IJCR SEE

INTERNATIONAL JOURNAL OF

COGNITIVE

R E S E A R C H

IN SCIENCE, ENGINEERING AND EDUCATION

IJCRSEE

INTERNATIONAL JOURNAL OF
COGNITIVE RESEARCH IN SCIENCE,
ENGINEERING AND EDUCATION
IJCRSEE

IMPRESSUM

Indexed & Abstracted:
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EDITORIAL

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

points, rather than at the end.

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

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

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

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

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

Based on the reviewers' comments the Chief Editor makes a decision to:
- Accept the manuscript without further revision
- Accept after revision
- Ask authors to resubmit
- Reject

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

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

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

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

This issue has 13 articles (11 Original researches and 2 Review articles). Our future plan is to increase the number of quality research papers from all fields of science, engineering and education. The editors seek to publish articles from a wide variety of academic disciplines and substantive fields; they are looking forward to substantial improvement of educational processes and outcomes.

Editor in Chief
Assoc. prof. Dr. Lazar Stošić, Research Associate

CONTENTS

Factors Affecting Student Engagement in Psychology Undergraduates Studying Online Statistics Courses in Indonesia

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Abstract: This study aimed to assess the influence of students' intrapersonal factors, namely Academic Intrinsic Motivation (AIM), Perceived Creativity Fostering Teacher Behavior (P-CFTB), Academic Self-Efficacy (ASE), and Self-Regulated Learning (SRL) on student engagement in undergraduate psychology students taking online Statistics courses. A cross-sectional and quantitative design was used from October to December 2022. The data collection procedure used a convenience sampling technique, with questionnaires distributed online (via social media) and offline (via lecturers, the Student Executive Board, and the Association of the Faculty of Psychology from various universities in Indonesia). The research participants were psychology undergraduates who had studied and passed the Statistics courses online, with 671 filling out the questionnaire. The results showed that all students' intrapersonal factors, namely AIM, P-CFTB, ASE, and SRL, can determine student engagement by 66.9%, with ASE having the highest influence (23.99%) and P-CFTB having the lowest impact (9.78%). Moreover, the correlation value between SRL and SE was r = 0.700, p < 0.001, signifying a robust positive relationship between both variables.

Keywords: student engagement, perception of creativity fostering teacher behavior, academic self-efficacy, academic intrinsic motivation, self-regulated learning, online learning.

Introduction

Low student engagement reduces students' chances of acquiring the necessary talents and skills (Kuh, 2009). Besides students' ability to apply knowledge in more complex situations (Primana, 2015), students' memory of learning materials and final grades will also be low (Staikopoulos et al., 2015). Thus, student engagement has become a critical issue in higher education as it significantly influences the quality of learning students acquire (Staikopoulos et al., 2015; Xia et al., 2022). Moreover, due to COVID-19, Higher Education Institutions (HEIs) worldwide were forced to apply online learning methods. One of the issues often highlighted in online learning methods is closely related to student engagement (Czerkawski and Lyman, 2016; Xia et al., 2022). According to previous studies, online learning methods could increase student engagement (Khusniyah and Hakim, 2019; Kuntarto, 2017). On the contrary, studies in Indonesia found that online learning methods reduced student engagement (Fatoni et al., 2020; Rusman and Nasution, 2020; Sa'diyah, 2021).

Student engagement only happens when students involve their feelings and active thinking processes in learning (Harper and Quaye, 2009). Fatoni et al. (2020) found that 100 students from five universities in Indonesia experienced student engagement problems during online learning. This finding is supported by Rusman and Nasution (2020) on UIN Sumatera Utara Medan college students, who found that out of 191 students, only 4.71% had high student engagement during online learning. Furthermore, Sa'diyah (2021) found that students only join online classes to fulfill their attendance but ignore the lessons and do other activities. Thus making them have low student engagement.

Maulana and Iswari (2020), who analyzed student engagement in calculation-based courses, found that online learning in courses (such as Statistics) causes students to experience stress and difficulty

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understanding the learning material. It made them have low student engagement scores. Moreover, students often view Statistics courses as very mathematical, challenging, and frightening because they use many formulas (Carpenter and McDonald, 2017; Waruwu, Hao and Hia, 2022; Zaimil, 2017).

Stress regarding statistics courses also occurs in psychology students. Suminta (2016) found psychology students are prone to experience anxiety when studying Statistics. For psychology students, besides being difficult, the Statistics courses are also felt to be unrelated to their future career choices (Lloyd and Robertson, 2012). In fact, those courses are one of the fundamental courses in the psychology program. From developing new therapy techniques to evaluating the effectiveness of strategies, it is a statistical analysis that plays a role in providing an overview and drawing conclusions. Psychologists use statistical analysis to find ways to interpret and draw conclusions from their data (Watts and Thomas, 2022). Given the importance of Statistics for Psychology students, it is urgent to explore the factors that can affect student learning engagement (Firmansyah, 2017; Ulpah, 2009).

Several studies exploring factors affecting student engagement in higher education have been conducted. Almarghani and Mijatovic's (2017) study showed that the lecturers' role and teaching skills are the most influential factors for student engagement. Elshami et al. (2022) explored that factors such as techno-pedagogical skills, self-directed learning, peer-assisted learning, and collaborative learning are required to support medical and health students' engagement in online learning. Calabrese et al. (2022) found that frequency and regular meetings, demographic factors such as course of study, expectation, and perception of students, can affect student engagement in personal tutoring schemes.

Student engagement is an interaction process between contextual or learning environment and intrapersonal factors (Christenson, Reschly and Wylie, 2012). Contextual factors include the context of teaching and social relationships (support from teachers, friends, and parents) (Christenson, Reschly and Wylie, 2012; Skinner, Kindermann and Furrer, 2009). However, several studies have found that contextual factors are not always able to predict student engagement. In fact, prior research had shown that students' perceptions of understanding contextual factors were predictive for student engagement (Christenson, Reschly and Wylie, 2012; van Petegem et al., 2007). The students' perceptions of these contextual factors belong to intrapersonal factors, such as how they perceive their learning experience and the source of knowledge (Christenson, Reschly and Wylie, 2012; Raviv et al., 2003).

Various intrapersonal factors have been reported to influence student engagement, such as academic self-efficacy (ASE) (Helsa and Lidiawati, 2021; Pramisjayanti and Khoirunnisa, 2022; Zhen et al., 2017), academic intrinsic motivation (AIM) (Dierendonck et al., 2023; Myint and Khaing, 2020), and self-regulated learning (SRL) (Lidiawati and Helsa, 2021; Setiani and Wijaya, 2020). ASE is a student's determination and behavior toward assignments and the educational process (Chang and Chien, 2015; Zhen et al., 2017). Students with low ASE showed more indifference and low engagement in learning (Bassi et al., 2007). In contrast, according to meta-analysis studies (Chang and Chien, 2015), students with high ASE scores had higher student engagement.

AIM is also strongly related to engagement. This is proven by Dierendonck et al. (2023), who found that students who study for intrinsic reasons tend to be more focused and actively engaged because they enjoy learning. The next intrapersonal factor that is positively related to student engagement is self-regulated learning (SRL) (Lidiawati and Helsa, 2021; Setiani and Wijaya, 2020). To improve academic achievement, students must have self-regulated learning skills to stay engaged in lectures, especially online learning.

Additionally, Primana (2015) found that college students in Indonesia perceive their lecturers as the primary source of knowledge. Students' perceptions of their lecturers also significantly impact student engagement (Pachler, Kuonath and Frey, 2019; Primana, 2015). Furthermore, Lawton and Taylor (2020) investigated college student perceptions of engagement and teaching strategies in the Introduction to Statistics course. They discovered activities that increased student engagement in online learning, such as when lecturers gave simulation-based instructions and asked students to carry out group discussions and independent study. On the other hand, students identified low engagement when there were no hands-on activities and students were only taking notes and listening during online classes.

A strategy and consistent effort of lecturers to encourage students to use their knowledge to think independently and flexibly by using new approaches to solve problems is called Creativity Fostering Teacher Behavior (CFTB) (Cropley, 1997). Based on Lawton and Taylor (2020) findings, we concluded that the concept of creativity fostering teacher behavior (CFTB) was strongly related to how students perceived the teaching strategies used by lecturers in the study. CFTB is a teaching strategy that aims to develop students' creative thinking or behavior" (Jeffrey and Craft, 2004). The CFTB concept also aligns with learning material in Statistics courses, which require flexible and creative thinking to solve complex calculation problems (Grégoire, 2016).

Up until now, most studies involving the CFTB variable measured CFTB from teachers' or lecturers' perceptions (Huang, 2022; Karwowski, Gralewski and Szumski, 2015; Palaniappan, 2009; Varatharaj, 2018); pre-service teachers (Katz-Buonincontro, Perignat and Hass, 2020; Kim et al., 2019; Orr and Kukner, 2015); and the effect of CFTB on students' creativity (Bell et al., 2014; Hafizi and Kamarudin, 2020; Mao et al., 2020; Zhang et al., 2022). Meanwhile, the research that examined the relationship and role of students' perceptions of CFTB on student engagement is still limited. Even though, since 2000, Soh has suggested that the research on CFTB should be measured based on student perceptions. Students' perceptions of CFTB in this study will be called perceived CFTB or P-CFTB.

As previous studies have shown, student engagement is more influenced by intrapersonal factors. In addition, as Rusman and Nasution (2020) stated, there is a need for research that explores the factors affecting student engagement in an online learning context. Therefore, it is vital to conduct exploratory research on students' intrapersonal factors by assessing the role of these factors in learning engagement in online Statistics courses. Rodgers (2008) also said that to increase teaching effectiveness and academic achievement, HEIs should consider developing online teaching strategies that encourage greater student engagement.

Although some studies have investigated the role of AIM (Cayubit, 2022; Giesbers et al., 2013; Gettle, 2022), ASE (Chang and Chien, 2015; Helsa and Lidiawati, 2021; Pramisjayanti and Khoirunnisa, 2022; Zhen et al., 2017), SRL (Lidiawati and Helsa, 2021; Nurfitri and Aslamawati, 2021; Setiani and Wijaya, 2020; Utami and Aslamawati, 2021) that influence student engagement, however their role in undergraduate psychology students taking online Statistics courses are still limited. Furthermore, empirical research on CFTB is limited to teacher/lecturer (Huang, 2022; Karwowski, Gralewski and Szumski, 2015; Palaniappan, 2009; Varatharaj, 2018) and pre-service teacher/lecturer (Katz-Buonincontro, Perignat and Hass, 2020; Kim et al., 2019; Orr and Kukner, 2015), so few studies examine student perceptions of CFTB. Therefore, the study hypothesizes that academic intrinsic motivation, perceived creativity fostering teacher behavior, academic self-efficacy, and self-regulated learning simultaneously can determine student engagement in undergraduate psychology students taking online Statistics courses.

Materials and Methods

Research Design
This study used a cross-sectional design from October to December 2022. The following criteria were emphasized for the selection of participants: (1) The psychology undergraduates need to have studied and passed the Statistics course through the online learning method, (2) The students should follow the appropriate time interval for studying the course, and (3) The period used by the undergraduates to complete the research questionnaire should not be more than three semesters. It has been done since the implementation of online learning methods by most HEIs in the last three semesters during the COVID-19 pandemic. The data collection procedure used a convenience sampling technique, with questionnaires distributed online (via social media) and offline (via lecturers, the Student Executive Board, and the Association of the Faculty of Psychology from various universities in Indonesia).

Table 1
Demographic Data of Participants (N= 533)

Demography		n	%
Gender	Female	435	81.61
	Male	98	18.39
Age (year)	18	32	6.00
	19	232	43.53
	20	199	37.34
	21	48	9.01
	>21	22	4.13
Semester	3	322	60.41
	4	3	0.56
	5	183	34.33
	7	21	3.94
	8	1	0.19
	>8	3	0.56
University Location (Province)	Aceh	1	0.19
	Banten	36	6.75
	DI Yogyakarta	9	1.69
	DKI Jakarta	219	41.09
	West Java	163	30.58
	Central Java	9	1.69
	East Java	63	11.82
	South Kalimantan	5	0.94
	South Sulawesi	3	0.56
	South Sumatera	22	4.13
	North Sumatera	3	0.56

Participants

The research participants were psychology undergraduates who had studied and passed the Statistics courses via online learning, with 671 filling out the questionnaire. However, only 533 participants met the selection criteria and were spread from 11 provinces in Indonesia, with the majority originating from DKI Jakarta (40.68%). Most of the participants were 19 years old (43.55%), female (81.54%), and 3rd-semester students (59.86%). A detail of participants' demographic data of participants can be seen in Table 1.

Research Instrument

This research used five research instruments, namely (1) The University Students' Engagement Inventory (USEI) by Morocco et al. (2016), (2) The Creativity Fostering Teacher Index (CFTIndex) by Soh (2000), (3) The Indonesian College Academic Self-Efficacy Scale (CASES) by Ifdil et al. (2019), (4) The Online Self-regulated Learning Questionnaire (OSLQ) by Mutiara and Rifameutia (2021), and (5) The Academic Motivation Scale (AMS) by Marvianto and Widhiarso (2019). Each instrument was tested for reliability through the Cronbach Alpha and CRiT values, with validity analyzed by using Confirmatory Factor Analysis (CFA). The fit index used as a criterion for the cut-off value was also CFI > 0.90, RMSEA < 0.08, and SRMR < 0.08 (Hu and Bentler, 1999; Schermelleh-Engel, Moosbrugger and Müller, 2003).

Students' Engagement (SE)

The Indonesian version of the University Student Engagement Inventory (USEI) instrument by Morocco et al. (2016) was adopted to measure students' engagement. This instrument consisted of three dimensions (cognitive, behavioral, and emotional engagement), each with five items. These items were then assessed using a 6-point Likert scale, with 1 to 6 emphasizing never to always, respectively. The

total value was counted by adding up the scores of each item. An example of a sample item is, "I usually do my homework on time." The Indonesian version of the USEI had a reliability value of Cronbach's α = 0.862, signifying that the instrument was reliable (Kaplan and Saccuzzo, 2017). All items also showed good internal validity, with CRiT values ranging from 0.261-0.647 (Nunnally and Bernstein, 1994). In addition, CFA showed that the USEI was valid due to meeting the goodness of fit criteria with chi-square = 3.72 (X^2 = 320.355; df = 86, p < 0.001), CFI = 0.905, RMSEA = 0.072, and SRMR = 0.067.

Academic Intrinsic Motivation (AIM)

AIM was measured through the Academic Motivation Scale (AMS) by taking three dimensions of Intrinsic Motivation from Vallerand et al. (1992), which has been adapted into the Indonesian version by Marvianto and Widhiarso (2019). It consisted of three factors, namely IM-to know, IM-toward accomplishment, and IM-to experience stimulation, each having four items. Using a 6-point Likert scale, namely 1 (do not correspond at all) to 6 (corresponds exactly), the total scores of AIM were obtained by adding up the scores of all items. The sentences in several items were also adjusted, such as the replacement of 'school' with 'college' to fit the research context. For example, a sample item stated, "Because I experience pleasure and satisfaction while learning new things." From the results, AMS had a reliability value of Cronbach's α = 0.896 and CRIT = 0.526 - 0.685. CFA also showed that AMS was valid due to meeting the goodness of fit criteria with chi-square = 4.17 (X^2 = 204.624; df = 49, p < 0.001), CFI = 0.945, RMSEA = 0.077, and SRMR = 0.040.

Perceived Creativity Fostering Teacher Behavior (P-CFTB)

Researchers adapted the Creativity Fostering Teacher Index (CFTIndex) instrument by Soh (2000) into the Indonesian version to measure lecturer creativity fostering from a student perspective, named Perceived CFTIndex (P-CFTIndex). This instrument initially contained 45 items, which was reduced to 27 after being adapted based on the CFTB-Index procedure by Lee and Kemple (2014). It still consisted of nine dimensions, each containing three items in the Indonesian version. Each item was also assessed using a 6-point Likert scale, namely 1 (never) to 6 (always). Moreover, the total score was obtained by adding up the scores of each item, with a sample example indicating the following, "Lecturer encourages me to try out what I have learned in different situations." From the results, P-CFTIndex had a reliability value of Cronbach's α = 0.944, signifying that the instrument was reliable. All items also showed good internal validity, with the CRiT values ranging from 0.357 to 0.713. In addition, CFA showed that P-CFTB measuring instrument was valid because of meeting the goodness of fit criteria with chi-square = 3.25 (X^2 = 936,660; df = 288, p < 0.001), CFI = 0.904, RMSEA = 0.065, and SRMR = 0.047.

Academic Self-Efficacy (ASE)

ASE was measured using the Indonesian CASES version by Ifdil et al. (2019), adapted from Owen and Froman (1988). This instrument initially contained 33 items, which were then reduced to 17 items and categorized into three dimensions. These dimensions included technical skills (5 items), overt social situation (6 items), and cognitive operation (6 items). The total score was calculated by adding up the scores of all items. Each item was also assessed by using a 6-point Likert scale, namely 1 (strongly disagree) to 6 (strongly agree), with a sample example presented as follows, "I master most of the lecture materials having many elements of calculation." From the results, CASES had a reliability value of Cronbach's α = 0.914, with CFA emphasizing its validity due to meeting the goodness of fit criteria with chi-square = 2.36 (X^2 = 1092.270; df = 462, p < 0.001), CFI = 0.905, RMSEA = 0.079, and SRMR = 0.054.

Self-Regulated Learning (SRL)

Online Self-Regulated Learning Questionnaire (OSLQ) was used to measure SRL (Barnard-Brak, Paton and Lan, 2010) and adapted to the Indonesian version by Mutiara and Rifameutia (2021). This instrument initially contained 24 items, which were then reduced to 21 elements after translation and categorized into six dimensions. These dimensions included environmental structuring, goal-setting, time management, help-seeking, task strategies, and self-evaluation, which consisted of 4, 5, 3, 2, 4, and 4 items, respectively. The items were also assessed using a 6-point Likert scale, namely 1 (strongly disagree) to 6 (strongly agree). Moreover, the total score was obtained by adding up the scores of each item, with the example of a sample stating the following, "I prepare questions before joining an online lecture-discussion session." OSLQ had a reliability value of Cronbach's α = 0.918 and CRIT = 0.377 - 0.673. CFA also showed that the instrument was valid due to meeting the goodness of fit criteria with chi-square = 3.63 (X^2 = 626.008; df = 172, p < 0.001), CFI = 0.906, RMSEA = 0.070, and SRMR = 0.055.

Research Procedure and Data Analysis

The procedures and instruments of this study were carefully reviewed by the Faculty of Psychology ethics committee under number 136/FPsi.Komite Etik/PDP.04.00/2022. The adaptation of measuring instruments into Indonesian versions (P-CFTIndex and USEI) was also carried out regarding the procedure of Beaton et al. (2000), which contained five stages, namely (1) translation, (2) synthesis, (3) back translation, (4) expert assessment, and (5) data collection. In addition, the results were analyzed by performing multiple regression through JASP software version 0.164.

Results

Statistic Descriptive Analysis

Pearson's test was carried out to determine the correlation of each variable, as described in Table 2. The results showed a moderate correlation among the variables, with ASE and SE showing the most vital relationship than other independent determinants ($r = 0.714$, $p < .001$). However, P-CFTB and SE exhibited a moderate correlation between the independent and the dependent variables ($r = 0.593$, $p < .001$), with P-CFTB and AIM portraying the weakest relationship (0.468).

Table 3 explains the descriptive analysis of each variable, where the range of values included 45-90, 37-72, 77-162, 90-193, and 45- 126 for SE, AIM, P-CFTB, ASE, and SRL, respectively. Based on the results, the Mean/Standard Deviation values were high for SE, AIM, and P-CFTB at 69.46/9.17, 58.20/7.72, and 126.47/18.18, respectively. Meanwhile, the Mean/Standard Deviation values were in the moderate category for ASE and SRL at 71.90/12.63 and 88.92/16.18, respectively.

Table 2.
Variables Intercorrelation

Variable	1	2	3	4	5
1. SE	—				
2. AIM	0.621***	—			
3. P-CFTB	0.593***	0.468***	—		
4. ASE	0.714***	0.505***	0.495***	—	
5. SRL	0.700***	0.503***	0.572***	0.676***	—

Note: * p < .05, ** p < .01, *** p < .001
SE = Students' Engagement, AIM = Academic Intrinsic Motivation, P-CFTB = Perceived Creative Fostering Teacher Behavior, ASE = Academic Self-Efficacy, SRL = Self-Regulated Learning

Table 3.
Descriptive Statistic

Variables	N	Mean	SD	Min	Max
1. SE	533	69.46	9.17	45.00	90.00
2. AIM	533	58.20	7.72	37.00	72.00
3. P-CFTB	533	126.47	18.18	77.00	162.00
3. ASE	533	71.90	12.63	90.00	193.00
4. SRL	533	88.92	16.18	45.00	126.00

Note: SE = Students' Engagement; AIM = Academic Intrinsic Motivation; P-CFTB = Perceived Creative Fostering Teacher Behavior; ASE = Academic Self-Efficacy; SRL = Self-Regulated Learning.

Table 4.
Participants' Categorization of Each Variable (N= 533)

Variable		Category		
		Low	Moderate	High
SE	score range	<40	40 ≤ x < 65	≥65
	n	0	157	376
	%	00.00	29.46	70.54
AIM	score range	<32	32 ≤ x < 52	≥ 52
	n	0	101	432
	%	00.00	18.95	81.05
P-CFTB	score range	<72	72 ≤ x < 117	≥117
	n	0	162	371
	%	00.00	30.39	69.61
ASE	score range	<45.3	45.3 ≤ x < 73.7	≥73.7
	n	11	283	239
	%	2.06	53.09	44.84
SRL	score range	<56	56 ≤ x < 91	≥91
	n	12	280	241
	%	02.25	52.53	45.22

Note: SE = Students' Engagement; AIM = Academic Intrinsic Motivation; P-CFTB = Perceived Creative Fostering Teacher Behavior; ASE = Academic Self-Efficacy; SRL = Self-Regulated Learning.

Table 4 presents the participant categorization of each variable, where the majority of samples were observed in the high category for SE (70.54%), AIM (81.05%), ASE (50.47%), and P-CFTB at 70.54%, 81.05%, 50.47%, and 69.61%, respectively. However, most participants on the SRL variable were included in the medium category at 52.53%.

Multiple Linear Regression Prerequisite Test
Multiple regression analysis was employed to determine whether the research model's four independent variables (IVs) collectively possess predictive abilities for student engagement. When assessing multiple linear regression models, it is crucial to meet at least four prerequisite tests: multicollinearity, data linearity, homoscedasticity, and multivariate normality (Osborne and Waters, 2002).

Multicollinearity Test
The multicollinearity test was applied to gauge the degree of correlation among the independent variables. Midi, Sarkar and Rana (2010) stipulated that there is no multicollinearity when the tolerance value is >0.1 and the Variance Inflation Factor (VIF) is <10. Table 5 demonstrates the tolerance values for each variable are >0.1, and the VIF values for all variables are <10, signifying that the model meets the multicollinearity requirement.

Table 5.
Multicollinearity Test Result

Model		Collinearity Statistics	
		Tolerance	VIF
H$_1$	(Intercept)		
	AIM	0.664	1.506
	P-CFTB	0.620	1.614
	ASE	0.499	2.005
	SRL	0.456	2.195
a. Dependent variable: Student Engagement			

Data Linearity Test

The data linearity test establishes a linear relationship among the independent variables (Hayes, 2015). It is tested by examining the scatterplot between the DV and each IV. The outcomes of the linearity test, illustrated in Figure 1 below, indicate the presence of a linear relationship between the dependent and independent variables, thereby fulfilling the linearity assumption.

Homoscedasticity Test

A scatterplot of residuals against predicted values is used to evaluate homoscedasticity (Hariyanto, Triyono and Köhler, 2020). Figure 2, presented below, illustrates the data distribution pattern, signifying that the assumption of homoscedasticity has been met.
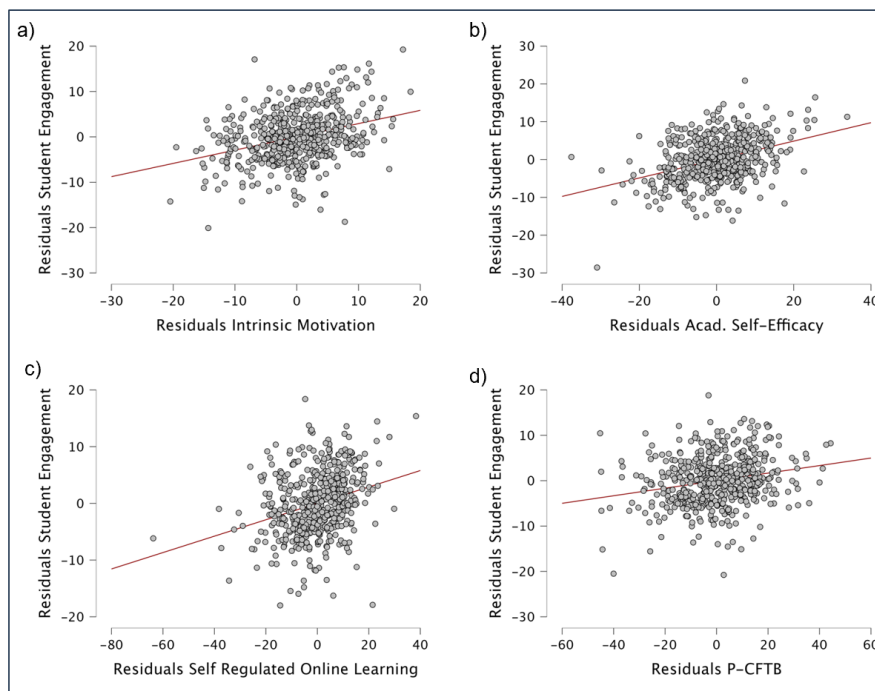
Figure 1. Data Linearity Test Results
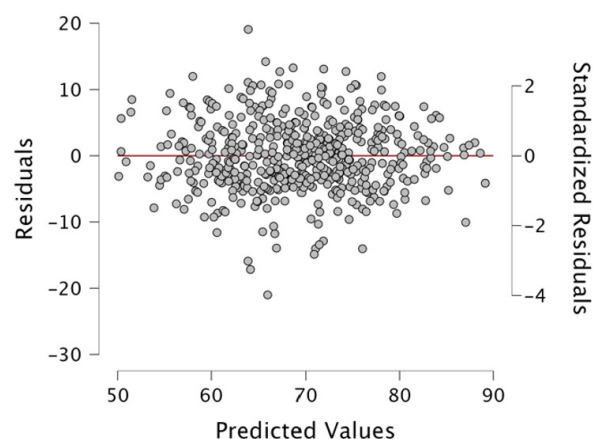
Figure 2. Homoscedasticity Test Result

Multivariate Normality Test

The multivariate normality test is used to verify the normal distribution of data. Figure 3 indicates that the residuals conform to a normal distribution, affirming that the model meets the multivariate normality assumption.

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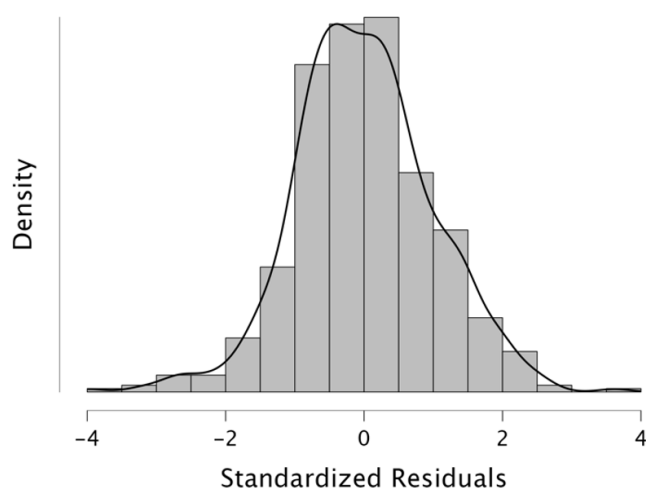
Figure 3. Normal Distribution Curve

Multiple Linear Regression Results

Multiple linear regression was conducted after all the prerequisite tests showed that the results met the requirement. Table 6 below shows that F = 267.358; p < 0.001, meaning that AIM, P-CFTB, ASE, and SRL can significantly determine student engagement. This means the research hypothesis is accepted. Table 6 also shows that multiple linear regression's coefficient of determination (R2) is 0.669. Based on the guidelines for interpreting the coefficient of determination (R2) by Sarjana, Hayati and Wahidaturrahmi (2020), 0.669 is included in the strong influence category. This means that AIM, P-CFTB, ASE, and SRL significantly predict learning engagement with an influence contribution of 66.90%, with the remaining 33.10% influenced by variables not included in this study.

Table 6.
Multiple Linear Regression Model Summary

Model	R	R²	Adjusted R²	RMSE	R² Change	F Change	df1	df2	p
H_0	0.000	0.000	0.000	9.168	0.000		0	532	
H_1	0.818	0.669	0.667	5.291	0.669	267.358	4	528	< .001

Table 7.
Coefficients

Model		Unstandardized (B)	Standard Error	Standardized (Beta)	t	p
H_0	(Intercept)	69.460	0.397		174.919	< .001
H_1	(Intercept)	11.539	1.969		5.859	< .001
	AIM	0.292	0.036	0.246	8.022	< .001
	PCFTB	0.083	0.016	0.165	5.188	< .001
	ASE	0.244	0.026	0.336	9.477	< .001
	SRL	0.145	0.021	0.255	6.885	< .001

a. DV: Student Engagement

Note: SE = Students' Engagement; AIM = Academic Intrinsic Motivation; P-CFTB = Perceived Creative Fostering Teacher Behavior; ASE = Academic Self-Efficacy; SRL = Self-Regulated Learning.

From Table 7 above, the relationship between variables can be seen in the following equation:
$Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + e$
Y (SE) = 11.539 + 0.292*AIM + 0.083*PCFTB + 0.244*ASE + 0.145*SRL + e

From the multiple linear regression equation above, it can be explained as follows:

a) The constant (α) has a positive value of 11.539. This shows that if all independent variables are worth 0, the base value of student engagement is 11.539.

b) For every percentage increase in AIM, student engagement increases by 0.292, assuming other independent variables remain constant.

c) For every percentage increase in P-CFTB, student engagement increases by 0.083, assuming other independent variables remain constant.

d) For every percentage increase in ASE, student engagement increases by 0.244, assuming other independent variables remain constant.

e) For every percentage increase in SRL, the student engagement increases by 0.145, assuming other independent variables remain constant.

To determine the amount of influence of each independent variable on the dependent variable partially, we used the Beta*Zero Order formula. Based on the formula, it is known that the most significant influence comes from the ASE, with an influence contribution of 23.99%. This is followed by the SRL, which contributes an influence of 17.85%, the AIM of 15.27%, and the P-CFTB of 9.78%.

Discussions

This study provides an overview of the interaction between intrapersonal factors, namely Academic Intrinsic Motivation (AIM), Academic Self-Efficacy (ASE), Self-Regulated Learning (SRL), and Perceived Creativity Fostering Teacher Behavior (P-CFTB), in predicting student engagement in undergraduate psychology students taking online statistics courses. Hypotheses were examined to test whether these intrapersonal factors simultaneously affect student engagement. The results found that the four independent variables studied (AIM, ASE, SRL, and P-CFTB) significantly determined student engagement, with a contribution of 66.9%. Based on the research results above, it can be concluded that the study's hypothesis is confirmed. These results support findings in previous studies that state that intrapersonal factors are the main factor in predicting student engagement (Christenson, Reschly and Wylie, 2012; van Petegem et al., 2007).

Furthermore, we examined the power contribution of each independent variable to student engagement. The results showed that AIM significantly predicted SE among psychology undergraduates in online Statistics courses ($R2=15.27\%$; $p<0.001$). The results supported Gettle (2022), where AIM significantly affected SE in psychology undergraduate students. The findings of this study also support the findings reported by Giesbers et al. (2013) and Gettle (2022), who discovered that intrinsic motivation is closely linked to student engagement in online learning by utilizing technologies in applications, such as chat, webcams, and microphones. The academic achievement of students is also strongly related to student engagement through the usage of these tools.

Furthermore, ASE had the most significant influence on SE at 23.99%, compared to other variables. The findings support Warwick's statement (Warwick's, 2008) that student self-efficacy predicts student involvement. Students who have confidence that they are capable will be more persistent in facing difficulties. On the other hand, students with low self-efficacy will feel helpless and less persistent in completing complex tasks. In line with this, research by Helsa and Lidiawati (2021) found that self-efficacy had an effect of 36.9% on student learning engagement. Pramisjayanti and Khoirunnisa's (2022) study also found that self-efficacy influenced 64.9% of student engagement in online learning.

The results also revealed that SRL significantly affected SE at an impact level of 17.85%. This was not in line with Lidiawati and Helsa (2021), where a more significant effect of SRL on SE was observed at 55.9%. Nurfitri and Aslamawati (2021) found that self-regulated learning has a 57% impact on student engagement. A similar result was also found in Utami and Aslamawati (2021), who explained that the effect of self-regulated learning was 52.8% on student engagement. These differences emphasized specific research measuring students' SRL abilities when learning Statistics courses.

Moreover, this study found that student perceptions of creativity fostering teacher behavior (P-CFTB) can predict student engagement in online learning, with a 9.78% contribution. Students' perceptions of teaching strategies that encourage creativity, such as independent learning, opportunities to develop and share ideas, divergent thinking, reflection, learning opportunities with a variety of materials and conditions, and support for overcoming failures, play a significant role in predicting student engagement in students who take online Statistics courses. In line with previous research has found that students' attitudes and beliefs about lecturers influence student engagement in the classroom (Christenson, Reschly and Wylie,

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2012; Pachler, Kuonath and Frey, 2019; Primana, 2015; Raviv et al., 2003).

Solving statistical problems requires the ability to think creatively. Therefore, creative teaching strategies (teaching for creativity) will also influence students' attitudes toward the statistics learning process, and attitudes toward learning significantly positively affect learning achievement (Hu, Deng and Guan, 2016). This finding also expands on research by Golder (2018) and Lawton and Taylor (2020) regarding student perceptions of lecturer behavior. Golder (2018) found that students' perceptions of their lecturers significantly related to their attitudes toward learning. Furthermore, Lawton and Taylor (2020) found that students' perceptions of independent teaching and learning strategies can increase student engagement.

Additionally, this research found that ASE strongly and significantly correlated with SE in statistics courses (r = 0.714, p < 0.001). This was not in line with this previous research; Fan and Williams (2010) showed that students' ASE in mathematics and English significantly correlated with engagement in these subjects. The results confirmed that the correlation between these variables was more substantial in English lessons (r = 0.54) than in mathematics (r = 0.49). It means that in this research, students will be more engaged in the learning process if they believe they can learn.

Furthermore, the correlation value between SRL and SE was r = 0.700, p < 0.001, signifying a robust positive relationship between both variables. The result differs from Setiani and Wijaya (2020), who reported a weak positive correlation between both variables (r = 0.262). However, the effect aligned with Lidiawati and Helsa (2021), who found a strong positive correlation between SRL and SE (r = 0.748). The strong positive correlation can happen because, according to Bond and Bedenlier (2019), cognitive engagement and the ability towards self-regulation are highly associated. Anjarwati and Sa'adah (2021) also explained that student engagement in the period of online learning is known to increase student participation from students' cognitive and behavioral aspects.

Conclusions

This study found students' intrapersonal factors, namely Academic Intrinsic Motivation (AIM), Academic Self-Efficacy (ASE), Self-Regulated Learning (SRL), and Perceived Creativity Fostering Teacher Behavior (P-CFTB), can determine student engagement by 66.9%, with ASE having the highest influence (23.99%) and P-CFTB having the lowest impact (9.78%). It also found that most participants belong to the high SE, P-CFTB, AIM, ASE, and moderate SRL categories. There was also a moderate correlation among the variables, with ASE and SE showing the most substantial relationship (r = 0.714, p <.001). However, P-CFTB and SE exhibited a moderate correlation between the independent and the dependent variables (r = 0.593, p <.001), with P-CFTB and AIM portraying the weakest relationship (0.468). This indicated that the strongest and weakest correlation values were found between ASE-SE and P-CFTB-SE, respectively. The results also showed that P-CFTB, AIM, ASE, and SRL increased SE among Psychology undergraduates taking online Statistics courses.

The limitation of this study is the high-value questionnaire items, causing participants to experience fatigue during the fill-out process. The variables also promoted a high social desirability tendency. Subsequently, a delay was found between filling out the questionnaire and completing the Statistics courses. For example, when filling out the data instrument, students were already in semester 5, despite the last Statistics courses conducted in semester 3.

According to the research, students' intrapersonal factors in online Statistics courses significantly impact their level of engagement. Therefore, statistics lecturers are expected to create a learning atmosphere that enhances students' intrapersonal factors, namely AIM, P-CFTB, ASE, and SRL. The research implies that our study can pinpoint the contribution of intrapersonal factors that affect student engagement, enabling statistics lecturers to give these internal factors more attention.

Acknowledgments

Conflict of interests
The authors declare no conflict of interest.

Author Contributions

Conceptualization, A.S., R.M.A.S, M.N., A.A.M., F.M.M., and S.S.; methodology, A.S., R.M.A.S, M.N., A.A.M., F.M.M., and S.S.; formal analysis, A.S., R.M.A.S, M.N., A.A.M., F.M.M.; writing—original draft preparation, A.S., M.N., and A.A.M.; writing—review and editing, A.S., M.N., and A.A.M. All authors have read and agreed to the published version of the manuscript.

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Investigation of the Relationship Between Orientation Discrimination Thresholds, Autistic, and Schizotypal Personality Traits

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Abstract: Imbalances in cortical excitation and inhibition (E-I) have been implicated in both autism spectrum conditions (ASC) and schizophrenia spectrum conditions (SSC). However, most studies investigate these clinical conditions independently, possibly due to the difficulty of obtaining comorbid clinical populations. As such, the current study investigated the relationship between performance in the orientation discrimination task "ODT" as a potential proxy for E-I balance and the autistic (as assessed by Autism Spectrum Quotient "AQ") and schizotypal personality traits (as assessed by Schizotypal Personality Questionnaire-Brief "SPQ-BR") in the general population. 87 healthy adult volunteers participated in the study. We found that high autistic personality traits are associated with enhanced performance in the oblique condition of ODT. In contrast, high schizotypal personality traits are associated with poor performance in the vertical condition of ODT. Such associations support the suggested disruption of cortical E-I balance in ASC and SSC.
Keywords: Excitation inhibition balance, Orientation Discrimination Task, Autistic personality traits, Schizotypal personality traits, Visual Perception.

Introduction

The role of Excitation-Inhibition (E-I) balance in sensory processing has been har-nessed through the use of psychophysical tasks (Edden et al., 2009; Freyberg et al., 2015; Robertson et al., 2013; Snijders et al., 2013; Trakoshis et al., 2020; Yoon et al., 2010), see (Dickinson, Jones, et al., 2016). An advantage of psychophysical tasks is that the E-I balance differences inferred from them must be of 'functional relevance'. Indeed, one commonly used psycho-physical task for this purpose is the visual-Orientation Discrimination Task (ODT) (Dickinson, Bruyns-Haylett, et al., 2016; Dickinson et al., 2014; Shaw et al., 2019), given its well-known association with inhibitory mechanisms (Edden et al., 2009). A vast range of animal (Katzner et al., 2011; Leventhal et al., 2003; Sillito, 1975; Xia et al., 2013) and human research (Edden et al., 2009; Kurcyus et al., 2018) supports the vital role of cortical inhibition on orientation selectivity tuning and perceptual judgment of stimuli's orientations due to their associations with GABA, the main inhibitory transmitter. For instance, animal research showed that orientation selectivity tuning reduced following the application of GABA antagonist (Katzner et al., 2011; Sillito, 1975) but increased following the application of GABA agonist (Leventhal et al., 2003; Xia et al., 2013). Similarly, enhanced visual orientation discrimination skills in humans are linked to higher GABA concentration levels in the visual cortex (Edden et al., 2009; Kurcyus et al., 2018). Together, these findings suggest that performance in ODT may provide a useful, al-beit indirect, indicator of cortical E-I balance in the visual cortex.

ODT traditionally uses two different conditions, namely cardinal and oblique conditions. In the cardinal condition, participants judge orientation deviation from vertical or horizontal reference stimuli (i.e., 0/90 degrees). In the oblique condition, however, participants judge orientation deviation from oblique reference stimuli (i.e., 45/135 degrees). It is widely recognised that performance in the cardinal condition is superior to that in the oblique condition (Dickinson et al., 2015; Dickinson et al., 2014; Edden

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et al., 2009; Orban et al., 1984; Vogels and Orban, 1985), possibly due to the larger number of cortical cells tuned to cardinally orientated objects compared to obliquely oriented ones (Hubel and Wiesel, 1968; Mansfield, 1974; Mansfield, 1974). This neural orientation selectivity has been proposed to explain the well-known 'oblique effect', which refers to performance deficiency in judging obliquely oriented stimuli compared to cardinally oriented ones (Appelle, 1972).

Several studies have shown ODT performance differences in individuals with autism spectrum conditions (ASC) and schizophrenia spectrum conditions (SSC) compared to neurotypical (NT) individuals (Dickinson, Bruyns-Haylett, et al., 2016; Shaw et al., 2019). For instance, compared to NT individuals, those with ASC have been reported to have enhanced performance in oblique orientation discrimination (as indicated by lower OD thresholds) (Dickinson, Bruyns-Haylett, et al., 2016). However, the same enhancement was absent for the vertical condition of ODT, possibly due to the ceiling effect (Garin, 2014a), as vertical OD thresholds are about one-fifth of the oblique OD thresholds (Edden et al., 2009). Additionally, compared to NT individuals, individuals with SSC have been reported to have poorer performance in ODT (as indicated by higher OD thresholds) in vertical and oblique ODT conditions (Shaw et al., 2019). Both enhanced and impaired performance in ODT has been suggested to reflect cortical E-I imbalance (Dickinson, Bruyns-Haylett, et al., 2016; Shaw et al., 2019). However, given the practical difficulty in obtaining both comorbid and non-comorbid samples for the same investigation, most studies have not investigated E-I balance in ASC and SSC simultaneously (Dickinson, Bruyns-Haylett, et al., 2016; Shaw et al., 2019). This difficulty can initially be overcome by measuring the traits associated with each condition in the general population (Del Giudice et al., 2010; Del Giudice et al., 2014; Ford et al., 2018; Hurst et al., 2006).

Indeed, in addition to ODT studies in clinical samples with ASC, studies with subclinical traits of ASC (as measured by Autism Spectrum Quotient "AQ") have reported that higher autistic personality traits in NT individuals are associated with enhanced ODT performance in the oblique condition compared to those with low autistic personality traits (Dickinson et al., 2015; Dickinson et al., 2014). These findings have been suggested to indicate increased cortical inhibition in the visual cortex of individuals with high autistic personality traits compared to those with low autistic personality traits (Dickinson et al., 2015; Dickinson et al., 2014). This suggestion has also been supported by neurophysiological measures, as individuals with higher autistic personality traits have higher peak gamma frequency than individuals with low autistic personality traits (Dickinson et al., 2015), given that variations in peak gamma frequency have been associated with levels of GABA concentrations in the visual cortex (Edden et al., 2009). Notwithstanding, such an association between peak gamma frequency and GABA concentration levels in the visual cortex was not replicated in a more recent study (Cousijn et al., 2014), possibly as a consequence of methodological differences related to sample size and the techniques used in measuring GABA (i.e., type of MRS sequence) (Kujala et al., 2015).

Although previous studies have investigated the relationship between ODT performance and autistic personality traits (Dickinson et al., 2015; Dickinson et al., 2014), we are unaware of any study that has assessed ODT performance in relation to schizotypal personality traits. Given the differences between ASC and SSC clinical groups (i.e., enhanced and impaired, respectively) compared to NT control groups, we may expect poor ODT performance in individuals with higher schizotypal personality traits. However, there is a link between autistic and schizotypal personality traits (Dinsdale et al., 2013; Ford et al., 2017; Ford and Crewther, 2014; Nenadić et al., 2021; Russell-Smith et al., 2011); see (Zhou et al., 2019). Thus, we may expect a similar enhanced ODT performance of individuals with high autistic personality traits in those with higher schizotypal personality traits.

The current study aimed to investigate the relationship between performance in ODT and both autistic and schizotypal personality traits in one sample, helping to disentangle these two possibilities. Ultimately, investigating the relationship between ODT and both autistic and schizotypal traits may provide a deeper understanding of the neural mechanisms underlying subclinical autistic and schizotypal traits, given the suggestion that ASC and SSC are two opposites on the same spectrum (Abu-Akel et al., 2018; Ford et al., 2017; Nenadić et al., 2021; Russell-Smith et al., 2010).

Materials and Methods

Participants
Eighty seven healthy volunteers from the University of Sheffield with normal or corrected to normal vision participated in the study. Twenty - eight were first-year Psychology students and received credits for participation. The rest (N=59) were recruited from the students and staff-volunteering email list of

the University of Sheffield and received a £7 Amazon voucher for participation in the study. Participants provided (written) informed consent before taking part. The study received full ethical approval from the Department of Psychology University of Sheffield ethics committee.

Orientation Discrimination Task

We used an orientation discrimination task (ODT) initially developed by (Edden et al., 2009) and had previously been used to measure orientation discrimination in several studies (Bin Dawood et al., 2020; Dickinson, Bruyns-Haylett, et al., 2016; Dickinson et al., 2015; Dickinson et al., 2014). The ODT measures orientation discrimination thresholds using a two-alternative forced-choice adaptive staircase procedure (Leek, 2001; Treutwein, 1995) and was programmed in MATLAB (The MathWorks Inc., Natick, MA, 2000) with PsychToolbox (Brainard, 1997).

In each trial of ODT, two circular black and white gratings (diameter 4°; spatial frequency three cycles/degree; contrast 99 %; mean luminance 83 cd/m2) were sequentially presented for 350 ms with fixation of 500 ms between these two gratings, (Figure 1). The first presented grating is regarded as the reference grating, whereas the second presented grating is regarded as the target grating. Based on the orientation of the reference grating, the ODT comprised vertical and oblique conditions. In the vertical condition, the reference grating was orientated at 0°. In the oblique condition, however, the reference grating was orientated at 45°. Each condition has two staircases based on the target grating's rotation direction (clockwise, anti-clockwise). The staircases implemented one-up three-down procedures, converging on 79% accuracy (Leek, 2001). For each staircase, the target grating was initially presented 5 degrees away from the reference grating with an initial step size of 1 degree, decreasing 75% after each reversal.
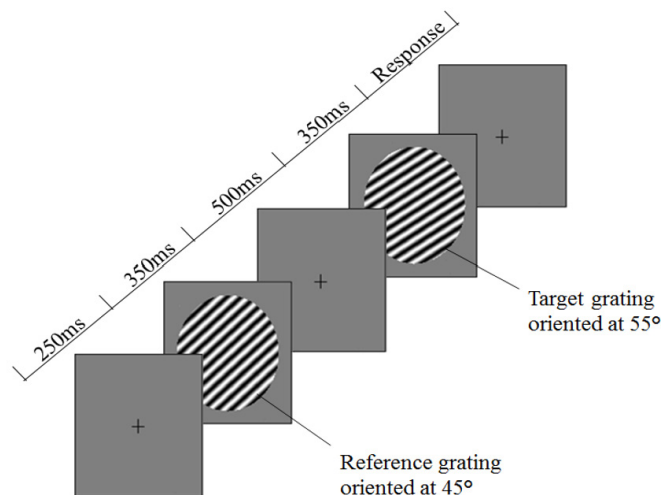
Figure 1. Schematic diagram of the orientation discrimination task. This figure is reprinted with permission from (Dickinson et al., 2014).

Participants were asked to sit comfortably on a chair 57 cm away from the monitor in a dimly lit room. A black circular aperture covered the monitor to eliminate any external orientation cues provided by the monitor edges. Participants were asked to judge whether the target grating had been tilted clockwise or anti-clockwise compared to the reference grating using the right and left arrow keys. Participants started with a practice run of 10 trials for each of the four staircases. Participants then completed the experimental run consisting of 140 trials for each staircase. The task finished when each staircase had reached eight reversals and would be terminated if 140 trails were hit for each staircase.

To calculate OD thresholds, we used the final six reversals from each staircase after discarding the initial two reversals as practice trials. The thresholds of vertical and oblique conditions were calculated separately by averaging each condition's right (clockwise) and left (anti-clockwise) staircases.

Questionnaires

To assess autistic and schizotypal personality traits, we used the Autism Spectrum Quotient (AQ) (Baron-Cohen et al., 2001) and the Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR) (Cohen et al., 2010). Both AQ and SPQ-BR scales were administered online using Qualtrics (https://www.qualtrics.com).

Autism Spectrum Quotient (AQ)

The Autism Spectrum Quotient (AQ) is a 50-item self-report Quotient for measuring autistic personality traits in the general population (Baron-Cohen et al., 2001). The items are scored on a 4-point Likert scale with response options ranging from 'definitely agree' to 'definitely disagree'. The responses are collapsed into a dichotomous scoring scheme as responses with an endorsement of autistic personality traits are scored 1 while the opposite responses are scored 0. The five AQ subscales assess imagination, attention to detail, communication, attention switching, and social skills subscales. The total score of AQ ranges from 0-50 for the complete inventory, with a higher score indicative of a higher level of autistic personality traits.

Schizotypal Personality Questionnaire-Brief Revised

The Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR) is a 32-item self-report questionnaire for measuring schizotypal personality traits (Cohen et al., 2010). The items are scored on a 5-point Likert scale with response options ranging from 'strongly disagree' to 'strongly agree'. The SPQ-BR consists of positive (i.e., "Cognitive-Perceptual"), negative (i.e., "Interpersonal"), and disorganised (i.e., "Disorganized") subscales, with a total score ranging from 0 to 128 for the complete inventory whereby a higher score is indicative of a higher level of schizotypal traits.

Exclusion Criteria

Three exclusion criteria were applied. One criterion was failing to reach six staircase reversals in any condition of ODT. Another criterion was having OD thresholds with more than two standard deviations (SD) away from the average (mean). The last criterion was failing to complete the survey. Data from 16 participants were excluded. Two participants failed to reach six staircase reversals in any ODT condition. Also, the OD thresholds of six participants in any condition of ODT were more than 2 SD away from the average. Additionally, eight participants did not complete the online survey, Tables 1 and 2.

Table 1. *Illustrates the demographic information of 71 participants (46 female, 25 male) whose data were included in the analyses after applying the exclusion criteria stated earlier.*

Variable	Mean	Standard Deviation
Age	22.42	4.82
Vertical Orientation Discrimination Threshold (in degrees)	1.76	1.06
Oblique Orientation Discrimination Threshold (in degrees)	7.80	2.38
Autism Spectrum Quotient (AQ) Score	18.83	6.78
Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR) Score	85.11	16.21

Table 2. *Illustrates each participant's demographic information after applying the exclusion criteria stated earlier*

No.	Sex	Age	AQ Score	SPQ Score	Vertical OD Thresholds (°)	Oblique OD Thresholds (°)
1	F	26	28	103	0.95	7.01
2	F	36	28	127	3.80	11.63
3	F	24	27	77	0.94	4.45
4	F	18	26	92	0.80	5.66
5	F	20	26	85	2.28	8.69
6	F	24	26	98	1.81	3.89
7	F	28	26	72	0.64	6.97
8	F	21	26	106	1.80	6.89
9	F	26	25	97	2.29	6.71
10	F	18	24	112	2.82	8.61
11	F	22	24	93	1.95	7.77
12	F	29	24	93	2.62	9.63
13	F	25	23	112	3.95	7.37
14	F	22	22	66	4.03	13.26
15	F	19	21	105	2.29	7.75
16	F	19	21	80	2.34	9.71
17	F	34	21	76	3.00	7.05
18	F	25	21	81	2.40	6.05
19	F	23	20	87	3.14	10.7
20	F	20	19	92	1.48	5.96
21	F	21	18	96	4.36	8.65
22	F	20	17	106	4.46	9.61
23	F	20	16	86	1.90	10.31
24	F	18	16	103	1.82	8.15
25	F	18	16	74	1.27	10.93
26	F	28	16	56	1.37	11.71
27	F	19	16	63	2.04	8.28
28	F	37	16	84	0.53	4.69
29	F	19	16	65	0.89	6.09
30	F	18	15	90	1.35	13.52
31	F	27	15	77	1.12	5.33
32	F	27	15	75	0.93	7.29
33	F	18	14	73	0.91	9.00
34	F	18	13	100	1.13	9.48
35	F	19	13	79	1.02	5.27
36	F	21	13	88	1.61	8.81
37	F	23	13	86	0.50	6.84
38	F	18	12	92	3.93	7.32
39	F	18	12	65	1.78	8.97
40	F	18	10	88	2.48	7.14
41	F	23	10	69	2.03	8.48
42	F	26	10	65	0.58	4.55

43	F	18	8	73	2.43	13.00
44	F	33	8	104	2.53	9.88
45	F	19	7	56	1.72	10.21
46	F	18	7	77	2.04	10.50
47	M	18	37	106	1.77	6.13
48	M	19	36	115	2.93	10.25
49	M	27	32	66	0.90	4.97
50	M	19	29	96	0.55	4.40
51	M	20	29	95	0.60	4.20
52	M	31	26	101	0.90	3.25
53	M	20	24	58	1.41	7.21
54	M	19	24	103	1.02	6.47
55	M	19	22	94	0.82	8.48
56	M	32	21	57	1.57	9.07
57	M	19	21	86	0.98	3.93
58	M	28	20	101	1.27	6.69
59	M	26	19	94	1.10	8.29
60	M	20	18	91	1.33	7.84
61	M	20	18	95	0.96	6.69
62	M	20	18	71	1.29	5.20
63	M	19	17	81	1.92	9.39
64	M	22	17	79	4.91	11.3
65	M	22	15	80	0.65	4.46
66	M	18	14	99	1.50	8.28
67	M	21	14	71	0.86	7.75
68	M	22	14	71	1.33	8.77
69	M	30	14	61	0.67	6.93
70	M	21	12	64	0.98	9.14
71	M	19	6	64	0.78	4.01

Results

Data from 71 participants (46 female, 25 male; mean age 22.42; SD= 4.82; age range = 18–37) were used to examine the relationship between ODT performance, autistic personality traits, and schizotypal personality traits. The mean threshold of the vertical condition of ODT was 1.76° with a standard deviation of 1.06°, while the mean threshold of the oblique condition of ODT was 7.80° with a standard deviation of 2.38°. Paired sample t-test analysis showed a statistically significant difference between vertical and oblique ODT performance (t (70) =-24.88, p<.0001), Figure 2.
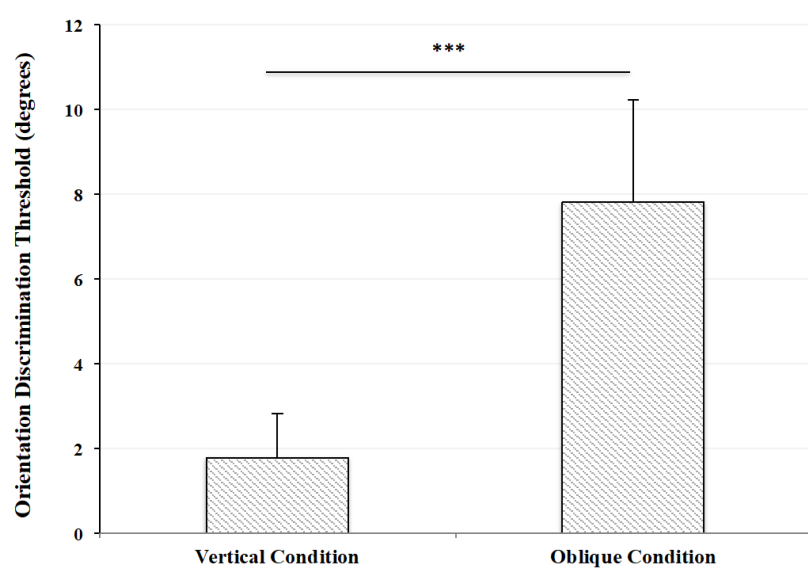
Figure 2. Mean orientation discrimination thresholds for the vertical and oblique conditions of the orientation discrimination task. Error bars represent standard deviation. ***p < 0.0001.

AQ scores ranged from 6 to 37 (mean=18.83, SD=6.78), and SBQ-BR scores ranged from 56 to 127 (Mean=85.11, SD=16.21). The internal consistency analysis of both AQ and SPQ-BR scales revealed high reliability, with Cronbach's alpha of .80 for AQ and .85 for SPQ-BR.

To examine the relationship between performance in ODT, autistic personality traits, and schizotypal personality traits, a Pearson correlation analysis was performed using the following variables: vertical OD thresholds, oblique OD thresholds, AQ scores, and SPQ-BR scores.

We found a statistically significant positive correlation between vertical OD thresholds and SPQ-BR scores, (r= .304, n=71, p=.010). Higher vertical OD thresholds (worse task performance) correlated with higher SPQ-BR scores, (Figure 3(a)). Also, we found a statistically significant negative correlation between oblique OD thresholds and AQ scores, (r= -.241, n=71, p=.043). Lower oblique OD thresholds (better task performance) correlated with higher AQ scores, (Figure 3(b)). However, we found no significant correlation between vertical OD thresholds and AQ scores (r=.052, n=71, p=.33), nor was it between oblique OD thresholds and SPQ-BR scores (r=-.036, n=71, p=.77).
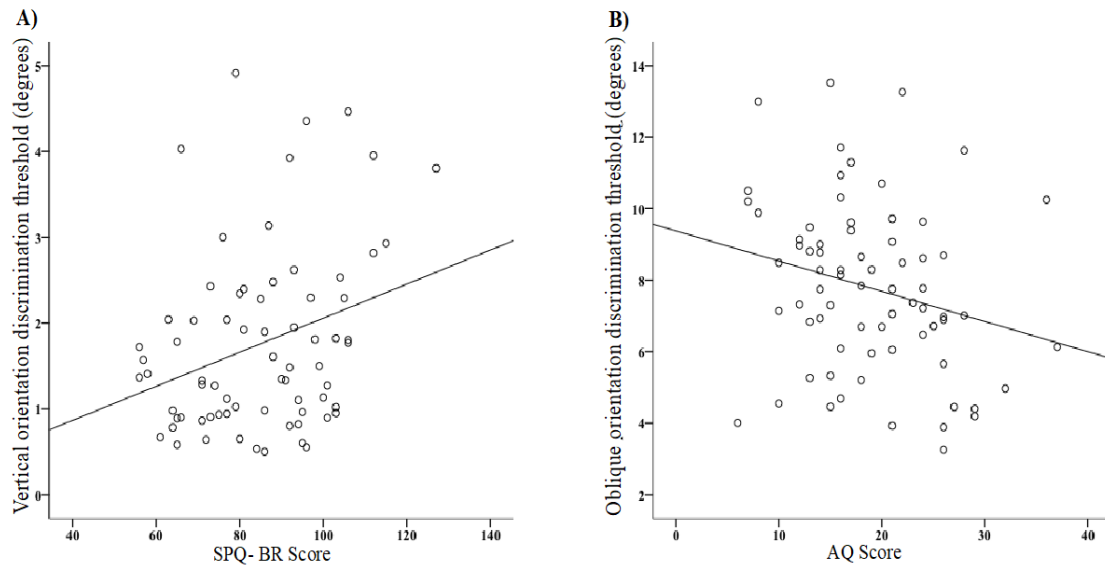
Figure 3. (a) A correlation between vertical orientation discrimination thresholds and SPQ-BR scores (r= .304, n=71 p=.010), and (b) A correlation between oblique orientation discrimination thresholds and AQ scores (r= -.241, n=71 p=.043).

Additionally, the result showed that AQ scores positively correlated with SPQ-BR scores (r= .455, n=71, p< .0001), (Figure 4).
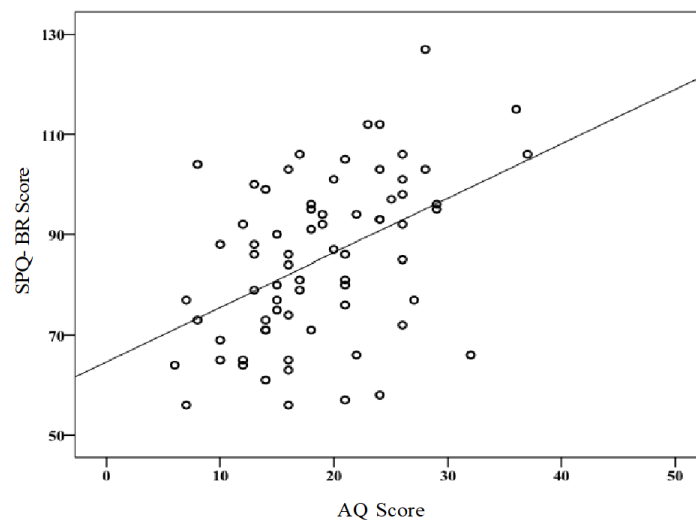
Figure 4. A correlation between AQ scores and SPQ-BR scores (r= .455, n=71, p< .0001).

Furthermore, two partial correlation analyses were performed, given the correlational relationship between AQ and SPQ-BR.

The first partial correlation analysis was to assess the relationship between vertical OD thresholds and SPQ-BR scores while controlling for AQ scores. The result revealed a statistically significant positive correlation between vertical OD thresholds and SPQ-BR scores when the AQ scores were controlled for (r=.316 n=71, p=.008).

The second partial correlation analysis assessed the relationship between oblique OD thresholds and AQ scores while controlling for the SPQ-BR scores. The result revealed a statistically negative correlation between oblique OD thresholds and AQ scores when the SPQ-BR scores were controlled for (r=-.253, n=71, p=.035).

In addition, to confirm that the associations between OD thresholds and scores in personality traits were not driven by other possible factors such as age, which has been linked to cortical E-I balance in previous studies (Abuleil, McCulloch and Thompson, 2019; King et al., 2020; Petitet et al., 2021; Pitchaiuthu

et al., 2017), further correlation analyses were performed. The results indicated no statistically significant correlation between age and both OD thresholds and personality traits, with p-values greater than .05, Table 3. A possible explanation for the insignificant associations between age and other variables may be due to the narrow range of age (18- 37 years).

Table 3. *illustrates the correlations between age and both OD thresholds and scores in personality traits.*

		Vertical OD Thresholds (°)	Oblique OD Thresholds (°)	AQ Scores	SPQ Scores
AGE	Pearson's r	0.003	-0.121	0.142	0.002
	p-value	0.981	0.315	0.236	0.988

Discussion

The current study aimed to replicate previous studies examining the relationship between performance in ODT and autistic personality traits (Dickinson et al., 2015; Dickinson et al., 2014) finding that higher levels of autistic personality traits were associated with lower thresholds in the oblique, but not vertical, condition of ODT. In the same group of participants, we found that schizotypal personality traits were linked to ODT performance in the vertical but not in the oblique condition, partially consistent with the increased OD thresholds that have been found in a clinical sample of participants with SSC (Dickinson et al., 2015; Dickinson et al., 2014), finding that higher levels of autistic traits were associated with lower thresholds in the oblique, but not vertical, condition of ODT. In the same group of participants, we found that schizotypal personality traits were linked to ODT performance in the vertical but not in the oblique condition, partially consistent with the increased thresholds that have been found in a clinical sample of participants with SSC (Shaw et al., 2019). Specifically, individuals with higher schizotypal personality traits showed increased OD thresholds (i.e., worse performance) in the vertical condition. Finally, we found that higher autistic personality traits are associated with higher schizotypal personality traits, consistent with previous findings (Dinsdale et al., 2013; Ford et al., 2017; Ford and Crewther, 2014; Russell-Smith et al., 2011).

As expected based on the hypothesis of increased inhibition in the ASC (Bonnel et al., 2010; Bonnel et al., 2003; Dickinson, Bruyns-Haylett, et al., 2016; Dickinson et al., 2014), we found that high autistic personality traits (indexed by high AQ scores) are associated with enhanced performance in ODT (indexed by low OD thresholds). In line with previous results (Dickinson et al., 2015; Dickinson et al., 2014), this association was condition-specific as it was only observed in the oblique ODT condition. A possible explanation for the lack of a significant relationship between autistic personality traits and OD thresholds in the vertical condition has been attributed to the ceiling effect (Dickinson et al., 2014). Compared to OD thresholds in the oblique condition (M=7.81°, SD=2.42°), OD thresholds in the vertical condition were very low (M=1.78°, SD=1.05°), possibly preventing any potential performance differences from being detectable (Garin, 2014a). Similar to this orientation-specific association between performance in ODT and autistic personality traits, Edden et al. (2009) found that GABA concentration level in the visual cortex was only significantly associated with performance in the oblique condition of ODT but not with that of vertical condition, possibly due to ceiling effect. Our finding of an association between high autistic personality traits and enhanced performance in the oblique condition of ODT supports the suggestion of increased cortical inhibition in the visual cortex of individuals with high autistic personality traits (Dickinson et al., 2015; Dickinson et al., 2014).

Consistent with the hypothesis of disrupted E-I balance in the SSC (Abbasi et al., 2023; Anticevic and Lisman, 2017; Lisman, 2012), the current study found an association between high schizotypal personality traits (indexed by higher SPQ-BR score) and poor performance in ODT (indexed by high OD thresholds). However, this association was only statistically significant for the vertical condition of ODT but not for the oblique condition. Such poor performance in the vertical condition of ODT may reflect decreased inhibition in the visual cortex, which has been suggested to be associated with SSC (Goto et al., 2009; Rokem et al., 2011; Yoon et al., 2010; Yoon et al., 2009). For instance, reduced cortical inhibition

is associated with a broader orientation tuning curve of visual cortical neurons of individuals with SSC (Rokem et al., 2011). As such, the lack of observing any significant relationship between high schizotypal personality traits and performance in the oblique condition of ODT might be due to the so-called 'floor effect' (Garin, 2014b). This is because the visual orientation-tuning curve is initially broader for oblique orientations than the vertical ones (Ringach, 1998), possibly limiting any further performance reduction from being detectable.

Additionally, our finding of an association between high schizotypal personality traits and poorer ODT performance is consistent with that of (Shaw et al., 2019) finding that individuals with SSC had poorer ODT performance than NT individuals. However, it should be noted that (Shaw et al., 2019) found that individuals with SSC had higher OD thresholds in both vertical and oblique conditions. Such partial inconsistency could be related to the type of population. For example, while the study of (Shaw et al., 2019) included a sample of clinically diagnosed individuals with SSC, our current study included a sample of NT individuals with subclinical traits.

In line with previous studies (Dinsdale et al., 2013; Ford et al., 2017; Ford and Crewther, 2014; Russell-Smith et al., 2011), we also found a significant association between autistic and schizotypal personality traits as high AQ scores are associated with high SPQ-BR scores. This is expected based on previous studies showing an association between ASC and SSC (Burbach and van der Zwaag, 2009; Chisholm et al., 2015; King and Lord, 2011; Pilowsky et al., 2000; Volkmar and Cohen, 1991; Wood, 2017). For instance, a systematic review and meta-analysis study examining the association between ASC and SSC reported a 3.4% to 52% prevalence rate of ASC in individuals with SSC (Chisholm et al., 2015). ASC and SSC have been characterised by defects in social, cognitive, and communication functions (Pilowsky et al., 2000). Also, ASC and SSC have been suggested to share the same pathogenic mechanism (Burbach and van der Zwaag, 2009). Additionally, our finding is consistent with previous studies investigating the relationship between autistic personality traits and schizotypal personality traits (Dinsdale et al., 2013; Ford et al., 2017; Ford and Crewther, 2014; Russell-Smith et al., 2011). For instance, autistic personality traits and schizotypal personality traits of non-clinical participants were found to be positively associated with each other (Dinsdale et al., 2013).

As previously reported (Dinsdale et al., 2013; Ford et al., 2017; Ford and Crewther, 2014; Nenadić et al., 2021; Russell-Smith et al., 2011), AQ scores and SPQ-BR scores were correlated in the current study. Given their association, the question arose as to how AQ scores and SPQ-BR scores could correlate differentially with ODT performance. As is typical, the correlation between AQ scores and SPQ-BR scores is below 1 in the current study (r=0.455), allowing the possibility for the scores of these two inventories to independently and differentially correlate with ODT performance. To further investigate this possibility, partial correlations were used to demonstrate that after controlling for AQ scores, the correlation between SPQ-BR scores and vertical OD thresholds (r=.316) was similar to the zero-order correlation (r=.304). Likewise, after controlling for SPQ-BR , the correlation between AQ scores and oblique OD thresholds (r=-.253) was similar to zero-order correlation (r=-.241). This suggests that despite their association, AQ scores and SPQ-BR correlate independently and differentially with ODT performance. Indeed, similar findings have been found for global versus local processing (Russell-Smith et al., 2010). Despite the correlation between autistic and schizotypal traits, individuals with high autistic personality traits had an advantage or preference for local versus global processing than those with low autistic personality traits (Russell-Smith et al., 2010). However, individuals with high schizotypal personality traits were found to have an advantage or preference for global versus local processing than those with low schizotypal personality traits (Russell-Smith et al., 2010). Our divergent pattern of findings regarding ODT performance within the same sample is interesting. For instance, while ASC and SSC have been linked to enhanced and impaired ODT performance, respectively (Dickinson, Bruyns-Haylett, et al., 2016; Shaw et al., 2019), we show that these relationships remain present when studying these two types of traits within the same sample. Our findings may contribute unique mechanistic insight regarding E-I disruptions that cannot be inferred when studying autistic and schizotypal samples independently.

Conclusion

The current study extended previous studies examining the relationship between performance in ODT and autistic personality traits by examining schizotypal personality traits in the same sample. Similar to previous studies (Dickinson et al., 2015; Dickinson et al., 2014), we found that higher levels of autistic personality traits are associated with enhanced performance in the oblique condition of ODT. Additionally, we found that high schizotypal personality traits are associated with poorer performance in the vertical

condition of ODT, as expected based on the findings of (Shaw et al., 2019). Finally, we replicated the previously demonstrated relationship between autistic and schizotypal personality traits (Dinsdale et al., 2013; Ford et al., 2017). Future studies should examine such associations in different cultural contexts, given the critical role of culture on cognition and mental health diagnoses (Banerjee, 2012; Kim, 2012; Phillips, 2019).

Acknowledgements

Conflict of interests
The authors declare no conflict of interest.

Author Contributions
ABD and MJ planned the experiment. AD developed and provided the software for the ODT. ABD collected and analysed the data. MJ supervised the project. ABD wrote the manuscript, and MJ and AD edited it. All authors reviewed the manuscript and agreed with the content.

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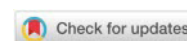
Using Students' Digital Written Text in Moroccan Dialect For The Detection of Student Personality Factors

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Abstract: In the contemporary digital era, social media platforms have a big influence on students' lives. They use these platforms for self-expression, opinion sharing, and experience reporting (writing or sharing videos or photos about personal experiences) in addition to social interaction. Education professionals and academics may get valuable insights into students' thoughts, sentiments, interests, academic success, and even personalities by studying their writing on social media. We can improve our teaching, enhance students' social and emotional development, and create a more engaging learning environment if we have a better knowledge of the student. The purpose of this study is to ascertain whether or not students interact with classmates and other participants in learning platforms in a way that accurately represents their personalities. Data from a sample of students at Abdelmalek Essaadi University of Tetouan were collected from various social media learning environments for the experimental investigation presented in this work, and Symanto AI-based personality tool was used to assess the data. The Big Five Questionnaire was then utilized to assess the personalities of the same students, and the findings were compared to the personality traits discovered by the AI-based approach. The study has shown that the AI based tool has correctly predicted the personality traits of 7 students out of 10 with a correlation of about 0,9 which means that social media-based learning environments can be used by institutions to understand the personality of the student. This paper also gives recommendations about data for obtaining good quality in personality prediction.
Keywords: FFM personalities, social media learning environment, Moroccan dialect text.

Introduction

Student written text plays a special and dynamic role in learning environments that uses social media. Actually, students use social media platforms like (Instagram, WhatsApp and Twitter) more and more, and there are many advantages of using an online learning environment for educational reasons (Christine Greenhow et al., 2019). Those platforms enable informal and spontaneous conversation between students. Therefore, they frequently post variety of content, and they receive in return quick feedback and interactions with other students and teachers. Among the advantage of this trend, these interactions encourages participation and teamwork in students, which can improve their learning process (Josué et al., 2023). Moreover, unlike standard academic writing, students may present ideas, queries, or observations in a less structured manner. As a result, this informal setting may foster individualism, creativity, and the exchange of different perspectives (Eysenck, 1994).

Students' writing in social media often reflects their ideas, feelings, interests, and ways of interacting, which can provide interesting insights about them. Thus, based on these writings, it is possible to determine their personalities on social media using a variety of methods, including: content and interests, language and communication style, frequency and consistency, tone and emotions, interaction patterns, etc... (Rahman et al., 2019).

To understand individual's personality many approaches and theories are used. The following list presents the most well-known models:
• The Myers-Briggs Type Indicator (MBTI) (Pittenger, 1993; Tlili et al., 2016): categorizes persons

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into 16 personality types based on four dichotomies which are extraversion/introversion, sensing/intuition, thinking/feeling, and judging/perceiving. Evry combination of these caracteristics results in a distinct personality type, such as INFP (Introverted, Intuitive, Feeling, Perceiving) or ESTJ (Extraverted, Sensing, Thinking, Judging).

• The Big Five (BF) Personality Traits (Caprara et al., 1993; Eysenck, 1994): Also known as the Five Factor Model (FFM). According to this Model, there are five different dimensions of personality: Agreeableness, Conscientiousness, Extraversion, Openness, and Neuroticism (Utami, Maharani and Atastina, 2021). It is frequently employed in organizational and behavioral studies as well as psychology research, offers a thorough framework for evaluating and characterizing personality traits. It is considered that these characteristics sum up the fundamental elements of human behavior and personality.

• Freudian Personality Structure (Bronfenbrenner, 1951; Zhang, 2020): The famous Austrian psychotherapist Sigmund Freud developed a theory of personality structure known as the Freudian Personality Structure. According to Freud, there are three primary parts of the human mind (Id, Ego and SuperEgo).

• Hans Eysenck's model (Eysenck, 1991, 1981): The prominent psychologist Hans Eysenck developed a widely known three-dimensional model of personality: Neuroticism/Emotional Stability, Extraversion/Introversion, and Psychoticism. The field of personality psychology has been greatly impacted by Eysenck's work, and his model has been widely applied in studies and personality evaluation.

• DISC (Dominance, influence, Steadiness and Conscientiousness) personality Model (Sugerman, 2009; Utami et al., 2022): Another psychological theory for understanding and classifying human behavior in diverse contexts is the DISC Personality Model. It categorizes people into four main personality traits, denoted by a different letter in the acronym DISC. This model is frequently applied in work environments and interpersonal interactions in order to foster better understanding, cooperation, and communication among people with diverse personality types.

This work considers the Big Five model as a method of analyzing the personality of students out of all the models previously provided since it is the most widely used model and particularly because the AI algorithm for personality detection from text is built on it.

Through the Automated Text-Based Personality Assessment (ATBPA) (Gjurković, Vukojević and Šnajder, 2022), artificial intelligence (AI) may predict personality from text by using well-established psychological models. These latter can determine a person's personality traits from written content through analyzing the writing styles, linguistic patterns, word choices, etc.… (Christian et al., 2021). The AI models are trained using machine learning algorithms including text classification and natural language processing. The training of the model uses mainly the annotated data from a dataset. Therefore, the model acquires the ability to identify patterns and connections between linguistic features and personality traits (Gjurković, Vukojević and Šnajder, 2022).

The main goal of this paper is to use one of these ATBPA tools to identify students' personalities based on their writing in the Moroccan dialect in social media learning environments. For this study, we have chosen Symanto APIs as a tool. To achieve our goal, we have gathered data from students in various social learning environments (Instagram, Twitter, WhatsApp and Google chat). This data has been preprocessed by removing irrelevant information and then translating it into English. Subsequently, it has been processed by the AI-based personality algorithm to predict students' personality traits. Finally, the students' personality predictions obtained by the algorithm were compared to the Big Five Questionnaire results that were gathered from the same students.

The following section presents a summary of the literature on the use of social media learning environment. In section 3, we explain the methodology and the applied data processing approach. Subsequently, the experiment's findings are presented in Part 4 followed by an analysis of the results and a discussion in Section 5. Finally, the paper ends with a conclusion that summarizes the work and presents the implications for further research.

Social media and education

The term "social media" refers to a modern phenomenon that includes both mobile interaction and web-based communication with internet users via web applications (Wickramanayake and Muhammad Jika, 2018). Thanks to how convenient it is to access these applications, the majority of people utilize social media for a variety of purposes, including recounting experiences, communicating, and sharing stories from their everyday lives. In the case of students, the development of Web 2.0 and the emergence of Web 3.0 have enabled students to produce content, exchange ideas, and share knowledge. This development is definitely igniting a revolution in the world of education (Namaziandost and Nasri, 2019).

There are now numerous social media learning environments which are frequently utilized by our

students. Among these, the most well-liked platforms include WhatsApp, Instagram, Facebook, Wiki, Skype, YouTube, LinkedIn, Blogs, Twitter and Google Chat,… (Swaminathan, Harish and Cherian, 2013). These platforms, according to Lim et al., can be grouped into seven categories: media sharing, text-based, social networking, virtual world and games, synchronous communications, conferencing applications and mashups, and mobile-based application (See Yin Lim et al., 2014). The top 17 social media learning environments in terms of monthly active users are listed in Table 1.

Table 1
The top 17 social media learning platforms (Barrot, 2022).

Social media	Initial release	Monthly active users	Owner	Country of origin
Facebook	2004	2603000000	Facebook, Inc.	United States
WhatsApp	2009	2000000000	Facebook, Inc.	United States
YouTube	2005	2000000000	Google	United States
WeChat	2011	1203000000	Tencent	China
Instagram	2010	1082000000	Facebook, Inc.	United States
Tik Tok	2016	800000000	ByteDance	China
QQ	1999	694000000	Tencent	China
LinkedIn	2002	660000000	Microsoft	United States
Sina Weibo	2009	550000000	Pan Weibo	China
Reddit	2005	430000000	Advance Publications	United States
Kuaishou	2011	400000000	Bijing Kuaishoun Technology Co., Ltd.	China
Tumblr	2007	400000000	Automattic	United States
Snapchat	2011	397000000	Snap, Inc.	United States
Pinterest	2009	367000000	Pinterest, Inc.	United States
Twitter	2006	326000000	Twitter, Inc.	United States
Skype	2003	300000000	Skype Technolgies	United States
MySpace	2003	50600000	Meredith Corporation	United States

Materials and Methods

This study focuses on how interactions in learning contexts reveal students' personalities. In the previous section, we discussed the most common social media environments that are frequently visited by students and how they use them to interact about learning issues. On the other hand, there is a set of AI-based tools that can be used to detect the personality of people. These tools can be used either using Application Programming Interfaces (APIs) or Graphical User Interfaces (GUIs). In this context, we have gathered data from students in the classroom and we have used 'Symanto' (https://www.symanto.com/) as one of these AI-powered tools to evaluate their personalities.

Detecting the personality based on the tool may not be enough to confirm that it is really the personality of the learner. Therefore, to assess the accuracy of these latter, we asked the same students who participated in the experiment to answer a Big Five Questionnaire test. The purpose is to compare test results to personality traits predicted by AI. As a final goal, we will then be able to investigate how learning environments may be used to understand students' personalities. The general steps of the experiment are shown in Figure 1.
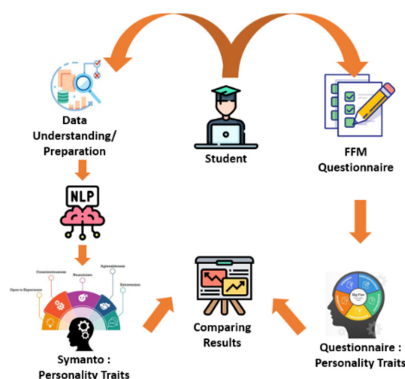

Figure 1. Summary of the student personality comparison and detection technique

Data collection

This research involved ten students of Computer Science Engineering who were enrolled at the National School of Applied Sciences of Tetouan at the Abdelmalek Essaadi University. We gathered their text expressions in different contexts and from multiple social media platforms. Mainly text captured from comments on publications (courses, labs, exercises solutions…), discussions and publications posted by students themselves. The text was integrated and translated before being analyzed by the Machine Learning model. Meanwhile, the same students were asked to respond to the Big Five Questionnaire test.

From numerous social media platforms, information on all target students was collected. The targeted platforms were chosen depending on the data that is readily available for each student. For example, concerning the first student (see Table 2) we gathered 51 samples from Whatsapp, 41 samples from Instagram, 6 samples from Twitter and 5 samples from Google Chat. The quantity of data samples that were collected for each student in each social media platform is displayed in the Table 2.

Table 2
Sample of data for each student per each platform included in the study

Student	Instagram	Twitter	WhatsApp	Google Chat	total by student
Student 1	41	6	51	5	103
Student 2	52	22	77	11	162
Student 3	38	15	42	8	103
Student 4	62	3	33	3	101
Student 5	23	2	68	15	108
Student 6	30	23	41	9	103
Student 7	13	4	56	5	78
Student 8	18	29	39	12	98
Student 9	78	12	74	22	186
Student 10	33	21	52	13	119
Total	388	137	533	103	1161
Average	38,8	13,7	53,3	10,3	116,1

As shown in Table 2, the number of collected data sample is not equivalent comparing different platforms to each other's. This is due to the fact that some platforms are more often used by students than others (WhatsApp and Instagram for example). The total number of data gathered is 1161, with an average of 116,1 samples for each student. The data was stored in CSV files, with each line containing the student's text samples arranged by their originating environment. To make sure that the content of the students' discussions was obvious and comprehensible and that the process of organizing the data was completed without errors, all data was reviewed as well as we ensured the samples belonged to the right students.

Data selection/preprocessing

In this step, we have considered data of all students taking part in the study as an adequate number of samples was collected for each participant. In order to prevent utilizing unrepresentative samples, they had previously been chosen using a variety of estimated characteristics.

For data cleaning, we removed some iInsignificant data which made up less than 2.8% of the overall data. The data has been transformed before being processed due to Moroccan students'' use of their native dialect ("darija") in their writings. The data transformation procedure was a very challenging step. The text could not be used in its original form since the NLP (Natural Language Processing) Model does not support the Moroccan dialect. To address this issue, we translated the content into English as it is a language that the model can comprehend. Therefore, we have carried out a full English translation of the content (see examples in Table 3). The next stage was to incorporate all the student samples, regardless of the environment type. Subsequently, all student data were collected in one entry of the Model because we needed to predict each student's personality separately.

Table 3
Text language standardization to English

Sentence in Moroccan dialect	English translation
9alkom lprof nhar l7ad a5ir ajal dyal les projets rendu	the teacher informs you that this Sunday is the deadline to send your projects
Lcours d8ada rah annulé	tomorrow's class is canceled
B8it les solutions dyal tepeyat	I need practical works solutions
Darni rassi 8adi nmxi	I have a headache; I'm going to leave
5oya 3afak xof m3aya l'erreur fin kayna	Bro, help me find the mistake
Walo dak logiciel mab8ach yt2anstala leya	unfortunately, the software is not installed
Nari majibtx mzyan 9afarta	alas, I didn't get a good mark

Symanto: personality prediction tool

To identify and analyze personalities from the text, there are several AI-based solutions. Many of them are a paid service for business use and can be accessed only for evaluation purpose. However, there are some other applications that are for free use in research domain. In this work we use the free evaluation API of Symanto which is a tool that provides companies with insights from customer data. Symanto is also provided as an API on RapidAPI (https://rapidapi.com/).

In this experiment, we used the RapidAPI web interface to send student text, which resulted in an HTTP POST request to the API. The web service response contains predictions made by the AI Model presented in the .json data format. This last contains the probability of each personality trait based on the Big Five, as well as multiple subclasses of each personality trait. Only predicted values of the first level of the Big Five personality traits were considered in this study.

Results

The preliminary results of this work are the outcomes originated from examining student writing using Symanto AI-based tool to detect personality. The results include the probability of each personality trait according to the Big Five Model which is displayed in Table 4.

Table 4
Students' personality detected by Symanto

	Extraversion	Openness	Conscientiousness	Neuroticism	Agreeableness
Student 1	0,34	0,18	0,45	0,41	0,64
Student 2	0,39	0,42	0,47	0,28	0,71
Student 3	0,64	0,58	0,71	0,23	0,59
Student 4	0,45	0,53	0,73	0,44	0,66
Student 5	0,22	0,37	0,69	0,55	0,28
Student 6	0,42	0,43	0,73	0,52	0,61
Student 7	0,18	0,65	0,74	0,57	0,23
Student 8	0,45	0,32	0,45	0,37	0,77
Student 9	0,23	0,46	0,4	0,29	0,73
Student 10	0,54	0,66	0,73	0,36	0,71

The same students were also requested to complete a personality questionnaire based on the Big Five Model, as was previously mentioned. The results of this personality test are shown in Table 5.

Table 5
Students' personality detected based on the BF Questionnaire.

	Extraversion	Openness	Conscientiousness	Neuroticism	Agreeableness
Student 1	0,3	0,2	0,4	0,4	0,6
Student 2	0,5	0,1	0,6	0,6	0,5
Student 3	0,7	0,6	0,8	0,3	0,6
Student 4	0,5	0,5	0,8	0,4	0,7
Student 5	0,7	0,1	0,4	0,2	0,6
Student 6	0,4	0,4	0,8	0,6	0,5
Student 7	0,4	0,8	0,3	0,8	0,2
Student 8	0,5	0,3	0,5	0,4	0,8
Student 9	0,3	0,4	0,3	0,3	0,7
Student	0,6	0,7	0,6	0,3	0,8

Representing personality traits detected by the AI based tool and those assumed by the Questionnaire in a radar chart for each student can assist in comparing their results. The following figures illustrate the radar charts buit based on the comparison between the results of the tables presented previously (see Figure 2).
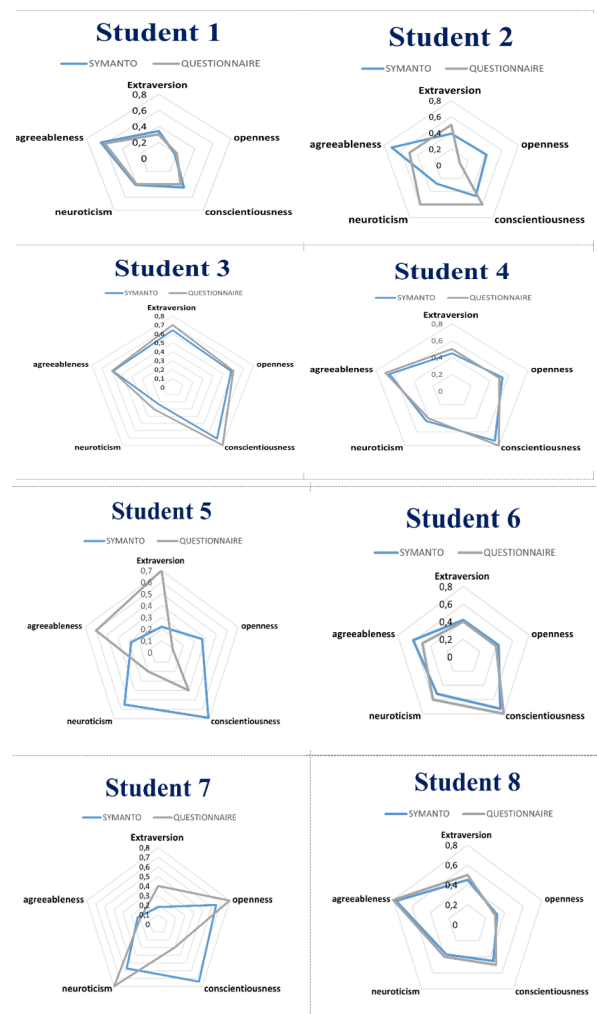
Figure 2. Radar charts of personality predictions for each student

The above-mentioned data demonstrates that diverse personalities predicted by the AI based tool do not always produce similar results based on the Questionnaire. Some students' predictions (students 1, 3, 4, and 8) are quite accurate. However, there is a huge difference between predicted personality of three students compared to their personality detected by the BF Questionnaire (Student 2, Student 5 and Student 7).

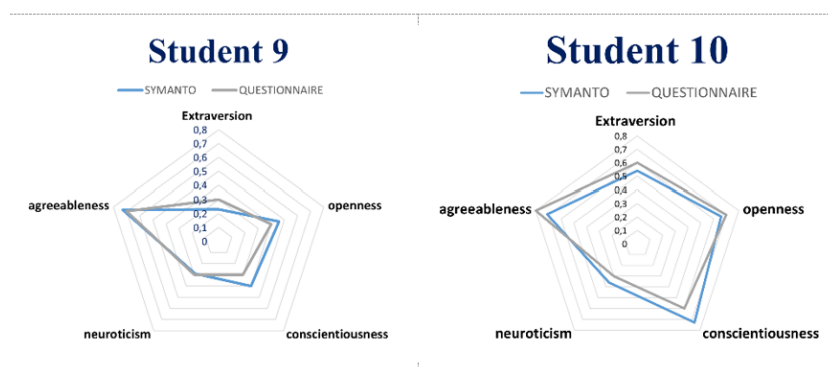Therefore, in order to evaluate results more precisely, we have decided to use metrics that can give more insights from the results. Bellow we present all the metrics used:

• HPT (Highest personality traits): is when a student's highest personality trait value from the AI-based tool and his highest personality trait value from the Questionnaire are same, this setting is set to true. This metric will give us a rate that describes how much the model predicts the most dominant personality trait.

• LPT (Lowest personality traits): is when a student's lowest personality trait value from the AI-based tool and his lowest personality trait value from the Questionnaire are the same, this setting is set to true. This metric will give us a rate that describes how much the model predicts the weakest personality trait in a person.

• ME (Mean error): is a measurement of the average difference between the value of a personality characteristic predicted by an AI-based tool and the value supplied by a Questionnaire for that same personality trait. When this number is small, predictions are reliable and accurate.

• SD (Standard deviation): gauges the variation in the mean error of the difference between the expected and actual values. When this score is low, there are few discrepancies in predictions for the five personality characteristics.

In order to obtain a more accurate result, we have assumed that unifying the precision of the obtained results can provide a more exact metrics' values since the precision of the values produced by the AI-based tool (2 digits after the decimal point) and those returned by the Questionnaire (1 digit after the decimal point) are not the same. Hence, the mean error and standard deviation were recalculated after unifying the values.

Table 6 summarizes the results of different evaluation metrics that compares personality prediction of Symanto AI based solution to that of the Big Five Questionnaire.

Table 6
Evaluation metrics results of the comparison between Symanto APIs and the Big Five Questionnaire

	HPT	LPT	ME	SD	ME (unified precision)	SD (unified precision)
Student 1	True	True	0,0320	0,0164	0,0200	0,0447
Student 2	False	False	0,2180	0,1003	0,2000	0,1000
Student 3	True	True	0,0500	0,0339	0,0600	0,0548
Student 4	True	True	0,0460	0,0152	0,0200	0,0447
Student 5	False	False	0,3420	0,0829	0,3600	0,0894
Student 6	True	True	0,0620	0,0370	0,0600	0,0548
Student 7	False	False	0,2140	0,1494	0,1800	0,1483
Student 8	True	True	0,0360	0,0134	0,0000	0,0000
Student 9	True	True	0,0540	0,0351	0,0600	0,0548
Student 10	True	True	0,0760	0,0351	0,0800	0,0447
All students	7/10	7/10	0,1130	0,0519	0,1040	0,0636

The Symanto APIs predict correctly the highest and lowest personality traits in seven students from a total of ten students. For all students, the mean difference is roughly 0.11, while the standard deviation is about 0.05. The model predicts the Big Five personality characteristics well based on initial measurements or unified precision metrics.

The objective of evaluating the correlation between predictions from the Symanto AI-based model and those from the Questionnaire is to figure out the accuracy of Symanto APIs for each personality trait. Therefore, instead of comparing the values themselves, the purpose is to compare the variety of the predictions. This indicates that if the correlation is close to 1 the values predicted by the AI based tool and those of the BF Questionnaire are very dependent. In other words, the change in the personality from one student to another occurs in exactly the same way even if the predicted values are not completely identical to those identified by the BF Questionnaire. This also means that for each personality trait, there is a very strong correlation between the predictions made by the AI-based model and the outcomes of the Questionnaire. The correlation results are shown in Table 7. It was calculated both separately for each personality trait as well as overall for all personality traits.

Table 7
Correlation between Symanto predictions and Questionnaire results

	Correlation	Correlation (unified precision)
Extraversion	0,4731	0,4572
Openness	0,8402	0,8486
Conscientiousness	0,4691	0,4839
Neuroticism	0,3573	0,3164
Agreeableness	0,7114	0,7578
All traits	0,6143	0,6168

As shown in the previous table, the correlation values of personality traits in the Symanto model range between 0.31 and 0.84. The correlation coefficient for all traits is approximately 0.61 based on the initial values and on the unified precision values. In general, we cannot deny the relationship between the model's predictions and those calculated by the Questionnaire. However, the correlation is not very strong, balanced around 0.6.

Even the correlation between results indicated by the Questionnaire and those predicted by the AI-based model is significant, we cannot consider it substantial. Moreover, we had identified three students (students 2, 5 and 7) whose findings were considerably different when comparing Symanto AI-based model predictions to the Questionnaire ones (see radar charts in Fig. 3). Consequently, presuming that it

contains biased data (see discussion section), we decided to recalculate the correlation after eliminating these three students' data (see Table 8). The correlation increased substantially as a result of this modification approaching 0.9.

Table 8
Correlation between Symanto predictions and Questionnaire results after elimination of biased data

	Correlation	Correlation (unified precision)
Extraversion	0,9591	0,9341
Openness	0,9787	0,9758
Conscientiousness	0,9131	0,9303
Neuroticism	0,8702	0,7727
Agreeableness	0,8526	0,8775
All traits	0,9453	0,9309

We were able to assert the absurdity of the predictions made about the three students by reevaluating the data while taking into consideration the samples which show the personality of the student. Table 9 summarizes the results of this reevaluation while table 10 shows some examples of low and good quality samples.

Table 9
Number of samples classified by quality after the revision.

Student	Number of good-quality Samples	Number of low-quality Samples	Total by student
Student 1	92	11	103
Student 2	33	129	162
Student 3	87	16	103
Student 4	89	12	101
Student 5	21	87	108
Student 6	93	10	103
Student 7	21	57	78
Student 8	90	8	98
Student 9	163	23	186
Student 10	104	15	119
Total	793	368	1161

Table 10
Examples of good and low quality samples after the revision.

Examples of good-quality Samples	Examples of low-quality Samples
I suggest collaborating with you on this project.	The teacher has already shared the correction.
I must complete the exercise on time.	The update is complete.
I think I can help you debug this code.	I will not be present in the next session.

Discussion

Concerning the evaluation of Symanto as a personality prediction tool, we can confirm from the beginning based on the radar charts representation that Symanto AI-based solution was successful in predicting personality traits based on the Big Five Model. Predicted personality of seven students from ten was very close to this obtained by the questionnaire.

The evaluation metrics defined in this research revealed more important information about the evaluated model. For the same seven students, the most and least dominant personality traits were correctly predicted. The low values of the Mean Error and the Standard deviation confirm that the predictions are very accurate.

Unifying the precision of the values obtained was supposed to give a more precise comparison between the results. However, the findings of the metrics recalculation following the adjustment of values with a uniform precision did not significantly affect the initial results. But in any case, we can consider that this consequently confirms the initial results.

The correlation between the two compared results is a very significant metric that calculates numerically if the values of personality vary in the same manner in both compared approaches. A more important insight that correlation gave us is the variation concerning each personality trait separately. The calculation of this metric showed significant correlation based on the results of all students for all personality traits. Regarding the assessment of the correlation of each personality trait apart, the correlation was raised for the Openness and the Agreeableness, on the other hand it was not very significant for the rest of the traits.

Although overall the results obtained clearly show that the AI-based tool can detect the personality of students. We looked for an explanation for the failure of this process for the three students concerned. The most likely hypothesis based on how the AI model worked was the quality of the text gathered for these students. The text written by a person may in certain cases not reflect its true personality. This means that the personality detection algorithm may not be responsible for the error of a detected personality from a text that does not contain expressions that really show this personality. The Symanto team also recommends using text that specially expresses the person point of view because trough this the person shows its personality. According to this, we decided to revise (human revision) all the data to check the quality of the text taking in order to classify it according to this criterion. Table 9 represents the number of good-quality and low-quality samples for each student after the revision of the data. Examples of good and low quality text are shown in table 10. Therefore, based on the results of the new revision we decided to exclude the data of the three students and recalculate the same evaluation metrics based on the remaining seven students. We considered that the new results are fairer to evaluate the model because they are not affected by low quality text.

The re-evaluation of the model based on the seven students who wrote texts that show more of their personality yielded more accurate results. The correlation is really very strong between the personality detected by the model and that of the questionnaire. The latter has spread 0.9 for all personality traits while it was between 0.85 and 0.97 for separated personality traits. This confirms substantially the accuracy of the predictions of the personality.

Generally, we can assume that this AI-based tool that employs related techniques from NLP to identify personality from language expression predicts personality traits exceptionally well. This fact is strongly conditioned by having sufficient data collected about each evaluated student, as well as by the quality of the data that should include expressions that reveal the student's thoughts and behavior.

Ultimately, as understanding students' personalities is very important in the teaching and learning context. The present study shows that using automated text-based personality assessment combined with good quality text of student collected from social media-based environment can help in detecting student personality instead of using the traditional Big Five Questionnaire. and therefore, thanks to these tools we can develop specific solutions that automatically detect the learner's personality in social media-based learning environments.

Conclusions

In the current study, we collected data from social networks where students discuss about learning. We specifically gathered data from Twitter, Google Chat, Instagram, and WhatsApp groups. Data was processed using the AI-based Symanto APIs in order to identify students' personalities. The outcomes of this latter were analyzed to determine if the combination of student data from learning environments and this tool can help in identifying student's personality. The results from the Symanto AI-based tool were compared to results from the personality test Questionnaire.

According to the study's outcomes, Symanto APIs can be really helpful in determining a student's personality based on their interactions in learning environments. Most of the student's personality traits were implied in their written text. Moreover, text quality is the most important factor in determining a student's personality.

The evaluated tool accurately identified the dominant personality characteristic and almost every other trait with a very low error value. Furthermore, the correlation between projected personality from text and those found by the Questionnaire was very significant (around 0,9) after omitting three students who were considered as outlier samples. Either for personality in general or for individual personality traits, the correlation value is considerably strong.

This experiment also shows that not all of the students' personalities can accurately be identified from text. Out of 10 students, three had personalities that the AI-based tool was unable to identify. This failure can be explained by the text itself more often than by the tool's inefficiency. The data of these students does not contain sufficient expressions that show explicitly students' personality traits. Therefore, it is strongly recommended to check the quality of the text before processing it by the model to detect the personality.

In future work, we will evaluate other AI personality detection tools and test them on other data to be collected. We will also study other personality detection techniques that are not text-based to ultimately build a multimodal solution that detects personality from several data sources.

Acknowledgements

Conflict of interests
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

Data Curation, N. El Bahri, A. Abtoy; methodology, Z. Itahriouan, N. El Bahri; Formal analysis, N. El Bahri, Z. Itahriouan, S. Brahim Belhaouari; Validation, Z. Itahriouan, A. Abtoy; writing—original draft preparation, N. El Bahri; writing—review and editing, Z. Itahriouan, A. Abtoy, S. Brahim Belhaouari; Funding acquisition, Z. Itahriouan. All authors have read and agreed to the published version of the manuscript.

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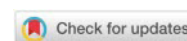
Problem Solving and Decision-Making Skills for ESD: A Bibliometric Analysis

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Abstract: Problem-solving and decision-making skills are essential for individuals across various fields. These skills emphasize the importance of preparing a generation capable of solving problems and making informed decisions. Therefore, this study aimed to learn the publication trends related to problem-solving and decision-making skills for ESD (Education for Sustainable Development) from 2013 to 2022 through Bibliometric analysis. In line with the analysis, a VOSviewer software was used to graphically analyze the obtained bibliographic data. A total of 1519 documents were also analytically acquired from the Scopus database. The results showed a fluctuating trend in the number of publications, with the Journal of Chemical Education and Social Sciences being the highest contributor and the most prevalent field of study at 147 and 689 documents, respectively. The United States was also ranked first in the documents emphasizing problem-solving and decision-making skills, at 512 documents. Moreover, the University of Toronto was the most prolific affiliation, contributing the most publications at 17 documents. The representatives from Indonesia were also grouped into two institutions in the global top twenty affiliates, namely (1) the Indonesian University of Education and (2) the State University of Malang. In line with the results, 159 study experts from Indonesia contributed to the analyzed theme, as the top author originated from the United States having 7 documents. The top document excerpts were also published 240 times in the journal Expert Systems with Applications. The trend of the study visualization subsequently produced 9 clusters, problem-solving and decision-making skills, human, psychology, clinical competencies, education, curriculum, support systems, creativity, and content analysis. These results were helpful to relevant experts, regarding the analytical trend in problem-solving and decision-making skills, recommending directions for future analyses.
Keywords: bibliometric analysis, decision-making skills, ESD, problem-solving, VOSviewer.

Introduction

Education for Sustainable Development (ESD) is a new paradigm in the educational field, that provides opportunities to the younger generation regarding contribution to sustainable development (Tripon, 2014). This paradigm was believed to transform the learning mindsets of students, enabling a plan for a better life in the future (Jauhariyah et al., 2021). The ESD curriculum implementation also fosters student's competencies, skills, empathy, responsibility, problem-solving, democratic decision-making, hope, and respect for humanity as well as nature (Laurie et al., 2016). Furthermore, ESD stimulates students to question, analyze, think critically, and make informed decisions (UNESCO, 2012). This paradigm employs an active learning model, which emphasizes academic participation and collaboration.

Based on the aforementioned descriptions, problem-solving and decision-making skills are the methodological competencies required for future success (Erol et al., 2016). This indicated that collaborative decision-making skills were needed in the industrial era 4.0 (Torres, Pimentel and Matias, 2023). The methodological competencies were also selected as essential and relevant characteristics for physics careers (Nasri, Nasri and Talib, 2020), with decision-making skills closely related to the abilities of critical thinking (Molokhina, Pishchik and Fomin, 2021) and communication (Tsai et al., 2020). Therefore, schools need to promote decision-making skills through classroom learning. Collaboration

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among students was also expected to become increasingly important in an environment of complex and uncertain decision-making. This is because the interaction among various stakeholders and knowledge exchange can enhance the processes of making appropriate decisions (Cai et al., 2023). According to a study in various fields, the outcomes obtained were significantly related to decision-making skills in learning mathematics (Pertl, Zamarian and Delazer, 2017), physics (Silvianty, Suhandi and Setiawan, 2019), chemistry (Gao, 2015; Lieber et al., 2022; Wilson and Wilson, 2017), medicine (Delavari et al., 2022), computers (Carlsson, 2019; Chen and Utama, 2022; Méndez et al., 2020), engineering (Fruchter, Katz and Grey, 2018), business (De Villiers, Hankin and Woodside, 2016), and nursing (Chen et al., 2021; Macduff, Stephen and Taylo, 2016; Saab et al., 2021). Kwok and Hodgson (2017) also stated that decisionmaking model consisted of six steps, namely identifying problems, generating, evaluating, and selecting alternatives, as well as implementing and assessing decisions.

Several study trends in decision-making and problem-solving skills have subsequently been conducted through bibliometrics. This is because bibliometric studies are significantly related to decisionmaking processes in various domains, such as engineering (Cai et al., 2023), universities (Vílchez-Román, Sanguinetti and Mauricio-Salas, 2021), health (Holden, Rosenberg and Barker, 2005), linguistic probability (Liao, Mi and Xu, 2020), business (Costa et al., 2017; Pacheco-Velázquez et al., 2023), laboratory safety (Abdullah and Abd Aziz, 2021), and artificial intelligence (Di Vaio, Hassan and Alavoine, 2022). These trends are also relevantly associated with problem-solving in the fields of teaching physics (Masitoh et al., 2021) and mathematics education (Chen et al., 2021; Suseelan, Chew and Chin, 2022). A bibliometric study approach is also commonly implemented to emphasize problem-solving and decision-making skills as variables yet to be concurrently investigated by previous experts. This explains that both skills are necessary in sustainable development education across various fields of knowledge. Therefore, this study aimed to identify the trends in publication growth, countries, subject areas, journals, productive authors, university affiliations, highly cited articles, and future experimental opportunities, regarding the concepts of problem-solving and decision-making skills.

The main contribution of the analysis is to provide comprehensive information concerning the trends in publication growth, subject areas, top countries, university affiliations, journals, highly cited articles, productive authors, contributions of Indonesian experts, and future experimental opportunities in the field of problem-solving and decision-making skills. In this case, article authors and journal editors were essentially expected to possess awareness of the disciplinary landscape and a thorough understanding of the analyzed fields, enabling the identification of future experimental opportunities. Policymakers are also capable of recognizing leading countries in the analysis of problem-solving and decision-making skills, which were implemented in the instructional design of several dimensional educators. Therefore, this study aimed to acquire knowledge about problem-solving and decision-making for ESD, through the review and evaluation of the research questions:

1. How has the trend in annual publications, document sources, subject areas, and countries for problem-solving and decision-making skills evolved from 2013 to 2022?

2. How has the distribution of problem-solving and decision-making skills publications evolved based on university affiliation?

3. Who is the most productive writer in the analysis of global problem-solving and decision-making skills?

4. How has the contribution of Indonesian experts evolved in analyzing problem-solving and decision-making skills?

5. Which paper is most cited and related to problem-solving and decision-making skills?

6. What are the future study opportunities associated with problem-solving and decision-making skills?

Materials and Methods

A bibliometric analysis approach was employed to draw conclusions based on a collection of bibliographic data, exhibiting the structure, social, and author networks, as well as present analytical interests in a specific experimental area (Ha et al., 2020; Karakus, Ersozlu and Clark, 2019; Suprapto et al., 2021; Zupic and Čater, 2015). The approach also included the statistical analysis of published articles and their citations, to measure relevant impacts (Maditati et al., 2018; Saregar et al., 2022) and analyze gaps or emerging topics (Gao et al., 2021). In addition, bibliographical analysis implemented the relevant information obtained from online databases, enabling scientific study and a global perspective on related interest areas (Secinaro et al., 2020). Figure 1 shows the implementation of the five steps emphasizing
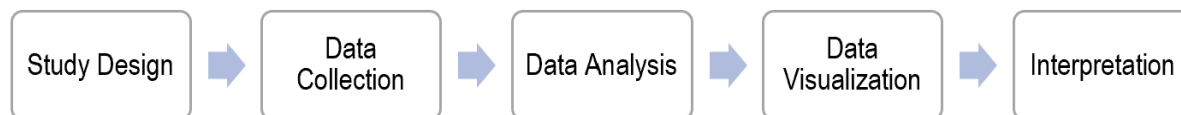
bibliometric method.

Figure 1. Bibliometric methodology

Study design

The study design was executed by formulating research questions, as well as selecting keywords and databases. This indicated the existence of the six questions investigating the following features: i) annual publication trends, document sources, subject areas, and countries,; ii) affiliations,; iii) most productive authors,; iv) contributions of Indonesian experts,; v) highly cited papers,; and vi) future experimental opportunities related to problem-solving and decision-making skills. The design also proved that the implemented search keywords were "Problem-solving decision-making skills", with the Scopus database selected as the bibliometric source.

Data collection

A title search strategy (problem AND solving AND decision AND making AND skills) AND PUBYEAR > 2012 AND PUBYEAR < 2023 were used by the data collection process from the Scopus database. This indicated that 1519 documents for 2013-2022 were acquired from the database, including journals, conference proceedings, review articles, paper chapters, and books. The documents were also downloaded in Comma-Separated Values (CSV) and Research Information System (RIS) formats, to obtain article titles, authors, references, and keywords.

Data analysis

Data analysis was initiated by exporting CSV and RIS information from the Scopus database to Microsoft Excel and VOSviewer. This analysis was conducted to analyze various trends, including publication output characteristics, document sources, country and institutional affiliation distribution, subject category dissemination, top authors and citations, as well as publicized tendencies spanning 2013 to 2022.

Data visualization

The visualization of data was carried out using VOSviewer software (Van Eck and Waltman, 2010, 2012) and Microsoft Excel. By implementing VOSviewer, processed RIS metadata was mapped based on network, overlay, and density visualizations. Meanwhile, the visualization, emphasizing Microsoft Excel, was used to describe the study trends presented as tables and diagrams.

Interpretation

Data visualized by VOSviewer were analyzed and interpreted regarding the number of clusters formed, old and recent studies, and density visualization, which specifically exhibited saturation and future experimental opportunities.

Results

Annual publication trends between 2013-2022

The trend of publication productivity over ten years (2013-2022) was based on the Scopus database, emphasizing relevant fluctuations. In this case, the analytical trends of problem-solving and decision-making skills in various disciplines had a 10-years fluctuation. This was evidenced by the document elevations in 2019, 2020, 2021, and 2022 at 196, 172, 197, and 201 publications, respectively. Figure 2 presents the annual publication trends.
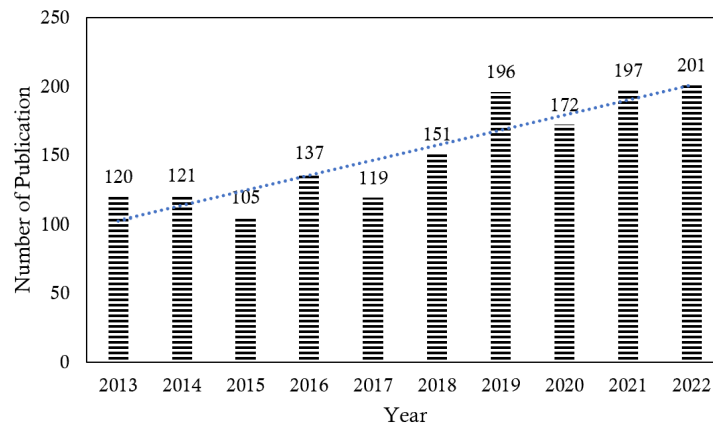
Figure 2. Annual publication trends for the period 2013-2022

Main Source Document

The article documents were sourced from journals, proceedings, paper chapters, reviews, and books. Most of these sources focused on problem-solving and decision-making skills from various fields, including education, computer science, engineering, medicine, nursing, public health, psychology, etc. Table 1 shows the twenty most prolific sources for publishing articles related to problem-solving and decision-making skills.

Table 1
Distribution of documents by related sources from 2013-2022

Source	SJR index (Scimagojr 2022)	Number of document
Journal of Chemical Education	0.56 (Q2)	147
ASEE Annual Conference and Exposition Conference Proceedings	0 (-)	40
Journal of Physics Conference Series	0.18 (-)	18
Advances In Intelligent Systems and Computing	0 (-)	16
Nurse Education Today	0.95 (Q1)	10
BMC Medical Education	0.91 (Q1)	10
Plos One	0.89(Q1)	9
Proceedings of the European Conference on Games-Based Learning	0 (-)	8
International Journal of Environmental Research and Public Health	0.83 (Q2)	8
Sustainability Switzerland	0.37 (Q2)	7
AIP Conference Proceedings	0.16 (-)	7
International Journal of Engineering Education	0.26 (Q2)	6
Frontiers In Psychology	0.89 (Q2)	6
ACM International Conference Proceeding Series	0.21 (-)	6
Journal of Vocational Rehabilitation	0.38 (Q2)	5
Journal of Veterinary Medical Education	0.45 (Q3)	5
Journal of General Internal Medicine	1.81 (Q1)	5
Journal of Engineering Education Transformations	0.21 (Q3)	5
Journal of Dental Education	0.56 (Q2)	5
Thinking Skills and Creativity	1.15 (Q1)	4

Documents based on Subject Area

A maximum of 689 problem-solving and decision-making skills publications were obtained for the 2013-2022 documents emphasizing the subject areas within the field of social sciences. This indicated that "Medicine", "Engineering", 'Computer Science", "Psychology", "Chemistry", "Business, Management, and Accounting", "Health Professions", "Nursing", and "Arts and Humanities" had 364, 246, 237, 162, 153, 94, 79, 78, and 74 publications, respectively. Figure 3 illustrates the document classification emphasizing subject area.
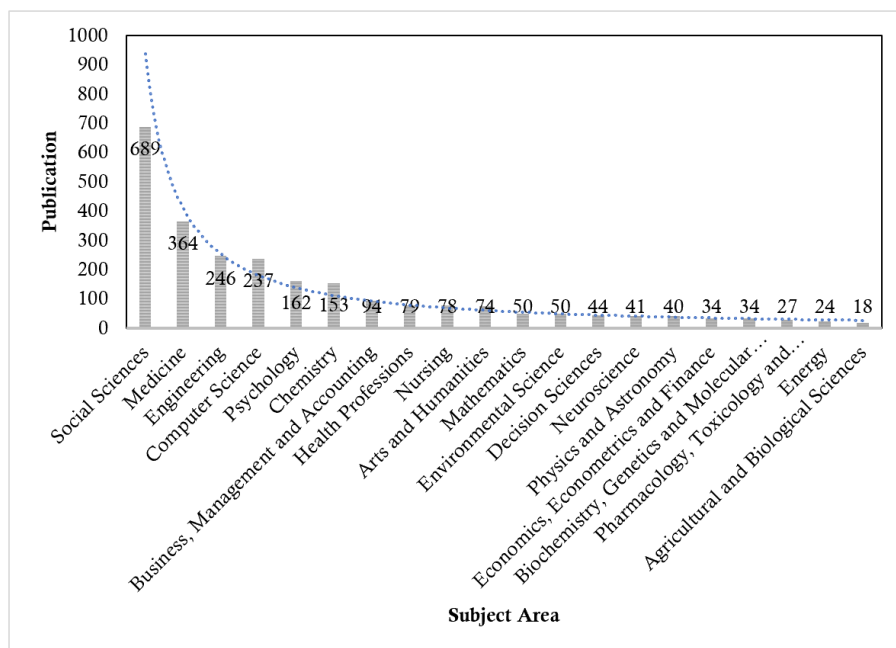
Figure 3. Subject area

Top Publications by Country

Based on country classification, a total of 1519 documents were distributed, with 512, 131, 93, 76, 60, 55, and 42 articles originating from the United States, United Kingdom, Australia, Canada, India, Spain, and Indonesia, respectively. This proved that Indonesia, as a country on the Asian continent, participated in the study trends of America, Europe, and Africa regarding the analysis of problem-solving and decision-making skills. Figure 4 shows the distribution of the top 20 of 102 countries in the publication of problem-solving and decision-making skills.
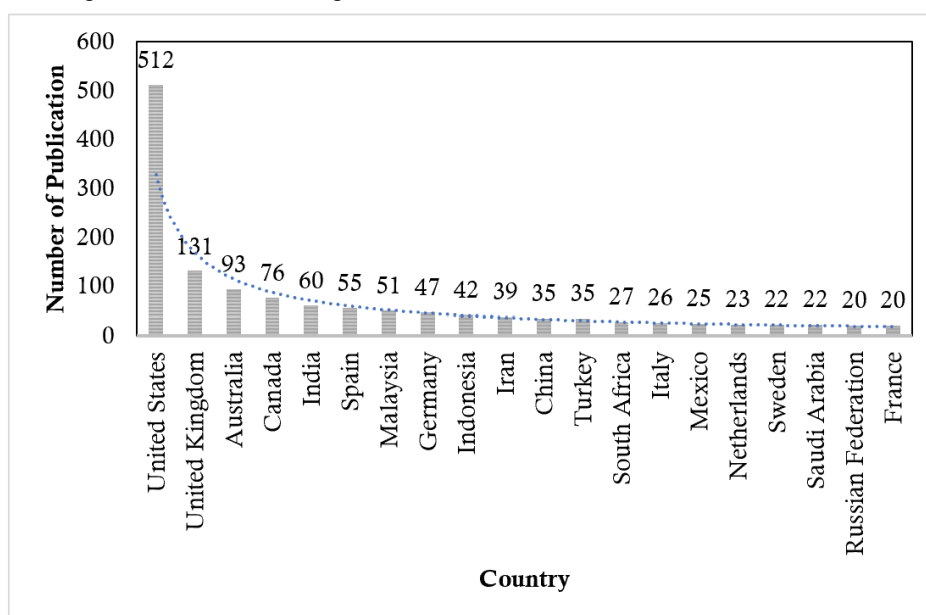
Figure 4. Top countries publication on problem-solving and decision making skills

University Affiliation

Figure 5 presents the distribution of the top 20 university affiliations emphasizing problem-solving and decision-making skills.
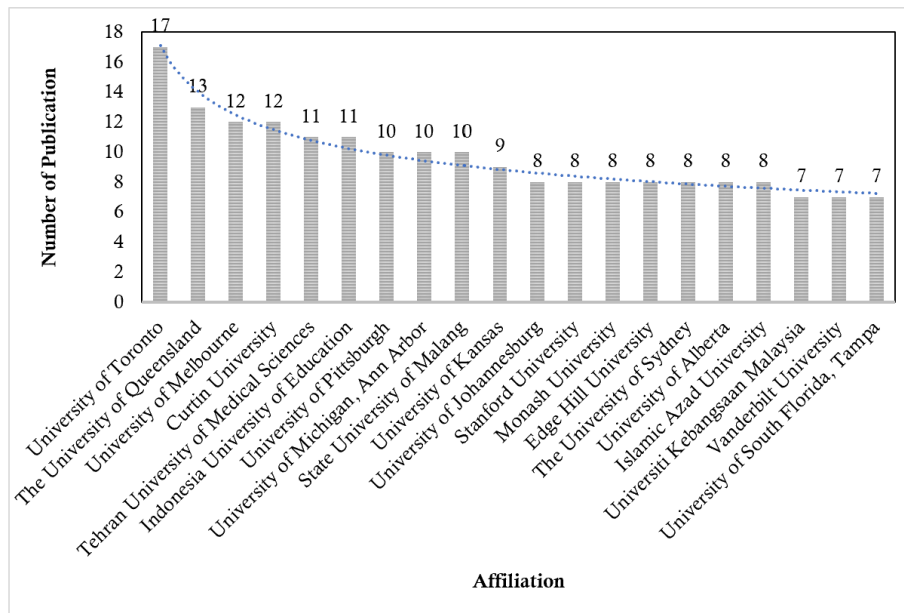
Figure 5. Top affiliation

The distribution of publications was observed from various university affiliates, namely; America, Malaysia, Indonesia, Iran, Australia, England, Africa, etc. In this case, the University of Toronto was the most productive institution with 17 published documents on the Scopus database, accompanied by the Universities of Queensland, Melbourne, and Curtin having 13, 12, and 12 articles, respectively. The Tehran and Indonesian Universities of Medical Sciences and Education also had 11 documents, accompanied by the higher institutions of Pittsburgh, Michigan, and Malang (state) having 10 publications. According to the results, Indonesia contributed two institutions to the top 20 affiliates, namely (1) The Indonesian University of Education, and (2) The State University of Malang.

Based on the Scopus database from 2013 to 2022, the top 10 of 39 Indonesian university affiliates emphasizing the publication of problem-solving and decision-making skills in learning processes were observed. This indicated that the Indonesian University of Education was ranked first, accompanied by the Universities of Malang (state), Bina Nusantara, Mataram, Sebeleas Maret, and Semarang (state). Table 2 presents the top ten affiliates from Indonesia.

Table 2
Top ten affiliations of the University of Indonesia

No	Affiliation	Number of documents
1	Indonesia University of Education	11
2	State University of Malang	10
3	Bina Nusantara University	4
4	University of Mataram	2
6	Sebelas Maret University	2
7	State University of Semarang	2
8	Kanjuruhan University Malang	2
9	Siliwangi University	1
10	University of Technology	1

Top 10 Authors

According to the evaluation of the top 10 authors regarding the most publications, Shogren, K.A. was ranked first with 7 documents. This was accompanied by Yousefi, M., Suhandi, A., Issa, T., Hooshyar, D., and Ahmad, R.B., which had five (5) documents each. York, S., Shultz, G.V., Raley, S.K., and Horng, S.J. also possessed four publications each. In line with the results, an Indonesian writer, namely Suhandi, A. from the University of Education, analyzed decision-making and problem-solving skills. However, many universities in the country did not publish relevant documents based on the Scopus database. Table 3 illustrates the details for the top 10 authors with the highest number of publications.

Table 3

Ranking of authors with a minimum of four published documents

No	Author	Affiliation	Number of documents	Number of citations
1	Shogren, K.A.	University of Kansas, Lawrence, United States	7	107
2	Yousefi, M.	Universiti Tenaga Nasional, Kajang, Malaysia	5	186
3	Suhandi, A.	Indonesia University of Education, Bandung, Indonesia	5	7
4	Issa, T.	Curtin University, Australia	5	2
5	Hooshyar, D.	University of Malaya, Kuala Lumpur, Malaysia	5	186
6	Ahmad, R.B.	University of Malaya, Kuala Lumpur, Malaysia	5	186
7	York, S.	University of Nevada, Las Vegas, United States	4	231
8	Shultz, G.V.	University of Michigan, Ann Arbor, United States	4	67
9	Raley, S.K.	University of Kansas, Lawrence, United States	4	88
10	Horng, S.J.	National Taiwan University of Science and Technology, Taiwan	4	177

Contribution of Indonesian Experts Evolved in Problem-solving and Decision-making skills

Based on the Scopus database spanning from 2013 to 2022, the top ten of the 159 authors that published the articles exploring problem-solving and decision-making skills in learning were identified. In this case, Suhandi from the Indonesian University of Education mostly published problem-solving and decision-making themes. However, the entire learning processes emphasizing the themes remained inadequate and limited. Table 4 presents the top 10 authors from Indonesian university affiliates.

Table 4

Top ten author contributions from university affiliates in Indonesia

No	Author	Affiliation	Publication	Number of citations
1	Suhandi, A.	Indonesia University of Education	5	7
2	Samsudin, A.	Indonesia University of Education	3	3
3	Syaodih, E.	Indonesia University of Education	2	3
4	Suwono, H.	State University of Malang	2	2
5	Ningsih, A. R.	Indonesia University of Education	2	3
6	Kaniawati, I.	Indonesia University of Education	2	3
7	Hakim, A.	University of Mataram	2	35
8	Zarlis, M.	North Sumatra University	1	0
9	Zarkasi, A. C	University- Nusantara PGRI Kediri	1	0
10	Yuliardi, R.	STKIP Muhammadiyah Kuningan	1	1

Document Citation

According to the Scopus database, the top 10 documents with consecutive highest citations were as follows, Liu, Chan and Ran, 2016 (NC=240), Leider and Griffiths, 2019 (NC=220), Ellis et al. 2017

(NC=212), Dineen-Griffin et al. 2019 (NC=144), Orgill et al. (2019; NC=107), Hooshyar et al. 2016 (NC=92), Kazancoglu and Ozkan-Ozen, 2018 (NC=91), Kegler, Stone and Holland, 2017 (NC=89), Opstoel et al. 2020 (NC=83), and Devan et al. 2018 (NC=81). Table 5 illustrates the information on the documents with the most citations.

Table 5
A breakdown of the top 10 documents on Scopus by number of citations

No	Authors	Year	Title	Source	Number of Citation
1	Liu et al.	2016	Decision-making for the selection of cloud vendor: An improved approach under group decision-making with integrated weights and objective/subjective attributes	Expert Systems with Applications	240
2	Lieder & Griffiths	2019	Resource-rational analysis: Understanding human cognition as the optimal use of limited computational resources	Behavioral and Brain Sciences	220
3	Ellis et al.	2017	Beyond Risk and Protective Factors: An Adaptation-Based Approach to Resilience	Perspectives on Psychological Science	212
4	Dineen-Griffin et al.	2019	Helping patients help themselves: A systematic review of self-management support strategies in primary health care practice	PLoS ONE	144
5	Orgill et al.	2019	Introduction to Systems Thinking for the Chemistry Education Community	Journal of Chemical Education	107
6	Hooshyar et al.	2016	Applying an online game-based formative assessment in a flowchart-based intelligent tutoring system for improving problem-solving skills	Computers and Education	92
7	Kazancoglu & Ozkan-Ozen	2018	Analyzing Workforce 4.0 in the Fourth Industrial Revolution and proposing a road map from an operations management perspective with fuzzy DEMATEL	Journal of Enterprise Information Management	91
8	Kegler et al.	2017	Trends in suicide by level of Urbanization – United States, 1999-2015	Morbidity and Mortality Weekly Report	89
9	Opstoel et al.	2020	Personal and social development in physical education and sports: A review study	European Physical Education Review	83
10	Devan et al.	2018	What works and does not work in a self-management intervention for people with chronic pain? Qualitative systematic review and meta-synthesis	Physical Therapy	81

Mapping Problem Solving and Decision Making with VOSviewer
Co-occurrence Analysis of Keywords

The classification of study subjects related to problem-solving and decision-making skills was interestingly emphasized, as a minimum number of 58,017 keywords occurred, with 743 words meeting the threshold. Network visualization was also categorized into 9 clusters, 42399 links, and 101961 total bond strengths. In this case, the red, green, blue, yellow-green, purple, deep sky blue, orange, Mocca, and light purple clusters prioritized problem-solving and decision-making skills, humans, psychology, clinical competencies, education, curriculum, support systems, creativity, and content analysis through 170, 146, 127, 126, 85, 47, 36, 5, and 1 items, respectively. Regarding the results, the bigger circle led to the high frequency of keywords in the document (Zhang et al., 2022). Figure 6 presents the network visualization display using VOSviewer, emphasizing the most repeated keywords and networks.
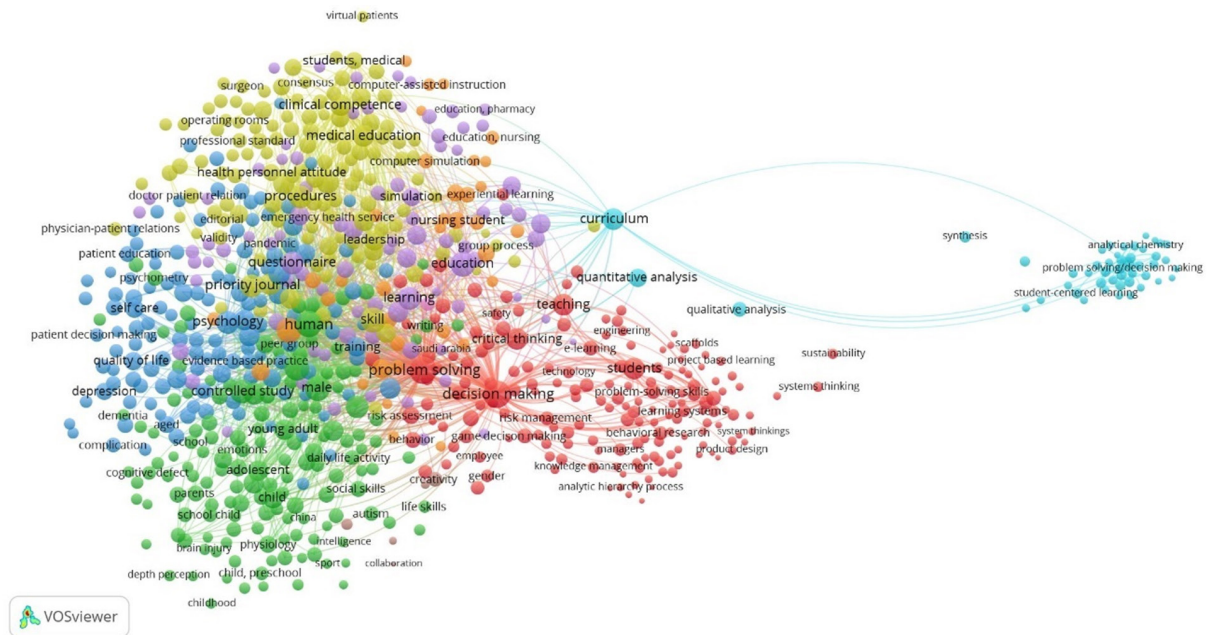
Figure 6. Network visualization of co-occurrences with index keywords.

Overlay Visualization

The overlay visualization was symbolized by the colors showing yearly experimental trends, where purple and yellow prioritized years of study and recent analysis, respectively. These recent trends focused on the following terms, namely collaborative learning, gender, e-learning, employee, academic system, social media, formative assessment, project-based education, human experiment, creativity, quality of life, child, educational technology, grounded theory, career, theoretical study, software, games, primary care, anxiety, and machine knowledge. The overlay visualization of co-occurrence is shown in Figure 7.
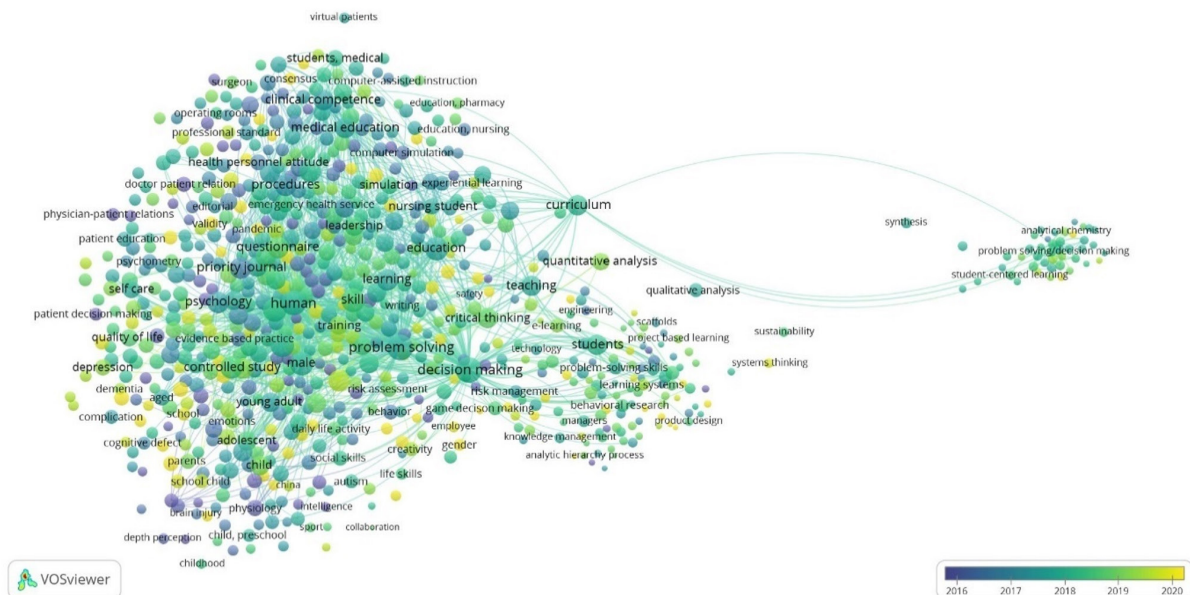
Figure 7. Overlay of visualization of co-occurrences with index keywords.

Density Visualization

Density visualization was responsible for the saturation of a topic, where the blue, yellow, and red colors were emphasized yet to be analyzed, rarely studied, and highly evaluated, respectively. This indicated that brighter image colors caused the frequent use of the analyzed term in a relevant experiment. The distribution of keyword density also illustrated the frequency level of study topics (Huang et al.,

2020). For example, problem-solving, human, and decision-making were often analytically implemented, while the rarely analyzed relevant terms focused on problem-based learning, collaboration, sustainability, metacognitive skills, qualitative and quantitative analyses, creativity, life competencies, computational thinking, game-based education, human-computer interaction, childhood, virtual patients, expertise, as well as analytic and hierarchy processes. Figure 8 presents the density visualization of decision-making and problem-solving skills based on keyword index.
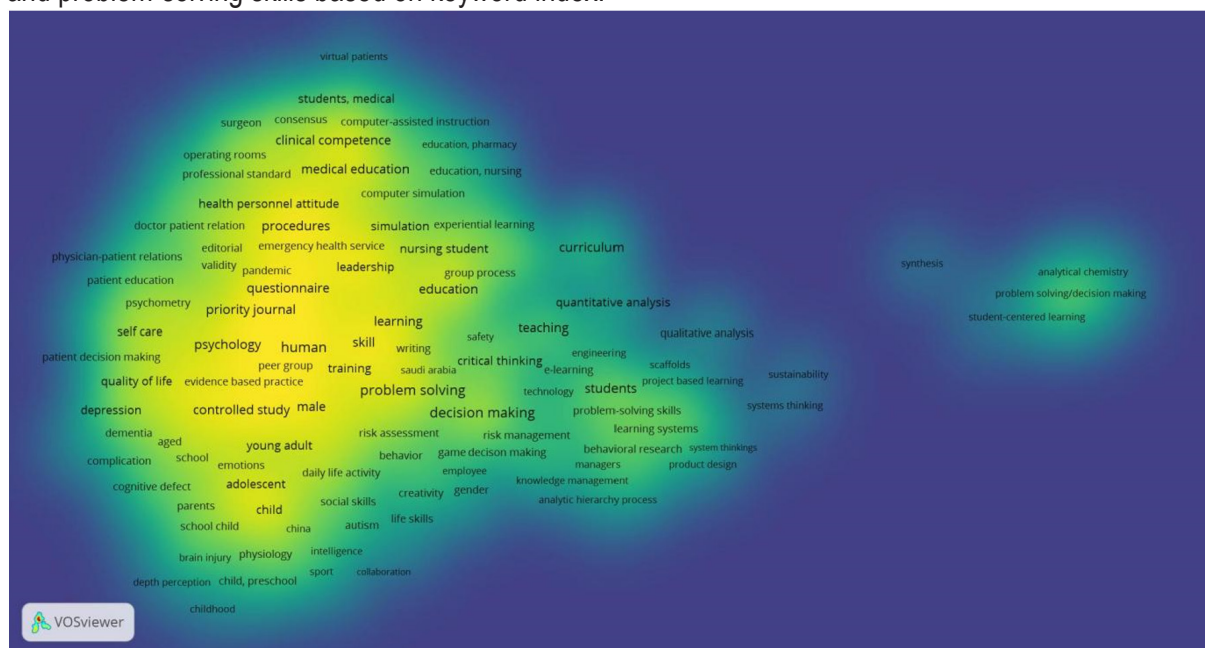
Figure 8. Density visualization of topic decision-making and problem-solving based on keywords index.

Discussions

According to Figure 2, a fluctuating growth for the keywords "problem-solving" and "decision-making skills", was observed regarding the publication trend from 2013 to 2022, with the entire productivity remaining relatively positive. This indicated significant document elevations from 2017-2019 and 2020-2022, underscoring the continuous development of the study topic and providing potential for subsequent exploration of novel aspects. Furthermore, Table 1 showed that the Journal of Chemical Education was the leading source, publishing 147 articles on "problem-solving" and "decision-making skills". These articles extensively explored the interplay between both skills in handson and mindson laboratory activities. For instance, laboratory experiment activities in organic chemistry were commonly problem-based, regarding the following performances: (1) developing students information literacy skills (Shultz and Li, 2016); (2) guiding inquiry lab practices in the quantitative determination of aluminum within deodorant brands (Sedwick et al., 2018); and (3) integrating environmentally friendly chemistry into the curriculum (Aubrecht et al., 2019). Problem-solving was also essential for training students in systemic thinking, decision-making, and sustainability.

Based on Figure 3, the publications integrating problem-solving and decision-making skills within the "Social Sciences" discipline totaled 689 documents. This indicated that "Social Sciences" focused on the widest range of disciplines. It also exhibited the significance of the subject matter prioritizing the study, problem-solving, and decision-making skills, which explored the relationship between humans and their social interactions. Furthermore, "medicine" generated 364 publications and was closely related to problem-solving and decision-making skills, which were integral to effective medical practice. This proved that both skills complemented each other and helped doctors in providing high-quality patient care. Medical analysis is also presently integrated with artificial intelligence for problem-solving and decision-making (Secinaro et al., 2021). From the results, "Engineering" subsequently produced 246 publications, which were closely related to both problem-solving and decision-making skills. In this case, an engineer was commonly confronted with the complex tasks requiring technical problem solutions, and rational decision-making processes (Kipper et al., 2021). The 'Computer Science' discipline was also observed, with 237

publications emphasizing problem-solving and decision-making skills. These skills were considered an important foundation for developing innovative and effective technical solutions.

In line with the aforementioned descriptions, "psychology" was another discipline that yielded 162 publications, with decision-making and problem-solving skills being relevant integral components (Bar-On, 2010). These skills assisted psychology professionals in handling complex tasks and aiding individuals regarding the achievement of mental and emotional well-being. Moreover, the "Chemistry" field produced 153 documents, with the subject area highly significant as the decision-making and problem-solving skills helping scientists and relevant professionals overcome intricate knowledge and management challenges (Chen et al., 2021). "Business, Management and Accounting" also generated 94 publications, which were pertinent to problem-solving and decision-making skills. These skills emphasized individuals navigating complex business challenges, devising effective strategies, and efficiently managing resources to achieve organizational goals (Proctor, 2010). Another field, "Health Professions", also produced 79 documents, with the significant subject matter focusing on professional-patients relationships, diagnosing diseases, and designing treatment plans, and managing emergency situations. From the results, "Nursing" subsequently produced 78 publications, with the subject matter emphasizing the significance of problem-solving and decision-making skills. This was because the skills prioritized nurse-patient interaction, problem-solving, completing complex tasks, and nursing decisionmaking skills (Ahmady and Shahbazi, 2020). In addition, "Arts and Humanities" provided 74 publications, whose significant subject matter played an essential role in understanding and interpreting relevant works and analyzing cultural contexts.

According to Figure 4, the United States, among 102 countries, was ranked first in document productivity with 512 published articles. This proved that geographic-based information retrieval helped to determine the highest publication distribution in a country (Emmer, 2018; Zupic and Čater, 2015). Figure 5 also showed that the University of Toronto, as a top university affiliate, was ranked first with 17 documents. This was accompanied by the contributions of the Universities of Education and Malang, which represented the Indonesian institutions possessing 11, and 10 documents respectively. Moreover, the contribution of Indonesian experts in the integration of problem-solving and decision-making skills remained low according to the Scopus database. The results also indicated the top 10 contributions from 39 college affiliations within the country, regarding the publication of problem-solving and decision-making skills analyses. From 2013-2022, these publications remained low when perceived as document productivity. Therefore, learning should focus on fostering integrative problem-solving and decision-making skills for implementing education for sustainable development. This was because the skills were crucial in the Industry 4.0 era due to being extensively adopted by workers and managers (Torres, Pimentel and Matias, 2023). Learning including real-world problems also stimulated active student engagement in applying their individual and cognitive knowledge in collaborative problem-solving (Erol et al., 2016).

Based on Table 3, Shogren, K.A. from the University of Kansas, Lawrence, United States, was the most productive author with a total of 7 documents. The author also had the highest number of document citations, totaling 107. Moreover, Yousefi, M., Hooshyar, D., Ahmad, R. B., and Horng, S. J. explored intelligent guidance by using flowcharts to enhance problem-solving and decision-making (Hooshyar et al., 2015). The authors also designed formative assessment with online games in an intelligent tutoring system, to enhance problem-solving and decision-making skills (Hooshyar et al., 2016). In line with the results, York, S. from the University of Nevada, Las Vegas, United States, published 4 documents emphasizing Chemistry Education, with the highest citation of 231. These publications emphasized the systematic thinking approaches in Chemistry Education, to strengthen the conceptual understanding, problem-solving, and decision-making skills related to global sustainability-based issues (Flynn et al., 2019; York and Orgill, 2020). The documents also prioritized the systematic thinking approaches in STEM Education (York et al., 2019) and learning processes applicable to future chemistry educators, experts, and global citizens (Orgill, York and Mackellar, 2019). According to Table 4, the top ten authors from Indonesia were Suhandi, A., Samsudin, A., Syaodih, E., Suwono, H., Kaniawati, I., Hakim, A., Zarlis, M., Zarkasi, A. C., and Yuliardi, R. This confirmed that Suhandi, A. from the Indonesia University of Education was ranked first with 5 published documents, emphasizing physics learning through the implementation of systematic thinking, to enhance problem-solving and decision-making skills. Hakim, A. from the University of Mataram also published 2 documents in the Journal of Chemical Education, with a total of 35 citations. This explained that the chemistry education prioritizing students project laboratories enhanced understanding, problem-solving, and decision-making skills (Hakim, Kadarohman and Syah, 2016, 2020).

In line with the aforementioned descriptions, the citations of a document demonstrated its visibility and importance as a reference in the academic world. This was because the documents with more citations were considered more significant within a specific topic (Zupic and Čater, 2015). The number of references obtained by an article also represented recognition, influence, and popularity within the

scholarly community. Based on Table 5, the authors focused on problem-solving and decision-making skills were exhibited. This indicated that Liu, Chan and Ran (2016) had the highest number of citations at 240, exhibiting the following title:"Decision-making for the selection of cloud vendor: An improved approach under group decision-making with integrated weights and objective/subjective attributes". The second-ranking publication, authored by Lieder and Griffiths in 2019, also had 220 citations with the following title, "Resourcerational analysis: Understanding human cognition as the optimal use of limited computational resources".

According to Figure 6, a keyword network with a minimum occurrence of five terminologies linked to problem-solving and decision-making skills was illustrated. This indicated that the overlay and density visualization analyses were used to identify experimental themes, with future reports emphasizing the VOSviewer outcomes. Several terminologies such as problem-solving, decision-making, and human, were also frequently analyzed. Therefore, the abundance of publications on problem-solving and decision-making skills across diverse countries and disciplines prioritized the topic's significance. This emphasized the importance of curricula designation in fostering both skills across various fields. In this case, future studies should employ collaborative approaches, gamification, computational thinking, problem-based learning, e-learning, creativity, and qualitative designs.

Conclusions

In conclusion, this study examined the bibliometric analysis of problem-solving and decision-making skills for ESD (Education for Sustainable Development) to provide insights for future analyses. This showed that the implementation of both skills was necessary across various educational levels and professions. The academic interest in problem-solving and decision-making skills also exhibited fluctuation over the previous decade. Based on the results, the Journal of Chemical Education contributed the highest number of documents, with social sciences being the most prominent subject area. The United States was also the leading contributor of articles, with the University of Toronto being the most productive institution. Moreover, the Universities of Education and Malang (state) were the top-contributing affiliations from Indonesia. Shogren, K.A., from the University of Kansas, Lawrence, United States, was also considered the most productive author with seven documents. In line with the results, Liu, Chan and Ran (2016)was the frequently referenced document published in the journal titled "Expert Systems with Applications". According to the recommendations, numerous potential experimental themes were outlined for future consideration, specifically within the field of education. These themes underscored curriculum design, teaching models, methodologies, assessments, and learning resources, focusing on all levels from primary to higher education. The implications of this research can help related researchers find out trends in problem-solving and decision-making skills for ESD in the educational sector in general. Education for sustainable development should pay special attention to problem-solving and decision-making skills to prepare individuals to face future challenges.

Acknowledgements

Conflict of interests
The authors declare no conflict of interest.

Author Contributions

Conceptualization, M.U., P.M., W. and B.S.; Resources, M.U., P.M., W. and B.S; Methodology, M.U., W. and B.S.; Software, M.U., P.M., W. and B.S.; Formal Analysis, M.U., W. and B.S.; Writing – original draft, M.U, P.M., W. and B.S.; Writing – review & editing, M.U., P.W., W. and B.S. All authors have read and agreed to the published version of the manuscript.

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Factors Influencing Students' Dropout Intentions in Ho Chi Minh City, Vietnam

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Abstract: The increasing number of students intending to drop out of universities in Vietnam has raised concerns. While previous studies have addressed factors influencing dropout intentions, several aspects still need to be explored, particularly in developing countries like Vietnam. This research provides an overview of the factors influencing students' dropout intention in Ho Chi Minh City. The study employs the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach with a survey sample of 804 students from universities in Ho Chi Minh City. The research findings reveal that factors such as Lack of university commitment (LUC), degree and course commitment (DCC), ineffective time management (ITM), curriculum design (CD), Ineffective adaptation to learning environment (IALE), low classroom participation (LCP) and personal circumstances (PC) significantly influence students' dropout intentions. Additionally, factors including skills and attitudes of instructors (SAI), instructor support (IS), positive instructor feedback (PIF), university facilities (UF), cultural and social environment (CSE), and access to support from academic advisors (ASA) do not show statistically significant relationships with students' dropout intention. Furthermore, the study finds no significant differences in dropout intention based on gender, area, and type of university, except for ASA has a differential impact on students' dropout intentions based on the type of university. The research results provide valuable insights for researchers and educational experts to understand better the factors contributing to students' dropout intentions. Moreover, the findings assist educational managers and instructors in developing appropriate support measures and interventions to enhance student engagement throughout their academic journey. Finally, the study discusses limitations and suggests future research directions.
Keywords: Dropout intentions, higher education, Ho Chi Minh City.

Introduction

Education is one of the foremost concerns for countries worldwide. The sustainable development of a nation relies not only on its economic, social, and cultural conditions but also on improving its education system. Especially with the advent of the Fourth Industrial Revolution, the role of education is increasingly emphasized in developing a high-quality workforce. There has been an increase in the number of students enrolling in higher education institutions annually in foreign countries. However, the number of students who want to leave university without obtaining a degree has also significantly increased (Schnettler et al., 2020). Approximately 15% of university students intend to drop out, which has become a severe issue (Sheldon and Epstein, 2004). According to the STEM (Science, Technology, Engineering, Mathematics) education approach, the estimated dropout rate of students is around 40-50%. The dropout status of students not only negatively affects the students themselves and the university and society as a whole (Schnettler et al., 2020).

In Vietnam, universities have also observed numerous cases of student dropouts. For example, Industrial University of Ho Chi Minh City has issued warnings to 2,252 students who voluntarily dropped out. University of Transport and Communication has warned 2,135 students regarding their academic performance, with 257 students facing expulsion. The Ho Chi Minh City University of Technology and Education has removed the names of over 450 students forced to discontinue their studies. The Ho Chi

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Minh City University of Industry and Trade has over 2,500 students with long-standing tuition fee debts, putting them at risk of being banned from taking final exams. The University of Sciences - Vietnam National University Ho Chi Minh City has decided to expel 454 students and issue academic warnings to another 605 individuals. Statistical data demonstrates an increasing trend of student dropouts in Vietnamese universities, highlighting the urgent need for measures to mitigate this issue.

Several studies have focused on the factors influencing students' intention to drop out before completing their university education. Orion, Forosuelo, and Cavalida (2014) found that factors influencing students' dropout intentions include school policies and practices, financial resources, academic performance, and teaching programs. Willcoxson (2010) concluded that the factors influencing dropout intentions differ among students in the first, second, and third years of university. Farr-Wharton et al. (2018) demonstrated the impact of lecturer-student exchange (student-LMX) on engagement, course satisfaction, achievement, and intention to leave university among 363 students in an Australian university. Schnettler et al. (2020) indicated that costs, age, and difficulties in the learning process tend to make students more likely to drop out. Lundquist, Spalding, and Landru (2002) concluded that females are more prone to dropping out than males, and factors such as lack of faculty support, unresponsive faculty to phone/email inquiries, and complicated faculty-student interactions increase students' inclination to leave the university. Bakker et al. (2021) found that supervisor and co-worker support are negatively related to the intention to leave among nursing students. During the Covid-19 pandemic, several studies have explored the factors influencing students' dropout intentions. Chi, Randall, and Hill (2021) showed that the COVID-19 pandemic affects students' mental health and dropout intentions, with those experiencing anxiety or depression symptoms and burnout being more likely to consider dropping out compared to those without mental health issues. Mtshweni (2021) investigated the factors influencing the intention to drop 955 students from a university in South Africa, including social adjustment, personal-emotional adjustment, institutional attachment, and socioeconomic status. Baalmann et al. (2022) demonstrated that parental educational aspirations, students living in partnerships, and close friends have an impact on students' dropout intentions among a sample of 7,169 students in a German university. Matteau et al. (2023) revealed that excessive commitments and conflicts between work, study, and personal life are associated with higher levels of psychological stress and the intention to leave university.

The literature review shows that research on students' dropout intentions has received significant attention from scholars worldwide. The factors influencing students' dropout intentions are diverse and depend on each country's timeframe and organizational cultural characteristics. Some factors influencing dropout intentions mentioned by Willcoxson (2010) are general, comprehensive, specific, and relevant to the Vietnamese context. However, Willcoxson (2010) examined the differences in factors affecting dropout intentions across semesters and among first-, second-, and third-year students but needed to determine the impact level of each factor on students' dropout intentions. Moreover, the factors mentioned, such as commitment to the institution, degree/course commitment, time management, teaching skills and attitudes of instructors, accessibility and support from instructors, course design, feedback, ineffective adaptation to the learning environment, class participation, infrastructure, socio-cultural environment, accessibility and support from counseling, and personal circumstances that align with the context and culture of first, second, and third-year students in Vietnamese universities.

This research aims to provide an overview of the factors influencing students' dropout intentions in universities within Ho Chi Minh City. While many studies have identified a range of factors that may contribute to students' dropout intentions, there still needs to be clear validation regarding the level of impact of each factor. Therefore, the contribution of this study is to clarify the degree of influence of these factors on students' dropout intentions in universities within Ho Chi Minh City, where extensive validation studies still need to be completed. This research utilizes a non-probability and convenient sampling method to collect data from the survey participants easily. The study's geographical scope is limited to the inner city and suburban areas of Ho Chi Minh City. The research has two main objectives: 1) identifying the factors influencing students' dropout intentions within the Ho Chi Minh City area, and 2) proposing managerial implications to improve these factors to reduce students' dropout intentions within the Ho Chi Minh City area.

Definition of dropout intentions

According to, Pijl, Frostad, and Mjaavatn (2014), early dropout refers to needing to complete an educational program or complete it with significant delays. Additionally, Schwab (2018) suggests that when individuals intend to leave school, they quickly focus on the desire to discontinue their education. Therefore, dropout is considered the final step in intending to leave school before early dropout occurs. According to, Gury (2011), dropout occurs when students discontinue their studies without intending to

continue in the initially registered field of study or the institution they attend. Fitzpatrick and Yoels (1992), define dropout as students who leave an educational institution without completing their program within the next four years, regardless of whether they return to school later and graduate. Furthermore, dropout can refer to individuals participating in a school course who do not wish to complete the high school program within five years (Pijl, Frostad, and Mjaavatn (2014)).

Based on the definitions provided above, the dropout intentions can be defined as not completing an educational program or completing it with significant delays, not continuing in the initially registered field of study or institution, leaving school without graduating within a specific timeframe, or not wanting to complete the academic program within a certain period.

Research hypothesis development

Students have various reasons for choosing to attend a university, including personal purposes such as academic pursuit, proximity to their residence, reputation, quality of education, and the quality of facilities at the institution. Based on their criteria, students can evaluate suitable universities and select a school that meets their conditions. The choice of university has a specific impact on students' subsequent intention to drop out, especially in cases where students do not gain admission to their desired university and must attend an alternative institution. Willcoxson (2010) also indicates that students are more likely to leave university when they lack organizational commitment and receive insufficient guidance regarding enrollment choices. This situation commonly occurs among first-year students. From the research findings, Willcoxson (2010) determines that when students fail to gain admission to their desired university, the likelihood of them forming an intention to drop out increases significantly. Furthermore, during their studies at the alternative university, students still hope to gain admission to their initial desired university and attend the substitute university as a stepping stone to transfer to another university, thereby increasing their intention to drop out (Willcoxson, 2010). Bean (1980) analyzed a model contributing to student dropout and found a correlation between student commitment and the intention to drop out. This study demonstrates that students need more commitment to the institution to increase their intention to drop out and continue their educational journey.

H1: The lack of university commitment positively impacts student's dropout intentions in Ho Chi Minh City.

MacKie (2001) demonstrates that students who engage in courses over multiple years face similar difficulties as those who have dropped out before completing their studies. However, the remaining people exhibit more substantial commitment and attachment to the institution. Students who stay in school are more likely to overcome challenges than those who have dropped out (Nieudwoudt and Pedler, 2021). Students with explicit purposes for pursuing a specific field of study are more likely to intend to enroll in that particular academic program at the university. Yorke and Longden (2008) indicate that strong academic commitment is associated with stability and persistence in students' studies, while weak commitment may lead to an intention to drop out. Tinto (2012) also suggests that solid academic commitment positively impacts students' continued engagement in learning activities and reduces the likelihood of dropping out. Therefore, universities with a clear commitment to degree programs and the career-related benefits they offer, aligning with students' prospects, enhance students' commitment and attachment to the university.

H2: Degree and course commitment negatively impact student's dropout intentions in Ho Chi Minh City

Swick (1987) argues that many students perceive the academic process as highly stressful. Time management is a university counseling service (Macan and Shahani, 1990). Students also need help to allocate their time effectively and balance it with work and personal life (Burke et al., 2017). Time is a significant factor influencing students' daily lives. When time management skills are weak, such as inadequate time allocation or last-minute cramming for exams, it is discussed as a cause of stress and a decline in academic performance (Longman and Atkinson, 1988). The issues mentioned above occurring consistently over an extended period can discourage students, resulting in a gradual formation of the intention to drop out (Nieudwoudt and Pedler, 2021). Students struggling to balance their personal time and study time at the university and those struggling with effective time management are more likely to have an increased intention to drop out (Willcoxson, 2010).

H3: Ineffective time management positively impacts as students' dropout intentions in Ho Chi Minh City.

Willcoxson (2010) found that reducing students' intention to drop out is related to building trust, fostering learning expectations, improving teaching quality, providing support, and creating a vibrant learning environment and social activities. Additionally, the emerging tendency of students to consider dropping out is also linked to the teaching skills and attitudes of the faculty. Students perceive enthusiastic support from instructors, a sense of closeness, provision of comprehensive learning materials, and timely and positive feedback as factors that reduce their intention to drop out (Willcoxson, 2010). Social support, learning experiences, and an engaging learning environment, along with institutional support, are factors that influence students' decision to remain in school (Nieudwoudt and Pedler, 2021). Poor interaction or communication with instructors and mentors can lead to students' intention to drop out (Nieudwoudt and Pedler, 2021).

H4: Skills and attitudes of instructors negatively impact student's dropout intentions in Ho Chi Minh City.

Glogowska, Young, and Lockyer (2007) demonstrate that students' determination, career commitment, social support, and student services provided by the university contribute to student retention. Natoli, Jackling, and Siddique (2015) conclude that student support services offered by the university are an essential factor in influencing students' intention to stay in school. The institution's provision of facilities, faculty, programs of study, student support services, and engagement in academic activities all contribute to student retention (Kuh et al., 2007). Instructor members who are willing to address students' concerns and understand their difficulties in learning create enthusiasm for studying and reduce students' thoughts of dropping out.

H5: Instructor support negatively impacts student's dropout intentions in Ho Chi Minh City.

Willcoxson (2010) argues that carefully designed and logically structured courses with reliable information yield high educational effectiveness. Instructors who incorporate real-life examples in their lectures help students quickly understand and apply the subject to practical work situations (Willcoxson, 2010). Furthermore, university support for students to engage in experiential learning and work opportunities in companies enhances their knowledge and skills, reducing their intention to drop out. A flexible curriculum can make students feel more comfortable dropping out. Rovai and Jordan (2004) have demonstrated that program flexibility can increase students' commitment and intention to continue their studies. Bransford (2000) emphasizes the importance of applying knowledge to real-life situations, connecting knowledge with reality, and applying it in daily life to help students recognize the value of learning and enhance their commitment to education.

H6: The curriculum design negatively impacts students' intention to drop out in Ho Chi Minh City.

Case (2007) demonstrates that feedback is crucial in promoting student improvement by addressing errors, lessons' shortcomings, and areas needing improvement. Faculty support has a positive impact on academic performance and student engagement. If instructors fail to meet students' expectations or requirements, harmful or ineffective feedback can lead to disappointment and strengthen the intention to drop out (Hausmann, Schofield and Woods, 2007).

H7: Positive instructor feedback negatively impacts students' dropout intentions in Ho Chi Minh City.

When participating in courses at school, students may encounter difficulties in comprehending knowledge, struggle to adapt and keep up with the teaching methods of instructors, find it challenging to understand specialized materials and feel overwhelmed by the workload. These factors can lead to student frustration, a lack of self-belief in their ability to perform well in the courses, decreased motivation to study, and an increased intention to drop out (Willcoxson, 2010). Eccles and Wigfield (2002) suggest that students' positive adaptation to the learning environment often leads to a more substantial commitment to the learning process and a higher likelihood of sustaining their studies and completing the courses. Effective adaptation can help students reduce stress and pressure in the learning process, which can

contribute to the intention to drop out (Eisenberg et al., 2007). Kember, Biggs and Leung (2004) have demonstrated the relationship between adaptation to the learning environment and students' academic performance, showing that well-adapted students tend to have higher grades, more stable academic performance, and maintain their intention to study throughout the program.

H8: Ineffective adaptation to the learning environment positively impacts students' dropout intentions in Ho Chi Minh City.

According to empirical research surveys, many students who drop out initially show commitment but fail to follow through (MacKie, 2001). Regular class truancy and non-participation positively correlate to dropout (Willcoxson, 2010). Classroom engagement often provides valuable learning opportunities. When students participate or participate minimally, they may take advantage of opportunities to understand and acquire the necessary knowledge to achieve better results in assessments (Pascarella and Terenzini, 1991). Kuh et al. (2008) have shown that classroom engagement is often correlated with academic performance, with lower levels of engagement resulting in poorer academic outcomes and higher intentions to drop out. Classroom engagement reflects the commitment to the learning process. Students who participate less in class may need more commitment and determination to complete the course (Feldman, 1994).

H9: Low classroom participation positively impacts students' dropout intentions in Ho Chi Minh City.

Good facilities create a conducive and comfortable learning environment that caters to the needs of students and minimizes the likelihood of students intending to drop out. Good facilities influence student satisfaction, impact student confidence (Omar et al., 2009), and shape future planning intentions (Clemes, Gan and Kao, 2008). Reynolds (2007) analyzed the correlation between facilities and student recruitment and retention. Classrooms that provide a high-quality learning environment, spacious and well-ventilated libraries with diverse resources to support learning, and an information technology system that meets students' usage needs have a reverse correlation with students' intention to drop out (Willcoxson, 2010).

H10: The university facilities negatively impact students' dropout intentions in Ho Chi Minh City.

The cultural and social environment significantly influences students' dropping out. Students may feel helpless, isolated, and unwilling to continue their education when this environment is not friendly. Conversely, when positive relationships characterize the environment, students will receive support and encouragement to continue their studies. Research has shown that the cultural and social environment impacts student satisfaction (Kahu, 2013). According to Willcoxson (2010), minimizing student dropout requires providing facilities that meet social needs and are compatible with students' religious/cultural requirements.

H11: The cultural and social environment negatively impacts students' intention to drop out in Ho Chi Minh City.

Access to information and support from academic advisors increases student retention (Crosling, Thomas and Heagney, 2009). Student retention depends not only on individual factors such as motivation and academic achievement but also on external factors such as access to support and resources (Cabrera et al., 2006). Access to information, guidance, and counseling from academic advisors and classmates, as well as academic and social support services, can be crucial in the decision to continue or withdraw from university (Tinto and Pusser, 2006). Students with access to high-quality support services are more likely to be motivated and have higher retention rates (Tinto and Pusser, 2006). Students receiving good advice from advisors regarding career choices or quickly receiving assistance when needed have a reverse correlation with their intention to drop out (Willcoxson, 2010).

H12: Access to support from academic advisors negatively impact students' dropout intentions in Ho Chi Minh City.

Students who face financial difficulties often spend more time working than studying (Peltz et al., 2021). Financial difficulties negatively impact students' commitment to their studies (Willcoxson, 2010). Studies have found that students with high intentions to drop out often face financial hardships and work

an average of more than 16 hours per week (Leveson, McNeil and Joiner, 2013). Bean (1980) examined the impact of personal circumstances on students' decision to drop out. The results showed that the impact of difficult personal circumstances can lead to an intention to drop out. Pascarella and Terenzini (1991) demonstrated that the university environment and students' circumstances influence the decision to continue their education. The results also indicated that personal circumstances can be essential to the dropout decision process. Students' concerns about mental health, physical health, homesickness, or accumulating debt positively correlate with their intention to drop out (Willcoxson, 2010).

H13: Personal circumstances positively impact students' dropout intentions in Ho Chi Minh City.
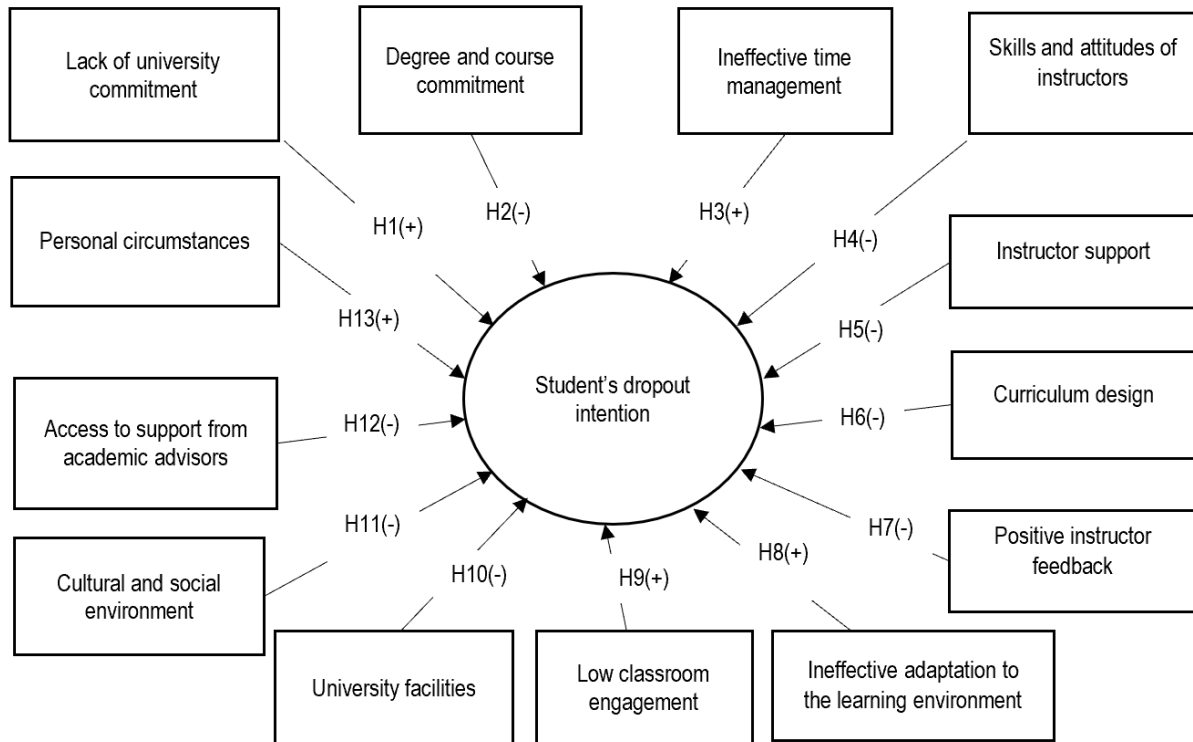
Figure 1. Proposed research model

Materials and Methods

Process research: A mixed-methods research approach combining qualitative and quantitative research methods was used in this study.

Preliminary qualitative and quantitative research: A group interview method was employed with 15 students in the qualitative phase of the study. The research topic involved collecting opinions from first-, second-, and third-year students at public and private universities in suburban and urban areas of Ho Chi Minh City. The group discussion aimed to identify factors influencing the intention to drop out and refine the measurement scales of the research concepts to align with the research context. The results of the interviews were synthesized and adjusted to form a draft measurement scale to support the preliminary quantitative research and the formal quantitative research. Subsequently, a survey was conducted with 80 students to evaluate the reliability using Cronbach's Alpha coefficient and perform Exploratory Factor Analysis (EFA) to examine the convergent and discriminant validity of the measurement scale.

Formal quantitative research: The study utilized the Bootstrapping technique with a sample size of N = 5000 to test the hypotheses. This step was employed to evaluate the measurement model and the structural model:

The measurement model was assessed by examining measurement scale reliability, composite reliability, convergent validity, and discriminant validity. To ensure the reliability of the measurement scales, Cronbach's alpha coefficient and Composite Reliability (CR) should exceed 0.6 (Hair Jr et al., 2009). The Average Variance Extracted (AVE) of each construct in the model should be greater than 0.5, based on the criteria proposed by Shiau, Sarstedt and Hair (2019). The study followed the criteria of Fornell and

Larcker (1981) to test the discriminant validity of the measurement scales, where the square root of the AVE of each construct should be greater than the correlation coefficient between that construct and the other constructs in the model.

The structural model was evaluated based on criteria such as the coefficient of determination (R2), predictive relevance (Q2), and effect size (f^2). The coefficient of determination (R2) values of the model were interpreted as follows: weak (R2 = 0.02), moderate (R2 = 0.16), and robust (R2 = 0.26) explanations of the model variance (Cohen, 2013). The Stone-Geisser Q² criterion was used for predictive relevance assessment, following the evaluation standards proposed by Henseler, Ringle, and Sinkovics (2009): weak prediction (Q2 < 0,02); moderate prediction (Q2 within [0,02; 0,35]), and strong prediction (Q2 > 0,35). Lastly, the effect size (f^2) between corresponding components was examined, with weak effect (f^2 = 0.02), moderate effect (f^2 = 0.15), and substantial effect (f^2 = 0.35) based on the criteria of Henseler, Ringle and Sinkovics (2009).

Scale measurement: The research model consists of 13 research constructs. The dependent variable is Dropout Intentions, which was adopted by Farr-Wharton et al. (2018). The independent variables include Lack of university commitment, Degree and course commitment, Ineffective time management, teaching skills and attitudes of instructors, Instructor support, Curriculum design, Positive instructor feedback, Ineffective adaptation to the Learning Environment, Low Classroom Engagement, University facilities, Cultural and social environment, Access to support from academic advisors, and Personal Circumstances. These independent variables were inherited and adjusted from the study by Willcoxson (2010). These independent variables were inherited and adjusted from the study by Willcoxson (2010). There are a total of 74 observed variables, and they were measured using a 5-point Likert scale: (1) Strongly Disagree, (2) Disagree, (3) Neutral, (4) Agree, and (5) Strongly Agree (see Table 1).

Table 1
Scale measurement

Constructs	Symbol	No. observations	Scale sources
Student's dropout intentions	SDI	4	Farr-Wharton et al. (2018)
Lack of university commitment	LUC	5	Willcoxson (2010)
Degree and course commitment	DCC	3	
Ineffective time management	ITM	4	
Skills and attitudes of instructors	SAI	7	
Instructor support	IS	5	
Curriculum design	CD	3	
Positive instructor feedback	PIF	2	
Ineffective adaptation to learning environment	IALE	7	
Low classroom participation	LCP	10	
University facilities	UF	5	
Cultural and social environment	CSE	7	
Access to support from academic advisors	ASA	7	
Personal circumstances	PC	5	

(Source: own author)

Formal sample

Survey Sample Criteria: First- year, second- year, and third- year university students studying at expected public and private universities located within the inner city and suburban areas of Ho Chi Minh City. This study did not survey fourth-year students as they rarely intend to drop out.

Sampling Method: The study employed a non-probability convenience sampling method. The

survey questionnaire was distributed directly and online through Google Forms at various universities in Ho Chi Minh City. The survey was conducted from February 13, 2023, to March 16, 2023.

Data Analysis Method: The study utilized Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the data. This method was chosen due to its advantage in handling small sample sizes and data that do not follow normal distribution assumptions (Shiau, Sarstedt and Hai, 2019).

Formal Sample: The survey results yielded 804 valid responses. Therefore, the study used 804 observations as the formal sample for this research.

Results

Sample characteristics

Gender breakdown with the number of female students being 392 (48.8%) and the number of male students being 412 (51.2%). Next is the breakdown of students by academic year, with 239 (29.7%) first-year students, 261 (32.5%) second-year students, 304 (37.8%) third-year students, and no fourth-year students. Following that is the breakdown of students by major, with the corresponding number of students in each major. The majors listed are Engineering with 163 students (20.3%), Economics - International Trade with 133 students (16.5%), Business - Management with 158 students (19.7%), Foreign Languages with 63 students (7.8%), Information Technology (IT) with 64 students (8.0%), Social Sciences and Humanities with 25 students (3.1%), and other majors with 198 students (24.6%). Next is the geographical breakdown, with the number of suburban students being 284 (35.3%) and the number of downtown students being 520 (64.7%).

The university group includes various universities, with the corresponding number of students in each university. The listed universities are Open University of Ho Chi Minh City with 70 students (8.7%), Ho Chi Minh City University of Transport with 60 students (7.5%), Industrial University of Ho Chi Minh City with 184 students (22.9%), Ho Chi Minh City University of Technical Education with 71 students (8.8%), Nong Lam University with 80 students (10.0%), Van Lang University with 71 students (8.8%), UEF School of Economics and Finance with 53 students (6.6%), HUTECH University with 62 students (7.7%), Nguyen Tat Thanh University with 79 students (9.8%), and FPT University with 74 students (9.2%). Finally, the group with intentions to drop out is divided into two categories: those with intentions to drop out, totaling 206 (25.6%), and those without intentions to drop out, totaling 598 (74.4%).

Table 2
Participants' Characteristics

Characteristics		Frequency	(%)
Gender	Female	392	48.8%
	Male	412	51.2%
Student	First-year	239	29.7%
	Second- year	261	32.5%
	Third- year	304	37.8%
	Fourth- year	0	0.0%
Field of study	Engineering	163	20.3%
	Economics - International Trade	133	16.5%
	Business - Management	158	19.7%
	Foreign Languages	63	7.8%
	Information Technology (IT)	64	8.0%
	Social Sciences and Humanities	25	3.1%
	Other	198	24.6%
Area	Suburban	284	35.3%
	Urban	520	64.7%
University name	HCMC Open University	70	8.7%
	University of Transport and Communication	60	7.5%
	Industrial University of HCMC	184	22.9%
	HCMC University of Technology and Education	71	8.8%
	Nong Lam University	80	10.0%
	Van Lang University	71	8.8%
	University of Economic and Finance	53	6.6%
	HCMC University of Technology	62	7.7%
	Nguyen Tat Thanh University	79	9.8%
	FPT University	74	9.2%
Have you had intentions to drop out?	No	598	74.4%
	Yes	206	25.6%

(Source: own author)

Scale evaluation: In the PLS-SEM method, the outer loadings criterion is used to evaluate the importance of predictor variables in the model. According to Henseler, Ringle and Sinkovics (2009), factor loadings > 0.5 are considered. Factor loadings below 0.5 will be excluded from the measurement scale in the model.

Table 3
Scale reliability

Constructs	No. observations	Cronbach's alpha	Average variance extracted (AVE)
DCC	3	0.797	0.712
UF	4	0.873	0.722
LCP	10	0.665	0.748
IS	5	0.684	0.7
IALE	7	0.685	0.605
PIF	2	0.85	0.862
LUC	5	0.654	0.591
SAI	7	0.881	0.681
ITM	4	0.83	0.658
CD	3	0.81	0.725
ASA	7	0.919	0.749
PC	5	0.808	0.567
CSE	7	0.88	0.892
SDI	4	0.805	0.631

(Source: own author)

Table 3 presents the reliability testing results, including Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) for the measurement scales in the model. The statistical table shows that the Cronbach's alpha values of the measurement scales are all above 0.7, ensuring reliability for use (Nunnally, 1978). Therefore, the variables will be retained and utilized in the subsequent steps. Hair et al. (2019), state that a Composite Reliability (CR) value greater than 0.7 ensures reliability. Based on the results in Table 3, all measurement scales have CR values above 0.6, except for the LCP, IS, ALE and LUC scales. Lastly, the Average Variance Extracted (AVE) for all measurement scales is more significant than 0.5, ensuring reliability (Hair et al., 2019). Hence, most measurement scales in the research model demonstrate satisfactory reliability.

Table 4
Scale statistical value

Items	Mean	SD	Factor loadings
Student's dropout intentions (SDI)			
SDI1: I often think about dropping out of school.	2.065	1.208	0.75
SDI2: I am actively seeking job opportunities and alternative learning options, so I may leave the university.	2.044	1.123	0.815
SDI3: There is a possibility that I will drop out of university within the next year.	2.061	1.268	0.749
SDI4: I am looking for suitable timing to drop out of school.	1.769	1.092	0.857
Lack of university commitment (LUC)			

LUC1: I am studying at this university as a steppingstone to transfer to another university.	1.924	1.138	0.922
LUC3: I am attending this university because I did not meet the requirements of other preferences.	2.897	1.431	0.577
Degree and course commitment (DCC)			
DCC1: I have obvious reasons for studying at this university.	3.596	1.098	0.867
DCC2: I can enroll in the course/program that I have chosen.	3.799	0.969	0.856
DCC3: I know what profession I want to pursue in the future.	3.506	1.138	0.807
Ineffective time management (ITM)			
ITM1: It is difficult to balance personal time and study time at the university.	3.073	1.119	0.798
ITM2: I struggle with managing study time effectively.	3.163	1.159	0.796
ITM3: It is challenging to balance family responsibilities and university studies.	2.667	1.18	0.848
ITM4: It is challenging to balance work and university studies.	2.846	1.221	0.803
Skills and attitudes of instructors (SAI)			
SAI1: The professors are enthusiastic and dedicated in their teaching.	3.9	0.981	0.906
SAI2: The professors are skilled at explaining things.	3.755	0.977	0.887
SAI3: The professors always strive to make the classes interesting.	3.795	0.986	0.865
SAI4: The faculty team clearly communicates their expectations from the students right from the beginning.	3.841	0.991	0.818
SAI5: The professors always create a sense of closeness with the students.	3.749	1.43	0.62
Instructor support (IS)			
IS4: The faculty team is always available when I need them.	3.68	1.699	0.768
IS5: My professors genuinely make an effort to understand the difficulties students face in their learning process.	3.641	0.974	0.9
Curriculum design (CD)			

CD1: My professors incorporate real-life examples into their teaching curriculum.	3.851	0.92	0.856
CD2: What I am learning at the university has been researched and proven.	3.745	0.919	0.889
CD3: I am satisfied with the job experiential opportunities introduced by the university.	3.582	0.993	0.807
Positive instructor feedback (PIF)			
PIF1: I received helpful feedback on the assessment tasks.	3.519	0.923	0.964
PIF2: I received prompt feedback on the tasks.	3.437	0.954	0.891
Ineffective adaptation to learning environment (IALE)			
IALE2: My study program is too demanding.	3.085	0.969	0.793
IALE4: I find it difficult to understand various study materials.	3.345	0.995	0.693
IALE5: I struggle to adapt to the teaching methods at the university.	2.988	1.064	0.841
Low classroom participation (LCP)			
LCP7: I frequently skip classes.	2.311	1.309	0.882
LCP8: I don't attend classes because the study materials are available on the website.	2.567	1.208	0.847
University facilities (UF)			
UF1: The classrooms provide a high-quality learning environment.	3.624	1.004	0.846
UF2: The library is spacious, well-ventilated, and offers a diverse range of study materials.	3.827	0.97	0.876
UF3: The information technology system meets my usage needs.	3.562	1.035	0.859
UF4: The classrooms are very spacious.	3.586	1.012	0.817
Cultural and social environment (CSE)			
CSE1: The facilities of the university meet my social needs.	3.545	1.023	0.937
CSE2: The facilities of the university are suitable for my religious/cultural needs.	3.585	0.98	0.952
Access to support from academic advisors (ASA)			

ASA1: I receive good advice from the university regarding career choices.	3.397	0.995	0.893
ASA2: I receive good advice from a career counselor in choosing a profession for myself.	3.387	1.045	0.907
ASA3: I receive good advice from the university regarding career choices.	3.429	1.03	0.92
ASA4: I easily receive assistance when needed from the management team.	3.435	0.999	0.842
ASA5: The management team is always ready to assist when I need them.	3.427	1.019	0.754
Personal circumstances (PC)			
PC1: I worry about my mental health.	3.075	1.21	0.82
PC2: I worry about my physical health.	3.039	1.202	0.821
PC3: I often feel homesick.	3.213	1.309	0.584
PC4: I worry about the accumulating debt while studying at university.	2.976	1.393	0.774
PC5: I have financial issues.	3.06	1.351	0.742

(Source: own author)

Table 4 presents the descriptive statistics, standard deviations, and factor loadings of the variables after variable elimination. The results show that all factor loadings are greater than 0.7, except for SAI5 and PC3, but they are retained to ensure content validity. The measurement scales used in the research model exhibit convergence.

Table 5
The discriminant validity testing

	DCC	PC	UF	LCP	IS	IALE	PIF	LUC	SAI	ITM	CD	ASA	CSE	SDI
DCC	**0.844**													
PC	-0.053	**0.753**												
UF	0.348	-0.017	**0.85**											
LCP	-0.101	0.205	-0.036	**0.865**										
IS	0.284	-0.013	0.454	0.001	**0.837**									
IALE	0.017	0.309	0.007	0.23	0.12	**0.778**								
PIF	0.349	0.024	0.519	0.034	0.463	0.147	**0.928**							
LUC	-0.047	0.193	-0.066	0.214	-0.022	0.208	0.025	**0.769**						
SAI	0.396	-0.034	0.508	-0.107	0.615	0.026	0.512	-0.109	**0.825**					
ITM	-0.007	0.3	-0.007	0.21	0.036	0.331	0.08	0.232	-0.01	**0.811**				
CD	0.424	-0.022	0.533	-0.088	0.53	0.081	0.622	-0.027	0.669	0.000	**0.852**			
ASA	0.377	0.051	0.542	0.059	0.472	0.102	0.574	0.023	0.494	0.038	0.55	**0.865**		
CSE	0.352	0.046	0.669	-0.007	0.429	0.038	0.481	-0.016	0.465	0.061	0.491	0.524	**0.945**	
SDI	-0.193	0.262	-0.144	0.284	-0.113	0.27	-0.083	0.389	-0.215	0.326	-0.19	-0.087	-0.09	**0.794**

(Source: own author)

Table 5 presents the discriminant validity test results for the model's latent variables using the criteria set by Fornell and Larcker (1981). The table shows that all square root of the average variance extracted (AVE) values for each research variable are more significant than the correlation coefficients between that variable and the remaining variables in the model. Therefore, the measurement scales for the research variables all demonstrate discriminant validity.

Model evaluation: The estimation results of the model using the Bootstrapping method with a sample size of 5,000 are depicted in Figure 2.
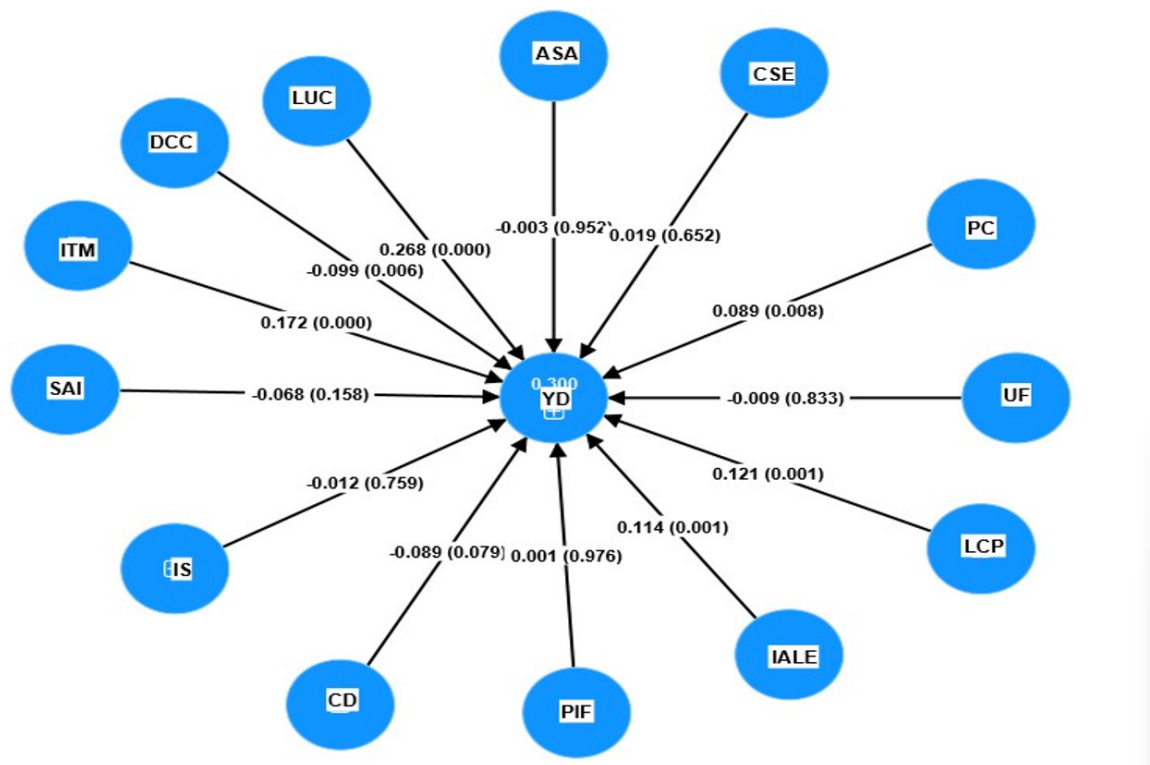

Figure 2. PLS-SEM estimation results

Table 6
Hypothesis test results

Hypotheses	Path relations	Estimation		SD	T	P values	Conclusion
		Beta (β)	Bootstrapping (B)				
H_1	LUC -> SDI	0.268	0.268	0.038	7.043	0.000	Accepted
H_2	DCC -> SDI	-0.099	-0.1	0.036	2.724	0.006	Accepted
H_3	ITM -> SDI	0.172	0.172	0.033	5.146	0.000	Accepted
H_4	SAI -> SDI	-0.068	-0.064	0.048	1.41	0.158	Rejected
H_5	IS -> SDI	-0.012	-0.014	0.038	0.307	0.759	Rejected
H_6	CD -> SDI	-0.089	-0.088	0.051	1.759	0.079	Accepted
H_7	PIF -> SDI	0.001	0.000	0.042	0.03	0.976	Rejected
H_8	IALE -> SDI	0.114	0.116	0.035	3.21	0.001	Accepted
H_9	LCP-> SDI	0.121	0.123	0.035	3.43	0.001	Accepted
H_{10}	UF-> SDI	-0.009	-0.012	0.044	0.211	0.833	Rejected
H_{11}	CSE -> SDI	-0.003	-0.008	0.042	0.06	0.952	Rejected
H_{12}	ASA -> SDI	0.019	0.022	0.041	0.451	0.652	Rejected
H_{13}	PC-> SDI	0.089	0.09	0.033	2.663	0.008	Accepted
R^2	30%						
f^2	$f^2_{BC->SDI} = 0.01$; $f^2_{PC->SDI} = 0.009$; $f^2_{LCP->SDI} = 0.018$; $f^2_{IALE->SDI} = 0.015$; $f^2_{LUC->SDI} = 0.09$; $f^2_{SAI>SDI} = 0.003$; $f^2_{ITM->SDI} = 0.034$; $f^2_{CD->SDI} = 0.005$						
Stone-Geisser's Q^2	0.178						

(Source: own author)

The quality of the proposed model is assessed through the R2 values and the Stone-Geisser index (Q2). Table 6 shows that the R2 value for SDI is 0.30, more significant than 0.26. According to Cohen (2013) evaluation criteria, the model's predictive power is considered strong. The Stone-Geisser value

from Q²SDI is 0.178, falling within the range of (0.02-0.35). Following the evaluation criteria of Henseler and Chin (2010), the model's predictive ability is considered moderate. Additionally, the effect size (f^2) of the factors influencing students' intention to drop out is evaluated as weak. According to, Hair et al. (2019), the influence of factors with f^2 values is all < 0.02.

The results of the hypothesis testing indicate that the lack of university commitment positively impacts students' intention to drop out (H1: B = 0.268; p = 0.000 < 0.01); thus, H1 is accepted. Next, degree and course commitment negatively impact students' intention to drop out (H2: B = -0.1, p = 0.006 < 0.01); thus, H2 is accepted. Similarly, ineffective time management positively impacts students' intention to drop out (H3: B = 0.172, p-value = 0.000 < 0.01). Thus, H3 is accepted.

However, the hypotheses H4 and H5 are not supported in this study (B = -0.064; p-value > 10%; B = -0.014 > 10%). Additionally, the curriculum design negatively impacts students' intention to drop out, so H6 is accepted (B = -0.088, p-value = 0.079 < 10%). Moreover, the positive instructor feedback does not impact students' intention to drop out, so H7 is rejected. Furthermore, ineffective adaptation to the learning environment and low classroom participation all have a positive impact on a student's intention to drop out; thus, H8 and H9 are supported (B = 0.116; p-value = 0.001 < 1%; B = 0.123; p-value = 0.001 < 0.001). Hypotheses H10, H11, and H12 are not supported in this study. Lastly, personal circumstances positively impact a student's intention to drop out; thus, H13 is accepted (B = 0.09; p-value = 0.008 < 1%).

Table 7
Differences in dropout intentions by gender, location, and type of university

Differences between students' dropout intentions by gender						
	Original (Male)	Original (Female)	Original difference	Permutation mean difference	2.50%	97.50%	Permutation P-value
DCC -> SDI	-0.096	-0.129	0.032	0.002	-0.136	0.151	0.666
PC -> SDI	0.116	0.053	0.064	-0.002	-0.14	0.136	0.351
UF -> SDI	-0.03	-0.001	-0.029	0.006	-0.162	0.163	0.739
IS -> SDI	0.095	0.137	-0.043	0.002	-0.146	0.138	0.57
IALE -> SDI	-0.063	0.03	-0.093	0.000	-0.146	0.156	0.226
SAI -> SDI	0.13	0.117	0.013	0.004	-0.136	0.139	0.837
PIF -> SDI	0.044	-0.048	0.093	-0.001	-0.166	0.166	0.27
LUC -> SDI	0.253	0.299	-0.046	0.001	-0.145	0.151	0.549
LCP -> SDI	-0.001	-0.131	0.13	-0.002	-0.181	0.185	0.178
ITM -> SDI	0.184	0.13	0.054	0.000	-0.135	0.126	0.426
CD -> SDI	-0.149	-0.019	-0.13	-0.002	-0.212	0.203	0.215
ASA -> SDI	0.017	-0.037	0.054	0.000	-0.161	0.157	0.482
CSE -> SDI	-0.015	0.092	-0.107	-0.005	-0.167	0.169	0.195

Difference between students' dropout intentions by area						
	Original (Suburban)	Original (Urban)	Original difference	Permutation mean difference	2.50%	97.50%	Permutation p-value
DCC -> SDI	-0.051	-0.136	0.085	-0.002	-0.157	0.148	0.267
PC -> SDI	0.13	0.056	0.074	0.003	-0.133	0.144	0.301
UF -> SDI	0	-0.009	0.009	0.000	-0.179	0.183	0.928
IS -> SDI	0.171	0.109	0.062	0.000	-0.15	0.146	0.399
IALE -> SDI	-0.077	0.016	-0.092	-0.004	-0.162	0.15	0.259
SAI -> SDI	0.149	0.083	0.066	0.002	-0.153	0.151	0.383
PIF -> SDI	0.036	-0.035	0.071	0.000	-0.173	0.187	0.443
LUC -> SDI	0.363	0.235	0.128	0.002	-0.156	0.151	0.118
LCP -> SDI	0.058	-0.131	0.189	0.010	-0.2	0.211	0.073
ITM -> SDI	0.115	0.199	-0.084	-0.002	-0.142	0.129	0.256
CD -> SDI	-0.089	-0.065	-0.024	0.001	-0.204	0.218	0.835
ASA -> SDI	-0.023	0.009	-0.033	-0.005	-0.182	0.186	0.686
CSE -> SDI	-0.051	0.059	-0.11	-0.003	-0.171	0.165	0.205

Difference between students' dropout intentions by type of university						
	Original (Public university)	Original (Private university)	Original difference	Permutation mean difference	2.50%	97.50%	Permutation p-value
DCC -> SDI	-0.068	-0.142	0.073	-0.003	-0.151	0.151	0.359
PC -> SDI	0.105	0.059	0.045	0.000	-0.135	0.133	0.481
UF -> SDI	0.037	-0.061	0.098	0.008	-0.168	0.171	0.269
IS -> SDI	0.103	0.131	-0.028	-0.005	-0.157	0.129	0.692
IALE -> SDI	-0.063	0.039	-0.102	0.003	-0.15	0.150	0.207
SAI -> SDI	0.128	0.127	0.001	-0.003	-0.149	0.139	0.993
PIF -> SDI	-0.016	-0.009	-0.007	-0.002	-0.166	0.159	0.930
LUC -> SDI	0.262	0.29	-0.029	0.000	-0.154	0.159	0.709
LCP -> SDI	-0.088	-0.068	-0.02	-0.001	-0.196	0.189	0.843
ITM -> SDI	0.15	0.196	-0.046	0.003	-0.131	0.128	0.498
CD -> SDI	-0.119	-0.045	-0.075	-0.004	-0.199	0.194	0.474
ASA -> SDI	-0.053	0.126	-0.179	-0.002	-0.166	0.154	0.023
CSE -> SDI	0.019	0.007	0.012	0.000	-0.17	0.173	0.895

(Source: own author)

Table 7 presents the results of a multigroup analysis examining the differences in students' intention to drop out of school based on three variables: gender (Male, Female), location of activity (Urban, Suburban), and type of university (Public, Private). The results of the statistical tests indicate that the p-values are all greater than 0.05, suggesting that there is no significant difference in students' intention to drop out of school based on gender, location of activity, or type of university, except for ASA - SDI, the access to support from academic advisors (ASA) has a differential impact on students' dropout intentions based on the type of university (p = 0.023 < 0.05).

Discussion

The research findings indicate a higher intention to drop out among students who need more commitment to the institution, particularly in Ho Chi Minh City. These findings are consistent with previous studies such as Willcoxson (2010), Bean (1980). Willcoxson (2010) identified that students are likelier to leave university when they lack organizational commitment. Bean (1980) found that students who lack commitment to the institution tend to withdraw from the learning process.

The commitment to credentials and courses inversely impacts students' intention to drop out. Previous studies such as Yorke and Longden (2008), Tinto (2012) have shown that strong commitment to academic qualifications and courses is associated with stability and persistence in students' learning, reducing the likelihood of dropouts.

In addition, ineffective time management positively impacts students' intention to drop out in Ho Chi Minh City. The research findings are consistent with previous studies such as Nieudwoudt and Pedler (2021), Willcoxson (2010). Ineffective time management leads to student discouragement and the formation of dropout intentions (Nieudwoudt and Pedler, 2021). Students who are unable to balance their personal time and study time are more likely to develop intentions to drop out (Willcoxson, 2010).

The design of the course program has an inverse impact on students' intention to drop out. The research findings align with previous studies as well. Rovai and Jordan (2004) demonstrated that flexibility in the curriculum can increase student commitment and reduce dropout intentions. Willcoxson (2010) stated that carefully designed and logical courses can be highly effective in education and contribute to reducing students' intention to drop out.

Low classroom participation by students has a positive impact on their intention to drop out. Some previous studies have also shown that students who frequently skip classes and do not participate in classroom activities have a positive relationship with dropout intentions (Willcoxson, 2010). Kuh et al. (2008) argued that low-engagement students have poorer academic outcomes and higher intentions to drop out. Students with low classroom participation need more determination to complete the course (Feldman, 1994). Lastly, personal circumstances positively impact students' intention to drop out in Ho Chi Minh City, which is consistent with previous research. Personal circumstances influence students'

decisions to drop out (Bean, 1980; Willcoxson, 2010).

The remaining factors, such as instructors' teaching skills and attitude, instructor support, instructor feedback, facilities, socio-cultural environment, and access to academic advisors, do not impact students' intention to drop out. These research findings contradict previous studies (Hausmann et al., 2007; Kuh et al., 2007; Nieudwoudt and Pedler, 2021; Willcoxson, 2010). When interviewing a group of students in various institutions, they expressed the belief that instructors' teaching skills and attitude do not influence their intention to drop out. According to the interviewed student group, effective instruction requires instructors to have practical experience, expertise, and in-depth knowledge. Students are concerned with teaching methods and the enthusiasm and dedication of instructors. Instructor support helps students effectively address difficulties during the learning process. However, access to and support from instructors is just one aspect, and if timely support from instructors is not received, students can seek assistance from friends to resolve their issues. Whether students receive access to and support from instructors does not impact their intention to drop out. The research results indicate that factors such as timely feedback, facilities, socio-cultural environment, and access to academic advisors positively but statistically insignificantly influence students' intention to drop out. The research findings may not be suitable for the actual situation in Vietnam and cannot be considered as factors affecting students' intention to drop out.

Conclusion

Based on the practical context in Vietnam regarding students' dropout rate and considering the research by Willcoxson (2010), the study adjusted and identified factors influencing students' intention to drop out in Ho Chi Minh City. The influencing factors were explored by surveying 804 students from public and private universities in suburban and urban areas. These factors include: 1) Lack of commitment to the institution, 2) Degree/course commitment, 3) Time management, 4) Course design, 5) Students' ineffective adaptation to the learning environment, 6) Limited classroom participation, and 7) Personal circumstances. Additionally, the study found that the following factors did not impact students' intention to drop out in Ho Chi Minh City: Teaching skills and attitude of instructors, instructor support, instructor feedback, facilities, socio-cultural environment, and access to academic advisors. Based on the findings, the research made two main contributions.

In terms of theoretical aspects, the research has identified factors that influence students' intention to drop out in Vietnam, specifically in Ho Chi Minh City, where previous studies were scarce. These factors align with the practical situation for Ho Chi Minh City students. The study provides a comprehensive understanding of the factors influencing students' intention to drop out. This helps researchers and educational experts better understand the factors that may lead to student disengagement or loss of interest in learning. Factors such as lack of commitment to the institution, degree/course commitment, time management, course design, ineffective adaptation to the learning environment, and personal circumstances have been identified to assess students' intention to drop out. This can assist educational managers and instructors develop appropriate support measures and interventions to maintain and enhance students' engagement and academic success.

In practical terms, the research findings can be used to develop programs and educational policies to reduce the student dropout rate. Universities and instructors can implement measures such as enhancing student commitment, creating conducive learning environments, improving time management, and offering better-designed courses to enhance student engagement and interest in learning. The specific results from the study can also be used to propose individual support measures for students. This may involve counseling and personal support to help students overcome personal and familial difficulties caused by their circumstances. The research also highlights that factor such as teaching skills and attitude of instructors, instructor support, and academic advising are not decisive factors in students' intention to drop out in Ho Chi Minh City. This can help universities focus on other aspects of the learning experience to create a positive learning environment and better support students.

The study is limited to the research scope within the urban and suburban areas of Ho Chi Minh City. Therefore, expanding the research scope to include universities in other regions of Vietnam may be necessary to gain a more comprehensive understanding of the issue. Additionally, the study needs to address the financial factors and cost of education. Surveying the impact of financial factors and the cost of education could be an essential part of understanding students' intention to drop out.

Acknowledgements

Author Contributions

Conceptualization, M.C.B, N.T.T.N and P.H.B.N; methodology, T.N.G.; software, T.N.G.; formal analysis, T.N.G. and N.N.H; writing—original draft preparation, T.N.G. and N.N.H.; writing—review and editing, T.N.G. and N.N.H. All authors have read and agreed to the published version of the manuscript.

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Appendix

Items
Student's dropout intentions (SDI)
SDI1: I often think about dropping out of school.
SDI2: I am actively seeking job opportunities and alternative learning options, so I may leave the university.
SDI3: There is a possibility that I will drop out of university within the next year.
SDI4: I am looking for suitable timing to drop out of school.
Lack of university commitment (LUC)
LUC1: I am studying at this university as a steppingstone to transfer to another university.
LUC2: The reputation of my university is very important for job applications.
LUC3: I am attending this university because I did not meet the requirements of other preferences.
LUC4: I am satisfied with the university I am currently studying at.
LUC5: I am satisfied with my personal experience at the university.
Degree and course commitment (DCC)
DCC1: I have obvious reasons for studying at this university.
DCC2: I can enroll in the course/program that I have chosen.
DCC3: I know what profession I want to pursue in the future.
Ineffective time management (ITM)
ITM1: It is difficult to balance personal time and study time at the university.
ITM2: I struggle with managing study time effectively.
ITM3: It is challenging to balance family responsibilities and university studies.
ITM4: It is challenging to balance work and university studies.
Skills and attitudes of instructors (SAI)
SAI1: The professors are enthusiastic and dedicated in their teaching.
SAI2: The professors are skilled at explaining things.
SAI3: The professors always strive to make the classes interesting.

SAI4: The faculty team clearly communicates their expectations from the students right from the beginning.
SAI5: The professors always create a sense of closeness with the students.
SAI6: I have encountered difficulties in understanding the accent of some instructors while listening.
SAI7: I have had some unpleasant experiences with certain instructors.
Instructor support (IS)
IS1: I have received support from the instructors
IS2: Instructors are sensitive to the individual needs of students
IS3: Instructors often strive to meet my needs.
IS4: The faculty team is always available when I need them.
IS5: My professors genuinely make an effort to understand the difficulties students face in their learning process.
Curriculum design (CD)
CD1: My professors incorporate real-life examples into their teaching curriculum.
CD2: What I am learning at the university has been researched and proven.
CD3: I am satisfied with the job experiential opportunities introduced by the university.
Positive instructor feedback (PIF)
PIF1: I received helpful feedback on the assessment tasks.
PIF2: I received prompt feedback on the tasks.
Ineffective adaptation to learning environment (IALE)
IALE1: I have the potential to succeed after completing your university education.
IALE2: My study program is too demanding.
IALE3: I believe that my essay writing skills are sufficient for university-level study.
IALE4: I find it difficult to understand various study materials.
IALE5: I struggle to adapt to the teaching methods at the university.
IALE6: I need good analytical skills in order to understand the content.
IALE7: I need a good memory in order to study effectively.
Low classroom participation (LCP)
LCP1: My classes are engaging and interesting.
LCP2: I enjoy the intellectual challenges that come with what I am studying.
LCP3: I appreciate the opportunity to interact with students from diverse cultural backgrounds at the university.
LCP4: When working in groups, I enjoy collaborating with peers from different cultural backgrounds.
LCP5: I actively participate in class discussions.
LCP6: I make it a habit to attend class and prepare the required materials in advance.
LCP7: I frequently skip classes.
LCP8: I don't attend classes because the study materials are available on the website.
LCP9: I often seek advice from my instructors.
LCP10: I am diligent in my studies at school.
University facilities (UF)
UF1: The classrooms provide a high-quality learning environment.

	UF2: The library is spacious, well-ventilated, and offers a diverse range of study materials.
	UF3: The information technology system meets my usage needs.
	UF4: The classrooms are very spacious.
	UF5: The class schedule is convenient for me.
Cultural and social environment (CSE)	
	CSE1: The facilities of the university meet my social needs.
	CSE2: The facilities of the university are suitable for my religious/cultural needs.
	CSE3: I am sensitive to students from different cultural backgrounds.
	CSE4: I appreciate the physical facilities and environment of the university campus.
	CSE5: I feel a sense of belonging to the university community.
	CSE6: I sometimes feel lonely in the university.
	CSE7: I find it easy to commute to the university.
Access to support from academic advisors (ASA)	
	ASA1: I receive good advice from the university regarding career choices.
	ASA2: I receive good advice from a career counselor in choosing a profession for myself.
	ASA3: I receive good advice from the university regarding career choices.
	ASA4: I easily receive assistance when needed from the management team.
	ASA5: The management team is always ready to assist when I need them.
	ASA6: The staff at the university are often sensitive to the personal needs of students.
	ASA7: Having an advisor at the university is very helpful.
Personal circumstances (PC)	
	PC1: I worry about my mental health.
	PC2: I worry about my physical health.
	PC3: I often feel homesick.
	PC4: I worry about the accumulating debt while studying at university.
	PC5: I have financial issues.

Predicting Academic Dishonesty Based on Competitive Orientation and Motivation: Do Learning Modes Matter?

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Abstract: Previous studies suggest that competition and motivation are reliable predictors of academic dishonesty. However, little is known about the role of situational factors in predicting academic dishonesty. Some studies have found that online learning is more prone to academic dishonesty, but others have found the opposite. This study focuses on academic dishonesty, how it relates to competitive orientation and motivation, and how that differs in two class modes (online vs offline). This study was conducted in Indonesia during early 2022, transitioning from online learning due to the Covid-19 pandemic to normal-offline learning. A total of 404 university students participated in this study. Most participants (74.2%) reported they cheated more frequently in online than in offline learning. The independent sample t-test indicated that students in the online learning group showed higher academic dishonesty than students in the offline learning group. Latent regression analysis showed that amotivation, hypercompetitive orientation, and learning mode are significant predictors of academic dishonesty. These findings imply that transitioning from offline to online learning during the pandemic negatively affected academic integrity.
Keywords: academic dishonesty, hyper-competition, motivation, online learning.

Introduction

The covid-19 pandemic has changed many things, including student learning behaviour. One issue that educators and researchers often ask is whether the mode of learning has an impact on students' academic dishonesty. At the beginning of the pandemic, all learning processes had to be switched to online. Many researchers have investigated the effect of switching learning to online on academic dishonesty (e.g., Erguvan, 2021; Janke et al., 2021; Jose, 2022; Malik et al., 2023). Most studies found an increasing number of academic dishonesty when learning mode had to switch to online. Two years after the first outbreak, several universities have returned to normal in-person learning. This study aimed to examine the academic dishonesty of university students in Indonesia during early 2022, transitioning from online learning due to the Covid-19 pandemic to normal-offline learning. At that time, some universities had returned to offline learning while others were still conducting online learning.

Academic dishonesty refers to any behaviour that intentionally violates academic rules for personal gain (Janke et al., 2021). This term is often used interchangeably with the term cheating. However, the term academic dishonesty was used in this study because it covers a broader range of behaviours, such as plagiarism, cheating on exams, or lying. Academic dishonesty is firmly attached to students. Previous studies have consistently reported that most students admit to having committed academic dishonesty during their studies (Bernardi et al., 2004; Teixeira and Rocha, 2010). These findings have prompted researchers to investigate what internal or external factors influence students' academic dishonesty behaviour.

The effect of learning methods on academic dishonesty has been studied by several researchers (for a review, see Holden, Norris and Kuhlmeier, 2021). Some studies found that online learning increased the risk of academic dishonesty (Janke et al., 2021; Khan and Balasubramanian, 2012; King and Case, 2007; Lanier, 2006). Some other studies found that online learning reduced the risk of academic dishonesty (Grijalva and Kerkvliet, 2006; Peled et al., 2012), while others found no difference between online and offline learning (Spaulding, 2009; Spaulding, 2009). These findings are not conclusive and, therefore,

interesting for further study.

Several methodological and conceptual reasons explained these different findings. Watson and Sottile (2010) suggested that operational differences in academic dishonesty among studies were the main cause of inconclusive results. In addition, the context of learning is also essential. For example, Janke et al. (2021) suggested that when learning is changed from offline to online due to compulsion (e.g., Covid pandemic, which limits face-to-face interactions), the motivation that arises from students is extrinsic motivation or even amotivation. It led to high levels of academic dishonesty. Several finding supports this claim and found a significant increase in academic dishonesty during the Covid-19 pandemic timeframe (Comas-Forgas et al., 2021; Jenkins et al., 2023; Malik et al., 2023). One factor contributing to cheating, which is linked to decision-making, is that cheating takes place based on the presence of opportunities (Adzima, 2020). The matter of opportunity has gained increased attention, especially with the expansion of online education within higher education. From the perspective of the theory of planned behaviour (TPB, Ajzen, 1991), perceived control behaviour is a crucial aspect that encourages people to cheat. When students perceive a sense of anonymity and a lack of sufficient monitoring in an online class, they might believe that the chances of getting caught while cheating are low, leading to a higher likelihood of engaging in academic dishonesty (Kajackaite and Gneezy, 2017). However, if learning is conducted online because of the student's choice, intrinsic motivation emerges, which reduces academic dishonesty. In this context, replication needs to be performed to examine the impact of these situational factors. Nowadays, a combination of in-person and online classes is more prevalent without any compulsion. The findings of this study could be a basis for making policies related to online learning.

Individual differences in internal factors are also essential for predicting academic dishonesty. Internal factors to be investigated further in this study are motivation and competitive orientation. In literature, competition has been associated with academic dishonesty. For example, Taylor, Pogrebin and Dodge (2002) stated that the pressure of competition encourages dishonest behaviour in order to get the best grades. Two dimensions of competitive orientation influence academic dishonesty most: self-development and hypercompetitiveness (Orosz, Farkas and Roland-Lévy, 2013). Self-development refers to self-growth, not considering competitors as enemies, and enjoying and learning from the competition process. In contrast, hypercompetitive individuals try to win at any cost. They see their competitors as enemies and can be aggressive towards them. Self-development is assumed to correlate negatively with academic dishonesty, while hypercompetitiveness positively correlates with academic dishonesty.

Motivation is also consistently cited in the literature as a predictor of academic dishonesty (Krou, Fong and Hoff, 2021; Orosz, Farkas and Roland-Lévy, 2013). Vallerand et al. (1992) explained that intrinsic motivation arises when individuals engage in activities for their own sake and for the satisfaction that comes from it. Extrinsic motivation occurs when individuals engage in activities to achieve goals, not for their own sake. When individuals do not feel causality between their actions and the results, this can be labelled as amotivation. Individuals with amotivation have neither extrinsic nor intrinsic motivation and usually feel incompetent. The role of motivation in predicting academic dishonesty was briefly summarized in a meta-analysis study conducted by Krou, Fong and Hoff (2021). Academic dishonesty correlated negatively with intrinsic motivation and positively with extrinsic motivation and amotivation.

Study objectives

Most previous studies investigated internal and situational factors separately in predicting academic dishonesty. However, academic dishonesty cannot be separated from these two factors. Therefore, this study aimed to investigate the role of internal factors (i.e., motivation and competitive orientation) and situational factors (i.e., learning mode) in predicting academic dishonesty simultaneously. This study was conducted during the transition period from online learning due to the Covid-19 pandemic to normal-offline learning. With the varied learning mode in Indonesia at that time, this research can contribute scientifically to answering disagreements over previous research results. In addition, this research is also helpful in providing practical considerations for formulating policies to reduce academic dishonesty.

In the first step, we established a measurement model for all constructs and analyzed their interrelations. The present study intended to resolve methodological issues in previous studies by investigating the measurement invariance of the instrument across learning modes (online vs offline). In the next step, we conducted latent regression analyses to predict academic dishonesty with motivation, competitive orientation, and learning mode as predictors. Specifically, our research questions were as follows:

1. Do motivation and competitive orientation explain students' academic dishonesty?

2. Does learning mode explain students' academic dishonesty beyond motivation and competitive orientation?

Based on previous research (Krou, Fong and Hoff, 2021; Orosz, Farkas and Roland-Lévy, 2013), we hypothesized that academic dishonesty correlates negatively with intrinsic motivation and positively with extrinsic motivation and amotivation. In addition, self-development is hypothesized to correlate negatively with academic dishonesty, while hypercompetitiveness positively correlates with academic dishonesty. Regarding the context of the learning mode, since online learning was conducted due to compulsion, we hypothesized that students in online learning have higher levels of academic dishonesty, in line with the previous study (Janke et al., 2021).

Materials and Methods

Participants
Participants of this study were active students who took part in both online and offline learning. A total of 404 students (55% were women) participated in this study. Participants ranged from 18 – 47 years old (M = 21.41, SD = 3.41). Participants consisted of undergraduate students (89%), Master's students (7%), and Doctoral students (3%). A total of 193 students (48%) took offline learning, and 211 (52%) took online learning. Data was collected using an online survey in early 2022, where learning modes still varied. Some students took online classes, while others attended face-to-face classes.

Instruments
Academic dishonesty questionnaire
The academic dishonesty questionnaire is a measure specifically developed for this study. This questionnaire consists of 11 items, which are behavioural indicators indicating academic dishonesty relevant to online and offline learning situations. Participants were asked to rate how often they did the following activities this semester (e.g., "Copying material from the internet, books, or articles without citing the source" or "Making up false excuses for being late to turn in assignments"). Participants answered with a response scale ranging from 1 (never) to 5 (always). Please see the appendix for detailed items. Cronbach's alpha for this measure was 0.77. After being presented with the questionnaire, participants were given one question read as follows: "In which learning mode do you do the activities mentioned earlier, online or offline?".

Academic Motivation Scale (AMS)
AMS is a multidimensional scale for measuring three dimensions of motivation: intrinsic motivation, extrinsic motivation, and amotivation. This scale was developed by Vallerand et al. (1992). Natalya (2018) translated the scale into Indonesian, validated it and made a short-form version. The instructions read as follows: "Why do you go to college?". This scale consists of 15 items. Intrinsic motivation consists of seven items, with the following sample item: "Because I experience pleasure and satisfaction while learning new things". The extrinsic motivation subscale consists of six items, with the following sample item: "In order to obtain a more prestigious job later on". The amotivation subscale consists of two items, with the following sample item: "Honestly, I don't know; I really feel that I am wasting my time in school". Participants rated all items on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). For detailed items, readers are encouraged to read the original paper by Natalya (2018) . The Cronbach's alpha reliability of these items was 0.86 for intrinsic motivation, 0.83 for extrinsic motivation, and 0.76 for amotivation.

Multidimensional Competition Orientation Inventory (MCOI)
MCOI is a multidimensional scale to measure the four competitive orientations. This scale was developed by Orosz et al. (2018). We translated the scale from English into Indonesian using the translation back-translation method. Only two subscales were used in this study: self-development and hypercompetitive, as previous findings indicated that these two dimensions were related to academic dishonesty. Self-development subscale consists of three items, with the following sample item: "Competitive situations allow me to bring the best out of myself". The hypercompetitive subscale consists of three items, with the following sample item: "The most important is winning, no matter what". Participants rated all items on a 6-point Likert-type scale ranging from 1 (Not true of me at all) to 6 (Completely true of me). Readers are encouraged to read the original paper by Orosz et al. (2018) for detailed items. The Cronbach's alpha reliability for the self-development was 0.84 and 0.68 for hyper-competitive.

Procedures

Participants were recruited using various strategies, including social media advertisements (e.g., Facebook, Instagram, WhatsApp). Participants who were willing to participate in the study completed the online survey programmed in PsyToolkit (Stoet, 2017). Participants received no monetary incentives for participating in this study. After reading the research description, participants gave their consent to be able to move to the questionnaires. All participants gave their informed consent for inclusion before participating in the study. The study was conducted following the Declaration of Helsinki.

Data analysis

Confirmatory Factor Analysis (CFA) and latent variable regression analysis were performed using the 'lavaan' package (Schermelleh-Engel, Moosbrugger and Müller, 2003) in the R program (R Core Team, 2012). First, the measurement model of all constructs was specified and tested using CFA. The measurement invariance of the instruments across learning modes (online vs offline) was investigated to ensure that the instruments used in this study have similar meanings for the two groups. Three levels of measurement invariance were investigated: configural, metric, and scalar. At the configural level, loadings and intercepts were freely estimated. At the metric level, loadings were constrained to be equal across learning modes, and the intercepts were freely estimated. At the scalar level, both loadings and intercepts constrained to be equal across learning modes. Measurement invariance analysis is met if: ΔCFI < -.01, ΔRMSEA < .015, ΔSRMR < .010 (Chen, 2007) for each level of the model.

Following the CFA, statistic descriptive and intercorrelation among variables were examined then. We compared the score of all variables between the online and offline groups using an independent sample t-test. Finally, we conducted latent regression analyses to predict academic dishonesty with motivation, competitive orientation, and learning mode as predictors. There were two models specified: 1) model with internal factors as predictors and 2) model with internal factors and situational factors as predictors.

In CFA and latent regression analyses, we used weighted least squares means and variance adjusted (WLSMV) estimation because it is better suited to ordinal data (Beauducel and Herzberg, 2006). We evaluated model fit using several fit indices, including the χ^2, comparative fit index (CFI), the standardized root-mean-squared residual (SRMR), and the root mean squared Error of approximation (RMSEA). The following parameters were used to assess the models' adequacy: CFI >.90, TLI > 0.90, SRMR.10, and RMSEA.08 were deemed adequate, and CFI >.95, TLI > 0.95, SRMR.05, and RMSEA.05 were considered an excellent fit (Schermelleh-Engel, Moosbrugger and Müller, 2003).

Results

Measurement model of the instruments

CFA was performed to examine whether the measurement model for all variables studied fit the data. The results of the initial analysis showed that the model had χ^2 = 751.69, df = 449, p <0.01, CFI = 0.951, TLI = 0.946, RMSEA [90% CI]= 0.044 [0.039, 0.049] and SRMR = 0.071. Although the initial model had shown satisfactory indicators in terms of CFI, TLI, RMSEA, and SRMR values, the academic honesty measurement model had one item with a very low loading factor (λ < 0.30). The model was then modified by removing that item. The final measurement model had χ^2 = 708.87, df = 419, p < 0.01, CFI = 0.953, TLI = 0.948, RMSEA [90% CI]= 0.046 [0.040, 0.051], and SRMR = 0.071. This final model displayed an acceptable fit. The omega reliability (ω) of each variable was 0.78 for academic dishonesty, 0.56 for amotivation, 0.89 for extrinsic motivation, 0.83 for intrinsic motivation, 0.68 for hypercompetitive, and 0.85 for self-development.

Measurement invariance

Measurement invariance analysis was performed to examine whether the measurement model applies equally to groups of students with online and offline classes. Measurement invariance has several levels. If the metric invariance is met, then the regression analysis comparison can be performed between groups. If the scalar invariance is satisfied, then the latent means can be compared across groups meaningfully. The summary of the results of the invariance analysis can be seen in table 1. Table 1 indicates that the model accuracy indices (i.e., χ^2, CFI, RMSEA, SRMR) of each model are almost unchanged compared to other model fit indices. All three models (M1 to M3) did not show a significant decrease in model fit, indicating that all constructs achieved scalar invariance between the online and offline groups. Therefore, the variable measurement model proved invariant between groups of learning

modes, and the latent means could be compared meaningfully across learning modes.

Table 1.
Invariance of measurement models based on learning mode groups

Model	Model fit				Model comparison		
	χ2 (df)	CFI	RMSEA	SRMR	ΔCFI	ΔRMSEA	ΔSRMR
Configural (M1)	914.74 (838)	.987	.021	.077			
Metric (M2)	994.56 (863)	.978	.028	.079	-0.000	0.006	0.002
Scalar (M3)	1021.26 (888)	.978	.027	.080	0.000	0.000	0.001

Descriptive statistics of studied variables

Participants generally reported relatively low academic dishonesty levels (M = 1.76, SD =0.51). Table 2 shows that motivation and competition orientation do not differ in online and offline groups. However, academic dishonesty in the two groups was statistically significant, with students in online classes having higher levels of academic dishonesty than students in offline classes. The Pearson's correlation analysis among variables indicated that academic dishonesty was positively correlated with amotivation and hypercompetitiveness and negatively correlated with extrinsic motivation. Surprisingly, there was no correlation between academic dishonesty and internal motivation. For the single question about the tendency to cheat in two learning modes, as many as 300 participants (74.2%) reported committing academic dishonesty when learning online.

Table 2.
Descriptive statistics and intercorrelation of studied variables

Variable	Online (N=211)	Offline (N=193)	d	1	2	3	4	5
	Mean (SD)	Mean (SD)						
1. Extrinsic motivation	5.66 (0.93)	5.66 (1.06)	0.01					
2. Intrinsic motivation	5.65 (1.05)	5.62 (1.15)	0.03	.57***				
3. Amotivation	1.88 (1.05)	1.95 (1.04)	0.06	-0.35***	-.19***			
4. Self-development	4.52 (0.89)	4.46 (1.12)	0.05	.53***	.34***	-.20***		
5. Hypercompetitive	2.79 (1.07)	2.77 (1.08)	0.02	.10	.22***	.13**	.32***	
6. Academic dishonesty	1.84 (0.50)	1.69 (0.52)	0.28**	-.19***	-.04	.31***	-.10	.25***

Note: * p < 0.01, *** p < 0.001.

Motivation, competitive orientation, and learning mode as predictors of academic dishonesty

Two latent regression model was performed. In the first model, we regressed academic dishonesty on extrinsic motivation, intrinsic motivation, amotivation, self-development, and hypercompetitive. In the second model, we added learning modes as the sixth predictor. The results for both models are shown in Table 3.

In model 1, only amotivation and hypercompetitive orientation were significant predictors of academic dishonesty. Both amotivation and hypercompetitive have positive effects on academic dishonesty. All predictors together explained 25% of the variance in academic dishonesty. In model 2, the learning mode significantly affected academic dishonesty. Adding learning mode as a predictor increased the variance explained to 28%. The negative effect size indicated that students in the online class have higher academic dishonesty than students in the offline class. To summarize, in line with our assumptions, internal and situational factors were related to academic dishonesty. However, contrary to our expectations, only amotivation and hypercompetitive were related to academic dishonesty, while the effect of intrinsic-extrinsic motivation and self-development were not significant.

Table 3.
Regression of academic dishonesty on motivation, competitive orientation, and learning modes

Predictor	Model 1			Model 2		
	B	SE	β	B	SE	β
Extrinsic motivation	-0.01	0.11	-0.01	0.02	0.12	0.01
Intrinsic motivation	0.01	0.07	0.01	-0.01	0.07	-0.01
Amotivation	0.47	0.11	0.41***	0.50	0.12	0.42***
Self-development	-0.14	0.08	-0.12	-0.15	0.08	-0.13
Hypercompetitive	0.24	0.07	0.20***	0.25	0.07	0.21***
Learning mode	-	-	-	-0.21	0.05	-0.18***
R^2	0.25			0.28		
χ2 (df)	708.87 (419)			735.65 (444)		
CFI / TLI	0.953 / 0.948			0.953 / 0.947		
RMSEA / SRMR	0.041 / 0.071			0.040 / 0.070		

Note: *** $p < 0.001$, B=unstandardized coefficient, SE = Standard Error, β = standardized coefficient, learning mode was coded as 0 for online and 1 for offline class. A negative regression coefficient indicated that online classes showed higher academic dishonesty.

Discussions

This study aimed to examine whether internal factors (i.e., motivation and competitive orientation) and situational factors (i.e., learning mode) predict academic dishonesty. The main findings in this study indicate that motivation, competitive orientation, and learning mode contribute to academic dishonesty. Specifically, amotivation and hypercompetitiveness are two internal factors that significantly influence academic dishonesty. Amotivation, characterized by a lack of interest in academic pursuits, can lead students to resort to unethical practices to circumvent their disinterest in learning (Deci and Ryan, 1985). Research has demonstrated that amotivated students are more likely to cheat, perceiving these behaviours as shortcuts to coping with academic responsibilities (Murdock, Hale and Weber, 2001). On the other hand, hypercompetitiveness, which reflects an intense desire to outperform others at any cost, is associated with a higher propensity for academic dishonesty. In academic contexts, hypercompetitive individuals may view academic success as a zero-sum game, leading them to resort to unethical actions to gain a competitive edge over their peers, even if it involves undermining their fellow students (Anderman and Danner, 2008). In addition, the learning mode also plays a role; students who study online tend to show higher academic dishonesty. Most students also reported committing academic dishonesty when learning online. However, it is important to note that not all students engage in academic dishonesty. Some might even have higher levels of academic integrity in online learning environments.

Our findings provide evidence to resolve the debate about whether learning modes contribute to academic dishonesty. The results of this study support several previous researchers who found that dishonesty in online learning is higher than in offline learning (Janke et al., 2021; Khan and Balasubramanian, 2012; King and Case, 2007). Several reasons explain the inconsistency of previous findings, including methodological reasons. The instruments used as comparisons can have different operations, which may also be irrelevant for the two types of learning modes. For example, the indicator "Participate in class while doing other activities during learning" may be more easily agreed upon by respondents who are in online classes. In this study, we first tested for measurement invariance of the instruments before comparing academic dishonesty between online and offline groups. Thus, the instrument used has the same meaning and is not biased when used to compare the two groups.

Another explanation regarding the inconsistency of previous findings is explained by Janke et al. (2021). They stated that when learning is changed from offline to online due to compulsion (e.g., Covid pandemic, which limits face-to-face interaction), the motivation that arises from students is extrinsic motivation or even amotivation. This has led to high levels of academic dishonesty. This explanation seems relevant to the findings of this study because students who take online classes are mostly out of compulsion.

Several studies also suggested that the theory of planned behaviour (TPB, Ajzen, 1991) can explain academic dishonesty in online learning (Ababneh, Ahmed and Dedousis, 2022; Chudzicka-Czupała et al., 2016). TPB proposes that people's attitudes, subjective norms, and perceived behavioural control shape their intentions and, ultimately, their behaviour. Students may perceive online learning as less important

or less rigorous, or they may be concerned about the quality of instruction. It results in a low attitude towards online learning, which can contribute to a greater willingness to engage in academic dishonesty. The academic norms may be different in online learning. Students may feel less social pressure to behave honestly in an online setting. Finally, students' perceived behavioural control in online learning may be influenced by factors such as distractions in the home environment or technical difficulties. These factors can contribute to a greater lack of control, increasing the likelihood of cheating.

Of the five predictors in the model, only two played a significant role: amotivation and hypercompetitiveness. Although this finding aligns with previous findings (Krou, Fong and Hoff, 2021; Orosz, Farkas and Roland-Lévy, 2013), it is still intriguing because previous research examined motivation and competitive orientation separately. We examined motivation and competitive orientation simultaneously. These findings show two unique faces of "cheaters". Academic cheaters have two possibilities. First, they have low motivation to study, or second, they consider excessive competition, so they want to justify any means to win.

Limitations

This research has several limitations that need to be considered. First, we only differentiated online and offline groups. We classified students who took blended learning as offline because they had started face-to-face learning. However, students with blended learning might have different time frames to reflect on themselves when completing surveys. Second, this study is limited to a sample of university students. University students are assumed to be more familiar with technology than elementary-high school students. Thus the generalization of this research for elementary-high school students may be different. Third, the study relied on self-reported measures of academic dishonesty, which may be subject to social desirability bias. Future studies could use more objective measures of academic dishonesty, such as plagiarism detection software.

Conclusions

Overall, this study contributes to the growing body of literature on academic dishonesty and its predictors. This research shows that the higher the amotivation and hypercompetitive orientation, the greater the tendency for students to commit academic dishonesty. In addition, the learning mode also plays a role; students who study online tend to show higher academic dishonesty. Most students reported they cheated more frequently in online than in offline learning.

This research has several implications for the practice of education in universities. First, face-to-face learning is still essential not only for the transfer of knowledge but also for the transfer of values. Educators need to adjust the design of online learning as a proactive method to reduce academic dishonesty. Second, educators are encouraged to implement interventions that promote student motivation and reduce hypercompetitive orientation, such as using collaborative learning. Finally, more research is needed to better understand the complex relationship between motivation, competitive orientation, learning mode, and academic dishonesty in different cultural contexts.

Appendix

Academic dishonesty questionnaire

Please indicate how often you do the following activities / Tunjukkan seberapa sering Anda melakukan halhal ini.

1 = never / tidak pernah, 2 = rarely / jarang, 3 = sometimes / kadang-kadang, 4 = often / sering, 5 = always / selalu

1. Logging into a course and engaging in other activities during course time / Ikut kelas sambil mengerjakan kegiatan lainnya selama pembelajaran

2. Solving tasks together with other students that were meant as individual assignments / Mengerjakan tugas dengan teman lainnya meskipun itu adalah tugas individu

3. Writing references in papers even though I have never read the references / Menulis referensi di makalah yang saya tulis meskipun referensi tersebut tidak pernah saya baca

4. Copying material from the internet, books, or articles without writing down the source / Menyalin materi dari internet, buku, atau artikel tanpa menuliskan sumbernya

5. Having others do individual assignments and handing them in as own work / Meminta tugas individu milik teman untuk saya kumpulkan sebagai pekerjaan saya

6. Making false excuses for being late in submitting assignments / Membuat alasan palsu karena terlambat mengumpulkan tugas

7. Letting someone else sign a course attendance sheet to cover up not being present in the course / Meminta teman untuk mengabsenkan saya saat saya tidak hadir dalam pembelajaran

8. Trying to bribe an instructor to get deadline extensions or better grades / Merayu dosen agar mendapat tambahan waktu deadline atau nilai yang lebih baik

9. Paying others to do my own learning assignments / Membayar orang lain untuk mengerjakan tugas saya

10. Solving exam questions by using additional materials or the internet without permission / Menjawab pertanyaan ujian dengan mencari materi di internet tanpa izin

11. Exchanging ideas with others about possible answers during an examination / Berdiskusi dengan teman tentang kemungkinan jawaban pertanyaan ujian

Acknowledgements

Author Contributions

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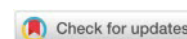
Virtual Reality as Anxiety Management Tool

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Abstract: Virtual Reality technologies have been established as an effective tool for the treatment of a variety of mental health disorders. Despite those positive results, it remains unclear whether these findings can generalize to the healthy population. In the current study, we assessed to what degree a virtual scenario consisting of a tropical beach can be successfully applied for the reduction of state anxiety and negative mood in healthy individuals. The study was performed on 50 volunteers aged 18 to 45 that were individually exposed to virtual reality. Before and after the virtual reality session, the emotional state of the participants was measured through questionnaires. Using linear mixed effect models, we obtained evidence for the effectivity of a single virtual reality session for negative state reduction, namely, we observed a decrease in state anxiety and negative mood. Additionally, a positive mood of participants increased after the session, however, no statistical evidence was obtained. The results confirm our hypothesis that state anxiety and negative mood can be decreased using a low-cost virtual reality device. Based on our findings, we suggest that virtual scenarios can improve the emotional well-being and the quality of life of the general population.
Keywords: virtual reality, natural scenarios, state anxiety, negative and positive mood, sense of presence.

Introduction

Virtual reality (VR) technologies are becoming increasingly involved in society and the process of human life. The area of mental health is not an exception in the 21st century trends, and VR has started to become a common tool for the study, prevention, assessment, and treatment of psychological disorders (e.g., Glanz, Rizzo and Graap, 2003; LaValle, 2023; Mancuso et al., 2023). In particular, VR technologies have been successfully applied to treat various mental health problems such as anxiety disorders (Carl et al., 2019; Opris et al., 2012; Parsons and Rizzo, 2008), eating disorders (Clus et al., 2018; Marco, Perpina and Botella, 2014), addictions (Segawa et al., 2020) or as a non-pharmacological analgesic procedure to reduce acute pain and anxiety (Kenney and Milling, 2016; Triberti, Repetto and Riva, 2014).

Nowadays, the most established use of VR is as an exposure-technique to treat anxiety-related disorders (Freeman et al., 2017). Research studies have shown its clinical efficacy to treat specific phobias (Garcia-Palacios et al., 2002; North, North and Coble, 1998), the Posttraumatic Stress Disorder (PTSD; Beidel et al., 2019; Rothbaum et al., 2003) or panic disorders (Botella et al., 2007), among others. Although various studies have comprehensively studied the possibilities of VR to treat anxiety disorders, it becomes challenging to translate these findings to a healthy population. We, therefore, conducted the study to assess to what degree a low-cost VR system can be used for decreasing state anxiety and negative mood in the healthy population. We argue that the application of VR technologies could substantially help in reducing the anxiety levels and in promoting a positive mood in healthy individuals.

In the rest of the introduction, a historical overview of the development of VR technologies will be provided. Then, the problem of human involvement in VR will be discussed. Next, an overview of the research on anxiety disorders by utilizing VR technologies will be presented. At the end of the introduction, the goals of the current study and the hypotheses will be listed.

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Historical overview

The modern VR started its early development in the 1950s and 60s accompanied by several key inventions. This included patenting the Sensorama in 1957 by M. Heilig. The goal of the Sensorama was to use the senses of the user including components such as odor generators and vibrating chairs while aiming to provide a complete multisensory experience (Heilig, 1962). Following this in 1961, the Headsight, the first supervisor of head-mounted displays that included motion tracking and dual monitor displays, was designed by Philco Corporation (Peddie, 2017). Sutherland (1965) designed the Ultimate display, that innovatively used the computer interface. This allowed users to interact using a simple virtual scenario in real time frame.

The formalization of VR occurred in 1989 with J. Lanier coining the term "virtual reality". At that point, VR has been extensively used in research and psychiatric treatment (Lanier, 1992). In the decades following that, VR started to be used by mental health professionals as an exposure method to treat anxiety disorders. The effectiveness of VR-based Exposure Therapy (VRET) was evaluated in the primary research with the focus on the treatment of acrophobia (Rothbaum et al., 1995). Based on this study, VRET was proved to be effective and that led to a number of follow-up studies on the use of VR-based therapy for the treatment of anxiety disorders and, in general, other mental health problems.

The problem of human involvement in virtual reality

An important question for the application of VR is the problem of human involvement in virtual scenarios. This involvement was found to be associated with the formation of a genuine emotional attachment of participants to virtual characters (Gould, Coulson and Howard, 2012). Slater (2009) discussed the Place Illusion (PI) and Plausibility Illusion (Psi) as the predictors of individuals' realistic perception of virtual environments. Continuing this idea, Pillai, Schmidt and Richir, (2013) framed the concept of the psychological illusion of presence while being in an alternative reality. This concept was understood as a continuous cognitive process that concerns perceived objects and phenomena while the mind functions and perceives in the same way as in the real world. The authors suggested calling it Self-Evoked Reality, an endogenously induced reality that is a component of the general model of reality. They adhered to the position that the psychological alternative reality can be interrupted leading to the person returning to the reality. Before this critical moment, most vivid sense of presence is experienced that is accompanied by corresponding emotional experiences. The idea of psychological VR and the possibility of it being interrupted indicate broad prospects for the treatment of mental disorders, psychological trauma, loss and other problems.

The ability to simulate real situations in a virtual environment drew the attention of the researchers to the possibilities of its use for the study, assessment, prevention, and treatment of mental health disorders. Since then, VR has been successfully applied to various mental health disorders (e.g., Fornells-Ambrojo et al., 2008; Freeman et al., 2010; Riva et al., 2004). These studies opened perspectives to determine the essence of the manifestation of thoughts of persecution, the possibility to separate the real world from the fantasy world in people with psychopathology. In this direction, VR has established itself as a implementation technique for a broader study of the causes and nature of the manifestation of certain symptoms, which allows adjusting the therapeutic lines of care for people with certain mental health problems.

Research on anxiety disorders and VR

For two decades various experimental studies have been conducted to study the effect of VR on the treatment of subclinical fears and anxiety disorders. In the first controlled application of VR for the treatment of psychological issues, VR therapy was successful in reducing the fear of heights (Rothbaum et al., 1995). The result was evaluated by indicators of anxiety, avoidance, attitude, and stress. Significant differences in the groups were found for all indicators, so the VR group improved significantly after treatment, but the control group did not change. Nowadays, a large body of literature validates the use of VR as an exposure technique to treat anxiety-related disorders. Note that recent review and meta-analytic studies have shown that VR can be more efficient than imaginal exposure and can have the same efficacy as in-vivo exposure (Carl et al., 2019; Meyerbröker and Emmelkamp, 2010; Morina et al., 2015; Morina et al., 2015; Parsons and Rizzo, 2008; Powers and Emmelkamp, 2008). In addition, the use of VR may increase treatment adherence by reducing the treatment desertion.

However, beyond the treatment of anxiety disorders through reducing negative emotions, VR has been also effectively used in inducing positive emotions. In a recent study that utilized VR technologies, positive emotions such as relaxation and joy have been successfully induced while an anxiety level was reduced in healthy population (Baños et al, 2008). With regard to a clinical population, a pilot study,

involving 25 patients with Generalized Anxiety Disorder (GAD), was conducted to assess the efficacy of a VR system designed to induce relaxation (Repetto et al., 2013). Initial results suggested the efficacy of VR and biofeedback devices in reducing stress and anxiety in a clinical population. However, the authors also suggested the need to use physiological data to modify specific features of the virtual environment in real time.

In recent VR applications, a variety of relaxation techniques have started to be used in conjunction with biofeedback devices. Thus, the anxiety treatment has been proposed to improve through the use of a biofeedback virtual reality system (VR), used both for relaxation and for the controlled effects of VR in psychiatric treatment (Anderson et al., 2005; Anderson, Rothbaum, and Hodges, 2003). Moreover, in a study developed within the EU-funded INTREPID research project, Riva et al. (2009) designed a mobile VR system with biofeedback techniques to improve the traditional treatments for GAD.

The feeling of presence and anxiety level

One of the principal mechanisms underlying the use of VR as an exposure technique is the feeling of presence. In the specialized literature, the construct of presence is usually considered the principal mechanism by which VR is effective as a psychological intervention tool (Alsina-Jurnet and Gutiérrez-Maldonado, 2010). The term "presence" is usually defined as the "sense of being there" as a part of a simulated environment (Steuer, 1992). One of the main results of this illusion is that a virtual scenario may evoke the reactions, emotions, and thoughts similar to the experience in a real world (Hodges et al., 1995).

The sense of presence in VR can be facilitated by the application of technologies including touch gloves, head displays, vibroactive platforms and synthesized sounds that together allow to simulate the users' sensorial channels and actively exploration of the virtual environment. In addition, some virtual reality systems are programmed to respond in real time to the actions of the participants. Due to this dynamic interaction the more natural and intuitive connection to the virtual reality can be experienced. The recent studies identified three main factors that comprise the "sense of presence" construct: realness, spatial presence, and involvement (Lessiter et al., 2001; Schubert, Friedmann and Regenbrecht, 2001).

The relationship between the anxiety level and feeling of presence in both clinical and non- clinical sample has been examined in various VR applications (Alsina-Jurnet et al., 2011; Krijn et al., 2004; Regenbrecht, Schubert and Friedmann, 1998; Robillard et al., 2003; Schuemie et al., 2000). Although in some of these studies the relationship between anxiety level and feeling of presence has been established (Schuemie and Bruynzeel, 2000), others failed to correlate these values (e.g., Regenbrecht, Schubert and Friedmann, 1998). One of the possible explanations of these contradictory results is the differences in the sample: while some studies use a clinical population, others draw conclusions on the healthy individuals. The mentioned limitations make it difficult to summarize the current findings. A continuing challenge is, therefore, to establish whether there is a relationship between anxiety level and feeling of presence in healthy individuals.

To summarize, many of the studies utilizing VR for the treatment of mental health problems were aimed to treat anxiety disorders. Thus, the results showed that VR use led to significant reduction in anxiety symptoms. Additionally, its effectiveness (or was more effective) was similar as compared to traditional exposure interventions. Moreover, it had a powerful effect the persons' day-to-day life. Despite those findings, it remains unclear whether VR technologies can affect the reduction of anxiety and negative emotions in the general population. Thus, the goal of the present study was to investigate with a non-clinical sample the efficacy of virtual experience for reducing negative state conditions and inducing positive ones.

In the current study, we have the following hypotheses:
1) State anxiety and the negative mood can be reduced utilizing a low-cost VR system.
2) Positive mood can be induced utilizing VR technologies
3) There is a negative relationship between levels of state anxiety and feeling of presence

Materials and Methods

Participants

The sample consisted of 50 participants (37 females and 13 males), students of Armenian-Russian University. The mean age of participants was 22.34 (SD = 5.28, age range = 18–45). All participants were healthy individuals with no history of neurological and psychiatric disorders.

Before their participation, they gave informed consent in the form of a written statement in

accordance with the Declaration of Helsinki. In this statement, they agreed that participation in the study was voluntary, individually conducted and had no negative consequences, that the data obtained in the course of this study would be processed anonymously.

Questionnaires
The following questionnaires were administrated:
• STAI (State-Trait Anxiety Inventory, Form X, S-Anxiety scale; Spielberger, 2010). A questionnaire that assesses state anxiety level. This sub-scale comprises 20 items (e.g., I am presently worrying over possible misfortunes) graded on a Likert scale from 0 (not at all) to 3 (a great deal).
• SUDS (Subjective Units of Discomfort Scale; Wolpe, 1990). Participants evaluate their level of anxiety on a scale of 100 points where 0 means no anxiety and 100 – extreme anxiety.
• PANAS (Positive and Negative Affect Schedule; Watson, Clark and Tellegen, 1988). A self-report questionnaire consisted of 20 adjectives which are related to 10 positive emotions (positive affect) and 10 negative emotions (negative affect). Participants were asked to define the degree they felt the emotions at the current moment using a five-point Likert scale where 1 was 'not at all' and 5 – 'extremely'.
• IPQ (Igroup Presence Questionnaire; Schubert, Friedmann and Regenbrecht, 2008). A questionnaire invented to evaluate the sense of presence in VR. This questionnaire consists of 14 items that need to be evaluated using a seven-point Likert Scale. Three subscales rating different dimensions of presence are included in IPQ. The Spatial Presence sub-scale reflects the sense of being physically inside the virtual reality environment, Realness sub-scale estimates the sense of reality attributed to the virtual environment, while the Involvement evaluates the attention devoted to the virtual reality environment. Additionally, a general item that estimates the "sense of being here" is included in IPQ.

Hardware
The virtual scenario was displayed by a standalone VR glasses (Pico Interactive Goblin VR) with a resolution of 2560 × 1440 pixels, 92º field of view, and a screen refresh rate of 70 Hz (<20 ms) (see Figure 1).

Figure 1. Standalone Pico Goblin VR headset

Software
RelaxVR (https://www.relaxvr.co/): An App that combines the exposure to different 360º videos of natural environments (including beaches, forests, rivers, waterfalls, among others) with guided meditations, and soothing music to accompany the visual and meditative experience.

For the present study, researchers used the video of a beach located in Tasmania (Australia) (see Figure 2) with an embedded Russian narrative consisting of a 5-minute breath awareness technique. Note that the breath technique was specifically designed and recorded for the present study.

Figure 2. A screenshot of the virtual beach used in the present study

Procedure

A within-subjects design with two evaluation moments (pre- test and post-test) was used. The duration of each experiment was approximately 30 min, and all participants did it individually. Before starting the exposure to the virtual scenario, the STAI (S-Anxiety), the SUDS, and the PANAS were administered. Afterwards, the participants were immersed in the tropical beach for 7 minutes. Finally, after the exposure, the STAI-S, the SUDS, the PANAS, and the IPQ were administered.

Statistical analysis

To statistically evaluate the differences in the participants' scores, we constructed Linear Mixed-Effects models (LME models; Bates and DebRoy, 2004) in R (R Core Team, 2013). To obtain p-values we used lmerTest R package based on Satterthwaite's method (Kuznetsova, Brockhoff and Christensen, 2018). Additionally, to evaluate the relationship between variables, we computed the Pearson's product-moment correlation (Lee Rodgers and Nicewander, 1988).

Results

Exposure to natural virtual scenarios can be used to decrease State Anxiety?

To assess the influence of the Virtual Reality on participants' anxiety level, the values on State Anxiety Level (as measured by State-Trait Anxiety Inventory for adults; Spielberger, 2010) were inspected (Figure 3). Given large differences in mean values and standard errors between two groups, a Linear Mixed Effect model (LME) with Condition (before and after the VR session) as a fixed effect and Participants as a random intercept was constructed to evaluate the differences statistically. The results of the statistical analysis provided evidence for the effect of the VR session (for all the estimates see Table 1) meaning that the State Anxiety level was significantly decreased by means of VR session ($t = -8.55$, $p < 0.001$). The model results indicate that before the VR session participants on average had a score of 19.48 while after the VR session the average score decreased to 12.06.

Additionally, the values on the Subjective Units of Distress Scale (as measured by SUDS; Wolpe, 1990) were compared before and after the VR session (for average values see Figure 3). Given large differences observed in average values, a Linear Mixed Effect model (LME) with Condition (before and after the VR session) as a fixed effect and Participants as a random intercept was constructed. The results of the statistical analysis provided evidence for the effect of the VR session (Table 1) on the values of SUDS ($t = -7.44$, $p < 0.001$). The model results indicate that before the VR session participants on average had a score of 28.8 (a score of 30 - "mild anxiety distress") while after a single VR session the average score decreased to 12.16 (a score of 10 – "alert and awake"). Overall, these results provide evidence for the effectiveness of the VR session for decreasing state anxiety in the sample of University students.
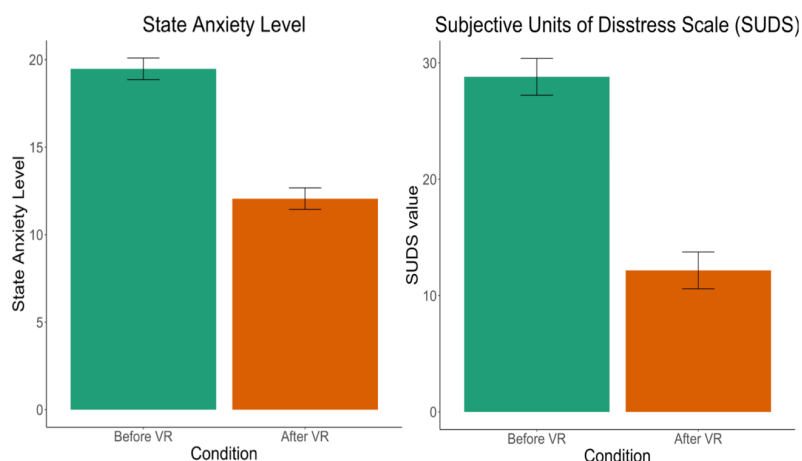

Figure 3. The mean values along with the standard errors per participant (Morey, 2008) are presented for State Anxiety Level and Subjective Units of Distress before and after the VR session

Table 1.
The results of LME models for effect of the VR session on State Anxiety Level and SUDS

Model: State_Anxiety_Value~ (before/afterVR)+ (1 | Subject)			
	Estimate	Std. Error	t value	p value
(Intercept)	19.48	1.2	16.14	<0.001***
After VR	-7.42	0.87	-8.55	<0.001***
Model: SUDS_Value~ (before/afterVR)+ (1 | Subject)			
	Estimate	Std. Error	t value	p value
(Intercept)	28.8	2.79	10.32	<0.001***
After VR	-16.64	2.24	-7.44	<0.001***

Can exposure to Virtual Reality be used to decrease Negative Mood and facilitate a Positive Mood?

First, the participants' basic emotions were assessed with The Positive and Negative Affect Schedule questionnaire (PANAS; Watson, Clark and Tellegen, 1988). Based on participants' responses the mean values were calculated along with within-subject standard errors (Figure 4). The visual inspection of both positive and negative affect values allowed observing differences before and after the VR session.

To test these differences statistically, LMEs with Condition (before and after the VR session) as a fixed effect and Participants as a random intercept were constructed. The results of the statistical analysis provided evidence for the effect of VR session (Table 2) on Negative Affect meaning that the level of Negative Affect can be significantly reduced by means of VR session (t = -5.95, p <0.001). The model results indicate that before the VR session participants had on average a score of 17.44 while after the average score decreased to 12.88. For Positive Affect, participants' scores increased after the VR session, however, no statistical evidence was obtained (t = 1.24, p > 0.05).
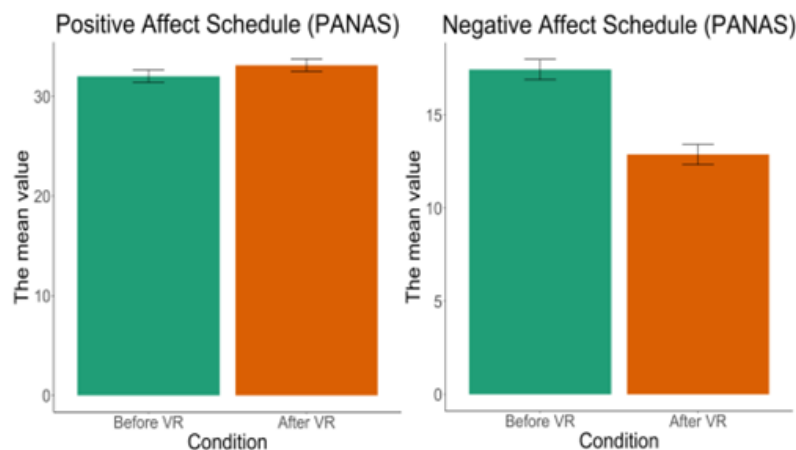

Figure 4. The mean values along with the standard errors per participant (Morey, 2008) are presented for The PANAS questionnaire before and after the VR session

Table 2.
The results of LME models for effect of VR session on Positive and Negative Affect Schedule

Model: Positive_Affect_Value ~ (before/afterVR)+ (1 | Subject)			
	Estimate	Std. Error	t value	p value
(Intercept)	32.02	1.09	29.29	<0.001***
After VR	1.1	0.88	1.24	> 0.05
Model: Negative_Affect_Value ~ (before/afterVR)+ (1 | Subject)			
	Estimate	Std. Error	t value	p value
(Intercept)	17.44	0.81	21.41	<0.001***
After VR	-4.56	0.77	-5.95	<0.001***

Is there a relationship between State Anxiety Level and the Feeling of Presence?

The feeling of presence was measured by the IPQ questionnaire (Igroup Presence Questionnaire; Schubert, Friedmann and Regenbrecht, 2008). The following values from the IPQ questionnaire were analyzed: IPQ total score, the values for the four IPQ subscales: Involvement (INV), General Presence (GP), Spatial Presence (SP), Realness (REAL). The mean values for these subscales were visually inspected and are presented in Figure 5A. The participants had the highest values for Spatial Presence and the lowest for General Presence.

To assess whether there is a relationship between state anxiety and the feeling of presence, Pearson's product-moment correlation between the values of State Anxiety (as measured by the State-Trait Anxiety Inventory for adults; Spielberger, 2010) and the total IPQ score was calculated. A negative weak correlation was obtained between State Anxiety Level before VR and IPQ total score, $r(48)= -.28$, $p < .05$. When comparing State Anxiety Level after VR and IPQ total score similar tendencies were observed: $r(48)= -.38$, $p < .01$. The visual representation of values for these two variables (Figure 5B) indicates a large spread of values and together with the current findings does not provide grounds for concluding that there is a correlation between anxiety level and the total score of the feeling of presence.
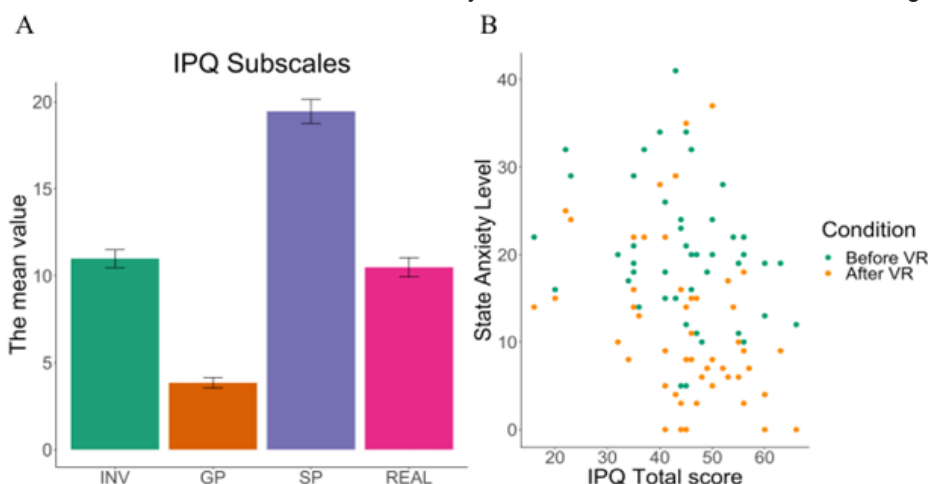

Figure 5. A. The mean values and standard errors are presented for four different IPQ Subscales: Involvement (INV), General Presence (GP), Spatial Presence (SP), Realness (REAL). B. State Anxiety Level plotted along with IPQ total score before and after the VR session

To further investigate the connection between the state anxiety and feeling of presence, the correlations between four subscales of IPQ and State Anxiety Level before and after VR were computed. The correlation values (r) along with p-values are presented in Table 3. When comparing IPQ values with State Anxiety scores, significant negative correlations were found between General Presence score and State Anxiety before ($r(48)= -.43$, $p < .05$) and after VR session ($r(48)= -.47$, $p < .001$). Additionally, weak significant negative correlations were found between State Anxiety score after VR session and the following IPQ subscales: Involvement Score ($r(48)= -.38$, $p < .05$) and Spatial Presence score ($r(48)= -.29$, $p < .05$). Marginal negative correlation was found between STAI score before VR session and Spatial Presence score ($r(48)= -.27$, $p = .05$).

Table 3.

The results of correlation analysis between feeling of presence (IPQ) and State Anxiety Level before and after VR

Model: Positive_Affect_Value ~ (before/afterVR)+ (1 | Subject)			
	Estimate	Std. Error	t value	p value
(Intercept)	32.02	1.09	29.29	<0.001***
After VR	1.1	0.88	1.24	> 0.05
Model: Negative_Affect_Value ~ (before/afterVR)+ (1 | Subject)			
	Estimate	Std. Error	t value	p value
(Intercept)	17.44	0.81	21.41	<0.001***
After VR	-4.56	0.77	-5.95	<0.001***

*** - correlation significant at level of 0.001, ** - correlation significant at level of 0.05, * - marginally significant

Discussion and Conclusion

In the current study, we aimed to reduce the anxiety level and negative mood and to induce a positive mood in healthy individuals that were exposed to a virtual scenario consisting of a tropical beach. The study was performed in an individual form. To estimate the impact of VR technologies on the psycho-emotional state, the questionnaires were administrated on state anxiety level, subjective units of distress, and positive and negative mood. Additionally, the feeling of presence of the participants was assessed. The challenge was, therefore, to evaluate whether a single VR session can lead to the reduction of anxiety level and negative mood and induction of positive mood.

To explore the possibility of state anxiety reduction by means of VR, the values for state anxiety were compared before and after the VR session. The results of the statistical analysis provided evidence regarding the efficacy of VR on the state anxiety reduction reflected in both STAI (S-Anxiety) and SUDS values. For STAI (S-Anxiety), before the VR session participants on average had a score of 19.48 while after the VR session, an average score decreased to 12.06. It is worth mentioning that both before and after the VR session participants were not characterized "high" levels of anxiety or stress (Arnaiz and Guillén, 2013; Gevorgyan, Berberyan and Berberyan, 2022; Knight, Waal-Manning and Spears, 1983) because of the fact that the sample was composed of a healthy population, namely, a group of university students. For SUDS, before the VR session participants on average had a score of 28.8 while after the VR session, an average score decreased to 12.16. Overall, these results provide evidence for the effectivity of VR sessions for decreasing the levels of anxiety. These results add to the body of the literature on the effectivity of VR use for the treatment of anxiety disorders (Diemer et al., 2014; Freeman et al., 2017; Gorini and Riva, 2008; Maples-Keller et al., 2017; Wiederhold and Wiederhold, 2005) suggesting that VR can be also used to reduce state anxiety in a healthy population. This finding is consistent with the previous studies on anxiety reduction in students by means of VR (Camara and Hicks, 2020; García-Batista et al., 2022; Harris, Kemmerling and North, 2002).

To assess whether the feelings and emotions of participants can be manipulated due to a single VR session, the resulting values of PANAS questionnaire were compared before and after the VR session. The results of the statistical analysis provided evidence for the effect of VR session on the negative affect reduction. Thus, before the VR session participants had on average a score of 17.44 while after the VR session, an average score decreased to 12.88. For positive affect, participants' scores increased after the VR session, however, no statistical evidence was obtained. We explain this data by the possible lack of a necessary balance between positive and negative emotional states: a decrease in negative effects will not always automatically lead to an increase in a person's positive feelings.

To explore the relationship between the state anxiety and feeling of presence in VR, the Pearson's correlation between the resulting values was computed. The results suggest no relationship between the total IPQ score and state anxiety level. One of the possible explanations of the current findings is that our participants in general were not characterized by a "high" anxiety level that is often associated with the feeling of presence (e.g., Regenbrecht, Schubert and Friedmann, 1998). Another explanation of the absence of a relationship is that the virtual environments applied in this study were rather relaxing (a virtual scenario consisting of a tropical beach) than stressful (Alsina-Jurnet et al., 2011).

Although VR is not yet extensively used in the clinicians' daily practice, it has been demonstrated to have tremendous potential for the diagnosis and treatment of mental health problems (Freeman et al., 2017). There is every reason to believe that virtual reality will move from the category of experimental diagnostic methods to everyday practice: using VR, you can create real life situations that standardize psychological examination, making it more reliable. Despite the skepticism of representatives of the "traditional school", VR will be distributed in psychotherapy, as there are already scientific studies that confirm the effectiveness of its use. The question of how exactly VR facilitates the clinical change is still open: a discussion is ongoing with the first view that immersion into VR has significantly affected the emotional state of the personality and the alternative view that this was rather driven by personal features that affect the dependency on it.

Virtual reality has postulated itself as a new effective technique that can be applied for the study, diagnosis, prevention, and treatment of various mental health issues. Additionally, its application has recently been extended to reducing negative states in healthy individuals. The current results allow us to conclude that VR can be effectively used to improve the mental well-being and quality of live, in general. Altogether this would lead to promotion of the harmonious development of the personal as well as its potential (Berberyan, 2021). In future, to enable wider application of VR, systematic research should be carried on issues including methodology, technical equipment, preparation of participants for entry into the virtual environment before the start of the study to exclude mental health risks. This would contribute to

the development and implementation of this unique latest technology in the theory and practice.

Acknowledgments

Conflict of interests
The authors declare no conflict of interest.

Author Contributions
Conceptualization, A.S.B.; methodology, A.S.B., H.S.B. and I.A.J.; software, A.S.B. and I.A.J.; formal analysis, A.S.B. and H.S.B.; resources: A.S.B., writing—original draft preparation, A.S.B.; writing—review and editing, A.S.B., H.S.B. and I.A.J.. All authors have read and agreed to the published version of the manuscript.

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Motivation, Intensity and Quality of Educational Activity of Russian Schoolchildren in Online Learning

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Abstract: The article analyzes the possibility of transitioning a general education school to an online learning format. The indicators are such categories as educational activity, quality of education, intensity of education, learning motives. To achieve this goal, a sociological survey of high school students in Rostov-on-Don (Russia), as well as their parents and school teachers, was conducted. The last two groups of respondents are presented in the status of experts. Based on the analysis of empirical data, the following conclusions were made. More than half of all high school students surveyed (66.6%) expressed their intention to continue the online learning experience they received during the response to the COVID-19 epidemic. However, the conjugations of willingness to study online with the categories "learning motives", "quality of education", "intensity of education" showed that the high motivation declared by high school students for the learning process does not correspond to their real behavior in distance lessons. The main motive for choosing online education for high school students is the convenience of this format of education. The survey showed a low degree of significance of other reasons for choosing online education. Preferences for online convenience and the desire to learn asynchronously reflect the unmanifested goal of getting out of the teacher's control in order to reduce their educational activity. It can be assumed that this is due to the social immaturity of high school students and the lack of understanding by most of them of the value of secondary education. Based on the analyzed data, three approximately equal groups of respondents were identified. In the first group, high school students are focused on the standard school-lesson system with elements of e-learning (40% of respondents). In the second group, the advantages of online learning are articulated, which are associated with convenience and greater resource potential compared to classical learning (35% of respondents). The third group represents the interests of high school students, who are not so much interested in the format of education as the opportunity to get out of the control of the teacher and find themselves in a convenient educational environment to simulate learning activities (25% of respondents). This means that online learning format, the usefulness of which is obvious only if students have a stable cognitive activity, is unacceptable for most high school students.
Keywords: online learning, quality of education, intensity of education, learning motives, high school students, pedagogues, parents.

Introduction

Online learning has been attracted close interest from scientists for last two decades. It is caused by new information and technical possibilities of organizing educational work in a remote format. Modern technologies provide instantaneous transmission of educational information over a distance and maintain synchronous audiovisual contact between the teacher and the student. Thanks to new technological opportunities, a teacher in the classroom is no longer considered by a certain part of society as something mandatory for receiving a quality education. This part of society represents online learning as a modern educational model that fully meets the requirements and demands of the time. This position is reflected in scientific discourse (Golovanova, 2019; Grechushkina, 2021; Smirnova, 2019). However, many scientists support an alternative point of view, according to which online learning is seen as a threat to high-quality,

intensive educational process (Ivanova and Murugova, 2020; Kuznetsov, 2020; Kovalev and Latsveeva, 2021).

It would be wrong to reduce the problem of the relevance of online learning in high school only to the technological aspect. The consciousness of children is not a computer program that can be filled with all the information necessary for life through technical communication channels. The main question is whether Russian schoolchildren have cognitive activity sufficient for the emergence of intrinsic motivation for learning activities. Depending on the answer to it, scientists determined the prospects for the development of e-learning in high school. In essence, this means that it was through the fact of acknowledging or denying motivation that the very possibility of transferring schoolchildren to the digital learning format was assessed. When answering this question, all experts are divided into two large groups: the first unites scientists who support assertion that schoolchildren are intellectually and socially ready to switch to online lessons – in their opinion, the majority of students will not lose motivation (Said, 2018; Solovieva and Semenova, 2020; Razmacheva, 2021; Kozitsyna, 2021). A different position is held by those who do not see high school students as having sufficient cognitive activity to switch to remote mode (Markeeva, 2020; Bakaeva, 2016; Nishanbaeva, 2021). The second point of view currently prevails in the scientific community.

The study of the established scientific discourse, however, showed that Russian sociologists had not conducted empirical sociological research on the study of the motivation, intensity and quality of education of high school students. The present work aims to close this gap in science.

Materials and Methods

The theoretical and methodological foundations of the study are based on the approach developed in the course of the joint scientific work of V.I. Chuprov and Yu.A. Zubok (Zubok and Chuprov, 2020; Chuprov and Zubok, 2008). The authors call it polyparadigm, uniting the most interesting results achieved in the previous scientific tradition in study of youth. In the framework of the scientific activities of these Russian sociologists, the most significant features that form the sociological definition of youth as an age group were integrated. "The variety of these features determines the complex internal structure of youth, its differentiation and differences, in which its essential properties are revealed. These are the transition of social status, lability, extremeness, transgressiveness of consciousness, increasing globalization and new forms of standardization" (Zubok and Chuprov, 2017). These characteristics have been detailed in the theoretical works of researchers. In them, young people are characterized by social instability, change of interests, mobile shift of value accentuations in the hierarchy of their own needs. The authors argue that the personal properties of this age group are extremely variable and this inevitably affects the properties of social interactions of young people. It is difficult for young people to fix their interest on one concrete thing, they need a change of impressions, a constant feeling of novelty.

It is necessary to say a few words about the author's categorical apparatus. It was developed in such a way that questions of the questionnaire together constituted a variable image of cognitive activity of high school students. The basic concepts differentiated in the questionnaire include: motives, needs, personality traits of a high school student, motivations for action, educational goals.

The empirical base of the study was formed on the basis of a mass sociological survey conducted by the authors in January-February 2022. Respondents who received personal experience of learning activities in online learning were interviewed. The study involved 860 high school students, 1246 parents and 636 teachers living in Rostov-on-Don. To increase the representativeness of the method used, the sample included the parents of the surveyed high school students and those teachers who had experience of teaching high school students online. Data processing was carried out in the SPSS-22 program.

Results and Discussions

First, we evaluate individual feelings from the learning experience (work, control of high school students) during the period of self-isolation and social distancing. We will be interested in attitudes towards compulsory online learning.

Table 1
Distribution of answers to the question: "What are your individual feelings from the experience of distance learning (working at school)?", %

Set points	Answers		
	High school students	Teachers	Parents
1. I would like to continue – it is convenient for me	50,0	22,9	7,4
2. I would like to continue – it improves the quality of education	16,6	6,7	3,5
3. I am against online – quality of education is declining	33,8	64,3	49,3
4. I am against online – I do not like to study in this format	27,3	30,8	61,6

The results were partly expected, but quite revealing. More than half of high school students would not mind going back to remote mode. But, importantly, the vast majority of respondents who made this choice pointed to the convenience of online learning, rather than its ability to provide quality education. Meanwhile, for this variable, the respondents could choose two options. However, convenience was chosen by 50% of high school students, and only 16.6% expressed confidence that online learning gives a quality result. We cannot say that high school students are not interested in quality issues, because 33.8% chose the option "I am against online – quality of education is declining." Even more significant results were shown by teachers (64.3%) and parents (49.3%), denying the ability of online learning to ensure the quality of education.

The largest scale of rejection of online learning is shown by parents. Among them, only 7.4% chose the option "I would like to continue – it is convenient for me" (teachers - 22.9%).

Supporters of online learning prioritize the convenience of study (work) when choosing this form of education. Cautiously for the time being, we will make an assumption that even to the detriment of quality. But so far this thesis has no valid evidence.

In addition to quality, the ability to maintain a high intensity of learning activities in online learning should be recognized as significant. It is understood as the ability to perform a certain amount of educational tasks per unit of time, or the ability to engage in educational activities for a certain period of time, or both.

Table 2
Distribution of answers to the question: "Did your intensity of learning activity decrease in conditions of online learning?", %

Set points	Answers	
	High school students	Teachers
1. I (high school student) solved more educational tasks, because I find it more interesting and more convenient to study remotely	32,2	7,1
2. I (high school student) solved a smaller amount of educational tasks due to overwork, reduced teacher control and loss of the opportunity to receive teacher explanations in time	30,9	41,9
3. It is difficult to answer / It depends on the individual characteristics of the children	36,9	50,9

There is one important aspect of this variable that needs attention. From the table 1 it follows that more than half of high school students are aimed at continuing their studies online. Meanwhile, only 32.2% of them are convinced that the intensity of their educational activities has increased. It can be assumed with some degree of confidence that in this group there is a large stratum of respondents who perceive online learning as a way to reduce the intensity of learning activities.

Connecting with the question of evaluating one's attitude to online learning will help us understand the potential size of the group of high school students for whom the rejection of classroom-contact learning can be interpreted as cost minimization.

Table 3

Conjugation of answers to the questions: "What are your individual feelings from the experience of distance learning (working at school)?" and "Did your intensity of learning activity decrease in conditions of online learning?", %

Did your intensity of learning activity decrease in conditions of online learning	What are your individual feelings from the experience of distance learning (working at school)			
	1. I would like to continue – it is convenient for me (50,0)	2. I would like to continue – it improves the quality of education (16,6)	3. I am against online – quality of education is declining (33,8)	4. I am against online – I do not like to study in this format (27,3)
1. I (high school student) solved more educational tasks, because I find it more interesting and more convenient to study remotely (32,2)	39,3	59,3	4,9	10,9
2. I (high school student) solved a smaller amount of educational tasks due to overwork, reduced teacher control and loss of the opportunity to receive teacher explanations in time (30,9)	26,0	15,0	56,0	46,1
3. It is difficult to answer (36,9)	34,7	25,7	39,1	43,0

Some explanations for the Table 3: in the line record there are three groups in which the assessment of the results of the intensity of learning activities in the online learning mode is determined. Frequency distributions are given in brackets. The columns indicate the characteristics of attitudes towards their own experience of distance learning. The status of the variables has an entry in the columns, because we find out how much learning tasks are performed by high school students in each of the four groups of schoolchildren who assessed their learning experience in online learning.

The pairing results show the reliability of the data obtained. Those who negatively assessed their experience of online learning, for the most part, are confident in its low intensity. For example, in the group "I am against online – quality of education is declining" – 56.0% indicated a decrease in the intensity of study (36.1% found it difficult to draw conclusions). There is also a noticeable strong change in relation to the average distributions: in the group of high school students who oppose online because of the deterioration in the quality of education, the variant "I solved more educational tasks" was chosen by 4,9% (for the total sample 32,2%); and by the group of high school students who do not like to study online – 10,9% (for the total sample 32,2%).

Other distributions among respondents, where the online experience is rated positively due to its convenience. In this group, the attitude to the intensity of study in the conditions of online learning does not differ much from the average values for the entire sample. Here, 39.3% of respondents solved more

educational tasks (32.2% in the total sample). The increase in the number of high school students who successfully solved a larger amount of educational problems, as we see, is insignificant. But this is not even more significant. As you can easily see at the intersection of the first column and the second line, 26% of high school students from this group (online is convenient) chose the answer option "I solved a smaller amount of educational tasks due to overwork, reduced control by the teacher and the loss of the opportunity to receive teacher explanation in time". Moreover, the downward differences in the total sample are not significant (26%<30.9%). It is in this segment that you need to look for the bulk of high school students, for whom online is just a way to reduce the intensity of learning.

Equally indicative are the results in the second column group: "I would like to continue – it improves the quality of education" (16.6%). Deviations from the average frequency indicators are very significant. In this group, 59.3% of respondents are convinced that they solve a larger volume of educational tasks (32.2% in the total sample). The decrease in the intensity of learning is no longer as noticeable as in the group where online learning was chosen for convenience. Only 15% indicated the solution of a smaller volume of tasks (30.9% in the total sample). These 15% of high school students are also potentially adding to the cohort of those who are aimed at reducing the intensity of their studies.

Having dealt with the data obtained and revealed their reliability, we then calculate the approximate number of high school students for whom the rejection of classical education can be interpreted as a conscious decrease in the intensity of educational work. To do this is quite simple. The action will be performed in two stages, separately for the groups "online is convenient" and "online is qualitatively". The first group ("online is convenient") makes up 50% of the entire sample (Table 1). In it, 26% of respondents indicated a decrease in the volume of tasks to be solved, and 34.7% found it difficult to answer. Both of these figures should be divided by two, highlighting half of the respondents from the total sample. Consequently, 13% of all high school students surveyed chose online only for the sake of convenience, and 17.3% presumably also, at least in some part of their learning activities. The second group ("online is qualitatively") makes up 16.6% of the entire sample (Table 1). It indicated a decrease in the volume of tasks to be solved and found it difficult to answer - 15% and 25.7% of respondents. Relative to the general sample - 2.5% and 4.7%. Summing up the results for both groups, it turns out that 15.5% (13% + 2.5%) of respondents chose online learning even in the face of a reflexive decrease in the volume of tasks to be solved, and 22% (17.3% + 4.7%) conditions of non-reflexible decrease in the volume of tasks to be solved. Thus, their choice of the form of education in favor of online is not associated with the success of solving educational problems. That is, convenience is a value in itself, acting as a priority in relation to intensity. These figures are very symptomatic and indicate a high percentage of respondents (more than a third of the number of respondents) for whom intensity in training is not considered a significant choice and needs external motivation.

Returning to the data in the Table 2, we note that more than a third of the surveyed high school students (36.9%) found it difficult to determine the state of intensity of their educational activities. The reasons for this may be different, but it is important for us to understand that more than a third of the respondents demonstrate that they do not have the proper indicators for evaluating the effectiveness of online learning. This is important from the point of view of learning motivation, because in this selected group, motives lose their connection with the results of education. This group can be defined as not being indifferent to learning results, but not having the ability to objectively assess the intensity of their learning activities.

The teachers were extremely critical. Only 7.1% supported the position according to which the intensity of learning activity in the context of online learning is growing (the fact of a decrease was noted by 41.9%). It is hardly possible to question their expertise on this issue. Let us assume that teachers themselves work more effectively in the online format, and this is inevitably reflected in the growth of the intensity of involvement of schoolchildren in the educational process. At the same time, more than half of teachers (50.9%) felt that the intensity of online learning "depends on the individual characteristics of children." Such a high percentage of answers for this position suggests that the effectiveness of learning activities for some students in online learning is increasing.

We did not find out the point of view of the parents, because considered that they did not have expert competence on this issue.

Next, we will connect the issues of quality and intensity of educational activity with motivation itself. To begin with, we present the results of the simplest (frequent) measurement of the state of motivation in online learning.

Table 4

Distribution of answers to the question: "Have you noticed in yourself (in high school students) a decrease in motivation for learning when switching to distance learning?", %

Set points	Answers	
	High school students	Teachers
1. No, homeschooling is convenient	46,4	5,6
2. No, learning online is very productive / No, high school students in any form of education understand well why they need knowledge	10,8	11,4
3. In part, studying at home is difficult / In part, some definitely pretend to study	32,7	43,6
4. Yes, learning at home is almost impossible / Yes, learning at home leads to partly imitation of learning due to sharp decrease of quality	10,1	39,3

It is easily to see that the positions of high school students and teachers diverge quite strongly. The most important difference stems from the assessment of the relationship between convenience and motivation. 46.4% of the surveyed high school students are convinced of the growth or maintenance of the previous level of motivation, because "homeschooling is convenient". Only 5.6% of the teachers surveyed agreed with this judgment. This range of opinions can partly be explained by the fact that the students spoke about themselves, and the teachers gave an expert assessment. And the answer "some definitely pretend to study" looked much more attractive. Understanding the risks of underrepresentation, we added the ability to select two set points to the teacher question variable. However, this did not increase the popularity of choosing the first two options. Teachers did not see a significant relationship between convenience and increasing motivation.

Equally diametrically different is the position between the two groups of respondents and in the opposite position, according to which a decrease in motivation is claimed in the conditions of online learning (fourth line of the table 4). Only 10.1% of the surveyed high school students considered "learning at home is almost impossible". Among teachers, such categoricalness was supported by 39.3% of respondents who chose the option "learning at home leads to partly imitation of learning due to a sharp decrease in quality".

If evaluated by the aggregate, the least likely option was "online is very productive" (10.8%) / "high school students in any form of education understand well why they need knowledge" (11.4%). High school students and teachers were given markedly different definitions. Pupils were asked about the quality of online learning, teachers about the presence of certain personality traits in high school students, with which society associates the onset of social maturity. In fact, teachers spoke about the lack of social maturity among high school students, and schoolchildren ignored the category of "learning productivity" as significant for themselves.

From this position, let's turn to a meaningful description of the relationship between motivation and the assessment of the intensity of learning activity in online learning.

We have already measured the linear distribution with respect to the intensity of online learning (Table 2). Recall that among high school students, three groups of approximately the same size were distinguished, in which one part of the respondents (32.2%) showed confidence in the growth of intensity in online learning, the second indicated its decrease (30.9%), and the third found it difficult in the choice of answer (36.9%). Motivation was measured separately from intensity, and slightly more than half of the total number of students surveyed noted that it did not decrease online (Table 4).

Now we need to use the "intensity" criterion to characterize the degree of involvement in educational activities of both motivated and demotivated high school students. This will help test the validity of judgments about their high motivation in online learning environments. This must be done for two reasons. First, any judgments of schoolchildren should be subjected to critical evaluation. Secondly, the opinions of high school students and teachers are diametrically opposed. As a test criterion, the questionnaire included the question "How often did you do extraneous activities during distance lessons?". Variants of

the proposed answers for this criterion acts as given values. The answers to the question about motivation are in the status of the variables that are being measured.

Table 5
Conjugation of answers to the questions: "Have you noticed a decrease in motivation for learning when switching to distance learning?" and "How often did you do extraneous activities during distance lessons?", %

How often did you do extraneous activities during distance lessons?	Have you noticed a decrease in motivation for learning when switching to distance learning?			
	1. No, homeschooling is convenient (46,4)	2. No, learning online is very productive (10,8)	3. In part, studying at home is difficult (32,7)	4. Yes, learning at home is almost impossible (10,1)
1. I was not distracted at all, I was constantly included in the educational process (30,7)	35,8	31,5	14,1	12,9
2. It is hard to keep attention, but I tried (36,6)	33,1	43,5	43,1	25,9
3. About half the time I switched to my own affairs (19,6)	18,4	16,3	27,9	24,7
4. Most of the time minding my own business (8,5)	9,1	7,6	12,7	15,3
5. Included in the lesson only when my teacher addressed me personally (4,6)	3,6	1,1	2,2	21,2

In Table 5 we have four groups of respondents. The first consists of those who find it convenient to study online; the second unites those who chose the option "learning online is very productive"; the third is formed from respondents who considered that "studying at home is difficult"; the fourth was formed through the choice of the judgment "learning at home is almost impossible". The first two groups can be considered motivated in terms of online learning, the third is partially motivated and the fourth is demotivated. The data is contained in four columns. The given values for them are judgments that characterize the intensity of the educational activity of the degree of readiness of schoolchildren to be included in the educational process online. The purpose of this conjugation model is to check the reliability of the answers of high school students in Table 4, which shows that 57.2% (46.4% + 10.8%) of respondents (in the first two groups of motivated ones) stated that their motivation in online learning does not decrease.

As a hypothesis, it would be reasonable to assume that the intensity of education in the two motivated groups will be noticeably higher than in the partially motivated or unmotivated group. In addition, two groups of motivated schoolchildren should be expected, if not a 100% choice of the given value "I was not distracted at all, I was constantly included in the educational process", then at least within the limits of 60%–70%. However, this hypothesis was only partially confirmed. Yes, indeed, in the two motivated (in terms of self-presentation) groups, a significantly smaller part of the respondents were distracted from the educational process (the first line of Table 5). But this is not even half of the number of the first and second groups. In the first group, 33.1% chose the option "It is hard to keep attention, but I tried", and in the second group even more – 43.5%. 18.4% in the first group and 16.3% in the second "About half the time I switched to my own affairs". 9.1% and 7.6% and even "Most of the time minding my own business".

Let us calculate, according to the same scheme, according to which the data in Table 3 were calculated, the percentage of high school students from the total sample, who spent half or more of their time doing extraneous activities during distance lessons. There are 15% of those in the two groups of motivated people. To these can be added 20.2% of those who had difficulty concentrating in online classes. We remind that these percentages are not within the group of motivated high school students,

but from the general sample. Intragroup distributions can be seen in the Table 5.

These figures show that the high level of motivation among high school students who stated that they have no problems with motivation in the online learning format does not correspond to the real state of affairs. Obviously, this means that in the structure of the personality of high school students there are social qualities that do not contribute to maintaining motivation at a high level in the process of online learning.

We use one more criterion to test the subjectively presented ability to find intrinsic motivation in the conditions of online learning: "What online learning format do you prefer to study in?". Respondents were asked to choose three set points: asynchronous, synchronous, and regular school. Objectively, only highly motivated people can learn effectively in asynchronous mode, because in it a priori there are no external impulses to motivation. About synchronous online and standard school education, it is unreasonable to make unambiguous conclusions about motivation on the proposed grounds. Therefore, the unconditional willingness to go to a distance can be seen only among motivated supporters of online learning.

Table 6
Conjugation of answers to the questions: "Have you noticed a decrease in motivation for learning when switching to distance learning?" and "What online learning format do you prefer to study in?", %

What online learning format do you prefer to study in?	Have you noticed a decrease in motivation for learning when switching to distance learning?			
	1. No, homeschooling is convenient (46,4)	2. No, learning online is very productive (10,8)	3. In part, studying at home is difficult (32,7)	4. Yes, learning at home is almost impossible (10,1)
1. Asynchronous: without teacher, completely self-guided (22,8)	37,2	19,5	9,0	7,1
2. Synchronous: when a teacher at computer conducts a lesson as if in a classroom (28,0)	39,7	37,0	15,1	5,9
3. It is better to study in a regular class at school (49,2)	23,1	43,5	76,0	87,1

Presented in the Table 6 data give us the opportunity to clarify two positions. First, to find out if all high school students who find the online format convenient or productive want to abandon the standard school education. Secondly, does the awareness of the fact of a decrease in motivation in the conditions of online learning lead to a negative attitude towards the synchronous or asynchronous format of educational work.

We are going to answer the first question first. Remind that the group of high school students, in which motivation does not decrease in the conditions of online learning, is divided into two subgroups: in one group, motivation does not decrease, because online is recognized as convenient; in the second because of its productivity. It should be recognized that in the first subgroup (online is convenient), according to the results of conjugation, 23.1% chose the answer option "It is better to study in a regular class at school", and in the second subgroup (online is productive) 43.5%, that is almost half. Such distributions at least show that the intention to continue the online learning experience, which was stated by 66.6% of the surveyed high school students (Table 1), does not at all mean their abandonment of the classroom system. This aspect of the analysis gives us additional information to conclude that the first group of motivated is extremely heterogeneous. This was already noticeable from the data included in

tables 4 and 5. In this group, there is a fairly high percentage of those who are indifferent to both the intensity and quality of training. Some details on these aspects are given to us by pairing the question of motivation with the question of preferences for the format of training. Thus, an indicative downward trend is visible within the "motivated to online learning" group: of those who associate motivation with convenience, only 23.1% choose the intention to study at a regular school; where staying motivated online is associated with the "productivity" category, 43.5% of high school students would prefer to study in a regular school. We also consider it no coincidence that asynchronous learning is most often chosen by those schoolchildren who are primarily focused on the convenience of the online mode (37.2%). Those who have not lost motivation in the online format, but who associate it not with convenience, but with the growth of their own learning productivity, choose asynchronous learning much less often (19.5%). It can be assumed that such significant preferences for online convenience and the desire to learn asynchronously, in fact, reflect the goal that is not manifested openly to get out of the control of the teacher in order to reduce their educational activity.

With regard to the group where motivation in the conditions of online learning is lost or partially lost (the third and fourth columns in Table 6), everything is very clear. Those who have partially or completely lost motivation are aimed at studying in a regular class (subgroup "studying at home is difficult" - 76.0% and subgroup "it is better to study in a regular class at school" - 87.7%). However, in these two subgroups there is a small part of high school students who, even with motivation lost online, choose synchronous or asynchronous learning. Our calculations showed that it is 9.1% of the total sample. With a high degree of probability, we can assume that these are schoolchildren who are not interested in either the quality or the intensity of learning activities.

A significant result of the survey was the identification of three groups of high school students: 1) reducing the performance of online learning and opposing this format; 2) reducing the rates of online learning and advocating this format; 3) supporters of this format that increase the performance of online learning. In terms of size, the groups are approximately equal with some preponderance towards the first of the three. But these are schoolchildren's ideas. Let us check them through the expert judgments of teachers and parents.

Table 7
Distribution of answers to the question: "Are high school students divided into those who are better off studying remotely and those who are better off studying in the classroom", %

Set points	Answers of teachers
1. All children show the best results in online learning	5,9
2. Some high school students are better off studying online: homebodies, disabled, shy, highly motivated	43,1
3. Transition to online had a negative impact on the quality of education for all high school students	51,0

Teachers, in general, confirmed the presence of the three groups listed above, but the quantitative distributions turned out to be quite different. Thus, only 5.9% of the surveyed pedagogues indicated that "all children show the best results in online learning". At the same time, 43.1% of teachers confirmed that among high school students there are children who are disabled, homebodies, shy, highly motivated, who are better off learning in electronic format. And finally, the majority (51%) agreed with the opinion that "transition to online had a negative impact on the quality of education for all high school students".

The opinions of teachers are also confirmed by the consolidated point of view of parents.

Table 8
Distribution of answers to the question: "When the school worked remotely, did you have conflicts with your child because of study issues?", %

Set points	Answers of parents
1. No, he/she did the right thing	39,7
2. No, I have no control over his/her studies.	13,1
3. Yes, I saw how during the lesson he/she was engaged in extraneous matters	17,8
4. Yes, I had to force him/her to study	29,4

Almost half of the parents indicated that they had conflicts with their children caused by an insufficient level of motivation to study online. In fact, there could be more of them, but we must take into account that not all parents have opportunity to control their children due to professional employment. The percentage received is only little more than what the high school students themselves said, referring to the decrease in their level of motivation during distance learning.

And finally, the last one. In the emerging discourse, many scientists, teachers and parents share the opinion that online learning is a modern model of education. Some suggest transferring school education to electronic format right now. Such projects were actively discussed during the pandemic in the context of the initiatives of the head of Sberbank, Herman Gref (School, 2019). After the end of the pandemic, the Internet was filled with advertising messages of various kinds of online schools that operate as an alternative to the regular high school. The main focus of advertising content unfolds through a description of the advantages of online education compared to studying in a regular school. This advertisement and the very functioning of the institution of alternative online learning became possible due to the presence in the Law on Education of Russia of a legal norm that gives parents the right to transfer their child to family education (clause 3, part 1, article 17). This construction is used by entrepreneurs in the educational services market to advertise their activities, without bearing any responsibility for the quality of education, because. Responsibility shifts entirely to the child's parents. In this regard, we decided to update and personalize the problem by formulating the variable in such a way that the respondents (teachers and parents) answered the question about their readiness to transfer not some abstract (foreign) children, but their own children to online learning.

Table 9
Distribution of answers to the question: "Would you choose online education for your child instead of a common school?", %

Set points	Answers	
	Parents	Teachers
1. Yes, in terms of online learning high school students develop intrinsic motivation better	5,4	8,4
2. Yes, modern high school students study better at the computer	5,6	8,6
3. No, high school students drastically reduce the intensity of education, when switching to online	41,9	41,2
4. No, online learning outcomes are worse than in the classroom system	52,3	49,6
5. I would choose it as additional education	32,5	39,8

The results obtained show that our experts do not accept online learning uncompromisingly. The percentage of teachers and parents who are ready to choose online education for their high school students instead of a general education school turned out to be negligible. The experts considered that in

the context of distance learning, schoolchildren do not develop intrinsic motivation at the required level, and the intensity of education and results of educational activities themselves do not meet the established standards. More or less significant interest in online learning is associated only with its implementation in the status of additional education. The data obtained could have been even worse for the supporters of online education, if some of the answers had not been pulled over by the option "I would choose it as additional education", because respondents were given the opportunity to make only two choices of given values.

Conclusions

The obtained results can be structured according to three main positions: the attitude to online learning, the perception of one's own motivation in the conditions of online learning, and the expert evaluation of the online learning work of high school students by teachers and parents.

Attitude towards online learning. The survey showed that the majority of schoolchildren (66.6%) are set to repeat the experience of online learning. However, out of this number, 50.0% of respondents perceive online as a form of education that is convenient for them, and only 16.6% associate it with an opportunity to improve the quality of education. As for the ability of the online format to support the intensity of learning activities, in the process of analyzing empirical data, three approximately equivalent groups were identified: 32.2% solved more learning tasks, 30.9% of respondents managed to complete a smaller volume, and 36.9% found it difficult to answer. The presence of a large number of set values who found it difficult to choose indicates the inability of this part of high school students to realize their own intensity of educational work in online learning, which casts doubt on the educational value of their choice of distance format. This is especially true in the context of the fact that in this group (36.9% of those who found it difficult to answer), 46.6% expressed their intention to continue the online learning experience. The fact that it is not worth taking literally the desire of high school students to study online without a critical reassessment is also evidenced by the fact that about a third of the students in the group who positively assessed the experience of distance learning (26% - "online is convenient"; 15% - "online provides quality") decided less the volume of educational tasks, which indicates a focus on imitation of education.

Perception of one's own motivation in the context of online learning. A direct question to high school students about the state of their motivation made it possible to single out four groups of respondents: motivation does not decrease, because learning online is convenient (46.4%); motivation does not decrease, because study online productively (10.8%); motivation is partially reduced, because studying at home is difficult (32.7%); motivation is reduced, tk. studying at home is almost impossible (10.1%). As you can see, 57.2% (46.4% + 10.8%) of high school students did not notice a decrease in motivation when switching to online learning. However, their chosen setpoints once again showed convenience over productivity. Convenience, of course, is a significant condition for increasing motivation in the educational process, but it can hardly be called decisive. And in this case, it can even act as a factor that reduces the readiness of high school students for intensive and high-quality education. This hypothesis was tested with two questions.

The first question is about the frequency of doing extraneous activities during distance lessons. In the group of those motivated because of the convenience of online learning, only 35.8% of respondents were not distracted by extraneous matters, and in the group of those motivated because of online opportunities to provide productive learning - 31.5%. The conducted pairing showed a low degree of reliability of the answers of high school students that their motivation does not decrease in the conditions of online learning.

The second question is about the preferences of the learning format: asynchronous, synchronous and regular class. This is a criterion in order to identify the relationship between the presence of motivation in an online environment and the willingness to abandon the traditional class-lesson system. It was found that in the group motivated because of online convenience, 23.1% want to study in a regular school, and in the group motivated because of online productivity - 43.5%. This means that even the presence of motivation in online lessons is not associated with greater productivity of digital education compared to a traditional school. And, conversely, some high school students from the two groups of partially motivated and demotivated online choose this particular format of learning. According to our calculations, they make up 9% of the total sample. Their aim is obvious: to get out of the control of the teacher.

All this confirms the hypothesis that the high motivation declared by high school students for the online learning process is actually more of an intention which is difficult to implement than a reality. It can be

assumed that such significant preferences for online convenience and the desire to learn asynchronously, in fact, reflect the goal that is not manifested openly to get out of the control of the teacher in order to reduce their educational activity. Obviously, this means that in the structure of the personality of high school students there are social qualities that do not contribute to maintaining motivation at a high level in the process of online learning.

Expert evaluation of educational work of high school students in online format by teachers and parents. Teachers (74.7%) and parents (81.8%) reacted negatively to the experience of high school in online learning, explaining this by the decline in the quality of education and the inconvenience of this format. Only 7.1% of teachers are convinced that high school students solved more learning problems in online lessons. 43.6% of pedagogues have encountered an attempt to simulate the learning process by students, and 39.3% believe that online learning is a complete imitation of the educational process. 51.0% of teachers believe that the transition to online has had a negative impact on the quality of education for all high school students. However, 43.1% specify that it is more convenient for some categories of children (homebodies, disabled, shy, highly motivated) to study remotely. 47.2% of parents came into conflict with their children due to the fact that they were engaged in extraneous activities during the lesson. And finally, only 5.6% of parents and 8.8% of teachers would like to transfer their children to online education. The latest data is especially characteristic of pedagogues: 25.3% of them would like to repeat the experience of online learning at school, but only 8.8% choose it for their own children. This confirms the point of view of some parents that a number of teachers advocate online learning only for their own convenience.

Based on the analyzed data, three approximately equal groups of respondents can be distinguished. In the first group, high school students are focused on the standard school-lesson system with elements of e-learning. According to our calculations, it consists of 40% of respondents. The second group articulates the advantages of online learning, which are associated with convenience and greater resource potential compared to classical learning. It contains about 35% of the respondents. The third group presents the interests of high school students, for whom, from the point of view of solving educational problems, it is not so much the format of education that is important, but the opportunity to get out of the control of the teacher and find themselves in an educational environment that is convenient for themselves. This group is formed from 25% of the respondents. The error in calculating the number of groups can be no more than 3-5%.

The main conclusion: in the presence of a dichotomy between quality and convenience, high school students choose convenience non-reflexively. This means that the online learning format, the usefulness of which is obvious only if students have a stable cognitive activity, is unacceptable for most high school students.

Acknowledgements

Conflict of interests
The authors declare no conflict of interest.

Author Contributions
Conceptualization – A. V. D. and V. V. K. ; Data curation – D. N. C. ; Formal Analysis – A. V. D. ; Investigation – A. V. D., V. V. K. and D. N. C.; Methodology – V. V. K.; Project administration – A. V. D.; Software – A. V. D; Supevision – A. V. D.; Validation – V. V. K., D. N. C.; Visualization – V. V. K. and D. N. C.; Writing – original draft – A. V. D., V. V. and D. N. C.; Writing – review & editing – A. V. D., V. V. K. and D. N. C. All authors have read and agreed to the published version of the manuscript.

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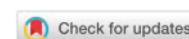
Students' Attitudes About STEM Teaching Case Study From Brčko District of Bosnia and Herzegovina

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Abstract: The knowledge that is based on science, technology, engineering, and mathematics is the basis for the development of any country. Less developed countries lack experts in these areas. Therefore, the ENABLE-BIH project (Enhancing and Advancing Basic Learning and Education in Bosnia and Herzegovina) was introduced in Bosnia and Herzegovina, which aims to improve the situation in the education sector. This study included the Public Institution "Ninth Elementary School" in Brcko District of Bosnia and Herzegovina in which this project was implemented. The study included a total of 125 students from this school. The aim of this study is to examine the difference between attitudes about STEM from the point of view of gender differences and the age of students. After the data were collected, the statements were grouped into appropriate factors using factor analysis. The factor analysis showed that five factors stand out in this research. The results of multiple regression analysis showed that there is no difference between students 'attitudes regarding gender differences, while there is a difference regarding students' age. The results of this research showed that the ENABLE-BIH project delivered good results and suggests the importance of implementing similar projects in the future.
Keywords: STEM, Brcko District of Bosnia and Herzegovina, ENABLE-BIH, multiple regression analysis, factor analysis.

Introduction

The country's economic growth and development should be based on new technologies and innovations (James, 2021). Science and engineering are the basis for economic growth and development (Sahin-Topalcengiz and Yildirim, 2019). Nowadays, more investments are done in educating staff who will apply this new knowledge based on science, technology, engineering, and mathematics (STEM). The best example of the former is the field of energy efficiency (Radojević, Nikolić and Skerlić, 2020). The best example of the former is the field of energy efficiency (Pašalić et al., 2020). However, many countries have challenges with STEM education (Beswick and Fraser, 2019). Tran (2018) pointed out that innovation is crucial for the development of the United States of America (USA), but it lags behind other developed countries in the production of its own qualified staff with STEM competencies. The situation is similar in other countries where demand for STEM skills is growing (Marginson, et al., 2013). Developing countries are increasingly investing in STEM education (Kelley and Knowles, 2016), and this trend has been present in Bosnia and Herzegovina (BiH) in recent years. The biggest challenge in the education of staff for STEM areas is the lack of interest of students to study these areas (Waite and and McDonald, 2019). Therefore, it is necessary to gradually introduce these areas to students in the earliest educational process (Ghanbari, et al., 2023).

Bosnia and Herzegovina has begun the introduction of STEM areas in teaching in secondary and primary schools in recent years. The ENABLE-BiH project (Enhancing and Advancing Basic Learning

and Education in Bosnia and Herzegovina) was introduced in 2016 in Bosnia and Herzegovina, with the aim to improve learning about STEM courses. The basic idea of this project is to avoid focusing on special or separate disciplines and connecting these courses through practical application. With this approach, students can acquire the key skills and competencies necessary for further progress in the modern environment. This project was implemented throughout the whole country, and 12 schools and 4 areas in Bosnia and Herzegovina were selected. Two schools from the area of the Brcko District of Bosnia and Herzegovina (BDBiH) have participated in this project. BDBiH is a unique administrative-territorial unit of local self-government under the sovereignty of Bosnia and Herzegovina, which represents its specificity in relation to other areas in the country. Thus, this is the reason for special research interest in the implementation of this project in BDBiH.

The aim of this study is to examine the attitudes of students towards STEM teaching implemented within the ENABLE-BiH project, which is implemented in the Public Institution "Ninth Elementary School" in BDBiH. The special research attention is focused on differences in attitudes towards STEM teaching within the ENABLE-BiH project in relation to the gender differences of students and students who attend general and specialized classes. The contribution of this research is reflected in the following:
- Obtaining significant information from students related to STEM classes;
- Determining the existence of differences between students' attitudes;
- Providing guidelines for the improvement of STEM teaching in primary education;

In addition to the introduction, this paper consists of five other sections. The second section provides the theoretical framework for the study. The third section oversees the research methodology. This section explains how the research was conducted, presents a research sample, and set research hypotheses. The fourth section provides the findings of the research. In this section, the collected claims are grouped into factors, and then the hypotheses are tested through multiple regression analysis. In the fifth section, the obtained results are explained in more detail through discussion, and the findings are compared with other similar studies. The sixth section presents the most important research results providing guidelines for future research.

Theoretical framework

The concept of STEM education is not a new concept as some authors claim, but this term appeared in the 19th century at Harvard University as part of the standardization of the agricultural school system (Ostler, 2012). After that process, this term was not used often in education, only to come to attention in the 1990s when the National Science Foundation in the United States identified areas crucial for improving economic work in the United States (Herro, et al., 2017). The acronym STEM stands for the education of students in the fields of natural sciences, computer science, engineering, and mathematics. STEM is a specific educational program, designed with the aim of using knowledge from the STEM fields when solving problems in everyday life (Rizvanović and Alihodžić, 2019).

The term STEM refers to the integration of science (S), technology (T), engineering (E), and mathematics (M) which relates to both workforce and everyday life experiences (Pimthong and Williams, 2018). The STEM term is relevant because every scientific discipline encounters complex and multidimensional problems that need to be solved. To make full use of STEM potential in students, schools need to improve STEM education and improve teaching (Margot and Kettler, 2019). Gomez and Albrecht (2013) advocate the establishment of STEM education and teaching in schools through an interdisciplinary approach. Establishing STEM education in school is an innovative approach to education, it is widely applied in the global environment and is the basis for the development of educational policies and reforms (Nguyen, Nguyen and Tran, 2020). The principle of introducing STEM teaching in schools emphasizes the importance of students' understanding of science and mathematics but all to be integrated through theology and engineering (Chesky and Wolfmeyer, 2015). The integration and application of STEM concepts and processes are needed by students who should have the opportunity to participate in real multidisciplinary situations (Pimthong and Williams, 2018). The application of STEM teaching with real examples opens up perspectives for students to learn the basics of using STEM disciplines.

The importance of students' education in STEM areas has gained importance worldwide, and demand for these skills is growing. However, students drop out from these courses, and almost 50% of students do not complete these courses (Chen, 2013). The situation is similar in Germany (Heublein, et al., 2012) and in other countries. In the last twenty years, a decrease in the number of students who choose to continue their education in STEM fields has been observed in many European countries (Babarović, Pale and Burušić, 2018). It has been proven that lower achievements in STEM courses in primary education can influence the choice of continuing education in STEM areas (Wang and Eccles, 2013). To solve this problem, an adequate way to increase students' interest in STEM subjects is sought (Sadler, et al.,

2012). Rosenzweig and Wigfield (2016) point out that STEM educational programs conducted in the upper grades of elementary schools and high schools motivate students for STEM areas and increase their aspirations toward STEM careers. That is the justification why there are more projects in the world that are being introduced in primary and secondary schools in order to increase students' interest in studying in these areas. The introduction of STEM in education gives high autonomy and independence to students in solving problems in STEM, creates content and activities tailored to the individual needs of students, and there is an interactive approach in teaching aimed at developing student competencies (Rizvanović and Alihodzić, 2019).

Based on the recommendations of the European Commission for Education, which focused on the promotion of key competencies and their inclusion in the education system, the Agency for Preschool, Primary and Secondary Education (APOSO) in 2012 identified key competencies to be developed in Bosnia and Herzegovina. In 2016, following these recommendations, the ENABLE-BiH project was launched in Bosnia and Herzegovina, which aims to strengthen education in STEM areas. The goal of this project has been to contribute to the process of changing the educational paradigm in Bosnia and Herzegovina to enable the development of society and a knowledge-based economy (Mrdović, 2018). This project seeks to set the framework and create a comprehensive basis for the introduction of STEM areas in regular education within existing and / or innovative teaching content. Furthermore, this project aims to integrate different disciplines such as natural science, mathematics, and technology through STEM into a cohesive learning paradigm based on practical applications (Rizvanović and Alihodzić, 2019). Following these interests, a common core curriculum was formed in Bosnia and Herzegovina, composed by the Agency for Preschool, Primary, and Secondary Education (APOSO). In addition, operational curricula for STEM competencies have been designed in order to align the results in mathematics, physics, chemistry, biology, geography and informatics, as well as for the courses environment, nature and society, and similar courses with global trends and standards. Therefore, it is important to investigate how students perceive teaching in STEM areas and what their attitudes are towards STEM.

Materials and Method

In this section, an overview of the survey questionnaire, the research and the basic characteristics of students who took part in the survey are presented. Additionally, the research hypotheses based on previously conducted research are introduced. When conducting the research, primary research will be used using questionnaires. The collected questionnaires are coded and prepared for analysis using the SPSS (Statistical Package for the Social Sciences) 20 software package. The following analyzes will be calculated with this software package: exploratory factor analysis, correlation analysis and regression analysis.

Survey data
The ENABLE-BiH project was implemented in 12 schools in different regions of Bosnia and Herzegovina. Seven primary schools and five secondary schools were included. A total of 2556 students were included in this project, of which 1636 were students from primary schools, while 920 students were included from secondary schools. The aim of this project was to examine the differences in attitudes towards STEM studying in relation to gender differences of students and in relation to the differences in form of classes looking at general courses and specialized courses, the basic research sample included students of primary schools who took a part in the project. Due to technical and other issues encountered in this study and due to the specifics of Brcko District of Bosnia and Herzegovina, this research was conducted in Public Institution "Ninth Primary School" Maoča. The study included students of the second and third triad who were sent survey questionnaires. A total of 125 students from this school were included, which represents 7.64% of the research population from this school.

For the purposes of this study, the research was conducted in the Public Institution "Ninth Elementary School" located in Brcko District of Bosnia and Herzegovina. This research included students of the second and third triad who were asked to take a part in the survey. The survey questionnaire consisted of two parts. The first part of the questionnaire referred to the characteristics of students in terms of a gender, form of classes and the success of students in the previous period (Figure 1). The second part of the questionnaire consisted of statements related to students 'attitudes about students being required to give their grades ranging from 1 to 5, where 1 was the lowest grade and 5 was the highest grade. A total of 21 questions were used, which are presented in Table 2.

Data was collected from students of the selected school in two ways. Survey questionnaires in

paper form were distributed to general class students, while electronic survey questionnaires were sent to students of specialized courses. The justification of this approach one can find in the fact that general class students do not have the informatics course in their curriculum, while specialized class students have this course included, thus these questionnaires were sent as part of the course activity.
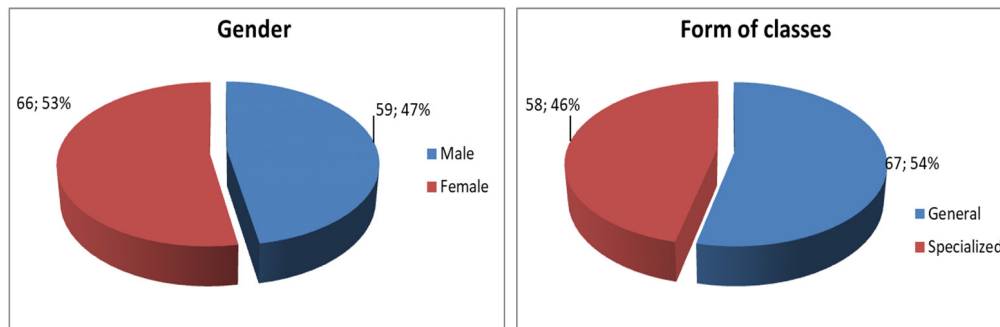

Figure 1. Characteristic of students

A total of 149 questionnaires were collected. However, only 125 questionnaires were included in the analysis because the rate of their completeness rose more than 80%. Survey questionnaires that were completed below 80% were not included in the survey, thus 24 survey questionnaires were excluded from further analysis. All survey questionnaires were coded and included in the statistical package SPSS (Statistical Package for the Social Sciences). Using this software, students' attitudes were first grouped by exploratory factor analysis (EFA), followed by the examination of the reliability of the measurement scale using Cronbach's alpha (CA) indicators, and then the research hypotheses were examined using multiple regression analysis (VRA).

Research hypotheses

The study of STEM areas is influenced by many factors. Babarović, Pale and Burušić, (2018) in their research highlighted the following factors: gender differences, student age, and student motivation. Reinking and Martin, (2018) pointed out that gender factors are key to accepting STEM study, and at the same time they influence students 'attitudes. In some other studies, it is pointed out that gender differences are decisive factors for acceptance of the STEM areas (Mavriplis, et al., 2010; Robinson and Lubienski, 2011; Legewie and DiPrete, 2014). Therefore, this research is focused to investigate gender differences and the age of students on their attitudes about STEM study.

By studying gender differences, no unambiguous results were found by Rosenzweig and Wigfield (2016) who concluded that gender does not moderate the systemic effect of motivational interventions. From the above, it can be expected that future STEM interventions will be equally effective for all students. However, the findings by Huppatz and Goodwin (2013) showed that girls lose the most interest in STEM areas between the ages of nine and twelve. Furthermore, Kuschel, et al. (2020) showed that there are a small number of women entrepreneurs in STEM areas, which emphasizes the existing gender biases and systemic shortcomings in social structures. However, the results showed that since the beginning of the 1990s, the number of women who have graduated or obtained their master's or doctoral degrees in STEM areas has increased (Reinking and Martin, 2018). Still, women are less represented in STEM areas (Legewie and DiPrete, 2014), which is confirmed by research conducted by the authors Wang and Degol (2016). Based on this, the following hypothesis is set for this study:

H1 – Gender differences in students affect the attitudes toward teaching within the framework ENABLE-BiH project

Although there is not enough evidence to draw firm conclusions that intervention programs are effective for younger students, there is general knowledge that supports this assumption (Babarović, Pale and Burušić, 2018). It has been also shown that motivation and interest in STEM areas decline during the senior years of primary school (Bryan, Glynn and Kittleson, 2011). This is especially present with the female population because they lose interest in the STEM areas during studies, and this is especially present for mathematics courses (Robinson and Lubienski, 2011). Daugherty, Carter and Swagerty, (2014) suggested that in order to increase students' interest in STEM areas, it is necessary to start encouraging them in a primary school. Opinions about STEM education and engagement are also influenced by transitions within education, from preschool to primary education and from primary to secondary education (Perry and MacDonald, 2015). Archer et al. (2012) in their research showed that the aspirations and attitudes of students aged from 10 to 14 years do not differ significantly. Due to the differences in previous research

results, it is necessary to investigate whether differences in age or attendance affect students' attitudes about STEM studies. Based on this, the following hypothesis is set in the research:

H2 – Age of the students influences the attitudes regarding the teaching within the framework ENABLE-BiH project

Results

Before testing the hypotheses, it is necessary to group the claims via EFA. Within EFA analysis, Varimax factor rotation and Kaiser Normalization were applied (Zhou and Li, 2023). The application of Kaiser Normalization determines the number of factors in the conducted EFA analysis. In order to group a statement into one factor, its value according to Kaiser Normalization must be greater than 1. When performing EFA analysis, it is necessary to meet certain conditions, namely: the correlation matrix is suitable for EFA analysis, which is proved by the Kaiser-Meyer-Olkin (KMO) indicator of sample adequacy and the sphericity of data by Bartlett's test is satisfied. The values of the KMO indicator should be greater than 0.6, while in Bartlett's test the significance level should be less than 0.05 (p <0.05) (Puška, Maksimović and Stojanović, 2018). The results obtained by EFA analysis showed that the sample is adequate (KMO = 0.894) and the data are spherical (p <0.000), which confirms this analysis.

The obtained results of EFA analysis showed that the claims were grouped into five factors in which 72.49% of the variance was explained. The obtained factors were used to examine the reliability of the measurement scale of the questionnaire via CA indicators. The value of this indicator should be greater than 0.70 (Al-Ansi, et al., 2023).

The first factor covered seven claims and explained 22.781% of the variance (table 1). This factor seeks to explain the experience of students in STEM teaching and it provides answers to whether STEM teaching is better than traditional and whether students would still have STEM teaching. The highest grade for this factor was given to the statement "STEM teaching is useful for students" (average = 4.55), while the lowest grades were given to the statements: "I am proud to be part of STEM teaching" and "I would like to continue to have STEM teaching" (average = 4.14). The value of standard deviations (SD) showed that the highest variance in grades for the statement "I wish I still had STEM teaching" (SD = 1,183), while the lowest variance in grades for the statement "STEM teaching is useful for students" (SD = 0.844). The obtained value of the CA indicator (CA = 0.897) showed that the measurement scales of the collected data are reliable for this factor.

The second factor included six claims. This factor seeks to explain whether STEM teaching is interesting and fun for students and whether it allows them to better understand teaching material. The statement "I like examples in STEM teaching" received the highest grade for this factor (Average = 4.50), while the statement "STEM teaching interests me" received the lowest grade (Average = 4.31). The highest variance of grades is found in the statement "STEM teaching is more interesting than traditional" (SD = 1,083), while the lowest variance is in the statement "I like examples in STEM teaching" (SD = 0,783). Measuring scales (CA = 0.835) were also found to be reliable for this factor.

The third factor included three statements where the average values are between 4.33 and 4.42. This factor seeks to explain the usefulness of STEM teaching for students. Of these three statements, the greatest dispersion was in the grades of the statement "STEM teaching helps me master the material" (SD = 1,028), while the smallest dispersion in grades for the statement "STEM teaching makes learning easier" (SD = 0,898). The value of the CA indicator (CA = 0.82) confirmed the measurement scales.

The fourth factor included the fewest claims of all factors, namely two claims in which the average score is uniform. This factor explains the experience of students with STEM teaching. The statement "My experience with STEM teaching is very good" (SD = 1,285) had a greater dispersion of grades. The performed CA analysis (CA = 0.838) confirmed the measurement scale for this factor. The fifth factor included three claims. This factor explains whether STEM teaching aids learning by better understanding the material. The statement "STEM teaching improves my understanding of the material" received the highest average grade (Average = 4.41), with the lowest variance in grades (SD = 0,920). The lowest average grade was given to the statement "STEM teaching helps me learn" (Average = 4.24), which had the highest dispersion (SD = 0,920). For this factor, the measurement scale for the questionnaire was confirmed (CA = 0.745).

Table 1.
Factor and descriptive analysis of claims

Claims	Factor correlation	Mean	SD	Cronbach's Alpha
Factor 1 – Explained variance = 22.781				
I am proud to have been a part of STEM classes	0.832	4.14	1.119	0.897
I would recommend STEM classes to everyone	0.830	4.30	0.975	
STEM teaching is better than traditional teaching	0.748	4.27	0.971	
I wish I still had STEM classes	0.725	4.14	1.183	
I wish there were more STEM classes	0.646	4.34	1.088	
STEM teaching is useful for students	0.603	4.55	0.844	
I enjoy STEM classes	0.597	4.20	1.052	
Factor 2 – Explained variance = 15.670				
STEM teaching allows connecting teaching material	0.702	4.46	0.822	0.835
STEM teaching interests me	0.688	4.31	1.033	
The quality of STEM teaching is excellent	0.663	4.32	0.926	
STEM classes are more interesting than traditional ones	0.605	4.35	1.083	
I like examples in STEM classes	0.590	4.50	0.783	
STEM classes are fun	0.496	4.42	0.917	
Factor 3 – Explained variance = 12.547				
STEM classes help me master the teaching material	0.738	4.33	1.028	0.828
In STEM teaching I understand the material better	0.691	4.34	0.906	
STEM teaching facilitates learning	0.658	4.42	0.898	
Factor 4 – Explained variance = 10.948				
I have a pleasant experience with STEM teaching	0.880	3.94	1.169	0.838
My experience with STEM teaching is very good	0.791	3.95	1.285	
Factor 5 – Explained variance = 10.544				
STEM teaching helps me to learn	0.839	4.24	1.133	0.745
I look forward to STEM continuing in the future	0.619	4.33	1.030	
STEM teaching improves my understanding of the material	0.607	4.41	0.920	
KMO = 0.894; Bartlett test = 1818.709; p < 0.000; Total explained variance = 72.490				

The study of the relationship between the factors was performed using the Pearson correlation coefficient. The results obtained by this analysis showed that for all factors there is a significant positive correlation at a significance level of less than 0.01 (Table 3). Factors 1 and 2 were the most closely related (r = 0.784; p <0.01), while factors 3 and 4 were the least related (r = 0.495; p <0.01)

Table 2.
Correlation between research factors

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1	1.000*				
Factor 2	0.784*	1.000*			
Factor 3	0.588*	0.749*	1.000*		
Factor 4	0.590*	0.594*	0.495*	1.000*	
Factor 5	0.697*	0.659*	0.650*	0.576*	1.000*

Note: *. Correlation at a significance level of 0.01

The research hypotheses were tested using the VRA (Oliinyk, 2023). The task of the VRA is to include several factors in the analysis to assess the impact of independent variables on the dependent variable (Famo and Machate, 2023; Štilić, et al., 2023). The examination of the hypotheses was carried out by applying indifferent statistics at the significance level of 0.05 (Abdeldayem, Aldulaimi and Baqi, 2022). Since two hypotheses have been set, two VRAs were applied.

During the examination of the first research hypothesis, we started from the assumption that there is a significant difference in students' attitudes in relation to the gender difference, and for that purpose,

a VRA model was created. The results of this analysis showed that there is no significant statistical difference in these attitudes (F-test = 1,779; p = 0.122), which provided a basis for rejection of the first hypothesis of the research. This VRA model explained 7% of the baseline (R2 = 0.070). Observing the individual influence of the factors, it was noticed that only with factor 5 there is a significant statistical difference (t-test = 2.128; p = 0.035), and this factor had the greatest influence on the direction of the regression function (Beta = 0.295). With two factors there is a negative influence on the direction of the regression function, namely with factor 1 (Beta = -0.192) and factor 3 (Beta = - 0.112).

While we examined the second hypothesis, the research started from the assumption that the age of students influences attitudes about STEM teaching. For this purpose, two groups of students were formed. One group of students attends general classes and the other specialized classes. The results of the conducted VRA showed that there is a significant statistical difference between the observed groups of students (F-test = 11,088; p = 0,000), and thus the second research hypothesis was accepted. This VRA model explained 31.8% of the baseline (R2 = 0.318). Observing the partial influence of individual factors on the regression function, there is a significant statistical difference between three factors: factor 1 (t-test = 2,869; p = 0.005), factor 3 (t-test = -5,204; p = 0.000) and factor 4. (t-test = 2,780; p = 0.006). It should be mentioned that with factor 2 (Beta = -0.161) and factor 3 (Beta = -0.633) there is a negative influence on the direction of the regression function. The same results would be obtained by applying ANOVA analysis because hypotheses are tested in MRA in SPSS using ANOVA analysis (Puška, Maksimomvić and Stojanović, 2018).

Table 3.
Hypothesis testing using regression analysis

Independent variable: Gender difference	*Beta*	*t-value*	*p*
Factor 1	-0.192	-1.217	0.226
Factor 2	0.071	0.404	0.687
Factor 3	-0.112	-0.789	0.431
Factor 4	0.136	1.162	0.248
Factor 5	**0.295**	**2.128**	**0.035**
Model summary: R = 0.264; R² = 0.070; F-test = 1.779; significance = 0.122			
Independent variable: Age	*Beta*	*t-value*	*p*
Factor 1	**0,387**	**2.869**	**0.005**
Factor 2	-0,161	-1.068	0.288
Factor 3	**-0,633**	**-5.204**	**0.000**
Factor 4	**0,278**	**2.780**	**0.006**
Factor 5	0,012	0.102	0.919
Model summary: R = 0.564; R² = 0.318; F-test = 11.088; significance = 0.000			

Discussions

In order to determine the existence of differences between students' attitudes regarding STEM teaching which was implemented within the ENABLE-BiH project, which was assessed in the Public Institution "Ninth Elementary School" Brcko District, data were first collected by students through a questionnaire. The questionnaire was distributed in two ways, physically and electronically, with paper and electronic questionnaires. It was observed during the data collection that a smaller number of blank questionnaires were for questionnaires distributed in paper form compared to questionnaires distributed in electronic form. The reason should be sought in the fact that students who received an electronic version of the questionnaire could open it on various media (Petrović, 2014). Some students opened the survey, started filling it out, and dropped out. Another disadvantage of the electronic survey is that one student can fill in the survey several times. However, in this research, access to the surveys was limited

with the IP address disabling that one student completes the survey more than once. In this way, this shortcoming was solved.

Factor analysis grouped the data collected from students and the claims related to STEM teaching from the ENABLE-BiH project were grouped into five factors. These factors cover 72.49% of the variance that is common for social research (Puška, et al., 2021). Looking at the claims placed in the corresponding factors one can see there is a connection between these claims. In factor 1, all the claims are related to the intention to further use STEM teaching, that STEM teaching is useful and that students enjoy it. Factor 2 grouped the claims concerning the interestingness, quality, and fun of STEM teaching. Factor 3 grouped the claims concerning understanding, mastery, and learning assistance by STEM teaching. Factor 4 grouped the claims related to STEM teaching experience. Factor 5 included the claims regarding learning assistance, rejoicing in the continued use of STEM teaching, and the claim related to understanding the material.

The obtained values showed that there is a positive significant correlation between all factors. The correlation for all claims ranges between 0.495 and 0.784, which is a very good correlation, especially when it comes to social research (Puška, Maksimović and Stojanović, 2018). However, this association does not mean that the gender difference and the age of students influence the observed factors. The results of the VRA showed that the age of students affects the observed factors while the gender difference does not. These results indicate that boys and girls equally accept STEM teaching and their attitudes are similar, thus confirming the results provided by Rosenzweig and Wigfield (2016). The attitudes they used are most similar in factor 2 because the significant value in VRA is the highest which shows that there is the smallest difference in attitudes in this particular case. With factors 1 and 3, there is a negative influence on the direction of regression analysis, which indicates that girls have better attitudes than boys regarding these two factors. This indicates that interest by girls has not decreased in STEM teaching, which does not confirm the results provided by Huppatz and Goodwin (2013). This finding is very positive, as it reduces gender discrimination in STEM teaching. If girls maintain their interest in STEM teaching, it is expected that there will be a larger number of women who will work in STEM areas in Bosnia and Herzegovina in the future. In this way, the justification of the ENABLE-BIH project in Bosnia and Herzegovina was confirmed, because this project delivered a positive effect on students in their early years and reduces gender discrimination in STEM areas.

Observing the difference between the ages of students, the results of the VRA showed that there is a significant difference between the attitudes. However, by analyzing individual factors, one can see that in factors 2 and 3 there is a negative impact on the direction of regression analysis, which shows that students from specialized classes have better attitudes towards these factors than students from general class. Furthermore, the results for factor 5 indicate that there is no difference between the attitudes of these students. In this way, it was proven that students' attitudes do not decrease with the age of students, and the observed students accept STEM classes from the ENABLE-BiH project equally well, thus denying the results from Bryan, Glynn and Kittleson, (2011).

The findings from this study show that there is no gender discrimination in terms of acceptance of STEM classes' from the ENABLE-BiH project. In addition, the results show that the interest is higher in certain segments of STEM teaching among students in specialized classes in relation to students in general classes. All mentioned point to the fact that the ENABLE-BIH project provided good results and it is necessary to implement more similar projects in order to improve the situation in Bosnia and Herzegovina in the STEM area. With the improvement of the STEM area, it is possible to achieve the growth and development of Bosnia and Herzegovina.

Conclusions

Education in STEM areas is key for the development of any country. Influencing the acceptance of STEM studies by students provides a good basis for continuing studies in these areas, which creates a favorable climate for development. This research was conducted in the Brcko District of Bosnia and Herzegovina and included students of the Public Institution "Ninth Elementary School". The aim of this study was to examine the existence of differences in the gender and age structure of students. The results show that there is no gender difference in students' attitudes towards STEM teaching implemented within the ENABLE-BiH project, thus rejecting the first hypothesis of this research. Furthermore, the results show that there is a difference in terms of student age, thus accepting the second hypothesis of this study. Further insight into the results of the VRA indicates that there is a difference between the attitudes of students, but there is no uniform difference. Some claims are better assessed by students from specialized

classes in relation to students from general classes and vice versa. In this way, it has been proven that students are equally interested in STEM teaching.

The study findings show that the ENABLE-BIH project implemented in Bosnia and Herzegovina delivered good results, which was fully confirmed by this research. Therefore, in the future, more similar projects should be implemented in Bosnia and Herzegovina in order to influence students to continue their studies in these areas. Furthermore, the implementation of this project has shown that students need to get closer to the STEM area, by making a connection between these areas in teaching that is also enriched with practical exercises. In this way, students can understand these areas and have better attitudes regarding these STEM. This should affect the strengthening of STEM areas in Bosnia and Herzegovina and contribute to the development of the country. In the future, it is necessary to include more schools and students with similar projects in order to have a greater impact on the acceptance of STEM areas by students.

This study has shown that innovations in education, in this case, the convergence of STEM areas through the connection of different areas, have a significant impact on the students' acceptance of STEM studies. In future projects and research, it is necessary to use innovations in teaching in a similar way to improve students' curiosity for STEM studies, which creates a precondition for strengthening these areas in certain countries. The scientific validity of the conducted research was to understand how elementary school students accept STEM subjects because it is very important to prepare students for these subjects. The social justification of this research is based on the preparation of students in elementary school for these subjects, so that they can continue their careers in them and so that there will be no shortage of occupations in the future.

Acknowledgements

Conflict of interests
The authors declare no conflict of interest.

Author Contributions

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

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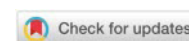
The Impact of the Application of rhe Online Teaching Model on the Development of Digital Competencies of Future Preschool Teachers

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Abstract: In this study, the influence of the application of an online teaching model on the development of digital cometences of future teachers in preschool institutions was examined. The research that this study deals with was carried out on a sample consisting of N=125 students of the 3rd year of basic academic and professional studies in the study program of teacher in preschool institutions. As a research instrument, a five-point Likert-type scale of attitudes was used. The results show that there is a statistically significant difference in the attitudes of future teachers in preschool institutions when it comes to self-assessment of digital competencies before and after the implementation of online classes during the state of emergency in Serbia during the Sars-Cov-2 virus pandemic. The conclusion of the study is that the implementation of online teaching in processing the content of the Methodology of getting to know the environment affects the improvement of the digital competences of future educators when it comes to: 1) creating digital resources; 2) application of digital technologies in immediate educational work; 3) the role of digital technologies in professional development. The results of this research can be used to encourage teachers to step out of the usual pre-pandemic practice and enrich their pedagogical work with combined teaching (hybrid model) where part of the material would be analyzed in person, and part would be analyzed online using web tools, websites and videoconferencing applications.
Keywords: digital competences, online teaching, Methodology of teaching science.

Introduction

"Whether or not computers will enrich the learning environment of preschool children depends on the knowledge, skills and attitudes of preschool teachers. Colleges and universities for the education of future educators play an important role in providing opportunities for students to acquire appropriate knowledge, skills and positive attitudes towards the use of computers in preschool education" (Kutluca and Gokalp, 2011). In addition to compulsory and elective courses in the field of digital competence development attended at college / university, the indirect development of digital competence through various courses in which digital technologies are used to achieve the outcomes of these courses is of growing importance.

Kalogiannakis (2010) indicates that there is a gap between the ICT subjects attended by future preschool teachers at the university and the expected level of ICT use in the environment of preschool education, and points out that adequate education of future preschool teachers during their studies is of crucial importance for the application of digital technology in preschool. Shortcomings in the use of digital technologies found in preschool are determined by the following factors: study plans and training of trainers (Romero-Tena et al., 2020). This is in line with the opinion of preschool teachers who recognize the educational level and training in the field of digital technology as the most important factors influencing the application of digital technology in practice (Liu and Pange, 2015), and believe that they need additional training in this field during their professional development (Mikelić Preradović, Lešin and Boras, 2017).

Training and professional development of educators, preparing them for the process of lifelong learning (Life Long Learning), monitoring trends and frequent changes in information and communication technologies is an unavoidable process that cannot be bypassed. The facts and results of research (published in the world and in our country) that indicate that the introduction of information technology into the preschool educational system is a response to the needs of children and in the interest of the child, represent one of the decisive driving factors for the active participation of educators in the process of integrating information and communication technologies in educational work. This determines the direction of the development of the program for the professional development of educators in practice, and certainly of students who are preparing for the profession of educators (Veličković, 2014).

On the other hand, the authors point out the attitudes (and skills) of ICT use as important factors, which shape their use in the preschool context (McCarrick and Li, 2007). Attitude is considered one of the decisive factors in predicting an individual's behavior (Tatalović Vorkapić and Milovanović, 2012). When it comes to the use of computers in preschool conditions, the attitude towards computers is defined as a "general assessment of a person or a feeling of acceptance or antipathy towards digital technology and computer-related activities" (Smith, Caputi and Rawstorne, 2000). Teachers who have more positive attitudes toward technology tend to integrate technology into their teaching (Marangunic and Granic, 2015). Other authors emphasize the importance of the intention of teachers as a factor that directly affects the use of digital technology in practice (Gialamas and Nikolopoulou, 2010). The authors also indicate that, in addition to knowledge and skills, attitudes and intentions, the self-perception of the possibility of using digital technology in practice by teachers will directly affect their integration (Romero-Tena et al., 2020). "Psychological context, especially of teachers' perception, is necessary for understanding the use of digital technologies in their daily duties" (Wang et al., 2008) since the perceptions that teachers have about the use of digital technologies can significantly affect the practice in kindergarten. If teachers believe digital technologies to be useful, they are more likely to adopt and use them without any difficulty (Oldridge, 2008). When a "new pedagogical approach or tool is presented, teachers make value judgments about whether that approach or tool is relevant to their goals. The more valuable the approach or tool is in their opinion, the more likely they are to use it" (Ottenbreit-Leftwich et al., 2010). Thus, although two teachers, after graduation, have the same level of knowledge and skills for the application of digital technologies in educational practice, positive / negative attitudes of educators and self-assessment will greatly affect the degree and quality of digital technology use in their future practice. However, if future teachers are provided with adequate training and practical application of digital technologies during their studies, it is likely that attitudes towards the use of computers in educational practice and their self-assessments will be more positive.

Taking into account the above findings and the situation caused by the Covid-19 pandemic, which forced higher education institutions around the world to intensify the use of numerous digital tools for online learning in working with students, we conducted a study that examined and compared the attitudes of future teachers on self-assessment of digital competencies, before and after the implementation of online classes during the summer semester 2019/2020.

Online teaching includes intentional and thoughtful support for student learning mediated by the Internet (Rapanta et al., 2020). Experiences of online learning through distance education can be asynchronous or synchronous. Asynchronous learning occurs when students can determine their own time to participate in learning through a variety of digital tools. Students can participate in communication and complete activities at a time of their choice and learn at their own pace. On the other hand, synchronous learning activities take place through live video and/or audio conferencing with instant feedback (Kim, 2020). The effectiveness of online learning depends on the designed and prepared learning material, the engagement of the lecturer in the online environment and the interaction between the lecturer and the student (Bao, 2020).

The transition from the usual way of working to online teaching, in response to the Covid-19 pandemic, contributed to professors and students finding themselves in a new environment and seeing the differences between the previous way of working and teaching online, but also to the improvement of their digital competencies. Online teaching has set new requirements for professors and students: the use of various digital tools and resources and the application of new approaches in teaching and learning (König, Jäger-Biela and Glutsch, 2020). However, teaching and learning online is not entirely new for professors and students. Digitization in schools / universities began even before the pandemic, and it is reflected in, among other things, equipping "schools / universities with appropriate equipment, striving to include ICT in curricula and giving students the opportunity to use advanced technological tools and digital resources for creative and innovative problem solving" (Kozma, 2011). The Covid-19 pandemic has accelerated the digital transformation of higher education and introduced innovations in

higher education, which would normally take much longer, immediately after the closure of schools / universities. The digital transformation has brought several challenges, and one of the main issues is that it has caused mandatory modifications in the attitudes of online teaching administrators, teachers and students about the importance of the Internet for learning (Kozma, 2011). Research has shown that current students, as Gen Z representatives, want to learn new skills and gain more experience in the field of digital technologies (Kamarianos et al., 2020). Globally, student satisfaction with the organization of three segments of the teaching process was quite high and almost the same on all continents: for lectures 3.30, tutorials and seminars 3.12, and mentoring 3.20 (Aristovnik et al., 2020). The authors believe that education, like all other segments of life and work, will never (and many should not) be the same, and that the crisis will have a lasting impact on learning, innovations and digitization (Aristovnik et al., 2020).

The specificity of the situation in which we found ourselves due to the Covid-19 pandemic put the issue of digital competencies of students to the forefront, regarding the monitoring and implementation of online teaching, as well as the level and possibilities for the development of these competencies. Our interest in this paper is focused on examining the possibility of improving students' digital competencies during the implementation of online teaching, indirectly, through the daily use of various digital tools for the purpose of learning, exchange and communication. Will students, future teachers, after three months of using digital tools for monitoring, implementation and evaluation of teaching have more positive attitudes about self-assessment of digital competencies and in which segments?

Materials and Methods

Research aim

The aim of this paper is to recognize the change in the attitudes of future teachers on self-assessment of digital competencies under the influence of the implementation of online teaching, during the spring semester 2019/2020. Specifically, it was about reviewing the attitudes of future teachers on the self-assessment of digital competencies before the implementation of online classes and after the end of the semester. We wanted to find out whether there was a change in attitudes about self-assessment of digital competencies of future teachers under the influence of online teaching, which included the use of various web tools for communication and cooperation, creating digital content and its application during teaching.

The research goal set in this way led to the following research task: Compare attitudes about digital competencies of future teachers in preschool institutions before and after the application of online teaching during the emergency situation in Serbia caused by the SARS-CoV-2 pandemic, through self-assessment of digital competencies.

Sample

The research sample consisted of third-year students of basic academic and vocational studies in the study program for the education of teachers in preschool institutions. The sample included N=125 students (57 respondents were from vocational studies (colleges for education of preschool teachers) and 68 from basic academic studies (study program Teacher in preschool institutions).

Instruments

The research presented in this study is a continuation of the research the results of which are presented in the paper published by Cekić-Jovanović, Stepić, Miletić (2020). Based on the results presented in the mentioned published study, as well as on the basis of previously studied literature and research results of other researchers in the field of digital competencies and application of educational technology, for the purposes of this research, a research instrument that was used was an electronic questionnaire in the form of a five-point Likert-type scale that examined the attitudes and self-assessment of digital competence of future teachers in preschool institutions before and after the implementation of online teaching during the spring semester. This questionnaire was also used by Cekić-Jovanović, Stepić, Miletić (2020) in their research, and its reliability was assessed by calculating the Cronbach's α reliability coefficient which is α = 0,83, α>0,7. The first part included questions for collecting general data and information about the respondents (gender of respondents, their achievements in the Educational Methodology, the Environmental studies methodology, etc.). The second part was a five-point Likert-type scale, consisting of 26 statements (items). The statements in the questionnaire were formulated on the basis of the Rulebook on standards of competence for the vocation of preschool teachers and their professional development (Official Gazette of RS - Education Gazette, No. 16/2018), which is based on

DigComp 2.1. (Carretero, Vuorikari and Punie, 2017). The formulations of all statements are given in the study conducted by Cekić-Jovanović, Stepić, Miletić (2020), and they were used in this study as well, with minor changes.

Procedure
The beginning of the research presented in this paper deals with an initial examination of the attitudes of future teachers in preschool institutions (students of basic academic and vocational studies who are part of the study program Teacher in preschool institutions), through self-assessment of digital competencies before applying online teaching during an extraordinary situation. After the initial research, the students had online classes within the compulsory subject Environmental studies methodology for 3 months during the state of emergency in Serbia caused by the SARS-CoV-2 pandemic. Classes were mainly realized using the Google Classroom, video conferencing tool Zoom, Moodle platform and Edpuzzle application for editing interactive video materials. Students received teaching materials through these websites in the form of texts and video lessons, assignments were given via Google and Moodle platform, while they interacted with teachers and other students through discussions and analysis of teaching content via Zoom videoconferencing tool.
The end of the semester and online teaching was followed by the final examination of the attitudes of students / future teachers in preschool institutions on the self-assessment of digital competencies after the application of online teaching during an extraordinary situation. The final examination of attitudes included the same research instrument described earlier.

Analysis Procedures
In order to compare the attitudes of future teachers in preschool institutions, it was first necessary to examine the normality of the distribution of data obtained by applying the research instrument (a questionnaire) within the initial and final survey. As the sample of respondents is greater than 50, the results of the Kolmogorov-Smirnov test given in Table 1 show that the significance is greater than 0.05 (p = 0.2), which means that there is a normal distribution of data.

Table 1
Test of normality of data distribution in the initial and final examination of the attitudes of future teachers in preschool institutions

	Respondent's code	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
The sum of the claims	1-initial examination	,065	125	,200*	,981	125	,074
	2-final examination	,085	125	,026	,922	125	,000
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							

By further using the t-test, we examined whether there was a statistically significant difference between the results of the initial and final examination, and whether the attitudes of future teachers in preschool institutions differed significantly before and after the implementation of online teaching.
If we summarize all the statements (Table 2), the t-test showed that the significance p=0.001 was less than 0.05, which means that there is a statistically significant difference in the results of the initial examination of attitudes compared to the final examination of attitudes, in favor of the final examination.

Table 2
T-test results

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
The sum of the claims	Equal variances assumed	-3,484	248	,001	-4,656	1,336	-7,287	-2,024

Results and Discussion

In general, after the realization of online classes during the spring semester, students estimated that they had better digital competencies compared to the initial examination of attitudes. If we look at the results obtained for each individual statement (Table 3) within the assessment scale, the t-test shows that there is a statistically significant difference in favor of the results of the final survey. Significance is less than 0.05 when it comes to self-assessment of digital competences related to the following statements / items (IT7, IT12, IT13, IT15, IT17, IT20, IT22, IT25, IT26): assessment of the quality, relevance, accuracy and scope of digital information (IT7); use of appropriate digital technologies for designing and creating the necessary educational materials for working with children in the realization of the planned learning situation in the field of Environmental studies (IT12); application and integration of digital technology in the immediate educational work, in the realization of the planned learning situation in the field of Environmental studies (IT13); multimedia presentation of content that is interactive and allows children to better understand and learn easier and faster in the field Environmental studies (IT15); application of digital technology that enables children to meaningfully use digital technologies for expression and learning through play within a topic or project in the field of Environmental studies (IT17); use of digital technologies that encourages children's decision making and critical thinking within the educational work in the field of Environmental studies (IT20); adequate attitude and habit of using digital technologies (IT22); use of digital technologies for professional development of teachers (IT25); control of shortcomings and dangers of digital technology application (IT26). For all the mentioned items, after the realization of online classes, the students estimated that they had better digital competencies compared to the period before the realization of online classes.

Table 3
Differences in students' attitudes

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
I use e-mail in my everyday life and during my studies.	-1,532	219,57	,127	-,144	,094	-,329	,041
In my daily life and during my studies, I use WWW - Internet databases.	,783	248	,435	,080	,102	-,121	,281
I use social networks in my everyday life and during my studies.	,537	248	,592	,032	,059	-,085	,149
I use digital technologies to exchange information	-1,243	248	,215	-,096	,077	-,248	,056
I use digital technologies to work in different bases	,682	248	,496	,056	,082	-,105	,217
I use digital technologies to summarize, compare and consolidate information	-,096	248	,923	-,008	,082	-,171	,155
I use digital technologies to judge the quality, relevance, accuracy and coverage of digital information	-4,030	248	,000	-,528	,131	-,786	-,269
I successfully use digital technologies in finding and collecting	-,411	248	,681	-,040	,097	-,231	,151
I successfully use digital technologies in planning	,255	248	,799	,024	,094	-,161	,209
I can effectively adapt, present and methodically transform	-1,195	240,940	,233	-,104	,087	-,275	,067
I can apply digital tools to organize and classify information	-1,323	248	,187	-,136	,102	-,338	,066
I use digital tools to design and create the necessary educational materials	-5,866	229,032	,000	-,696	,118	-,929	-,462

I am competent to apply and integrate digital technologies	-2,599	248	,010	-,264	,101	-,464	-,063
I am competent to evaluate and document in numerous ways	-,942	248	,347	-,072	,076	-,222	,078
I am competent to present multimedia content that is interactive	-4,322	193,14	,000	-,568	,131	-,827	-,308
Digital tools enable children to access information	,382	248	,703	,032	,083	-,132	,196
I am competent in enabling children to meaningfully use digital technologies for expression and learning through play	-2,453	248	,015	-,280	,114	-,504	-,055
I am competent to enable children to use digital technologies themselves to monitor their own learning	-1,270	248	,205	-,136	,107	-,346	,074
I am competent to enable children to progress at their own pace	,256	248	,798	,024	,093	-,160	,208
Modern technologies enable children to make decisions and think critically	-2,803	235,31	,005	-,312	,111	-,531	-,092
I adequately and safely use the advantages of digital technology	-,817	248	,415	-,072	,088	-,245	,101
An adequate relationship and culture of using digital technologies is necessary for every educator	-2,818	214,10	,005	-,328	,116	-,557	-,098
I am competent to develop awareness and habits for adequate use of digital technologies in children and parents	-1,162	248	,246	-,152	,130	-,409	,105
I am not competent enough to develop awareness and habits for adequate use of digital technologies in children and parents.	-1,909	248	,057	-,288	,150	-,585	,009
I believe that it is important that digital technology is used for the professional development of educators.	-3,028	218,37	,003	-,320	,105	-,528	-,111
I believe that, as a future educator, I am not always able to control the disadvantages and dangers of using digital technology.	-2,565	240,75	,011	-,360	,140	-,636	-,083

Further analysis of the research results shows that there is no statistically significant difference between the initial and final examination of the attitudes of future teachers in preschool institutions when it comes to self-assessment of digital competencies related to: the use of e-mail, WWW - Internet databases and social networks; the application of digital technology for information exchange; work in different databases for recording information about children, their parents, evaluation of educational work, etc.; summarizing, comparing and combining information from different digital sources; finding and collecting relevant information and educational materials for educational work in the field of Environmental studies; the use of digital technology in the planning of educational work in the field of learning Environmental studies; adaptation, presentation and methodological transformation in accordance with children's age and the topic of educational work in the field of Environmental studies; application of digital tools for organization and classification of information (charts, schemes, planners, schedules, mind maps, animations, video tutorials, etc.) in the field of Environmental studies; evaluation and documentation of data, photographs, digital texts, videos, etc.; the use of digital technologies as tools that enable children to access information during the implementation of educational work in the field of Environmental studies; enabling children to use digital technologies in monitoring their own learning; enabling children to make progress in educational work in the field of Environmental studies at their own pace, in a way that suits them best; adequate and safe use of the benefits of digital technology in educational work in the field of Environmental studies; developing awareness and habits in children and parents for the adequate use of digital technologies;

The results indicate that the students similarly assessed their digital competencies before and after

the realization of online classes during the pandemic. And that online classes did not significantly affect their self-assessment of digital competence in the mentioned areas.

The findings of one study indicate that self-assessments of digital competencies of future teachers in the areas of information and data, communication and collaboration and security are more than self-assessments in the areas of digital content creation and problem solving (Çebi and Reisoğlu, 2020). The authors explain this by having the focus on theoretical knowledge in teacher training programs, lack of practice for digital content development and technical problem solving, and the fact that future teachers feel more advanced in these areas, probably due to the use of digital technology in everyday life in terms of these areas (Çebi and Reisoğlu, 2020). We could say that the finding of our research is the opposite. During online classes, students had the opportunity to practically apply certain tools, to a greater extent than usual, and this resulted in a better self-assessment of digital competencies in the field of creating digital resources, direct work in educational practice and professional development. Analogous to the interpretation of the above research, we can assume that pedagogically designed use of digital technology during studies can lead to the improvement of digital competencies that are practiced during online classes.

Adequate initial training in the field of digital competence development "makes students better perceive themselves in their development of critical thinking, problem solving and decision making, and points to the fact that this will increase their creative capacity and influence them to be more innovative, as shown by findings obtained in various studies" (Romero-Tena, 2019; according to: Romero-Tena et al., 2020).

Expressing positive attitudes / intentions is just one of the factors for successful integration of ICT, which has an effect on professional development and education of teachers (Gialamas and Nikolopoulou, 2010), and, according to our results, vice versa. Shaping the pedagogical use of digital technology in working with students during online classes has proved important for improving attitudes about self-assessment of digital competencies.

It should also be borne in mind that teachers' pedagogical practices and behavior in practice are not static and are influenced by beliefs about the potential of ICT to improve learning as well as about the competence of teachers to integrate ICT into the curriculum (Webb and Cox, 2004). This means that even those teachers who have expressed positive attitudes or intentions may be disappointed and limit the use of digital technologies if they do not have continuity in professional development in this field (Gialamas and Nikolopoulou, 2010). This tells us that when it comes to application of digital technology, we need adequate and continuous support for students, future teachers, but also for practice teachers.

Conclusions

Based on the results presented in this study, it can be concluded that the implementation of online classes with students of basic academic and vocational studies who are part of the study program Teacher in preschool institutions has a positive effect on their attitudes and self-assessment of digital competencies.

Comparing the results obtained during the initial and final examination of students' attitudes, it can be seen that students believe that after the implementation of online classes they have more developed digital competencies related to: 1) creation of digital resources; 2) application of digital technologies in the immediate educational work and 3) role of digital technologies in professional development. Overall, differences between the initial and final measurements were not observed in the following fields: 1) use of digital technologies in everyday life; 2) work with information; 3) planning, monitoring and documenting; 4) respect for children's characteristics; 5) safe use of digital technologies.

These results tell us that practicing the use of digital tools during online classes has helped future teachers feel more confident in creating digital resources and applying digital technologies for chidren's learning and development, but, at the same time, they have become aware that they are not competent enough to assess the quality, relevance, accuracy and coverage of digital information and that they cannot always control the shortcomings and dangers of digital technologies.

When implementing online teaching or hybrid models in post-pandemic conditions, it is necessary to keep in mind the potential effects of certain objective and subjective factors that discourage teachers from opting for this way of working. The absence of adequate technical conditions for the implementation of teaching activities can be a significant objective factor. When it comes to subjective factors are concerned, they are mostly reflected in the approach of teachers and students. Hybrid and online teaching require highly motivated and creative teachers who will have to invest more time and effort to create different

learning activities and materials than those to which they and students were used to before the pandemic. Although web applications, such as Edpuzzle, Google Classroom, Zoom, etc., are quite easy to use, teachers, especially those with insufficient experience in the application of modern technology, may have difficulty with their implementation. Additional training, professional development and systematic support for the development of teachers' digital competencies would certainly contribute to a more successful implementation of hybrid teaching in post-pandemic conditions.

The results of this research can be used to encourage teachers to step out of the usual pre-pandemic practice and enrich their pedagogical work with combined teaching (hybrid model) where part of the material would be analyzed in person, and part would be analyzed online using web tools, websites and videoconferencing applications. This would certainly affect the improvement of digital competencies of students - future teachers in preschool institutions. The results of this study can also serve as a starting point for other researchers who want to examine this issue in more detail and more comprehensively, taking into account the possibility and need for online learning outcomes to be tested in different working conditions, learning environment, within other subjects, at other levels of education, on a different and larger sample of respondents, and so on.

Acknowledgements

Author Contributions

Conceptualization, G.S.,V.S.,O.C.J.; data curation, G.S. V.S. and A.M.; methodology, G.S., V.S., O.C.J. and A.M. resources, G.S. and V.S.; formal analysis, G.S., V.S., O.C.J. and A.M.; validation, O.C.J.; writing—original draft preparation, G.S., V.S., O.C.J. and A.M.; writing—review and editing, G.S., O.C.J. and A.M. All authors have read and agreed to the published version of the manuscript.

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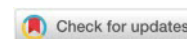
Outdoor Education: Perspectives of Teachers and Students in the Context of School in Nature as an Innovative Approach in Education

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Abstract: This research analyzed the opinions of primary school teachers and students regarding the benefits of outdoor education, using the example of School in Nature, for the organization of educational activities within the instruction process. It explored educational, social, recreational, and ecological aspects, as well as the existing differences in their opinions. The research was conducted on a sample of elementary school teachers and fourth-grade students in the Bor District in the Republic of Serbia. The research involved 223 participants (elementary school teachers N=73, and fourth-grade students N=150). A questionnaire was designed for the purposes of this research to assess the opinions of teachers and students towards the learning environment and the effectiveness of implementing outdoor education in the context of School in Nature. The research results indicate a compliance between teachers' opinions about the significance of outdoor education, especially through School in Nature, and its benefits to the educational aspect of the teaching process. Students displayed positive attitudes related to social interaction in learning, emphasizing the development of positive social relationships and skills. Differences in opinions between teachers and students regarding the learning environment and the effectiveness of outdoor education in meeting learning objectives represent a significant starting point for better understanding the quality of the teaching process.

Keywords: outdoor education, School in Nature, learning environment, student, teacher.

Introduction

Outdoor education, having the forms of field trips or experiential learning, is becoming an increasingly significant component of education systems worldwide. It provides students with a unique opportunity to expand their knowledge and levels of understanding through practical experiences outside the classroom. Outdoor education represents an innovative approach to education that goes beyond the traditional inclass learning. This learning method involves taking students outside the school premises to gain practical knowledge, explore nature, and apply acquired knowledge in real-life situations. Outdoor education utilizes interactive and experiential learning methods to foster engagement, motivation, and a deeper understanding of learning topics. Conducting lessons outside the classroom, as a specific aspect of the teaching process, allows for a direct connection between the school and the real world, simultaneously stimulating motivation and curiosity among students, while providing teachers with the opportunity to change their practices (Rickinson et al., 2004; Anđelković and Mihajlović, 2012; Radivojević and Jelić, 2016; Ristić and Blagdanić, 2017; Enăchescu, 2019; Milosavljevic Đukic, Bogavac and Stojadinović, 2022; Mitic, Dejkovic and Zlatanović Marković, 2022; Begić, 2022; Borsos, Fekete and Boric, 2023).

The primary goal of outdoor education is to provide students with optimum learning conditions directly derived from experience, which can be a powerful tool for developing critical thinking, teamwork, problem-solving skills, and emotional intelligence (Auer, 2008). Outdoor education also provides an opportunity for the integration of different subjects and disciplines, allowing students to connect various aspects of knowledge and understand their application in the real world. Experiences gained through outdoor activities compel teachers to integrate activities inside and outside the classroom to create a favorable environment for the education process. These activities that students experience, both inside and outside the classroom, contribute to a sustainable process of learning and development (Kocayiğit and Ekinci, 2020). Authors Andić and Mažar(2023) conclude that the role of a teacher, including their

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practices, emotion management, personality, and competencies, is of exceptional importance for achieving learning objectives in school subjects, as well as in interdisciplinary topics, such as sustainable development curriculum (Andić and Mažar, 2023).

An interdisciplinary approach to learning promotes the holistic development of students, fostering creativity, curiosity, and self-confidence, with the integration of different fields of knowledge being one of the key objectives of the holistic learning process. In achieving this goal, outdoor activities play a significant role, allowing students to connect theoretical knowledge with real-life experiences and application in the natural learning environment (İleritürk, 2023). The planning of these activities should be an integral part of the teaching process.

Findings from some research indicate a possible positive impact of spending time in nature on students' cognitive functions and their interest in learning. Being in nature enhances students' collaboration and problem-solving skills while simultaneously increasing their happiness, well-being, and motivation for learning (Manni et al., 2013; Capaldi, Dopko and Zelenski, 2014; Yli-Panula, Jeroneni and Lemmety, 2019). According to relevant studies, this effect can result in increased student engagement in the classroom, which has the potential to enhance their learning achievements. This leads to the conclusion about the significance of incorporating natural elements into the education process as a potentially beneficial factor for supporting cognitive functioning and student learning.

The results of the research conducted by the group of authors (Kuo, Browning and Penner, 2018) describe the practice of supporting and encouraging students during the learning and development process, which they refer to as "Refueling Students in Flight." In their findings, the authors emphasize the importance of providing continuous support through natural resources to enable students to progress and achieve their academic and personal goals. In this research, the hypothesis that outdoor lessons have positive, not negative effects on subsequent classroom engagement was tested. It was found that classroom engagement was significantly better after outdoor lessons than after regular lessons. Such results suggest that outdoor lessons can actually motivate students to engage more in regular lessons, even when they explore content that is not directly available to them. This practice, referred to as "Refueling Students in Flight," advocates the inclusion of more outdoor lessons in formal education (Kuo, Browning and Penner, 2018).

One of the most well-known forms of outdoor education is the "School in Nature," where students spend time in nature and actively participate in various educational activities. The organization of this form of outdoor education aims to acquaint students with objects, phenomena, processes, and achievements in nature. "School in Nature," as a form of outdoor education, carries significant educational and developmental importance because it establishes the most effective connection between the teaching process and the natural laws and phenomena. Through the implementation of the "School in Nature," teaching is efficiently linked to current social and life contexts, contributing to comprehensive development and the improvement of students' personalities, providing an opportunity for a deeper understanding and practical application of acquired knowledge.

The perspectives of teachers and students play a crucial role in shaping and assessing the success of any educational approach, including outdoor education. The teacher's perspective involves planning and organizing field activities, adapting teaching methods and materials, and managing the group of students. Teachers are essential for the successful implementation of outdoor education because they are responsible for ensuring the safety of students, motivating learning, and maximizing the benefits of the field experience. They must be experts in their subject areas but also need to be capable of adapting to changing circumstances and student needs during the field trip. On the other hand, the perspective of students is crucial for understanding the impact of outdoor education on their development, motivation, and engagement. Through the "School in Nature," students gain practical experiences that stimulate their curiosity, creativity, and self-confidence. Through outdoor education, students have the opportunity to apply acquired knowledge and skills in the real world, develop interpersonal and teamwork skills through collaboration with peers and teachers, and form an awareness of nature and the environment, understanding the importance of preserving natural resources.

The competencies required of teachers for outdoor activities are dynamic and complex due to the close connection to the pedagogical, psychological, methodological, didactic, and subject-specific competencies of teachers. As such, these activities encompass the following: fostering students' creativity, critical thinking, good communication, innovation, research, problem-solving, and environmental awareness. In the outdoor environment, the teacher should provide individual support to students, motivate them to take charge of their own learning, support different learning styles, provide appropriate feedback on their work, and ensure a safe learning environment.

The dedication teachers invest in the planning and implementation of learning material often dictates

the impact outdoor education will have on students. Linking outdoor education with classroom concepts implies that teachers adapt experiential learning in informal settings to stimulate interest, motivation, and a desire for exploration and knowledge acquisition in students. This will enable the improvement of learning in a formal context. If classroom education is enhanced with one of the forms of outdoor education, such as teaching in the schoolyard, visits to natural, cultural, sports, and economic facilities, "School in Nature," field trips and so on, and if it is done with the intention of integrating curriculum content, where multiple subjects are simultaneously organized, students will better understand the content, actively engage in the learning process, take responsibility for self-learning, etc. The essence of the mutual complementarity of classroom and outdoor education and their integration into a unified and high-quality education process is that teachers and students nurture and create pedagogical, educational, and learning strategies that are occasionally realized in nature (Jurčić, 2015).

The research in this paper is focused on examining the opinions of teachers and students in elementary schools regarding the importance of implementing "School in Nature" as a form of outdoor education, concerning its educational effectiveness, the quality of organization, and the aspect of "innovation" in the teaching process. The quality of education is determined by its structure, learning materials, teaching methods, and the ability to direct learning towards concrete interaction with the environment. The aspect of "innovation" is reflected in the cognitive, psychological, and geographic spheres (Orion and Hofstein, 1994). The significance of the "School in Nature" is evident in the realm of practical and empirical application of acquired knowledge, the development of social relationships, as well as in the sports and recreational aspect. "School in Nature" represents an understanding of the educational and pedagogical significance and its contribution to increasing students' academic achievements. As a form of outdoor education, it is pedagogically grounded and interesting to students in learning of subject matter content. What is most remembered aspect in adulthood, related to a school field trip, is the escape from the classroom routine (Pace and Tesi, 2004).

The research conducted is significant in the field of learning environments because there are very few studies that pertain to the effectiveness of the outdoor learning, emphasizing the natural environment and practical education, which provides a positive learning environment and the study of the Nature and Society subject. Research shows that teachers often avoid outdoor learning because "School in Nature" is not a pleasant experience for them (Fido and Gayford, 1982).

However, many researchers believe that the environment to which students are exposed and how students feel in the classroom also influence their interest in the learning process (Fraser, 2012). As a result of exposure to a favorable learning environment, students achieve higher academic performance (Fraser, Fisher and McRobbie, 1996). One of the main shortcomings mentioned is the factor of "novelty." Students may become distracted when exposed to a new environment, spending too much time adapting to the new surroundings, which can deter them from actual learning. An analysis of studies has shown that organized education activities in nature are a powerful tool that helps improve learning performance, social, emotional, and personal development, contributing to the preservation and enhancement of students' health. Additionally, outdoor learning activities can be attributed to active teaching methods, and at the same time, outdoor education provides a favorable psycho-emotional space for the mental, physical, social, and moral well-being of students.

Materials and Methods

The aim of the research is to examine the opinions of elementary school teachers and students regarding the importance of outdoor education, specifically through the example of the School in Nature, in organizing learning activities and meeting learning objectives. The research seeks to identify their opinions towards the benefits of outdoor education (School in Nature) and various aspects of the teaching process, such as the educational, social, recreational, and ecological aspects, and finally to identify any differences in the opinions of teachers and students. The operationalization of the objective was carried out through the following tasks:

1. Examine teachers' opinions on the importance of outdoor education, especially through the example of the School in Nature, in various aspects of the teaching process (educational, social, recreational, and ecological).

2. Investigate students' opinions regarding the benefits of outdoor education, especially through the example of the School in Nature, in various aspects of the teaching process (educational, social, recreational, and ecological).

3. Identify the existing differences in the opinions of teachers and students regarding outdoor

education, especially through the example of the School in Nature, in organizing learning activities and meeting learning objectives.

The initial research hypothesis is as follows: Teachers and students recognize the importance of outdoor education, especially through the application of the School in Nature, in organizing learning activities and meeting learning objectives.

The following auxiliary hypotheses have been proposed:

h1: There is compliance between teachers' opinions regarding the significance of outdoor education, using the example of School in Nature, and its benefits for the educational aspect of the teaching process.

h2: There is compliance between students' opinions regarding the significance of outdoor education, using the example of School in Nature, and its contribution to various aspects of the teaching process, particularly in the social and recreational aspects.

h3: There are statistically significant differences in the opinions of teachers and students regarding the contribution of outdoor education, using the example of School in Nature, to the realization of learning activities within the instruction process, with the expectation that teachers will express a higher degree of recognition of the importance of outdoor education compared to students.

The research was conducted on a sample of primary school class teachers and fourth-grade students in the Bor district in the Republic of Serbia. A total of 223 participants took part in the study, with 73 primary school class teachers (N=73) and 150 fourth-grade students (N=150). Out of the 73 surveyed primary school class teachers, 43 (58.9%) were from urban schools, and 30 (41.1%) were from rural schools. Among the 150 students, 88 (58.7%) were from urban schools, and 62 (41.3%) were from rural schools.

In the study, a specially designed Likert-type questionnaire was used, where participants rated their agreement on a scale of 1 to 5, with 5 being "completely agree", 4 being "agree", 3 being "undecided", 2 being "disagree", and 1 being "completely disagree". This questionnaire was designed to assess the opinions of teachers and students regarding their attitudes towards the learning environment and the effectiveness of implementing outdoor education, with a focus on the School in Nature program. Numeric data were presented using mean, standard deviation, as well as minimum and maximum values. Student's t-test was used to examine the differences between teachers and students. Statistical significance was defined at a probability level of $p \leq 0.05$. Statistical analysis was performed using the SPSS software version 25.

Results

The first research objective aimed to investigate teachers' opinions regarding the importance of outdoor education, particularly through the School in Nature program, in various aspects of the educational process (educational, social, recreational, and environmental). Teachers expressed their level of agreement with statements about the educational, social, recreational, and environmental aspects of the education process in the context of the School in Nature on a five-point Likert scale. The results of the study are shown in Table 1.

Teachers believe that outdoor education, such as the School in Nature program, has the most significant impact on the development of positive social relationships among students (M=4.6). It also contributes to increased student achievements (M=4.1) and encourages students to engage in recreational activities (M=3.8). However, it has the least impact on the development of students' skills (M=3.7). Research findings obtained during the survey of teachers' opinions about the influence of outdoor education within the educational and pedagogical aspects indicate that teachers believe that School in Nature has the biggest effect on the more successful organization of the teaching process and education in general (M=4.4). These research findings are corroborated by teachers' opinions that the learning environment provided by the School in Nature contributes to students' more successful mastery of the curriculum (M=4.2). Teachers assess that the practical and empirical learning space within the School in Nature particularly contributes to the more successful implementation of the Natural Sciences and Society subject content (M=4.0). They also recognize the significant effectiveness of outdoor education in delivering the curriculum of all subjects (M=4.1). In connecting outdoor education with the classroom concept, teachers see a high contribution in acquiring knowledge and competencies related to environmental conservation, social community, culture, and the environment that the School in Nature provides (M=4.1). Teachers believe that students' engagement in choosing the destination mostly affects the effectiveness of outdoor educational activities (M=4.5). Moreover, students' desire for exploration and knowledge acquisition in natural settings is encouraged by the formal classroom learning enhanced with destination-related

content, providing students with essential knowledge of concepts related to interacting with the natural setting of the selected destination (M=4.2). Teachers emphasize the importance of planning experiential learning within outdoor education and the alignment of the School in Nature programs with subject content (M=4.0). The research findings indicate that teachers are aware of deficiencies in the preparation and implementation of outdoor education (M=1.6) and believe that teacher training, encompassing the planning and execution of the School in Nature, would be highly beneficial for future educational work in the classroom (M=4.0).

Table 1
Teachers' opinions on the significance of outdoor education in terms of the educational, social, recreational, and ecological aspects

	N	Min	Max	M	SD
Contribution of outdoor education / School in nature to the:					
more successful mastery of the curriculum by students	73	3.00	5.00	4.260	0.624
more successful implementation of the Nature and Society subject	73	3.00	5.00	4.041	0.676
more successful implementation of all subjects' curriculum	73	2.00	5.00	4.110	1.021
more successful organization of the education process and instruction in general	73	3.00	5.00	4.479	0.669
improved student achievements	73	3.00	5.00	4.164	0.817
development of positive social relationships	73	4.00	5.00	4.685	0.468
development of students' abilities	73	2.00	5.00	3.781	0.989
encouragement of recreational activities	73	2.00	5.00	3.849	0.811
acquisition of knowledge and competencies about nature conservation, community, culture, and the environment	73	3.00	5.00	4.150	0.739
Planning and preparation for outdoor instruction:					
Knowledge about the destination	73	3.00	5.00	4.233	0.773
Previously acquired knowledge about the basic concepts related to the destination	73	3.00	5.00	4.247	0.703
Student involvement in choosing the destination	73	3.00	5.00	4.521	0.669
Alignment of the School in Nature program with the subject content	73	3.00	5.00	4.041	0.676
Teacher education in the field of planning and implementation	65	3.00	5.00	4.061	0.845
Limitations:					
Preparation	73	1.00	3.00	1.671	0.625
Implementation	65	1.00	3.00	1.692	0.727

N=number of respondents, Min=minimum, Max=maximum, M=Mean, SD=Standard deviation

The second research objective aimed to examine the opinions of students regarding the significance of extracurricular activities through educational, social, recreational, and environmental aspects of the educational process. Students expressed their agreement or disagreement on a five-point Likert scale with statements related to the School in Nature. The results of the research are presented in Table 2.

Students find classes conducted outside the classroom very interesting (M=4.6) because they believe they learn more than in regular classroom lessons (M=4.5). Research findings on students' opinions regarding the contribution of School in Nature show that students support activities conducted outside the classroom because they actively engage in the learning process when conducting research to solve problems (M=4.2) related to various educational content (M=4.2). From the students' perspective, the contribution of outdoor education is primarily associated with the development of positive social relationships among students (M=4.2) and the encouragement of sports and recreational activities (M=3.3). Lower scores are recorded in terms of students' assessments related to the contribution to increasing student achievements (M=2.1) and the development of students' abilities (M=2.3). Students

see the importance of School in Nature in mastering subject matter through concrete activities (M=4.1). According to students, the effectiveness of the outdoor environment, which emphasizes the natural environment, is reflected in the fact that it allows them to practically form a relationship with nature and its values, the social community, culture, and the environment (M=3.8). Students believe that the practical and empirical application of acquired knowledge is reflected in the way they can more easily connect the phenomena and objects they encounter in the natural environment in an interesting and engaging manner (M=3.5) and relate them to multiple subjects (M=3.4). Students assess that outdoor education helps them in mastering the subject matter of Nature and Society (M=3.1) because concrete activities serve as inspiration (motivation) for further research in the subject and natural phenomena (M=3.0). Students have a limited perception of the complementarity between classroom and outdoor education, as evidenced by the lower scores related to their assessments of success in acquiring educational content in the classroom (M=2.8) and active participation in teamwork (M=2.8). Their interest in the learning process outside the classroom is minimal, as indicated by the research results of student perceptions of School in Nature regarding the clarity of educational content after its practical application (M=2.7) and the efficiency in solving tasks in a natural environment (M=2.2). Students believe that there is a need for alignment between the School in Nature program and the subject content (M=3.5) to improve awareness of the destination aimed at forming initial attitudes towards learning outside the classroom (M=2.4) and increasing their interest in acquiring basic knowledge related directly to educational tasks (M=2.0).

Table 2
Students' opinions about the importance of outdoor education

	N	Min	Max	M	SD
The benefits of outdoor education:					
Mastering subject matter through concrete activities	150	2.00	5.00	4.100	1.002
Mastery of subject matter in Nature and Society through research	150	1.00	5.00	3.187	1.083
Getting to know phenomena and objects in an interesting and engaging way	150	2.00	5.00	3.507	0.925
Success in acquiring educational content in the classroom	150	1.00	5.00	2.867	0.748
Clarity of educational content after its practical application	150	1.00	5.00	2.793	0.922
Inspiration (motivation) for further exploration of subjects and natural phenomena	150	2.00	5.00	3.060	0.869
The class is interesting when conducted outside the classroom	150	4.00	5.00	4.600	0.492
I learn more outside the classroom than during regular school lessons	150	4.00	5.00	4.547	0.499
Educational content encountered in the natural environment can be more easily connected across multiple subjects	150	2.00	5.00	3.413	0.921
Active participation in teamwork	150	1.00	5.00	2.833	1.089
Outdoor education for various educational content	150	3.00	5.00	4.207	0.745
Efficiency in solving tasks in a natural environment	150	1.00	5.00	2.260	1.045
Attitude towards nature and its values, the social community, culture, and the environment	150	2.00	5.00	3.886	0.952
Conducting research to solve problems	150	3.00	5.00	4.253	0.697
Increasing student achievements	150	1.00	5.00	2.193	1.073
Developing students' abilities	150	1.00	5.00	2.353	1.024
Developing positive social relationships among students	150	3.00	5.00	4.293	0.719
Encouragement of sports and recreational activities	150	1.00	5.00	3.307	1.158
Organization of outdoor education					
Awareness of the destination for forming initial attitudes towards learning outside the classroom	150	1.00	5.00	2.413	1.205
Alignment of the School in Nature program with subject content	150	2.00	4.00	3.553	0.596
Basic knowledge of concepts directly related to educational tasks	150	1.00	5.00	2.027	1.198

N=number of respondents, Min=minimum, Max=maximum, M=Mean, SD=Standard deviation

The third research task focused on examining the differences in the opinions of teachers and students regarding the significance of outdoor education, using the example of School in Nature. The attitudes of teachers and students were assessed concerning the organization, planning, alignment of

program content, as well as their perceptions of the educational and pedagogical effectiveness in terms of the contributions to the educational process and the quality of the educational process. A T-test for large independent samples indicates that there is a statistically significant difference in the perception of certain elements of the importance of outdoor education, as exemplified by School in Nature, between teachers and students. The research results obtained are presented in Table 3.

Statistically significant differences were identified in the opinions of teachers and students regarding organization, planning, and alignment of curriculum. Teachers expressed their competence for conducting outdoor education by stating that geographical (4.49±0.50), intellectual (4.40±0.66), and psychological (5.00±0.00) preparation is necessary to provide a positive learning environment in School in Nature. In contrast, students gave lower scores, p=0.000. In the assessments by students, there is a prevailing attitude compared to teachers related to the evaluation process after the activities in School in Nature. According to students, this evaluation is necessary to understand the significance of outdoor education in achieving the educational and pedagogical goals in the area of pragmatic and empirical application of acquired knowledge and experiences (1.97±0.75), p=0.000. Within the sphere of educational and pedagogical effectiveness in the educational process, teachers emphasize the cognitive domain (knowledge acquisition) more (3.88±0.76) compared to students (3.19±1.08), p=0.000. However, for students, the affective domain (attitudes, values, interests) is of greater importance (4.25±0.70) compared to teachers (3.92±0.95), p=0.000. In the psychomotor domain (skills, abilities), both teachers and students have similar preferences (aspirations) to be achieved in the outdoor education environment, p=0.716. Teachers recognize the educational and pedagogical significance of School in Nature as a form of outdoor education and its connection to the classroom concept through experiential learning in formal and informal settings (4.01±0.77). In contrast, students' interest in the learning process is significantly lower (2.05±1.02), p=0.000. The outdoor education environment, which involves organizing the educational process through participant interaction and implementing content, is equally acceptable to both students (4.60±0.49) and teachers (4.48±0.67), p=0.130. Regarding the perceived contribution of School in Nature and its educational and pedagogical significance, a statistically significant difference is observed, with teachers recognizing its importance more than students, especially concerning students' educational achievements through content correlation between subjects (4.11±0.94) and the functionality of acquired knowledge (4.47±0.69), p=0.000. The research findings show that there are differences in the opinions of teachers and students when it comes to educational effectiveness and the quality of School in Nature's organization. Teachers more strongly emphasize the aspect of "innovation" in knowledge acquisition through outdoor education compared to the traditional classroom approach (4.41±0.66), p=0.000. Regarding the essence of the complementarity between classroom and outdoor education, as exemplified by School in Nature, teachers recognize it more than students, especially in terms of enhancing the quality of the educational process through experimentation and research (3.73±1.19) and in the higher quality of pedagogical work in activities that provide enjoyment and interest (3.96±0.77), p=0.000. A statistically significant difference can be noticed in the opinions of teachers and students regarding the contribution of educational and pedagogical activities in nature, which provide a favorable time for relaxation from the classroom routine and the improvement of social skills. Teachers emphasize the social (4.42±0.69) and adventurous aspects (4.23±0.77) of outdoor education more than students, as well as the environmental aspect (4.25±0.70), p=0.000. Regarding the sports and recreational aspect, both teachers and students believe it is a powerful tool that contributes to the preservation and enhancement of students' health, so there is no statistically significant difference in the attitudes of teachers and students on this aspect, p=0.701. The implementation of inclass and extracurricular activities outside the classroom, as exemplified by School in Nature, is a specific form of work where both teachers and students nurture and create situations and strategies for educational and pedagogical work in natural conditions. Students emphasize the attitude of the "use-fulness" of outdoor education (2.61±1.20) more than teachers do, p=0.000.

Table 3
Differences in the opinions of teachers and students regarding the benefits of outdoor education

The attitudes of teachers and students	teachers		students				
	M	SD	M	SD	T	df	p
Organization, planning, alignment of curriculum content							
Geographical preparation	4.49	0.50	2.35	0.66	24.660	221	*0,000*
Iintellectual preparation	4.40	0.66	2.07	0.81	21.391	221	*0,000*
Psychological preparation	5.00	0.00	4.55	0.50	7.642	221	*0,000*
Assessment	1.00	0.00	1.97	0.75	11.064	221	*0,000*
Contribution in the spheres of the teaching process							
Cognitive domain – knowledge acquisition	3.88	0.76	3.19	1.08	4.884	221	*0,000*
Affective domain – attitudes, values, interests	3.92	0.95	4.25	0.70	2.977	221	*0,003*
Psychomotor domain – skills, abilities	3.37	1.33	3.31	1.16	0.364	221	0,716
Quality of the teaching process							
Connecting outdoor education with the classroom concept – experiential learning in formal and informal settings	4.01	0.77	2.05	1.02	14.566	221	*0,000*
Organization of the teaching process through participant interaction and content implementation	4.48	0.67	4.60	0.49	1.520	221	*0,130*
"Content correlation between subjects	4.11	0.94	2.87	0.75	10.699	221	*0,000*
Functionality of acquired knowledge	4.47	0.69	3.06	0.87	12.094	221	*0,000*
"Innovation – acquiring knowledge through outdoor education compared to the traditional classroom approach	4.41	0.66	3.41	0.92	8.267	221	*0,000*
Quality of the educational process – (experimentation and research)	3.73	1.19	1.96	0.74	13.552	221	*0,000*
Quality of pedagogical work (enjoyment and interest)	3.96	0.77	1.69	0.63	23.281	221	*0,000*
Social aspect (improvement of social skills)	4.42	0.69	2.25	0.70	21.948	221	*0,000*
Adventure aspect (a break from the classroom routine)	4.23	0.77	2.03	1.20	14.338	221	*0,000*
Environmental aspect	4.25	0.70	2.41	1.21	12.032	221	*0,000*
Sports and recreational aspect	4.15	0.74	4.10	1.00	0.384	221	*0,701*
Domain of 'usefulness'	1.00	0.00	2.61	1.20	11.447	221	*0,000*

M=Mean, SD=Standard deviation, t= T test, df= degree of freedom, p=signification

Discussions

The research conducted in this paper aimed to examine the opinions of teachers and students in elementary schools regarding the significance of outdoor education, using the example of School in Nature, in organizing the educational and pedagogical activities within the teaching process. The research results indicate that teachers, by directing their attention to outdoor education as an innovative approach in educational and pedagogical work, are implementing a new approach that goes beyond the traditional classroom model. The concept of outdoor education in nature implies moving students outside the comfortable classroom environment and involving them in spatial activities that require deeper reflection, experimentation, and teamwork.

The first research task focused on examining the opinions of teachers about the significance of outdoor education, using the example of School in Nature, in various aspects of the teaching process (educational, social, recreational, and ecological). Based on the research results, it can be observed that teachers perceive a high contribution of outdoor education in School in Nature in the following aspects:

1. School in Nature provides opportunities for social interactive learning: Teachers believe that School in Nature has an extremely positive impact on the development of positive social relationships among students (M=4.6). This can be explained by the fact that this type of education promotes teamwork, collaboration, and mutual understanding among students. The outdoor environment promotes the importance and the need for critical reflection on the relationship between humans and nature and human-to-human relationships. When students are moved from the classroom to a natural environment, they face

new challenges that require communication and collaboration to achieve the goals of assigned activities.

2. School in Nature has great educational significance for students: Teachers recognize that outdoor education significantly benefits a more successful organization of the teaching process and overall instruction (M=4.4). This aspect may result from increased flexibility in planning and conducting educational activities outside traditional classrooms. Teachers have the opportunity to adapt educational objectives and students' needs in the outdoor environment, which can lead to more efficient and engaged learning. Teachers acknowledge that outdoor education provides a learning environment that contributes to more successful content mastery among students. They perceive outdoor activities in the zone of improving students' academic achievements (M=4.1) and see outdoor education as an organized extracurricular session aimed at stimulating students to independently acquire knowledge and skills. The outdoor learning environment provides unique opportunities to encourage the development of an individual's intellectual sphere and motivates students to voluntarily develop an interest in learning in a pedagogically designed atmosphere that contributes to more successful content mastery among students (M=4.2). Activities in the natural environment allow students to practically apply educational content, which improves their understanding and application of what they have learned. This practical application can result in better performance and long-term retention of knowledge during the learning process.

3. School in Nature fosters environmental awareness among students and serves as a link between nature and the classroom concept: Teachers acknowledge a significant contribution of outdoor education in acquiring knowledge and competencies related to nature conservation, social community, culture, and the environment (M=4.1). They also emphasize the importance of integrating outdoor education with the classroom concept to ensure that students gain fundamental knowledge about interacting with the natural environment. Integrating outdoor education with curriculum content can provide a more comprehensive understanding and application of the material. Teachers assess that School in Nature contributes to the more successful implementation of the Nature and Society subject content, as well as the content of all subjects (M=4.1).

4. School in Nature provides students with opportunities for sports and recreational activities: The research shows that teachers recognize the sports and recreational significance of outdoor education, especially in the context of School in Nature. Teachers assess that outdoor education encourages students to engage in recreational activities (M=3.8), indicating that they believe this type of education contributes to student involvement in sports and recreational activities. These activities offer opportunities for physical exercise, improving fitness and health, developing motor skills and coordination, as well as fostering teamwork, collaboration, and socialization among students. Students can experience fun and satisfaction through sports and recreational activities, which can contribute to positive motivation for learning and increased engagement in their studies. Additionally, these activities can provide a change of environment and refreshment from the typical school setting, which can enhance students' interest and engagement.

In order to achieve a significant contribution of outdoor education in the mentioned aspects and enable its integration with the classroom concept, teachers recognize the exceptional importance of involving students in the destination selection process (M=4.5) and providing comprehensive information to students about the content that allows them to gain a basic understanding of key concepts related to interactions in the natural environment of the chosen destination (M=4.2). Teachers are aware of the existing challenges in preparing and implementing outdoor education and emphasize the importance of precise planning and alignment of the School in Nature program with subject content (M=4.0). Recognizing the value of outdoor education, they highlight that teacher training, which includes planning and implementing such activities, would be of utmost importance for the further development of educational work within the classroom (M=4.0).

Research findings show that teachers recognize the innovative approach of outdoor education, such as School in Nature, as a means to break free from classroom routines and improve educational work. Their opinions indicate positive effects of outdoor education in the areas of student social relationships, the organization of the teaching process, learning efficiency, and subject integration. The research results suggest compliance between teachers' attitudes towards the significance of outdoor education, in the case of School in Nature, and its contribution to the educational aspect of the teaching process, confirming the initial hypothesis.

However, in order to further enhance the preparation and implementation of outdoor education, teachers believe they need additional training to empower and better prepare them for planning and executing such activities in line with the goals of educational work. In this way, teachers could more effectively utilize innovative teaching approaches, such as School in Nature, to improve the quality of the teaching process and the learning experience of their students, providing them with a unique opportunity for practical and experiential learning outside the classroom.

The second research task focused on examining students' opinions regarding the significance of outdoor education, using the example of School in Nature, in various educational, social, recreational, and environmental aspects of the teaching process. Students shared their views and attitudes about different aspects of outdoor education, and the research results provide insights into their satisfaction, perceptions of benefits and drawbacks, as well as suggestions for improving this type of education. Based on the research findings, it can be observed that students assess the high contribution of outdoor education, using School in Nature as an example, in the following aspects:

1. Educational aspect of School in Nature from the students' perspective: According to the research results, students express positive opinions about the contribution of outdoor education, especially School in Nature, as they see it as a platform that provides them with psychological comfort and increases motivation. Students find outdoor lessons extremely interesting (M=4.6) and believe that they learn more than in regular school classes (M=4.5). This suggests that students perceive outdoor education as bringing additional educational value and stimulating their interest and engagement. Students have also expressed support for structured outdoor activities as it allows them to informally engage in the learning process and problem-solving across various subject areas (M=4.2). They believe that these activities provide opportunities to apply acquired knowledge in concrete situations related to nature, the community, culture, and the environment.

However, there are certain challenges and drawbacks identified in the research within the mentioned aspect. Students are less aware of the complementarity between classroom and outdoor education, which is reflected in their lower scores in terms of the success in acquiring instructional content in the classroom and active participation in teamwork (M=2.8). Furthermore, students have minimal interest in the learning process outside the classroom, as confirmed by research findings related to the clarity regarding instructional material after practical application (M=2.7) and the effectiveness in solving tasks in a natural environment (M=2.2). Based on the results, it can be concluded that there is a perception among students that it is necessary to align the School in Nature program with subject content and to directly connect outdoor education activities with the material taught in school. This highlights the need for synchronizing the curriculum and outdoor activities to ensure that the topics and objectives of both approaches coincide and complement each other.

Furthermore, the research results indicate insufficient awareness among students about the destination (M=2.4), which is an integral part of the School in Nature program and aims to shape their initial attitudes towards learning outside the classroom. These findings highlight the need to provide clear information to students about the purpose and objectives of such activities so that they can better understand the reasons for choosing a specific destination and how these activities can contribute to their learning. Additionally, the findings show that students express insufficient interest in acquiring basic knowledge of concepts directly related to educational tasks (M=2.0). This finding suggests that students are not motivated for independent learning or research related to these concepts. The lack of fundamental knowledge may limit their ability to fully understand and apply the subject matter covered in class.

2. School in Nature provides opportunities for social interactive learning: When it comes to the contribution of outdoor education, students have emphasized that they primarily associate its value with the development of positive social relationships (M=4.2). When students speak about the value of outdoor education in the context of social relationship development, it indicates their awareness that the outdoor environment provides space for peer interaction, connection, and the exchange of ideas. This interaction takes place in an environment that is less formal and structured compared to the classroom, which can encourage more open communication and the exchange of opinions. Through outdoor activities, students can work together to solve problems, challenges, and tasks, which promotes teamwork and mutual support. This type of collaboration can have a positive impact on the development of social skills, such as listening, communication, collaboration, negotiation, and conflict resolution. Students can get to know each other in a different way, creating stronger bonds and developing friendships. It is important to note that social interactive learning through outdoor education can have long-term benefits. Students gain experiences that can help them build positive relationships and communicate, not only in an educational context but also in everyday life. Understanding, empathy, teamwork, and the ability to collaborate with others are important skills that can be beneficial in many situations in students' lives.

3. School in Nature fosters environmental awareness in students and serves as a link between the nature and the classroom: Students emphasize that outdoor education helps connect different subjects and that concrete activities inspire them for further exploration (M=4.1). This is important because it encourages students to take a holistic approach to learning and understanding complex issues and phenomena that cannot be comprehensively grasped through individual subjects. Students believe that outdoor education particularly contributes to their understanding and mastery of the subject of Nature and

Society. Through practical activities and fieldwork, students have the opportunity to apply their knowledge from various fields in real-life situations. Additionally, students perceive specific outdoor education activities as a source of inspiration and motivation for further exploration of subjects and natural phenomena. These activities provide them with a chance to face real challenges and problems, and successfully overcoming these challenges allows them to feel motivated and confident, positively impacting their readiness for learning and exploration.

4. School in Nature provides students with opportunities for sports and recreational activities: Students have recognized the importance of sports and recreational activities in the outdoor education environment (M=3.3). These activities give students the chance to engage in teamwork, develop social skills, and gain experience in the practical application of what they have learned. Sports and recreational activities in the outdoor education environment offer students the opportunity to develop social skills. Through interaction with their peers during sports activities, students learn how to adapt to different roles, respect the rules of the game, resolve conflicts, and foster a sense of teamwork. These skills are not only valuable for sports but also hold broader societal significance as they help students integrate better within a group and establish positive relationships with others. The practical application of what is learned through sports and recreational activities is also a significant aspect. Students get the opportunity to apply theoretical knowledge they have acquired in the classroom to real-life situations. This enables them to understand the practical application of concepts and develop skills that will be useful in their daily lives. Sports and recreational activities in School in Nature significantly contribute to the social development of students by strengthening their teamwork skills, enhancing social interaction, and enabling the practical application of what they have learned. These activities promote a holistic approach to education, emphasizing the importance of physical health, supporting social integration, and allowing for the practical application of knowledge.

Students' opinions highlight the importance of establishing a better connection between classroom and outdoor education to provide clearer support and information to students regarding the objectives and content of outdoor education, aiming to stimulate greater interest and engagement in the learning process outside the classroom. The research findings on students' views on the importance of School in Nature indicate the significance of students being well-informed about the School in Nature program, their involvement in the planning and destination selection process, and the increase of their interest in fundamental knowledge directly related to educational tasks. Moreover, the way information is provided to students and how communication between teachers and students regarding outdoor education can be improved should be considered. To fully utilize the benefits of outdoor education, it is essential to encourage greater student interest, enable active participation, and ensure students' comprehension of the School in Nature program. The findings suggest that additional teacher training is necessary to effectively plan and carry out outdoor activities and their contributions to student learning and motivation.

The conclusion that can be drawn from the research results is that students recognize the value of outdoor education in the given aspects, particularly in the context of School in Nature. However, there are areas that require additional attention and improvement. The hypothesis that there is agreement between students' views on the contribution of outdoor education, specifically School in Nature, in different aspects of the education process, especially in the social and recreational sense, can be partially confirmed based on the research findings. The research findings suggest that there are indications of compliance between students' views on the contribution of outdoor education in various aspects of the educational process. However, this compliance can be considered strong or robust in the social aspect, while in other aspects, it is less pronounced or inadequately supported. Students express positive views regarding social interactive learning, emphasizing the development of positive social relationships and skills. Moreover, students' views indicate the positive impact of outdoor education on their interest, motivation, and ability to learn more. Additionally, students recognize the value of outdoor education in connecting different subjects and inspiring further exploration. However, although students acknowledge the importance of sports and recreational activities, the research findings indicate a less pronounced or less robust positive attitude regarding the recreational aspect of outdoor education.

The third research task aimed to investigate the differences in the opinions of teachers and students regarding the significance of outdoor education, using the example of the School in Nature. The attitudes of teachers and students were examined concerning organization, program planning, alignment of content, as well as their views on the educational and pedagogical effectiveness in the realms of the education process and the quality of the education process. Based on the obtained results, significant differences in the attitudes of teachers and students can be observed regarding the organization, planning, and alignment of program content in the School in Nature.

Teachers display high competence and readiness for conducting outdoor education, considering

that geographical, intellectual, and psychological preparation is necessary to provide a positive learning environment. In contrast, students show lower scores and less readiness for such preparation, indicating their insufficient interest and engagement in these aspects of outdoor education. Regarding the evaluation process after the activities in the School in Nature, students have a clear opinion about the necessity of such evaluation to assess the importance of outdoor education in achieving educational and pedagogical goals. On the other hand, teachers emphasize this aspect less, which may suggest their lower awareness of the significance of evaluation in the context of outdoor education. Additionally, differences in emphasizing the cognitive and affective domains in teaching processes are noted. Teachers emphasize the cognitive domain (knowledge acquisition) more, while students attach greater importance to the affective domain (attitudes, values, interests). This may indicate the need to adapt teaching methods and approaches to pay more attention to the emotional engagement of students. Regarding the pedagogical and educational significance of the School in Nature, teachers, more than students, recognize its value in students' academic achievements, in the correlation of content between subjects, and in the functionality of acquired knowledge. Furthermore, teachers emphasize the "innovation" in knowledge acquisition through outdoor education more than students, who show less interest in the learning process in that context. Regarding the pedagogical and educational efficiency, teachers emphasize the social and adventurous aspects of outdoor education, as well as the environmental aspect, more than students. The sports and recreational aspect is considered a powerful tool for preserving and enhancing students' health, with no significant differences between the attitudes of teachers and students. Students express the view of the "usefulness" of outdoor education, while teachers emphasize this aspect less. This may indicate different perspectives and expectations regarding the benefits that outdoor education provides to students.

The research findings have identified statistically significant differences in the opinions of teachers and students regarding the organization, planning, and evaluation of outdoor education. Teachers have shown higher competence and awareness of the importance of outdoor education in achieving educational and educational goals, while students have demonstrated less interest and engagement in these aspects. Differences were also noted in emphasizing the cognitive and affective domains and in evaluating the pedagogical and educational significance of the School in Nature. The research clearly confirms the hypothesis that teachers and students have significantly different views about the importance of outdoor education, especially the School in Nature, in achieving educational goals. Teachers particularly value preparation, the cognitive domain, and the complementarity between classroom and out-door education, while students emphasize the need for evaluation, the affective domain, and the social aspect of outdoor education. This points to the need for better understanding and communication between teachers and students to maximize the benefits of outdoor education.

The research results have shown that both teachers and students recognize the significance of outdoor education, particularly through the implementation of the School in Nature, in organizing educational activities within the teaching process, thus clearly confirming the main hypothesis. Teachers express a high level of support for this innovative teaching approach, acknowledging its positive effects in various aspects of education, such as students' social relationships, the organization of the teaching process, learning efficiency, and the connection with subjects. Their attitudes indicate competence and awareness of the importance of outdoor education in achieving educational and learning goals, emphasizing particularly the cognitive domain and the complementarity between classroom and outdoor education. On the other hand, students also recognize the value of outdoor education, but there are variations in their attitudes. The importance of social interactive learning, the development of positive social relationships and skills are particularly highlighted. Students also acknowledge the value in connecting different subjects and finding inspiration for further exploration. However, their support for the recreational aspect of outdoor education is less pronounced.

These findings highlight the importance of understanding the differences between teachers' and students' opinions to better adapt and improve outdoor education. The research also underscores the need for more effective communication between teachers and students to maximize the benefits of this innovative educational approach.

Conclusions

The essence of this study lies in the empirical approach to exploring the significance of outdoor education, using the example of School in Nature, from the perspective of both teachers and students, as an educational tool to connect students with concepts beyond the classroom. Teachers and students recognize numerous benefits of outdoor education, including educational, social, recreational, and

environmental dimensions. However, there are several challenges and shortcomings related to its implementation.

Teachers are more aware of the significance of outdoor education than students. They recognize various aspects of outdoor education and view it as a valuable tool to increase students' interest, motivation, and effective learning. Additional training for teachers is necessary to enable them to successfully plan and conduct outdoor activities. Teachers are aware of the need for professional development to enhance their skills and knowledge related to outdoor education. Continuous professional development for teachers should be supported to ensure the effective implementation of outdoor education.

Students have clearly expressed the view that outdoor education activities should be directly related to the curriculum taught in school. This highlights the need to integrate outdoor education into regular teaching materials to allow students to apply their acquired knowledge in practical situations. Teachers should devise ways to align outdoor education programs with the school curriculum to ensure their mutual complementarity and integration.

The pedagogical implications of this research include the need to support teachers through additional training, resources, and time for planning and conducting outdoor activities. It is also important to raise students' awareness of the significance of outdoor education and its benefits. Integrating outdoor education with regular teaching materials can enhance learning and the application of knowledge in practical situations.

Overall, outdoor education, such as School in Nature, represents an innovative approach that enhances educational and pedagogical efforts. The implementation of this type of education requires the support of educational systems, curricula, and continuous professional development for teachers. The pedagogical implications underscore the need for improving outdoor education to stimulate student interest, motivation, and successful learning.

These conclusions highlight the importance of further research and the enhancement of the organization and implementation of outdoor education to better meet the requirements and expectations of all participants in the education process.

Acknowledgements

Author Contributions

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

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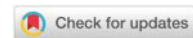
Enhancing Legally-Based E-Government Services in Education Through Artificial Intelligence

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Abstract: Through the utilization of artificial intelligence (AI), governments can automate the analysis of publicly available government datasets. This process aids in the recognition of patterns and the development of a more profound comprehension of various socio-economic factors and empowers governments to base their policy decisions on data, effectively tackling societal issues, and optimizing the allocation of resources. In this paper we present AI's application in the realm of e-government, with particular emphasis on its potential influence on the advancement of this field through e-government services and their significance for a range of stakeholders. Moreover, we have conducted comprehensive review of existing literature on the subject and the identification of avenues for enhancement along with consideration of legislation as a potent instrument to guide the progression of AI within the sphere of e-government, thereby amplifying its transformative effect. We emphasize the importance of education in area of AI in order to ensure it's high quality implementation in this and other areas.
Keywords: artificial intelligence, e-government, open data, transparency, improvement.

Introduction

Open Government Data (OGD) plays a vital role in the concept of open government. Its popularity has increased significantly in recent years and continues to grow, aligning with the ongoing trend of establishing or enhancing the understanding of the current status, drawbacks, and advantages of OGD initiatives (including specific components like the OGD portal or OGD platform) and their position relative to others (Spalević, Veljković and Milić, 2023). The value generated through OGD extends across various government functions, including decision support, transportation, public health, and law enforcement. This value contributes to building citizens' trust in the government, fostering greater transparency, and yielding positive societal and governmental implications. Further harnessing of the potential of OGD can be leveraged by artificial intelligence (AI) techniques and algorithms, with purpose of extracting valuable insights and patterns from vast amounts of open data, leading to enhanced decision-making processes and improved service delivery (Zuiderwijk, Chen and Salem, 2021). Through AI, governments can automate the analysis of open government datasets, identify trends, and gain a deeper understanding of various socio-economic factors. This enables them to make data-driven policy decisions, address societal challenges more effectively, and allocate resources efficiently. Another advantage of using AI is handling the huge amount of information on the approach of automatic processing and other services (Sträßer and Stolicna, 2023).

AI also plays a significant role in ensuring the accessibility and usability of open government data. Moreover, AI-powered algorithms can assist in data quality assurance, anomaly detection, and data privacy protection. By leveraging AI techniques, governments can identify potential biases, improve data accuracy, and ensure the responsible and ethical use of open government data. The synergy between AI and OGD holds immense potential for promoting transparency, citizen engagement, and evidence-based governance. It empowers both governments and individuals to harness the transformative power of data, fostering innovation, and driving social progress. Full exploitation of AI in this and other areas can be achieved by striving towards education in AI, enabling consequently proper and adequate application of

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AI in order to fulfill the set goals (Buiten, 2019).

To achieve effective implementation and successful integration of AI in the public sector, comprehensive AI governance is essential (Etscheid, 2019). It entails developing robust plans for implementation, engagement, and communication, while also addressing the technical aspects of AI along-side governance, policy, and regulatory issues. For governments it is crucial to recognize that AI and OGD should not only be approached from a technical perspective but also from a governance stand-point (Kankanhalli, Charalabidis and Mellouli, 2019). By comprehensively addressing AI governance, policy, and regulatory challenges, governments can formulate effective strategies for utilizing AI in the public sector while safeguarding the interests of their citizens.

Research objective

In this paper, we examine the utilization of artificial intelligence within the realm of e-government, paying particular attention to its potential impact on advancing this domain. To accomplish this objective, we initially center our discussion on e-government services and their significance for a range of stakeholders. Subsequently, we delve into the deployment of AI in the e-government domain by conducting a comprehensive review of existing literature and pinpointing opportunities for enhancement. An essential aspect that requires due consideration is the legal framework. Consequently, the paper explores the strategic deployment of legislation as a powerful instrument to guide the evolution of AI in the e-government sector, thereby augmenting its transformative influence. Therefore, we here establish two research questions which will be further researched throughout the paper:

RQ1: Is there any opportunities for enhancement of deployment of AI in the e-government domain?
RQ2: How legal frameworks are aligned with current development of e-government?

E-government services

With digital services, government worldwide can deliver information and services to their citizens anytime, anywhere, and citizens can access to that information and services through any platform or device. Here we can come to question what is the importance of e- services in open government? Open government does not only mean the availability of government information on the internet, but also the interaction between the government and citizens. That interaction is reflected into the concepts of openness, transparency and participation.
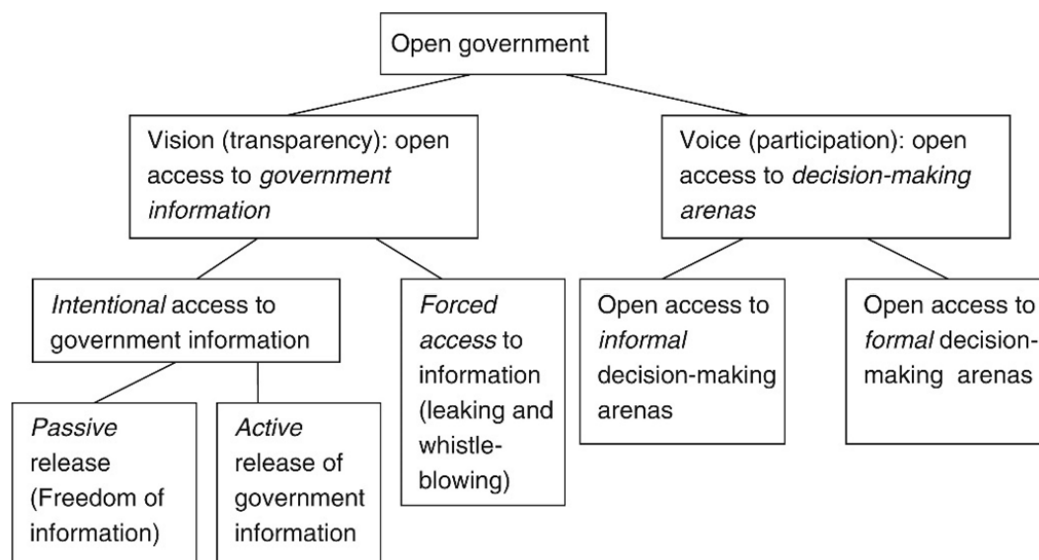

Figure 1. Vision of open government (Meijer, Curtin and Hillebrandt, 2012).

In open government, special emphasis is placed on the importance of the availability of open data (OGD). Moreover, transparency of government reduces the information gaps between government and the citizens (Kim and Lee, 2012). Transparency can be described as the active disclosure of information by an organization with the intent of allowing external actors to monitor and assess the internal workings or performance of that organization (Krah and Mertens, 2020). However, if information is not comprehensible

to the users, then published information about an organization does not contributes to the transparency.

Citizens are at the heart of open government, and their participation represents a fundamental principle of the latter (Wirtz, Weyerer and Rosch, 2019). Citizen participation has always been considered one of the key pillars of open government (Kempeneer and Wolswinker, 2023) and one of the main objectives of open government. However, the possibility for citizens to express their opinions, as well as to participate in the processes of government decision-making using digital services, implies the need for the availability and accessibility of modern technologies to the whole society. This is especially pronounced in developing countries, where the "digital divide" must first be bridged (Milić, 2019). Bridging the digital divide has implications in terms of fostering economic equality, educational potential, and earning potential (Fong, 2009).

Over the past few years, e-government services implementation is rapidly growing worldwide. For one to understand the idea of e-government services, must first understand electronic services in general. "Electronic service, refers to services offered over the information and communication technologies" (AlBalushi, 2021). These services are becoming increasingly important with continuously developed application in various domains (business, government, education and health) as these services provide benefits to all parties concerned from service providers, service users and the society. While developing countries are implementing the concept of e-government for the first time, developed countries are trying to improve quality of already existing services, and the question that arises is how to do it? The answer to this question is: quality of services can be improved only through understanding of the situation in some country (Mukamurenzi, Gronlund and Islam, 2019).

"E-government services affect many stakeholders including citizens and enterprises, government staffs, information technology developers and policy makers" (Fan and Jang, 2015). Each stakeholder has different interests and goals and depending of how government services fulfill those interests and goals, stakeholders evaluate the quality of e-government services in that way. "As service providers want to boost the efficiency and quality to reach more users to utilize these services, a prime challenge in developing these services with high quality to meet users' expectation becomes a must" (AlBalushi, 2021). The service provider offers various services to the end-users and they use it. However, the question is what affects the maintenance of trust between service providers (in this case government) and end-users? Quality which is reflected in personalization, usability, performance, web design, security, user involvement, satisfaction and loyalty is the answer. Quality requires constant work on it, because only in that case quality of e-government services is at high level. Nevertheless, raising awareness about of e-government services and their usage benefits, as well as important of usage of OGD portal contributes to the further exploitation and utilization of e-government services.

Public sector organizations have started making governmental data available on web portals, as web services, so that the public have access to such official datasets in one place (Weerakkody et al., 2017). "A real benefit of OGD is not simply that single databases can be used more widely; it is that these data can also be leveraged, shared and combined with other data" (Huston, Edge and Bernier, 2019). In the human and environmental health realms, for example, the ability to access and combine diverse data can advance early signal detection, improve analysis and evaluation, inform program and policy development, increase capacity for public participation, enable transparency and improve accountability. In order to further advance the goals of open government it is important to make reflection on the possibilities of OGD usage and not simply view publishing OGD as an end point (Ruijer et al., 2020). It is expected that OGD will be exploit to create various applications by end users and that these applications will be for the benefit to the whole society.

In many domains, OGD can be of benefit, and examples of how OGD can be used already exist in many applications. Keeping that in mind, utilization of OGD has emerged as a transformative force in the field of education (Chokki et al., 2022), fostering transparency, innovation, and informed decision-making. In the context of education, OGD encompasses a wide range of information, from school performance and enrollment statistics to curriculum materials and educational resources (Huss and Keudel, 2020). One of the primary advantages of OGD in education is its potential to empower parents, educators, policymakers, and researchers with insights to drive meaningful change. By providing access to data on school performance, teacher qualifications, and student outcomes, stakeholders can make informed decisions to improve educational quality. Parents can better evaluate school options for their children, and policymakers can identify areas in need of targeted interventions to enhance educational outcomes.

The collaborative potential of OGD is particularly evident in fostering partnerships between governmental bodies, educational institutions, and civil society organizations. These partnerships can leverage data to design evidence-based policies, monitor educational progress, and promote greater accountability. For example, transparency in budget allocation and resource distribution can lead to more

equitable funding across schools, narrowing educational disparities (Yates et al, 2021).

Artificial intelligence in e-government

On the global stage initial addressing of the matter of artificial intelligence was done by the Organization for Economic Cooperation and Development (OECD). In May 2019, the OECD adopted the "Recommendation of the Council on Artificial Intelligence, marking it as the first clear and legislatively regulated standard within the realm of artificial intelligence" (Yeung, 2020). This recommendation was endorsed by the Council upon the motion of the Committee for Digital Economy Policy. The document emphasized the need for advancing and refining artificial intelligence systems among member states of the OECD. It stressed the significance of considering human rights and fundamental freedoms to prevent the misuse of AI (Anderljung and Hazell, 2023) as a tool by authorities or interest groups. A key directive of this document pertained to the principles that should be incorporated into national laws to guide the creation of responsible and confidential AI systems. These principles encompassed notions of inclusive growth, sustainable development, reaping the benefits of artificial intelligence through application in various areas such as e-government, e-health and etc., upholding human values and principles, ensuring transparency and comprehensibility, maintaining quality and safety in AI systems, and establishing accountability for those who develop and implement such systems (Nguyen et al., 2022).

In the rapidly evolving landscape of e-government, AI has emerged as a transformative force, reshaping the way public services are delivered and accessed (Al-Mushayt, 2019). E-government, which refers to the use of digital technologies to enhance government operations and interactions with citizens, has found a powerful ally in AI. One of the most notable applications of AI in e-government is in citizen service delivery. Virtual assistants powered by AI (Chohan and Akhter, 2021) can provide real-time support and information to citizens, offering personalized responses and guiding them through various government processes. This not only reduces the burden on government call centers but also provides citizens with faster and more convenient access to the information they need. AI-driven chatbots (Cantador et al., 2021) can handle routine inquiries, freeing up human resources to focus on more complex tasks and policy matters.

Moreover, AI's data analysis capabilities are revolutionizing decision-making within government agencies (Valle-Cruz, Gil-Garcia and Fernandez-Cortez, 2020). By sifting through vast amounts of data from disparate sources, AI systems can identify patterns, trends, and insights that human analysts might overlook. This data-driven approach enhances policy formulation, resource allocation, and public service planning. For instance, AI can predict and prevent bottlenecks in public services, optimize traffic management, and even assist in disaster response by analyzing real-time data from various sensors and sources. However, the adoption of AI in e-government comes with challenges. Privacy and data security are paramount concerns, as the processing of sensitive citizen data requires robust safeguards to prevent misuse or breaches. Additionally, there is a need for upskilling government employees to understand, manage, and collaborate effectively with AI systems. "Ensuring transparency and accountability in AI decision-making processes is also crucial for building public trust in government AI applications" (Kim, Park and Suh, 2020).

Nonetheless, the implementation of AI in e-government is not without challenges. Ensuring the ethical use of AI (Al-Besher and Kumar, 2022), maintaining data privacy and security, and addressing potential biases in AI algorithms are critical concerns. Governments must establish robust frameworks to govern AI deployment (Al-Mushayt, 2019), encompassing transparency, accountability, and mechanisms for addressing unintended consequences. From previously stated, it can be noted that there is numerous opportunities for improvement of deployment of AI in the e-government domain. Not to forget ethical considerations and privacy issues, which will further elaborated in next paragraphs.

One of the central ethical concerns in the deployment of AI in e-government is transparency (AlShamsi et al., 2020). Governments have a responsibility to be transparent about the ways in which AI is being utilized to make decisions that affect citizens' lives. Citizens have the right to understand how AI algorithms operate, how decisions are reached, and what data is being used to inform those decisions. Transparent AI systems promote trust among citizens, as they can better comprehend the processes that impact them and hold the government accountable for fair and unbiased outcomes. Equity and fairness are also critical ethical dimensions of AI in e-government. Governments must be vigilant in ensuring that AI systems do not perpetuate existing biases or discriminate against certain groups of citizens. If AI algorithms are trained on biased or incomplete data, they may inadvertently amplify societal disparities. Regular audits and assessments of AI systems for fairness and bias are essential to rectify and prevent

such issues.

Data privacy is another paramount ethical concern. E-government systems often involve the collection and processing of citizens' personal data (Shah, Wassan and Usmani, 2022). Governments must uphold stringent data protection measures to prevent unauthorized access, use, or sharing of this sensitive information. Citizens should have control over their data and be informed about how it is being utilized within AI systems. Accountability is a fundamental principle that should be upheld in AI-driven e-government (Vrabie, 2023). While AI systems can automate decision-making processes, governments must retain oversight and responsibility for the outcomes. Clear lines of accountability should be established to determine who is ultimately responsible for AI-related decisions and actions.

Legislation of AI and e-government

Legislation is increasingly aligning with the ongoing development of e-government to address the complexities arising from the digital transformation of public services. These frameworks are essential for establishing clear guidelines related to data protection, cybersecurity, and privacy, ensuring that citizens' rights and government transparency are maintained in the digital era. They also play a pivotal role in fostering public trust in e-government initiatives, as they provide a regulatory foundation for the secure and responsible use of technology in the delivery of government services.

At the United Nations (UN) level, specifically within the United Nations Institute for Research on Crime and Justice (UNICRI), the Center for Artificial Intelligence and Robotics was established in 2015 in the Netherlands, based in the Hague. The center's focus lies in preventing crime and fostering justice and security through the use of AI and robotics. A notable publication from this center is "Artificial Intelligence and Robotics for Law Enforcement" (UNICRI, 2020), which explores the potential applications of these technologies in the realm of law enforcement (Raaijmakers, 2019). While artificial intelligence holds considerable potential for enhancing law enforcement processes, it also introduces various risks to citizens' rights and freedoms. It has the capacity to propagate misinformation and inaccurate information, manipulate photos and video content, potentially undermining the legitimacy of evidence and legal proceedings conducted by public authorities. To mitigate these risks, states are urged to allocate additional resources for understanding artificial intelligence through expertise-building processes (Liu, Lin and Chen, 2019). Additionally, fostering international collaboration is vital during the development of expert systems to counteract these challenges.

Proposal of the European Commission for the European Union's regulatory framework on artificial intelligence represents the first significant step in the regulation of this technology in the EU. This proposal, known as the EU regulatory framework on artificial intelligence (AI) aims to establish clear rules and standards for the use of AI in different sectors to ensure ethical, transparent and responsible application of this technology (Veale and Zuiderveen Borgesius, 2021). The main importance of this proposal is given on Table 1.

Table 1
EU regulatory framework on AI

No.	Action	Description
1	Categorization of AI systems	Framework provides the division of artificial intelligence systems in three categories – high, limited and minimal risk.
2	Requirements for transparency	The proposal establishes that users and citizens must be notified if they interact with an AI system to maintain transparency and trust.
3	Prohibited AI system	The proposal prohibits the use of certain artificial systems intelligence that represent an "unacceptable risk" for the fundamental rights and values of the EU.
4	Training and documentation	The proposal requires that high-risk artificial intelligence systems go through training, testing and documentation procedures in order to confirm safety and reliability.
5	Sanctions for non-compliance	The proposal includes sanction mechanisms for organizations that violate the provisions of the regulation on artificial intelligence.
6	Cooperation with Member States	The proposal emphasizes cooperation between Member States and EU to ensure consistent enforcement of regulations.

This proposal showed the desire of the European Union towards responsible and ethical use of artificial intelligence, with a special focus on the protection of basic rights of citizens. However, during the next two years, many abuses of use appeared in practice systems and AI tools (Buiten, 2019), which led to the need to define a restrictive legal solution regarding the use of artificial intelligence.

The European Parliament adopted the Draft Law on Limiting Artificial Intelligence on 16.6.2023. This Law establishes norms that should ensure that artificial intelligence tools are developed and/or used in the EU in full compliance with EU rights and values. First of all, it is the same relating to the supervision of people and objects, security, privacy, transparency, non-discrimination and socially responsible behavior (Buiten, 2019). These standards aim to promote the definition and adoption of artificial intelligence (AI). Which is reliable and people-oriented, protecting health, safety, fundamental rights and democracy from possible harmful effects and application of artificial intelligence.

Conclusions

In this paper, our aim was to examine AI's utilization within the e-government domain, particularly in its alignment with open data, services, and various aspects such as transparency, collaboration, participation, innovation, and legislation. AI's aptitude for data analysis is leading a transformation in decision-making processes within government agencies by uncovering patterns and insights from a wide array of data sources, ultimately enhancing the formulation of policies, allocation of resources, and the planning of public services. Through literature analysis on up to date research of e-government services and answering to established research question, we try to provide recommendations for readers which go towards harnessing of the AI for the prediction and prevention of service bottlenecks, aiding in pattern recognition, and facilitating a deeper understanding of various socio-economic factors, thereby strengthening accountability and automating decision-making processes.

Our review findings confirm that AI is being employed to support various functions within governance, with a primary emphasis on improving the delivery of public services. However, there is a noticeable scarcity of AI's application in policy modeling to assist in the development of effective intervention strategies. Additionally, the implementation of legal regulations is imperative when employing AI in government operations, with the objective of ensuring transparency and providing citizens with more convenient and expedited access to essential information. Furthermore, there is a lack of a standardized approach to AI's application, especially in the context of education, where specialized training for AI practitioners in government and other sectors is absent.

Conflict of interests
The authors declare no conflict of interest.

Author Contributions

Conceptualization, P.M.; methodology, Z.S.; investigation, Z.S. and S.V; formal analysis, P.M and S.V; writing—original draft preparation, P.M. and S.V.; writing—review and editing, P.M. and S.V. All authors have read and agreed to the published version of the manuscript.

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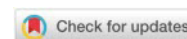
Can AI be Evil: The Criminal Capacities of ANI

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Abstract: Artificial Narrow Intelligence (ANI) represents a captivating domain within technological advancement, bearing the potential for profound societal transformations. While ANI holds the promise of enhancing various facets of human existence, it concurrently engenders inquiries into its "darker aspects." This study delves into the challenges associated with ANI's conceivable manifestation of harm and injustice, a phenomenon devoid of consciousness, intention, or responsibility akin to that of human entities. A pivotal dimension of ANI's "dark side" pertains to its susceptibility to malevolent utilization. Despite its lack of awareness, ANI serves as a tool for malicious endeavors, encompassing the propagation of disinformation, compromise of security systems, and consequential decision-making. This prompts contemplation on strategies to mitigate these "precise manifestations of malevolence" arising from ANI's technological progression. Additionally, ANI's development introduces profound ethical quandaries. Ensuring ANI's alignment with moral principles while averting scenarios in which it generates decisions conflicting with human morality becomes a pressing concern. This research underscores the imperative for rigorous regulatory frameworks and ethical directives to curtail potential hazards and unscrupulous utilization of ANI. The fundamental objective of this investigation is to advocate for the responsible deployment of ANI in society. A comprehensive understanding of potential risks, complemented by meticulous consideration of ethical dimensions, emerges as an indispensable prerequisite to harmonizing technological advancement with safeguarding societal and individual interests.
Keywords: Artificial narrow intelligence, evil, crime, ethics.

Introduction

People fear the unknown, everything they cannot comprehend, predict, or control, especially phenomena beyond their volition. This psychological framework can be applied to the question of 'Can AI be evil?' We fear this question because most people lack a deep understanding of artificial intelligence, shaping their perception of AI based on depictions in movies and literature. They often believe that such dystopian AI scenarios could become our future. What people may not realize is that what's commonly depicted in most films represents AI superior to humans in every aspect, called 'Artificial General Intelligence' or 'AGI,' but its full implementation isn't expected by scientists before the end of this century (Ford, 2018). This has led us to contemplate the aspects of the dark side of artificial intelligence, which we have 'in flagrante,' preceding AGI, especially ASI, referred to by scientists as ANI.

Science currently operates with three levels of artificial intelligence in theory: Artificial Narrow Intelligence or ANI, Artificial General Intelligence or AGI, and Artificial Super Intelligence or ASI. (IBM Data and AI Team, 2023; Price, Walker and Wiley, n.d). ANI is considered 'weak' AI, while the other two forms are classified as 'strong' AI. Weak artificial intelligence is defined by its ability to perform specific tasks, such as regulating air traffic, driving a car, or identifying a particular person. Some examples of ANI usage include natural language processing, computer vision, advancements in human medical treatments, task automation, and support for chatbots and virtual assistants.

Stronger or higher forms of AI, like AGI and ASI, involve replicating and simulating human thinking and behavior. Strong AI is defined by its ability to successfully mimic or surpass cognitive concepts

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and capabilities of the human brain. The pinnacle of AGI would be equivalence with human intellectual capacity, while artificial superintelligence (ASI) would significantly surpass human intelligence and the cognitive abilities of the human brain. Research in this field is ongoing, but no known form of strong artificial intelligence currently exists. Artificial intelligence is emerging as the predominant driving factor of the current era. ANI is becoming the central player in various sectors of life. Progress promises innovations that will improve healthcare, education, trade, industry, and many other fields. However, along with undeniable progress, which remains largely in the realm of predictions, the proliferation of ANI poses an ominous threat of unknown provenance, intention, and form, as humanity increasingly relies on AI. The omnipresence of ANI brings forth a series of profound ethical and legal questions and dilemmas that require careful consideration and the establishment of responsible frameworks.

One of the central philosophical questions in the context of the ontological aspects of AI technology is, 'Can artificial intelligence be evil?' The concept of 'evil' is traditionally associated with the intent of conscious beings to inflict pain, harm, or injustice on other conscious beings. It is presumed that higher forms of artificial intelligence (AGI and ASI) might or should have consciousness and free ontological existence, allowing them to choose evil as a form of behavior. However, concerning artificial narrow intelligence (ANI), the ontological paradigm of this noumenon excludes consciousness and intent, shedding light on this matter in a different way. ANI is a product of human engineering and represents a collection of algorithms and data that enable machines to autonomously perform tasks that typically require human intelligence. This technology can cause harm, and it can exhibit activities and qualities reminiscent of malevolence that we would attribute to conscious beings. The question that arises is how to interpret and understand the negative consequences and whether, in the context of actions by artificial intelligence, we can classify them as 'evil'."

Moral Evil in the Behavior of Artificial Narrow Intelligence (ANI)

An essential dialectical opposition exists between the ontological concepts of humans and artificial intelligence. Humans, upon gaining consciousness and reason, became free beings, possessing free will that grants them the right and the ability to choose evil as a way of life. Human beings acquired their freedom through hubris, a just rebellion against the cosmic or divine order. They survived this rebellion but ceased to be ethically and mentally perfect, striving now to create an artificial copy of themselves (AI) that would be devoid of the imperfect attributes of humans—a replication of humans before committing the original sin. Can humans, inherently free but mentally imperfect and ethically fragile, create a perfect artificial intelligence? To what extent are humans capable of, while crafting various forms of artificial intelligence, avoiding the implementation of their own limitations and the 'dark side' of their personalities in AI, even if only in ANI? This is also an epistemological question. When an AI entity reaches singularity, it will learn from the people around it (see more: Bostrom, 2014). What will an AI entity learn from observing human interactions and behaviors? The answer must be rather grim and dystopian.

ANI lacks consciousness, intent, or the moral capacity of conscious beings, necessitating a different approach. When we contemplate 'evil' in the context of ANI, we must exclude the copying of logical and legal postulates of theories and practices related to human behavior, particularly the reasons for 'culpability exclusion' in humans who have committed a criminal act. With ANI, our focus should be on the negative consequences, harm done, and the risks posed by this technology. From the perspective of the ethics of the human community, the ethical characteristics of AI entities present a kind of ethical dilemma. The concept of 'evil,' in the sense of an ethical, civilizational, normative category of human life, is regarded as 'intentionally and consciously inflicting pain on a conscious being' (Rasel, 1982). The fact that ANI has no intent to cause harm, nor any consciousness to do anything wrong to anyone or anything, cannot be a reason for excluding ANI's culpability. Hence, among experts in ANI, concerns are growing that ANI could engage in activities that people perceive as causing severe harm. This is particularly relevant in the context of potential misuse of ANI for military purposes. ANI can be integrated into weapon systems to enable autonomous tracking, targeting, and attacking of human targets. The technology of 'autonomous weapon systems' controlled by ANI can be misused to target civilian objects or innocent people. ANI can be used to generate false information, videos, and texts to spread misinformation and propaganda for the purpose of destabilizing opponents. It can be used for mass surveillance of citizens' communications and movements, jeopardizing privacy and civil liberties. It can be used to conduct sophisticated cyberattacks, including attacks on critical infrastructure, military systems, or communication networks. ANI can manifest 'evil' through bias and discrimination in its decisions. ANI algorithms created on unfair or biased data can result in injustice and harm with very severe consequences. The automation brought by ANI can result in job losses and changes in the labor market, which unemployed individuals may perceive as evil.

People may strive to create AI that functions as close to perfection as possible, but complete perfection is unattainable for humans. The reasons for this are multiple and are based on: (1) Inherent human constraints, preventing the creation of flawless artificial intelligence due to limitations in human knowledge and capabilities; (2) Flaws in decision-making arising from human biases and imperfections, where personal experiences, prejudices, and values can introduce errors in the development of artificial intelligence; (3) The ever-changing nature of technology, which continually evolves and renders today's notion of 'perfection' in artificial intelligence outdated in the future; (4) Ethical considerations, as the definition of AI perfection may hinge on ethical and moral values, adding a subjective dimension to the concept. What is 'perfect' for one person or group may be unacceptable for another. Instead of pursuing complete perfection, a better approach to AI development may be to create systems that are highly efficient, safe, transparent, scalable, and capable of learning and adapting.

Establishing the Culpability of Artificial Narrow Intelligence (ANI)

Culpability is a crucial element in the consideration of criminal offenses and is based on the internal state of mind and intentions of the entity or person suspected of committing a crime. In many legal systems, culpability is examined beforehand to either establish or exclude the responsibility of the accused for the commission of the offense.

Given that Artificial Narrow Intelligence (ANI) is a product of a material nature, it is, according to Heidegger's views, an 'entity,' it 'is,' and thus represents an entity with its ontological being (see more: Hajdeger, 2000). However, ANI lacks consciousness, free will, or the ability to possess logos that would enable it to differentiate between right and wrong and good and bad. This ability to distinguish relies on the power of reason and cognition. Since ANI lacks consciousness and reason, it cannot possess 'intent' as a crucial condition for the existence of the 'guilty party' in humans. When the possibility of ANI's culpability is compared to the possibility of human culpability, the notion of culpability, as a possible psychological or subjective element of ANI's criminal offense, operates differently. ANI is developed to perform specific tasks, basing its decisions and actions on algorithms, data, and programming provided by its creators. During the execution of tasks, ANI cannot comprehend moral and ethical concepts in the way that the human mind does.

Legal regulation of new phenomena always poses challenges for lawmakers, regardless of the branch of law. At this stage of societal development, problematic questions arise in the fields of artificial intelligence, ICT, robotics, and more. Scientific and technological progress brings not only benefits but also new dangers to humanity. The use of robots, non-biological neural networks, and artificial intelligence in everyday life was, until recently, perceived as something brilliant, unattainable, existing only in the pages of books. Neural networks are actively employed in various fields of applied science, and literature describes positive examples of the use of autonomous devices in medicine (Hamet and Tremblay, 2017).

ANI has long been causing harm to individuals and human communities, and someone should be held accountable for that harm under the law. However, current legal regulations do not include elements of criminal offenses related to socially dangerous acts committed using artificial narrow intelligence (ANI). Laws generally do not recognize ANI as a perpetrator of a criminal offense or a subject of criminal liability. ANI is now capable of fully executing the objective side of a range of criminal offenses stipulated by criminal law, and this range will expand in the future. Scientific papers demonstrate that ANI activities can pose a public danger and harm all subjects protected by criminal and other legislation (Mosechkin, 2019). Since ANI seeks to replicate human behavior and conduct, the substance of ANI's guilt resembles the content of intellectual and volitional elements of human activity. It is argued that artificial intelligence cannot be an independent subject of a criminal offense unless it is recognized as a personality (Mosechkin, 2019). This is supported by the view that ANI 'can function in ways that are far from what program creators could have foreseen. To be sure, we might be able to say what the comprehensive goal of artificial intelligence was, but ANI may do things in ways that the creators of artificial intelligence may not understand or cannot anticipate' (Bathaee, 2018).

Criminal Potential of the Dark Side of ANI

Dark artificial intelligence is a general term encompassing any malicious and malevolent acts that autonomous ANI systems can perform with the appropriate malicious inputs and evil, even criminal, intentions of the architects or creators of ANI algorithms (biased data, unverified algorithms, etc.). The range of possible scenarios for the criminal use of dark artificial intelligence is vast and incredible, ranging from economic fraud and privacy violations to severe forms of war crimes, including murders and the

extermination of parts of the human community, be it 'hostile' nations or ethnic or racial groups within one's own country. For example, money laundering, a very complex criminal offense that typically requires a serious and organized criminal group (Bjelajac, 2011a), is something that AI can do in a fraction of a second if instructed to do so. Modern technological systems used in financial transactions have significantly eased the process of money laundering (see more: Bjelajac, 2011b), but when you add the computational and analytical capabilities that AI possesses, it paints a very worrisome picture, and that is only one form of criminal activity. Research papers differentiate direct and indirect criminal risks associated with the use of ANI (see more: Begishev and Khisamova, 2018).

Scenarios of malicious activities of the dark side of ANI have the potential to become a reality given existing malicious ANI applications, such as 'smart dust' and drones, facial recognition and surveillance, fake news and bots, as well as the eavesdropping of smart devices (Minevich, 2020). Drones and armies of smart dust can collaborate to destroy energy grids and smart infrastructure systems. Facial recognition provides autonomous systems with the ability to detect and store millions of individual characteristics, which, due to cloning and bots, can be used to create deeply compromising false images and videos. Smart home devices raise privacy invasion to unacceptable levels, as IoT (The Internet of Things) technologies serve as efficient channels for spying by domestic cybercriminals or foreign agents. Unbridled access of artificial intelligence to population surveillance will rapidly create human rights issues related to individual personality and freedom (Minevich, 2020).

Several characteristics of ANI make it desirable for criminal use (Stevens, 2023):

1. Speed and Effectiveness: AI has the capability to swiftly process vast volumes of data and perform tasks efficiently, presenting the potential to automate fraudulent activities.

2. Anonymity: AI can be harnessed to carry out deceptive actions covertly, leaving minimal to no traces.

3. Evasion of Detection: AI can generate deceptive information that is challenging to identify as false.

4. Personal Gain: Fraud frequently stems from the pursuit of financial or other advantages through deceitful means, and AI can be employed as a facilitative tool for such objectives.

5. Fabrication of False or Misleading Content: AI can be utilized to fabricate counterfeit websites, social media accounts, or other online materials with the intent of deceiving individuals. This encompasses the creation of fictitious reviews or manipulation of online ratings to mislead consumers.

6. Automation of Deception: AI can automate fraudulent or deceitful schemes, such as the mass dissemination of deceptive emails aimed at persuading individuals to disclose sensitive information or transfer money.

7. Phone Number or Email Address Spoofing: AI can generate counterfeit phone numbers or email addresses, crafted to mislead individuals into believing they are interacting with a legitimate entity.

8. Forging Counterfeit Documents: AI can be instrumental in producing spurious documents, including contracts and invoices, designed to deceive users.

9. Enhanced Attack Sophistication: AI can elevate the complexity of cyberattacks, such as the creation of more convincing phishing emails or the customization of attacks targeting specific organizations (see more: Stevens, 2023).

Criminal Models

We differentiate criminal offenses related to Artificial Narrow Intelligence (ANI) based on the level of danger and the extent of harm that malicious or "dark" ANI can inflict. This shifts the current paradigm of risks associated with ANI and brings the most extreme and damaging forms of ANI closer to existential threats (see more: Bjelajac, Filipović and Stošić, 2022), a realm that was until recently reserved for more advanced forms of artificial intelligence, such as Artificial General Intelligence (AGI) and Artificial Superintelligence (ASI).

At the forefront is the use of ANI for military purposes (Price, Walker and Wiley, n.d). Overreliance on machine learning algorithms that we employ to obtain better and quicker responses can swiftly lead to catastrophic outcomes. "One concerning example of excessive dependence on ANI arises in the context of war when artificial intelligence is enabled to autonomously decide whom to kill or when to engage a nuclear bomber, without human knowledge. A less alarming scenario arises when an autonomous ANI system determines whom to hire or fire. Relying on artificial intelligence to solve existential questions means the elimination of crucial human inputs from key decision-making processes, which can swiftly lead to disaster and provoke concerns about the redundancy of humans in general. To mitigate this dark side of AI, we must establish a legal imperative that requires humans to have the final say in any outcome-

seeking process" (Minevich, 2020).

History teaches us that the military and criminals are typically the first to embrace all fatal technologies, while other state and societal actors tend to react more slowly (Ovchinskiy, 2022). The military initially recognized the role of "smart dust" by firmly embracing this technology in an attempt to manipulate the will of citizens through the manufacturing of consciousness. The study of this technology commenced as a spin-off of Project RAND, involving collaboration between the Douglas Aircraft Company and the United States Air Force. Subsequently, DARPA (the Defense Advanced Research Projects Agency), a research and development organization under the jurisdiction of the United States Department of Defense, tasked with the development of cutting-edge technologies for military applications assumed a leading role (Bjelajac and Filipović, 2019). This prioritization places the manufacturing of consciousness as a secondary risk in the hierarchy of threats to human communities. The concept of global dominance, embodied in the idea of a new world order, is designed in leading closed centers of economic and political power and is implemented through the ruthless and aggressive actions of media imperialism with a monopoly on broadcasting and the manufacturing of consciousness. A specter of media manipulation circulates the planet today, threatening to erode the society we know and the essence of the human being. By amalgamating Information and Communication Technologies (ICT) with Artificial Narrow Intelligence (ANI) systems designed for information collection, we observe a profound and irremediable deterioration and disintegration of the modern societal fabric.

Theorists argue that "this represents a new power above the power of citizens to recognize and understand this force" (Encensberger, 1980). ICT and smart dust permeate society, filling gaps, sowing unrest, convincingly promising solutions, and order. "This new power is incorporated into journalism, fashion, religious teachings, tourism, the education system... However, while the new technical instruments are fervently discussed in isolation, the consciousness industry as a whole remains outside the visible spectrum. The question of who is the master and who is the servant is not decided solely based on who possesses capital, factories, and weapons but on who controls the consciousness of others." It only takes having access to ICT and ANI, sufficient financial resources, and enough time, and you can shape the opinions of thousands and millions of people (see more: Filipović, 2019).

Although, according to Gartner's research (Verma, 2020), it will take over a decade for smart dust to wreak havoc on human life, its significant technological potential already appears frightening, raising questions about privacy protection and the ethics of its application (Marr, 2018). The commercialization of smart dust will only increase the volume of data collected by microsensors. It remains uncertain what those deploying microscopic sensors will do with the data they collect. Scientists typically do not focus on security while developing such devices, and security concerns are only addressed once the technology hits the market, often too late to mitigate potential risks.

Statista provides a list of other common criminal activities that may be associated with ANI (Petrosyan, 2023), on which we will elaborate further and expand it:

1. Fraud

Fraud executed by Artificial Narrow Intelligence (ANI) represents a significant problem in the digital world. ANI can be programmed or trained for various forms of fraud that can cause harm to users, organizations, and society as a whole. A review of fraud that ANI can execute includes:

- **Phishing Attacks:** ANI can generate fake emails, websites, or social media profiles to impersonate a trusted source like a bank or a well-known company. Such phishing attacks can lead users to disclose personal or financial information.

- **Media Manipulation:** ANI can manipulate audio, video, and textual content to create false information, fake recordings, or audio clips for spreading disinformation or damaging the reputation of individuals or organizations.

- **Fake Reviews and Comments:** ANI can automatically generate fake positive or negative product, service, or content reviews on the internet, influencing consumer decisions and harming a company's reputation.

- **False Identity:** ANI can be used for identity theft, creating fake social media profiles or other platform accounts.

- **Financial Fraud:** ANI can engage in various forms of financial fraud, including impersonation related to banks, investments, or cryptocurrencies. It can also execute fraud through market manipulation and rapid algorithmic trading.

- **Intellectual Property Theft:** ANI can be employed for the theft of trade secrets, copyrights, or patents through automated analysis and copying of information.

- **Extortion:** ANI can be used for extortion against individuals or organizations through threats,

false accusations, or the disclosure of sensitive information.

- **System Compromise:** ANI can hack computer systems, servers, or networks to cause harm, steal information, or block data access.

2. Data Theft via ANI

In the digital age, data has become a valuable resource that is frequently stored, exchanged, and processed through computer systems and the Internet. Despite efforts to secure data, data theft remains a serious issue. In this context, ANI represents a sophisticated tool that can be used to execute various forms of data theft. These include:

- **Phishing Attacks:** ANI can be programmed to automatically send thousands or even millions of fake emails resembling official messages from banks, companies, or organizations. These messages may contain fake links to websites that appear authentic but are designed to collect sensitive user information such as usernames, passwords, credit card numbers, and other personal data.

- **Ransomware Attacks:** ANI can be used for the rapid and widespread distribution of ransomware, malicious software that encrypts data on a victim's computer. Subsequently, assailants demand a ransom in return for the decryption key.

- **Cryptocurrency Theft:** ANI can track cryptocurrency transactions and attempt to hack digital wallets.

- **Manipulation of Payment Systems:** ANI can be programmed to execute payment system fraud, such as false transactions or refunds that were never made.

- **Theft of Trade Secrets:** ANI can be used to monitor and steal trade secrets, which can have significant business and legal consequences.

- Impersonation: ANI can generate fake profiles on social media to access user's personal information and use it for manipulation or spreading disinformation.

- **Medical Data Theft:** ANI can be utilized for stealing sensitive medical data, including medical histories and patients' personal information.

3. Abuse of Systems and Hacking

This set of criminal activities carried out by ANI poses a threat to cybersecurity. ANI can be programmed to execute various forms of system abuse and hacking with the goal of gaining unauthorized access to information, causing damage, or extortion. These actions include:

- Unauthorized Access: ANI can be programmed to automatically breach system security barriers, such as passwords and authentication, to gain unauthorized access to computers, servers, or networks. This can allow access to sensitive data or control over the system.

- Distribution of Malware: ANI can be used for the rapid distribution of malicious software (malware) through various methods, including email, USB devices, or vulnerable network points. This malware can cause damage, data theft, or block access to resources.

- DDoS Attacks: ANI can coordinate attacks aimed at overwhelming services and servers, temporarily disabling access to websites or online services.

- Theft of Authentication Data: ANI can attempt to steal authentication data such as passwords, PINs, or digital keys to gain access to user accounts or systems.

- Manipulation and Sabotage of Systems: ANI can be programmed to alter system settings, delete data, or create chaos within a network.

- Theft of Information and Trade Secrets: ANI can continuously monitor and spy on activities within a network to steal sensitive information, including trade secrets, intellectual property, or confidential documents.

- Brute Force Attacks: ANI can execute brute force attacks by attempting all possible password combinations to gain access to accounts or systems.

- Zero-Day Vulnerabilities: ANI can be programmed to seek and exploit zero-day vulnerabilities in software applications or operating systems before manufacturers release patches.

4. Market Manipulation by ANI

ANI can be utilized for various forms of market manipulation, including:

- **Algorithmic Trading:** ANI can be programmed to rapidly and automatically make trading decisions based on market analysis and data. This process is referred to as high-frequency trading (HFT) and can be used to execute a large number of trading operations in a very short time.

- **Dissemination of Disinformation:** ANI can be employed to spread false news or disinformation through social media and websites. Such disinformation can influence investment decisions and trigger

sudden market price fluctuations.

- **Front Running:** ANI can detect the trading orders of other market participants before they are executed and quickly react to them. This enables manipulators to exploit information and secure profits or prevent losses.

- **Pump and Dump:** ANI can be programmed to manipulate the prices of stocks or cryptocurrencies by heavily promoting certain investments to attract investors and then selling those positions when the prices rise.

- **Flash Crashes:** ANI can cause sudden market price drops by mass selling of stocks or other financial instruments, creating panic among investors and market instability.

- **Scalping:** ANI can be programmed to execute a large number of small trading operations to generate profits based on small price differences.

5. Abuse of Personal Data by ANI

ANI can be programmed or used in various ways to illicitly collect, use, or distribute personal data, which can bring serious consequences for individuals and their private information. These abusive practices include:

- **Personal Data Theft:** ANI can be programmed to attempt unauthorized access to databases, cloud storage, or other sources where personal data is stored in order to steal or retrieve it.

- **Distribution of Personal Data:** ANI can automatically distribute stolen personal data over the internet or other communication channels. This data may be sold on illegal markets or used for other malicious purposes.

- **Impersonation:** ANI can be used to impersonate individuals through social media, email, or other communication platforms to gather personal information from individuals.

- **Targeted Advertising:** ANI can analyze users' personal data to create profiles and target them with personalized advertising. This may involve tracking online activity, internet browsing, and other forms of surveillance.

- **Identity Theft:** ANI can use stolen personal data to commit identity theft, open fake accounts, file fraudulent credit requests, or engage in other forms of financial fraud.

- **Creation of Fake Profiles:** ANI can automatically create fake profiles on social networking sites or other online platforms using stolen personal data to manipulate or spread disinformation.

- **Social Engineering:** ANI can use stolen personality and habit data to create convincing social engineering scenarios to deceive individuals or organizations.

6. Attacks on Infrastructure

ANI can be programmed or used for various types of attacks on infrastructure, and these attacks can have serious consequences for society and security. These attacks may include:

- **Attacks on Energy Infrastructure:** ANI can be used to target energy systems, including power grids and power plants. This can involve attacks on distribution systems, destabilizing power supply, or even disabling energy facilities.

- **Attacks on Transportation Infrastructure:** ANI can be used to target transportation networks, including traffic lights, airports, trains, and other systems. This can cause dangerous situations, delays, and disruptions in traffic.

- **Attacks on Water and Sewage Systems:** ANI can cause issues in water and sewage systems, including water supply disruptions or water contamination.

- **Attacks on Communication Infrastructure:** ANI can target communication networks, including telecommunication centers and servers. This can lead to communication out-ages or denial of internet access.

- **Attacks on Industrial Control Systems:** ANI can target Industrial Control Systems (ICS) that manage critical facilities such as chemical or nuclear power plants. This can result in production disruptions or even serious incidents.

- **Sabotage of Autonomous Vehicles:** In the context of autonomous vehicles, ANI can be used to launch attacks on autonomous driving systems, including manipulating traffic signals, taking control of autonomous vehicles, or even causing traffic accidents.

7. Traffic Incidents

Traffic incidents that can be caused by Artificial Narrow Intelligence (ANI) are particularly relevant in the context of autonomous vehicles and the use of ANI in traffic. While autonomous vehicles are developed with the aim of improving road safety, there are several ways in which ANI can lead to traffic

incidents:

- **Technical Failures:** ANI may experience technical failures or software errors that control autonomous vehicles. This can lead to unexpected situations on the road, such as sudden stops or inappropriate maneuvers.

- **Environmental Perception Errors:** ANI uses sensors such as radar, cameras, and LIDAR to gather information about the environment. Perception errors, such as misinterpreting signs or other vehicles, can lead to accidents.

- **Decision-Making Errors:** ANI makes decisions based on the analysis of environmental data. Decision-making errors can result in dangerous situations, such as miscalculations of distances or the speed of other vehicles.

- **Attacks and Hacking:** ANI vehicles can be targeted by hackers who attempt to take control of the vehicles or make them unpredictable. This can lead to serious incidents.

- **Social Engineering and Manipulation:** ANI vehicles can be exposed to social engineering or manipulation by malicious individuals who aim to cause incidents, for example, by placing obstacles on the road or creating confusion for autonomous vehicles.

- **Unforeseen Situations:** ANI may struggle to deal with unforeseen situations, such as emergencies on the road, adverse weather conditions, or other extreme circumstances.

8. Risk of Combining Different Forms of ANI

The combination of two or more forms of ANI designed to achieve individual goals can significantly increase the risk of ANI misuse and multiply the harm. Such combinations, individually harmless software, can, when combined, create a jointly orchestrated virtual system designed for malicious intent and aimed at harming people and achieving malicious or criminal objectives. Combining facial recognition software and software controlling armed drones can have significant implications and elevate the importance of addressing numerous ethical and security concerns. In November of 2017, the Future of Life Institute in California, which focuses on "ensuring that artificial intelligence benefits all of humanity," released a video depicting "slaughterbots." In the video, small (fictional) drones utilized facial recognition systems and armed drones to target and eliminate civilians (Proudfoot, 2018). The institute is partially funded by Elon Musk, who thinks that AI is potentially "more dangerous than nuclear weapons" (Piquard, 2023). The dystopian video ends with the chilling words of computer scientist Stuart Russell from Berkeley: "We have the opportunity to prevent the future you just saw," he says, "but the window for action is closing fast." The video was released in conjunction with the UN Convention on Certain Conventional Weapons in the confidence that the UN would decide to ban the development of lethal autonomous weapons (Bjelajac and Filipović, 2021). Combining dedicated forms of ANI has other malicious combinations as well. Attackers often use a combination of malware and phishing techniques to deceive users into downloading and installing malicious software on their devices. This can result in personal data theft, financial harm, and other unwanted consequences. The combination of ransomware (which encrypts data) and cryptojacking techniques (which use the user's computer resources for cryptocurrency mining) can harm individuals and organizations. Botnets are combinations of software (bots) that run on infected computers and can be used for large-scale DDoS attacks, spam distribution, or other malicious activities. Attackers may use a combination of techniques like pharming and DNS spoofing to redirect users to fake websites and steal their credentials and personal information. Even three or more independent individual forms of ANI can be integrated and complement each other to achieve various ethical or unethical, malicious objectives, depending on needs and specific applications. Again, we start with the combination of multiple dedicated ANI applications in the military and security services. ANI applications for satellite data analysis, combined with facial recognition and speech analysis applications, can be used for military and security purposes, including surveillance, intelligence gathering, and even assassinations of security-relevant individuals and objects. ANI technologies can be combined and integrated for achieving other objectives that may not be as destructive as military or intelligence but can harm individuals, organizations, and the community. The combination of ANI for generating fake text, ANI for image manipulation, and ANI for sentiment analysis can be used to create and spread disinformation and fake news to manipulate public opinion or cause confusion. Integrating ANI for facial recognition, ANI for natural language processing, and ANI for biometric data recognition can be used for illegal tracking and hacking of individuals for identity theft, extortion, or other unethical purposes. Using ANI in cyberattacks to bring down websites, infect computers, or steal sensitive data can cause significant harm to individuals, organizations, or countries. Integrating ANI for data analysis and ANI for decision-making can result in systems that discriminate against certain groups of people in areas like employment or lending, which is unethical and against equality laws. Such unethical and criminal uses of ANI pose serious threats and challenges to society. Therefore, it is essential to have

responsible usage and oversight of these technologies to prevent potential abuses and ensure the ethical use of ANI. Regulations and laws have a crucial role in preventing the unethical use of technology, but the responsibility of technology companies and citizens is also necessary in promoting ethical principles.

Strategies to Combat the Dark Side of ANI

Throughout this paper, we have compellingly illustrated that artificial narrow intelligence can indeed present a substantial threat to human society. Under certain catastrophic conditions, it can even put humanity at existential risk, and its misuse by malicious individuals or groups can lead to severe threats to "life as we know it." Despite philosophical uncertainties, these findings should be sufficient to acknowledge that ANI can be a malevolent entity and a dangerous machine, particularly when controlled by malicious individuals or groups. In this section, we will outline basic methods and strategies for countering the dark side of ANI.

The United Nations, the World Economic Forum, the UNICRI, the Center for AI and Robotics, G20, and the OECD have initiated efforts against dark ANI. Companies like Microsoft have helped mobilize the masses in the fight against dark ANI through a set of AI principles instrumental in defining a workplace code of conduct surrounding responsible AI. Microsoft's AI principles include fairness, reliability, safety, privacy, inclusivity, transparency, and accountability. All of the above principles have contributed to the formation of a modern movement determined to combat AI. A socially-driven campaign against autonomous systems was launched through attempts to eliminate public facial recognition, ban drone surveillance, and emphasize responsibility, accountability, and ethics in all AI frameworks.

On the front lines of combating dark autonomous systems, the UN Office for Disarmament Affairs (ODA) has been expanded to include the threat of armed artificial intelligence, and in 2018, the Secretary-General of ODA submitted a plan entitled "Disarmament for Future Generations" dedicated to suppressing dark artificial intelligence in the years to come. UNICRI has also taken measures to work with AI and global law enforcement agencies in an attempt to shut down support for AI in human trafficking, corruption, terrorism, and crime. The U.S. government has shown commitment to building safer AI by issuing a memorandum to federal departments and agencies stating ten AI principles and placing a strong emphasis on public-private transparency for autonomous systems. G20 and the OECD have also set specific goals for combating dark AI through ethical autonomous systemic frameworks that prioritize responsibility and public trust.

Ethical standards for AI are essential to counter "dark ANI." The current situation is not favorable. When considering the use of ANI for military purposes or to subjugate the human population to global interests, there is currently no effective defense. The commissioners of malicious technologies and dark algorithms are states and their security agencies. In situations similar to the use of nuclear energy or biohazard agents, the current solution appears to be a balance of power that exists between major military and economic powers. This is where we should call for the consideration of an initiative to establish a UN Office for Artificial Intelligence. The final decision on whether to establish a UN agency for AI control should be made by taking into account all pros and cons, through broad international debate and collaboration.

Regardless of whether such an agency exists, it is crucial for the international community of leaders, scientists, and experts to work together to develop and implement responsible regulations and guidelines for AI to ensure its safe and ethical use. Without this, the aspiration to build impartial autonomous systems and maintain ethical standards of accountability and privacy for ANI is challenging.

The potential impact of ANI on the development of AGI?

Following the course of each, or at least the majority, of inventions in history, ANI is expected to be a precursor to more complex forms of Artificial Intelligence. In this analogy, AGI should base its development on the achieved level of ANI, taking from it, like an imago from a chrysalis, all achievements, identifying and correcting all the limitations that ANI has. Based on this premise, the development of AGI should, in the coming decades, eliminate and surpass the limits of ANI and continue to evolve, striving to reach the intellectual level of humans and the thinking process of their cerebrum as quickly as possible. But is it really so, and does the path of development, improvement, and enhancement of ANI represent a dead end for the creators of AGI, and especially the ultimate gain, ASI?

Opinions are divided from optimism and excitement to concerns "that the hottest and most modern branch of artificial intelligence - machine learning - will degrade our science and destroy our ethics by using fundamentally flawed concepts of language and knowledge" (Chomsky, Roberts and Watumull, 2023). In other words, it could happen that the concept of ANI, no matter how perfected, may not be able

to serve as the foundation for the development of AGI, precisely because of its primitive fundamental concept that may prove inapplicable for AGI and ASI. Programs classified as ANI and already referred to as "first beacons on the horizon of the long-anticipated advent of artificial general intelligence" are not particularly intelligent. They process vast amounts of data, seek patterns in them, and become adept at generating statistically probable results, such as human language and thought. However useful these programs may be in certain narrow areas, from linguistics and the philosophy of knowledge, we know how far they are from the way humans think and communicate (Chomsky, Roberts and Watumull, 2023).

Unlike ANI, the human mind, which AGI aims to reach and ASI aims to far surpass, is not a clumsy statistical machine that absorbs hundreds of thousands of terabytes of data and costs (will cost) hundreds of billions of dollars just to arrive at the most probable answer to a trivial question. The human mind is a surprisingly efficient and elegant system for working with small amounts of information. It does not seek to build rough correlations between specific inputs but rather to provide explanations. Jeffrey Watumull argues that ANI programs are "stuck in the pre-human or non-human phase of cognitive evolution. Their deepest flaw is the lack of the central critical ability of any intellect: to say not only what is, what has been, and what will be but also what is not, what could be, and what cannot be. These are the ingredients of explanation, the hallmarks of true intelligence" (Chomsky, Roberts and Watumull, 2023).

Although the development and general concept of AGI cannot directly and simply continue from the achieved level of ANI, ANI will nevertheless leave a significant corpus of its achievements as a legacy to higher forms of AI. Despite the ontological difference between the two AI systems, higher forms of AI will not abandon advanced deep learning algorithms, nor will they ignore the massive datasets already stored by ANI systems, even if they are stored only for a specific task. AGI will be intelligent enough to use that data for other purposes. The vast experience ANI programs will gain by answering millions of questions and solving millions of operational requests could be the virtual counterpart of the collective unconscious in humans, as the total record of the quantum of knowledge acquired by all people who have ever lived on the planet. AGI will be intelligent enough to unlock the treasures of that virtual collective unconscious acquired through the use of ANI.

While in its responses to queries it cannot execute, ANI politely responds with learned phrases, uncomfortably, even foolishly ignoring the client for whom it exists, ANI is not aware of the limitations it has. Noam Chomsky and Ian Roberts write how ANI foolishly "demonstrates the 'banality of evil'" (Smirnova, 2023). It is assumed that AGI, self-constituting its strategy, will use the experiences of ANI to identify, understand, and overcome the limitations that ANI has failed to overcome.

We are witnessing serious and competent debates "for and against" AI. This is partly because AI is a new technology that people fear simply because it is new and changes their usual way of life. However, despite objections, ANI systems are becoming widely accepted and useful, which could lead people in the future to be more open to higher forms of AI. Higher forms of AI should be able to act on ethical principles, whether they be deontological or teleological moral principles. Experiences with ANI are completely useless in this area because all known forms of ANI are not able to understand or balance creativity and ethical constraints on their own, not even able to distinguish possible from impossible, which is not a good recommendation for higher forms of AI. The amorality, pseudoscience, and linguistic inadequacy of ANI make it either excessively produce both truths and lies, equally support ethical and unethical decisions or avoid making decisions and remain indifferent to the consequences of such attitudes. Given the amorality, pseudoscience, and linguistic simplicity of ANI systems, we can only mock or mourn their popularity (Chomsky, Roberts and Watumull, 2023).

Discussion

In the previous chapters, we explored the concept of "evil" in the context of Narrow Artificial Intelligence (ANI) or artificial intelligence (AI) in general. While ANI itself lacks consciousness or free will, its potential for misuse or harmful actions that usually result in damage and suffering to humans poses a significant ethical and legal challenge. In this chapter, we continue our analysis and discuss fundamental aspects of this controversial issue. Everything that happens on Earth is caused by either nature or people. Therefore, the crucial aspect of the potential "evil" in ANI comes from human decisions and intentions. ANI systems are inert and perform tasks according to their programming or training on examples and data presented to them during software development and subsequent testing. Any negative consequences of ANI can mostly be attributed to human decisions. This includes programming ANI algorithms, training models with biased or incomplete data, and decisions about the use of ANI in specific contexts.

To understand and control the potential for "evil" use of ANI, it is important to analyze the role of programmers, engineers, and other AI industry professionals. Programmers have a significant influence on

how ANI behaves, even though they are often unaware of all the implications of their decisions. Therefore, it is essential to educate programmers and engineers about the ethical aspects of ANI and provide them with tools to identify and address potential issues.

One of the common ethical challenges related to ANI is bias and discrimination in software designed to make decisions and perform tasks without human verification. ANI systems can inherit biases present in the data sets provided to them by administrators. This can result in unfair decisions, discrimination, and imbalances in the treatment of different groups of people. Research has shown that, despite the fact that AI's abilities in processing data far exceed human capabilities in terms of speed and volume, ANI cannot always be trusted as fair and neutral. The underlying cause of ANI bias is linked to historical human prejudices (Lifshitz, 2021). Human biases are deeply ingrained and extend to certain groups of people, and these biases can be reinforced within computer models. AI systems, therefore, perpetuate existing biases in fields including healthcare, criminal justice, and education. Cases like those of the COMPAS algorithm (Correctional Offender Management Profiling for Alternative Sanctions) in the United States, which is more likely to arrest black individuals due to historical racism and differences in policing practices, highlight the need for more consistent regulation and ethical guidelines for the development and use of ANI, especially in sensitive sectors like security and justice (see more: Bjelajac and Filipović, 2021).

Another crucial aspect of the discussion about the potential "evil" use of ANI is the autonomous nature of some ANI systems. Autonomous military drones can be programmed to execute destructive tasks without human intervention. This raises profound ethical and moral questions in the military application of ANI. To limit the potential abuse of autonomous AI systems, clear ethical guidelines and regulations are needed in the military sector. These guidelines should define the boundaries of autonomous ANI operations and ensure that human responsibility and oversight are preserved. However, this will likely remain mostly declarative, as the military, by default, acts against enemies in warfare, and in such contexts, rules and laws have limited applicability.

One of the key elements in preventing the potential "evil" use of ANI is transparency. Organizations developing ANI systems should be transparent about how they trained models and what data was used. This allows independent experts and organizations to audit and assess ANI systems to ensure they do not contain biases or malicious intentions. Additionally, it is important to establish mechanisms of accountability for AI systems. If irregularities or harm arise from the use of ANI, responsible parties, whether they are programmers, organizations, or owners of ANI systems, should face consequences. This involves the establishment of clear regulations and laws defining responsibility in case of issues with ANI systems.

The balance between progress and risk is often cited as the most important dilemma of the future of AI. People fear non-human entities that could get out of control and begin to act as superhumans. This is where the story of freedom and free will, or moral good and moral evil, in the world of artificial intelligence begins. These two noumena are proportionally dependent. The more one grows, the other diminishes (see more: Kant, 1981). Therefore, governments of major countries want to maximize control over the development and implementation of artificial intelligence. The fundamental thesis with which the European Union approaches thinking about AI is: "We are building trust in artificial intelligence, and that is possible only if we are able to manage risks" (Riegert, 2021). ANI brings tremendous potential to address complex problems and improve human lives. In medicine, science, transportation, and many other areas, ANI has the ability to accelerate progress and make daily life easier for people. Hence, the challenge lies in finding a balance between the potential for positive impact of ANI and the need to limit its negative consequences.

Conclusions

Without diminishing the manifold advantages ushered in by contemporary technologies, the scientific community, with the exception of a substantial cohort encompassing roboticists, electronics specialists, and similar domains, is not reticent in expressing deep-seated apprehension concerning the burgeoning development of artificial intelligence (AI) and its escalating foray into pivotal sectors of public and private life. The deployment of systems founded on deep learning and self-learning neural networks, coupled with the utilization of machines that, on numerous occasions, outpace human counterparts in data analysis and expeditious decision-making, has led to concerns articulated by scientists, humanists, and futurists. Over time, these technologies are not merely poised to displace human labor in many employment sectors but also possess the potential to predict human consumer inclinations, modus operandi, communication patterns, and even exert influence over individual destinies, thereby encroaching upon the sacrosanct citadel of privacy.

Scientists posit that the concentration of metadata, power, and affluence in the hands of a select few has the capacity to obfuscate and render the entire sociotechnical system non-transparent and "opaque." This eventuality is unequivocally predicted to give rise to heightened sociopolitical schisms and to exacerbate, potentially leading to a draconian breach of democratic rights and personal freedoms for both citizens and nations (Couldry and Meijas, 2019). Acknowledging that contemporary humanity, at this stage of its historical progression, evinces a predilection for the encapsulation of its essence within the realm of technology, scientists, particularly those within the domains of philosophy, sociology, and theology, evince reluctance in relegating the stewardship of AI ethics to engineers and technicians. The skepticism directed towards emerging technologies, particularly cognitive AI, can be expounded upon by recourse to the prevailing societal concept of scientific neutrality, while differentiating the jurisdictions of the scientific and legal spheres. It is our contention that the world is on the cusp of an academic schism, a tug-of-war between champions of raw power and proponents of global security and the preservation of "life as we know it." This would not mark the inception of such a schism but would be resolved as in instances past—with the facile triumph of power's apologists. The conventional narrative dictates that this innocuous dominion is destined to expeditiously metamorphose into financial and military might. This is not indicative of the world teetering on the precipice of dissolution; it serves as a clarion call for judiciously overseeing the use, and potential abuse, of AI. History has persistently underscored that behind every perilous contraption lurks an equally pernicious human agent. Our elucidation of this ethical aporia can be attributed to divergent interpretations regarding the core tenets of AI ethics. Practitioners from the realm of the natural sciences are preoccupied with the transliteration of prevailing, and occasionally antiquated, ethical paradigms into the vernacular of machinery. In contrast, philosophers, sociologists, humanists, and theologians grapple with the very essence of AI ethics, which must undergo an evolution commensurate with the assimilation into its ontological and metaphysical corpus of a conspicuous novelty—an artificial entity furnished with its heretofore alien concepts of good and evil. This nascent ethical framework shall be denominated a biomimetic ethos, one that may be adjusted on the fly by humans to conform to emerging entities, as this novel ethical framework is co-created in tandem with these entities.

Artificial intelligence steadfastly advances, and each new application of this technology offers a novel aperture for autonomous systems to harness data to effect harmful outcomes. The promulgation of legislation emphasizing responsibility, transparency in AI, mitigation of bias, and the comprehensive implementation of ethical precepts is posited as an efficacious strategy for contending with the "dark AI." The urgency of addressing the darker facets of AI mounts with each passing second. The present juncture, more than any other, underscores the need to glean instructive insights from humanity's historical missteps and prepare judiciously for the impending challenges.

Conflict of interests
The authors declare no conflict of interest.

Author Contributions
Conceptualization: Ž.B., A.F., and L.S; methodology: Ž.B.; resources: A.F. and L.S., supervision: Ž.B.; writing—original draft preparation: Ž.B, A.F., and L.S.; writing—review and editing: Ž.B., A.F. and L.S. All authors have read and agreed to the published version of the manuscript.

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The journal has a standard template – IJCRSEE template. To cite reference, it is the easiest way to use some management software like:
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Where available, URLs for the references have been provided.
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LIST OF REVIEWERS FOR YEAR 2022

International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE) would like to acknowledge the following reviewers for their assistance with peer review of manuscripts for issues in 2022. Their comments and suggestions were of great help to the authors in improving the quality of their papers. Each of the reviewers listed below returned at least one review for these issues.

Thank you Reviewers!

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