author names in accepted version of the paper. An amendment to the data on the authors or co-authors is not possible after acceptance and publication in the online version.

If there is a need to amend the information on the authors, it is necessary to state the following:

1. The reason for the addition or deletion of author,
2. A written confirmation (send it scanned by e-mail) where all the authors agree that the notified operation is a named person is added or removed from the list of authors.
3. The editor will notify the author that needs to be added or removed from the list and will ask for his consent.

Requirements that are not sent by the respective author (corresponding author) will not be considered.

Originality and plagiarism

Authors are required to submit original written article. If other work necessary to work properly quote according to the instructions on the citation of work. If you use ideas of other authors require their written consent and using the same.

Plagiarism in all its forms constitutes unethical behavior and will be severely punished, and as such is unacceptable. The author or authors are required before reporting to work in the journal checking their work through some of the programs for testing against plagiarism. The Editorial Board reserves the right to verify each work through the test of plagiarism and if the same occurs to notify the author.

Disclosure and conflicts of interest

Disclosure and conflicts of interest can be multiple. If the author or institution where the author has a financial assistance in project design or research is needed to adequately cover letter to inform the editorial and the public. Publication in journal person or institution that is financially supported by the making of the work or project is the best way to protect against conflicts of interest.

At the end of the text, under a subheading “Conflicts of interest”, all authors must disclose any actual or potential conflict of interest including any financial (direct of indirect), personal or other relationships with other people or organizations within three years from the commencement of any work.

Fundamental errors in published work

If the author detects an error in the published paper is obliged to instantly inform journal editors or publishers and that as soon as possible the same document. The author shall, in the event of an error, to cooperate with the editorial board to remove the same.

Copyright Notice

The Author(s) warrant that their manuscript is their original work that has not been published before; that it is not under consideration for publication elsewhere; and that its publication has been approved by all co-authors, if any, as well as tacitly or explicitly by the responsible authorities at the institution where the work was carried out. The Author(s) affirm that the article contains no unfounded or unlawful statements and does not violate the rights of others. If copyrighted works are included, the Author(s) bear responsibility to obtain written permission from the copyright owners. The Corresponding author, as the signing author, warrants that he/she has full power to make this grant on behalf of the Author(s).

By signing this agreement, the Corresponding author grants to the Publisher the following rights to the Manuscript, including any supplemental material, and any parts, extracts or elements thereof:

- the right to reproduce and distribute the Manuscript in printed form, including print-on-demand;
- the right to produce prepublications, reprints, and special editions of the Manuscript;
- the right to translate the Manuscript into other languages;
- the right to reproduce the Manuscript using photomechanical or similar means including, but not limited to photocopy, and the right to distribute these reproductions;
- the right to reproduce and distribute the Manuscript electronically or optically on any and all data carriers or storage media – especially in machine readable/digitalized form on data carriers such as hard drive, CD-Rom, DVD, Blu-ray Disc (BD), Mini-Disk, data tape – and the right to reproduce and distribute the Article via these data carriers;
- the right to store the Manuscript in databases, including online databases, and the right of transmission of the Manuscript in all technical systems and modes;
- the right to make the Manuscript available to the public or to closed user groups on individual demand, for use on monitors or other readers (including e-books), and in printable form for the user, either via the internet, other online services, or via internal or external networks.

Articles published in the Journal are Open-Access articles distributed under a Creative Commons Attribution 4.0 International (CC BY)

The Journal allows Author(s) to deposit all versions of their paper in an institutional repository and non-commercial subject-based repositories, such as PubMed Central, Europe PMC, arXiv and other repositories, or to publish it on Author's personal website and departmental website (including social networking sites, such as ResearchGate, Academia.edu, etc.).Publisher copyright and source must be acknowledged and a link must be made to the article's DOI.

Upon receiving the proofs, the Author(s) agree to promptly check the proofs carefully, correct any typographical errors, and authorize the publication of the corrected proofs.

The Corresponding author agrees to inform his/her co-authors, of any of the above terms.

The journal allows readers to read, download, copy, distribute, print, search, or link to the full texts of its articles and allow readers to use them for any other lawful purpose.

Copyright Agreement

For open access articles, permitted third party (re)use is defined by the following Creative Commons user licenses:

Creative Commons Attribution (CC-BY)

Lets others distribute and copy the article, create extracts, abstracts, and other revised versions, adaptations or derivative works of or from an article (such as a translation), include in a collective work (such as an anthology), text or data mine the article, even for commercial purposes, as long as they credit the author(s), do not represent the author as endorsing their adaptation of the article, and do not modify the article in such a way as to damage the author's honor or reputation.

Language (usage and editing services)

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, the grammar, spelling, usage, and punctuation of the text 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. To avoid unnecessary errors, you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

Authors who feel their English language manuscript may require editing to eliminate possible grammatical or spelling errors and to conform to correct scientific English may wish to use the English Language Editing service available from EDANZ -

http://www.edanzediting.com/services/english_editing

NEW SUBMISSIONS

Manuscripts must submit only online, proceeds are totally online and you will be guided stepwise through the creation and uploading of your files. Electronic submission reduces the editorial processing and reviewing times and reduces the time of submission to publication.

You have to use IJCRSEE template to prepare your article and this version upload via

http://ijcrsee.com/index.php/ijcrsee/about/submissions#onlineSubmissions

Formatting requirements

The prepared article should be formatted with IJCRSEE template. There are some parameters for authors.

If your article includes any Videos and/or other Supplementary material, this should be included in your initial submission for peer review purposes.

Divide the article into clearly defined sections.

Structure of Manuscripts

Title Page

The title page should include:

The name(s) of the author(s)

A concise and informative title

The affiliation(s) and address(es) of the author(s)

The e-mail address of the corresponding author.

Abstract

The abstract should contain a maximum of 250 words. The abstracts should avoid any abbreviations and mathematical formulas.

Keywords should include 4-6 keywords.

Text Formatting

Manuscripts should be submitted in Word, A4, Arial Narrow, 10-point for abstract and keywords and 12-points for text.

A complete manuscript falls need to be maximum 8,000 words excluding references, tables, and figures. Depending on the research and work purposes, the editor decides the acceptance of a larger number of pages.

For numerations of pages use the automatic page numbering function.

In the text for emphasis use italics.

The use of abbreviations should be avoided. If using the first Abbreviations should be used throughout the text the same.

For headings use maximum three levels.

Footnotes should be avoided. If used, footnotes should only contain additional text (comment), and not information about sources used.

Acknowledgments should be placed in a separate section before the reference list.

Introduction – State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Materials and Methods – Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

Results – Results should be clear and concise.

Discussions – This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion

of published literature.

Conclusions - The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices - If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Acknowledgments - Collate acknowledgments in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proofreading the article, etc.).

Reference Style – All manuscripts should be formatted using the American Psychological Association (APA) citation style, which is used primarily in the social sciences. For additional examples, consult the most recent edition of the Publication Manual of the American Psychological Association. Use of DOI is highly encouraged.

CITING REFERENCES IN TEXT

Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Citation of a reference as 'in press' implies that the item has been accepted for publication.

• If an one author is sufficient to cite only the year, but not the page if you do not quote the text directly, or do not mention the fact that needs to be linked to the page.

Busk (2014) compared reaction times ...

In a recent study of reaction times (Busk, 2014) ... (ibid, str.105).

When citing in plain text, the author's name and year of release of work separated by commas.

If we are in the plain text provide the name and year of the author, there is no need to give the same information again in parentheses.

In 2012 Stosic compared reaction times ... (ibid, page 102).

• When a work has two authors, always indicate both names and year and between surnames of the authors specify the conjunction &.

Nightlinger and Littlewood (2003) demonstrated ...

As has been shown (Busk & Serlin, 1993) ...

• When in plain text quoting the names of three, four or five authors, first make sure to include all the names, and text enough to write only the first and add '' and associates".

First time: Yan, G., Tian, H., Bai, X. & Rayner, K. (2006). found ...

Second time: Yan, G.et al. (2006) found ... (ibid, p. 12)

• When a work has no author's name, whether it's because it is issued by the agency, organization, or governmental institutions, rather than the names of authors mention the name of the institution or organization that has signed the paper, and if a name is long, just so many words or abbreviation as needed to locate the source in the list of references.

First time: (National Institute of Mental Health [NIMH], 1999) ...
Second time: (NIMH, 1999) ...

• When you do not have the names of institutions or authors, when the work is anonymous, then mention only the first few words of the title, and we quote them in parentheses under the quotation marks

in plain text in italics.

These result present (‘’ Study Finds, ‘’ 2002) ...

The book College Bound Seniors (2003) ...

When work in the header nominated as anonymous, then it in the text under the anonymous quote and cite year, in English (Anonymous, 2011).

• If there are two references to the same author’s last name, then be sure to mention when citing the initials to avoid unnecessary search in a list of references.

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.

• The work of famous authors downloaded electronically 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], an indication of what kind of material is in square brackets,

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.

Woolf, NJ, Young, SL, Famselow, MS, & Butcher, LL (1991). Map-2 expression in cholinoceptive 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 Différentiel 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.

• If you download from the Internet work that you believe is different from the original, do not copy or no numbered pages, then at the end indicate the date of downloads and web address.

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 Sesvice.

• 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.

Reference management software

The journal has a standard template – IJCRSEE template. To cite reference, it is the easiest way to use some management software like:

Mendeley (http://www.mendeley.com/features/reference-manager)
EndNote (http://www.endnote.com/support/enstyles.asp) and
Reference Manager (http://refman.com/support/rmstyles.asp).

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.

After acceptance

Online proof correction

Corresponding authors will receive an e-mail with a link to our online proofing system, where have to make prof own article. The final version is created in PDF and authors have to accept final version or to immediately report the error. We will do everything possible to get your article published quickly and accurately. Please check carefully before replying, as the inclusion of any subsequent corrections cannot be guaranteed. Proofreading is solely your responsibility.

https://pubpeer.com/Check the comments on published and withdrawn works.

All the articles in this journal have been peer reviewed. Nonetheless, editors and organizers are not responsible for the content shown in this publication.

Submission Preparation Checklist

As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.

The submission has not been previously published, nor is it before 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, 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, which is found in About the Journal.

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

Have checked paper for possible accidental plagiarism. Some plagiarism checker websites includes: http://www.ithenticate.com, www.grammarly.com,www.plagtracker.com, or www.duplichecker.com

To verify originality, your article may be checked by the originality detection service CrossCheck.

PARTNERS AND SPONSORS

Don State Technical University - DSTU, Rostov on Don, Russia
https://donstu.ru/

Southern Federal University (Russia, Rostov-on-Don)
Academy of Psychology and Pedagogy
Rostov Institute of Further Training and Retraining of Educators (Russia, Rostov-on-Don)
http://sfedu.ru/

Moscow State University of Psychology and education
faculty of legal and forensic psychology
http://jp.mgppu.ru/en

The Faculty of Philosophy of Skopje, University St. Cyril and Methodius, Macedonia
http://fzf.ukim.edu.mk/index.php/en/

University “St. Kliment Ohridski”, Faculty of Education in Bitola, Macedonia
http://www.pfbt.uklo.edu.mk/

Polskie Towarzystwo Psychologii Klinicznej

Polish Society of Clinical Psychology

http://ptpk.org.pl/

PsyJournals.ru
russian psychological issues

Psychology and Law
http://psyjournals.ru/en/psyandlaw/

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

37

INTERNATIONAL Journal of Cognitive Research in Science, Engineering and Education / editor in chief Lazar Stošić. - [Štampano izd.]. - Vol. 1, issue 1 (June 2013)- . - Vranje : The Association for the Development of Science, Engineering and Education ; Rostov-on-Don : Don State Technical University, 2013- (Vranje : Aurora). - 30 cm

Tri puta godišnje. - Drugo izdanje na drugom medijumu: International Journal of Cognitive Research in Science, Engineering and Education (Online) = ISSN 2334-8496
ISSN 2334-847X = International Journal of Cognitive Research in Science, Engineering and Education
COBISS.SR-ID 199383052