ПСИХОЛОГИЧЕСКАЯ НАУКА И ОБРАЗОВАНИЕ

PSYCHOLOGICAL SCIENCE AND EDUCATION

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Dear readers!

We are pleased to present to you the third issue of the journal "Psychological Science and Education" (No. 3–2025). This issue features publications organized into two traditional sections: "Developmental Psychology" and "Educational Psychology."

The section "Developmental Psychology" begins with an article dedicated to the relationship between the quality of play support and the level of pedagogical reflexivity development. The theme is continued by a study examining the association between executive functioning and motor skills in older preschool children. Readers can also explore research on the personality determinants of emotional experiences among students of pedagogical universities, as well as an analysis of the influence of blended learning models and self-efficacy on digital civic behavior among primary school students in Indonesia. The section concludes with the results of two studies: one on recognizing emotional expressions depending on the observer's profession, and another on the impact of prolonged smartphone use on distractible attention.

In the "Educational Psychology" section, you can learn about the psychological prerequisites and barriers to teachers' innovative activity. Next, there is a study on the role of the scientific supervision style as a predictor of motivation and burnout among graduate students. The issue concludes with an experimental study of the interaction between 7th–8th grade students and hypertext using an eye tracker, as well as an analysis of awareness, readiness, and practices related to the application of artificial intelligence in school mathematics education.

We hope that the materials in this issue will be useful to researchers, practitioners, and everyone interested in modern trends in developmental and educational psychology.

The Editorial Board

DEVELOPMENTAL PSYCHOLOGY (AGE PSYCHOLOGY)
ПСИХОЛОГИЯ РАЗВИТИЯ (ВОЗРАСТНАЯ ПСИХОЛОГИЯ)

Научная статья | Original paper

The interrelation between preschool teachers' play support quality and their level of reflection

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Abstract

Context and relevance. Despite the widely recognized importance of play support in preschool age, the actual quality of conditions for play development remains low. Researchers highlight teachers' distorted understanding of play, difficulties in setting pedagogical goals, and the replacement of genuine play with play forms. In the article, pedagogical reflection is considered one of the factors ensuring the effectiveness of play support. Pedagogical reflection is understood as the process of going beyond immediate activities to analyze them, highlighting difficult situations and making sense of them. **Objective** is to analyze the interrelation between the play support quality and the level of development of pedagogical reflection. **Hypothesis.** The quality of play support is interrelated with the level of development of pedagogical reflection. **Methods and materials.** Play support quality was assessed based on video recordings of plays provided by teachers (39 teachers), the level of reflection was assessed based on the teachers' comments on these videos. Qualitative and quantitative data analysis was used. **Results.** Most teachers are characterized by low level of play support (5,8, sd = 2.5, med = 6) and a low level of pedagogical reflection (4, sd = 3,6, med = 3,5). Correlation analysis revealed a significant relation between the play support quality and the level of development of reflection (r = 0,71, p < 0,01). **Conclusions.** The teachers who play with children and create conditions to support play are often more accurate in identifying the strengths and deficits of children's play, setting adequate pedagogical tasks, and identifying their own deficits and those of the children in joint play.

Keywords: preschool age, play, play support, reflection, preschool teachers

Взаимосвязь качества сопровождения игры и уровня развития педагогической рефлексии

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Резюме

Контекст и актуальность. Важность игры дошкольников общепризнана, но качество условий для ее развития в детских садах остается низким. Исследователи указывают на искаженное понимание игры педагогами, трудности в постановке педагогических задач и подмену игры игровыми формами. В статье педагогическая рефлексия рассматривается как один из факторов, обеспечивающих эффективность сопровождения игры, и понимается как выход за пределы непосредственной деятельности для ее анализа, выделения ситуации затруднения и ее осмысления. **Цель**. Установить взаимосвязь качества сопровождения игры и уровня развития рефлексии педагогов. **Гипотеза.** Качество сопровождения игры связано с уровнем развития педагогической рефлексии. **Методы и материалы.** Качество сопровождения игры оценивалось по видеозаписям игры, предоставленным педагогами (39 педагогов), уровень рефлексии — по комментариям педагогов к этим видео. Применялся качественный и количественный анализ данных. **Результаты.** Для большинства педагогов характерен низкий уровень сопровождения игры (5,8, sd = 2,5, med = 6) и педагогической рефлексии (4, sd = 3,6, med = 3,5). Корреляционный анализ выявил значимую связь между качеством сопровождения игры и уровнем развития рефлексии (r = 0,71 при p < 0,01). **Выводы.** Педагоги, играющие с детьми и создающие условия для поддержки игры, чаще более точно определяли сильные стороны и дефициты детской игры, ставили адекватную педагогическую задачу, точно выделяли собственные и детские дефициты.

Ключевые слова: дошкольный возраст, игра, сопровождение игры, рефлексия, дошкольные педагоги

Introduction

Recent studies highlight several issues in teachers' play support: the substitution of play with quasi-play (Galasjuk et al., 2023; Iakshina, Le-van, 2022); a lack of understanding of the genesis and key features of play, the absence of appropriate pedagogical goals, and the low quality of the play

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environment (Shiyan et al., 2021); teachers' didactic approach instead of playing as a partner with the child (Abdulaeva, Alieva, 2020; Iakshina, Le-van, 2022; Bredikyte, 2022; Devi, Fleer, Li, 2021).

Teachers interpret play differently, reflecting two historically established perspectives: utilitarianism and the recognition of play's intrinsic value (Galasjuk et al., 2023; Iakshina, Le-van, 2022). The utilitarian approach involves organizing designated play areas, where play is viewed as a structured activity aimed at developing children's understanding of specific social or professional domains and behavioral norms. From this perspective, teachers observe many aspects of play (e.g., speech development, practical skills, communication, and conflict resolution) but overlook the play itself — its dynamics and development — and thus fail to set pedagogical objectives aligned with the logic of play development. The second perspective focuses on natural forms of play, broadly defined by motivation ("the motive of play lies not in the result of the action but in the process itself" (Leontiev, 1981, p. 486)) and the child's freedom: play is seen as an activity independent of adult involvement (Smirnova, 2014).

Both perspectives entail risks and may underlie ineffective teacher's play support. In the first case, play is replaced by quasi-play — play in form but not in content. In the second, key criteria of play are neglected (e.g., the divergence between visible and semantic fields (Vygotsky, 2004), dual subjectivity (Kravtsov, Kravtsova, 2017)), and the emergence of cultural, higher forms of play — such as narrative play — is unsupported, hindering the development of play as an activity (Galasjuk et al., 2023).

Effective play support involves creating conditions for play development, including teacher's participation as a partner and mediator in joint play, as well as indirect support (observing play, assisting in organizing play spaces, providing materials, commenting, and aiding children from a non-play position) (Galasjuk et al., 2023; Singer, DeHaan, 2019; Iakshina, Le-van, 2022; Bredikyte, 2022; Loizou, Loizou, 2022). Amplifying play conditions in kindergartens requires studying teachers' play support practices and factors enhancing its effectiveness.

Teacher's play support is not limited to spontaneous play with children (where the teacher occasionally joins in). It is a guided process requiring pedagogical objectives aligned with play dynamics, children's needs, and their zone of proximal development. Effective play support simultaneously boosts play development, remains responsive to children's needs (Bredikyte, 2022; Devi, Fleer, Li, 2021), and involves the teacher's analysis of both the play process and its broader development (Singer, DeHaan, 2019). Additionally, for appropriate engagement in children's play, teachers must analyze their own actions, their impact on children, recognize emerging challenges, and adjust flexibly based on children's feedback (Pramling et al., 2019).

In this study, pedagogical reflection is understood as stepping beyond immediate activity to analyze it, identify difficulties, and interpret them (Belolutskaya, Kristofik, Mkrtchyan, 2022; Shiyan et al., 2019). It is viewed as a mechanism for aligning developmental values and pedagogical practices (Isaev, Kosaretsky, Slobodchikov, 2000). We hypothesize that pedagogical reflection is a factor enhancing the effectiveness of play support. While the value of reflection in educational processes is acknowledged,

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its low levels among teachers struggling to analyze their own practice and the process of reflection as professional challenge are noted in several studies (Groschner et al., 2018; Pehmer, Groschner, Seidel, 2015). However, no research has examined the role of pedagogical reflection in preschool teacher' play support.

Research Objective: To establish the interrelation between the quality of play support and teachers' level of reflection.

Hypothesis: The quality of play support is linked to the level of pedagogical reflection.

Materials and methods

The study was conducted in 2022–2023. The quality of play support was assessed based on video recordings of teachers and children playing together in their usual kindergarten setting.

Video analysis included three levels of data interpretation (Hedegaard, 2008): review and analysis of all videos (presence of spontaneous play, teacher's involvement, its duration); identification of categories for analyzing teacher's actions; thematic analysis based on the cultural-historical approach to understanding adults' role in play development.

Play support quality was evaluated using the following parameters, derived from the cultural-historical perspective on play (Galasjuk et al., 2023; Shiyan et al., 2024):

1. Use of unstructured materials (UM).

2. Teacher's positioning in joint play (see Table 2).

3. Predominant type of teacher's suggestions during play.

4. Predominant type of teacher's response to children's suggestions (Singer, DeHaan, 2019).

5. The effect of teacher's actions — whether they act within the children's zone of proximal development (i.e., whether play advances to a more complex level, remains unchanged, or deteriorates after teacher's involvement).

Each parameter was scored from 0 to 2–3 points (minimum total score: 0, maximum: 11). Three levels were established based on the cultural-historical understanding of teachers' role in play development (Galasjuk et al., 2023; Kravtsov, Kravtsova, 2017; Shiyan et al., 2024; Elkonin, 1999) (Table 1).

The level of pedagogical reflection was assessed based on teachers' written comments on their own video recordings. The comments were free-form responses to questions that guided teachers in analyzing their own actions and identifying challenges. Prior to this, teachers received a list of questions for video analysis and could

Table 1

Play support quality levels

Low (0-4 scores)	UM are unavailable, teacher's positioning in play: outsider, didactic, formal functionary. A teacher's actions destroy the children's play. A teacher does not make suggestions and ignores the suggestions of the children playing.
Medium (5-8 scores)	Only limited UM are available, teacher's positioning in play: commentator, stage manager, observer, partial involvement in play, leader. A teacher suggests ideas about play-plot development. There are no changes in children's play.
High (9-11 scores)	Ample UM are available, teacher's positioning in play: mediator, partner. The teacher notices and supports children's play ideas. As a result of teachers' actions, children's play develops, becomes more complicated, and new ways of playing appear.

Legend: UM — unstructured materials.

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discuss them with experts to clarify wording and ask follow-up questions.

Each teacher was asked to watch their own video of play support and evaluate it by answering the following questions:

— What gaps in the children's play development did I notice in the video?

— What strengths in the children's play development did I observe in the video?

— What pedagogical objective did I have when joining the children's play?

— What was effective in my involvement in the children's play? How did I recognize this?

— How did my involvement affect the children's play?

— What was ineffective in my involvement in the children's play? How did I recognize this? Why might this have happened?

— What could I do differently next time regarding the children, considering this experience?

— What could I do differently next time regarding myself and my actions, considering this experience?

During the analysis, experts evaluated educators' video comments based on five parameters:

1. Alignment of pedagogical objectives with children's play in the video: How well the teacher identifies gaps in play and sets pedagogical objectives accordingly.

2. Understanding of play development dynamics (in relation to the video): Whether the teacher recognizes how their actions influence changes in children's play.

3. Consistency between pedagogical objectives, actual actions, and self-assessment of impact: The teacher's ability to assess whether observed play aligns with their intended objectives and actions.

4. Awareness of personal strengths and weaknesses, planning next steps for play facilitation (regarding children and own actions): The teacher's capacity to analyze their own actions in joint play and incorporate this into future planning.

Each parameter was scored on a scale from 0 to 3 (minimum total score: 0, maximum: 15).

Four experts participated in assessing the videos and comments: a practitioner recognized for high-quality play facilitation (based on the PERS assessment), two researchers from different universities with over 30 years of experience in play research and around 100 publications on the topic, including peer-reviewed journals, a certified expert in educational quality assessment. All experts work within the framework of cultural-historical psychology and activity theory. Inter-rater reliability was 85%. To assess reliability, experts independently evaluated two play support videos and two corresponding comments (randomly selected) using the defined parameters. The percentage of exact matches between expert scores and the agreed-upon assessment was then calculated.

Sample Characteristics

The study initially included 39 preschool teachers from various regions of the Russian Federation. After preliminary analysis, 11 videos were excluded as they depicted quasi-play — scripted scenarios predetermined by the educator. The remaining 28 teachers from 19 educational institutions formed the final sample. The majority of teachers (47, 6%) have more then 11 years of teaching experience, 28,6% — 3–10 years, 25% — less than 3 years. 71,5% of teachers have higher

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education, 21,4% — vocational education, 7,1% — incomplete higher education. The sample was formed on a voluntary basis.

Results

Correlation analysis revealed a significant positive relationship between the quality of play support and the level of reflection (Spearman's r = 0,71, p < 0,01). Teachers who created conditions to support play were more likely to accurately identify their own and the children's strengths and weaknesses in play, set appropriate pedagogical objectives, and plan effective next steps. Conversely, teachers who ignored play, engaged in it superficially, or used play solely for teaching tended to provide vague, generalized comments, failed to articulate pedagogical objectives, and struggled to identify their own or the children's play-related challenges.

Next, we examine in more detail the levels of play support and reflection among the preschool teachers in the study sample.

Quality of play support: The average score for play facilitation was 5,8 (SD = 2,5, median = 6, min = 1, max = 10). The sample was predominantly characterized by medium (53,5%) and low (35,7%) levels of play support, with only 10,7% of teachers demonstrating high-quality play-support (Table 1). Below, we analyze the five parameters used to assess play support quality.

Use of unstructured materials (UMs): Most teachers provide children with access to unstructured materials during play: 39,3% of videos are dominated by UMs, 35,7% use only few UMs, and 14,3% have some variety of UMs. Only 10,7% of videos do not have UM available for children to play.

Teacher's predominant positioning in play support: The teacher's role was a key factor in determining the quality of play facilitation (Table 1). Based on engagement levels, the observed positions (Table 2) fell into three categories: ignoring play (outsider position) — the educator remains uninvolved; indirect support – the teacher does not join the play but creates conditions for play (e.g., organizing space, providing materials); active participation in play – the teacher engages as a play partner (Singer & DeHaan, 2019).

High-quality play support involved not only indirect support but also active participation as a play partner. In contrast, low-quality play support often disrupted play by imposing didactic tasks or engaging superficially, pulling children back into a real field, non-playful mode.

Teachers' positioning in joint play as partial involvement, play leader, and partner involve the teacher's participation in play with children but differ in the balance of initiative between the adult and the children. Partial involvement in play: the teacher merely follows the children's lead, offering no play ideas of their own throughout the recorded play session. Play leader: the teacher takes most of the initiative, actively proposing ideas, while the children follow their lead. Partner: a balanced exchange of initiative is maintained between the teacher and children throughout the play session.

The most common positions observed were formal functionary, didactic, partial involvement in play, observer, and questioner, while the play leader and partner positions were the least frequent. Most teachers adopted two or more positions (often combining those related to indirect play support). For a third of the teachers, positions negatively impacting children's play prevailed — outsider, didactic, intrusive questioner, and formal functionary (Devi,

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Table 2

Teacher's positioning in play support

Position	Teacher's actions on the video
Didactic	Imposes external goals, directs and organizes children, gives instructions
Outsider	Doesn't participate in play, ignored playing children, a teacher is busy with other tasks
Intrusive interviewer	Intrusively asks children questions that interrupt their play
Formal functionary	Acts in formal and stereotypic way, only imitates play
Observer	A teacher is near playing children, involved in play observation
Commentator	Attentively observes and comments on children's play without participation in it
Stage manager	Helps with play materials and space transformation, suggests ideas without participation in play
Partial involvement in play	Occasionally participates in joint play, accepts children's invitation to join their play, but in play the teacher only follows children without suggesting their own ideas
Play leader	A teacher is emotionally involved in the process of play, actively suggests ideas, seizes the initiative and leads the play process
Partner	A teacher is emotionally involved in the process of play, accepts children's ideas, makes their own suggestions in response to children's ideas, accepts refusal if it occurs, maintains the balance of teacher-child initiatives

Fleer, & Li, 2021). The predominance of a particular role was considered in assessing the levels of play facilitation (see Table 1). For 14,3% of teachers, the dominant roles were partner and play manager.

Predominant types of teacher suggestions during play: teachers most often suggested ways to expand the play's storyline. Only a third introduced problematization — a play idea introducing a conflict or challenge that required resolution while maintaining and advancing the play (Kravtsov & Kravtsova, 2017; Pramling et al., 2019).

Teacher's typical response to children's suggestions: the most common pattern was two-sided interaction (60,7%), where teachers primarily accepted children's suggestions without imposing their own. In 25% of cases, teachers occasionally rejected children's ideas, while 14,3% ignored them entirely, insisting on their own proposals.

Impact of teacher's actions: in a third of cases, teachers' actions had no effect on

children's play. Most often, their involvement led only to minor plot changes, repetition of play actions, or an increased use of substitution. Complexity and new play strategies emerged in just 7,4% of cases following teacher intervention.

Level of development of pedagogical reflection: the average score for pedagogical reflection across the sample was 4 (SD = 3,6, Mdn = 3,5, min = 0, max = 11).

Teacher comments were categorized into three types based on: the core pedagogical goal, understanding of the teacher's role, ability to identify challenges and difficulties, relevance to the video recorded play session (see Table 3).

Only teachers who viewed play as intrinsically valuable were able to accurately identify challenges in their own practice.

Understanding the dynamics of children's play development (in relation to video observations). Teachers rarely identified specific play development deficits in chil-

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Table 3

Teachers' comments on their own videos

Type of the comment	Pedagogical goal	Teacher's role	Difficulty	Semantic connection between comment and video
Abstract words about play (39,3%)	-	-	-	-
Play as a form of teaching (21,4%)	Didactic	Transfer of knowledge, expansion of ideas, exploitation of play for learning	-	-
Play as valuable for itself (39,3%)	Play support and development	Play development through providing appropriate conditions, observation and participation in play	Highlights the deficiencies of their own play	Based on play observation

dren's play: plot-related issues (15%), role-playing difficulties (5%), brief role-based dialogues (2%), challenges with object substitution (6%), repetitive play actions (6%), lack of initiative and self-regulation (5%), limited imagination (2%), dominance of object play (2%), difficulty maintaining play rules (1%). The most noticeable deficits for educators were those not directly tied to play development specifics: communication and social interaction problems (23%), speech-related issues (11%), lack of real-world knowledge/experience (9%).

Alignment between pedagogical goals and children's play (as seen in video recordings). Based on the consistency between the play deficits noted by teachers and their proposed pedagogical interventions, five response types were identified (see Figure).

Understanding the deficits and strengths, planning the next step in play support in relation to children and teachers' actions. Most teachers (57,2%) were unable to analyze their own strengths and weaknesses in supporting children's play. 21,4% correctly identified their deficits (based on video analysis) but did not consider them in planning. Only 21,4% used their identified gaps as a basis for planning next steps in play support.

Alignment between pedagogical goals, actions, and evaluation of the effect of teacher's actions. About one-third of teachers successfully identified deficits in children's play development and formulated appropriate pedagogical goals. The remaining teachers showed a disconnect between observation, understanding of play development, and goal formulation — their stated goals did not match the actual children's needs observed in play.

Discussion

The study revealed that teachers rarely play as the partner and mediator, that is necessary for fostering play development (Abdulaeva, Alieva, 2020; Kravtsov, Kravtsova, 2017; Singer, DeHaan, 2019). This reflects a trend observed across different countries (Bredikyte, 2022; Devi, Fleer, Li, 2021). The prevalence of didactic and formal functionary approaches is concerning: exploiting play for instructional
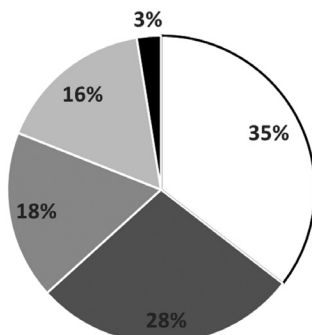
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Fig. Types of teachers' responds

purposes pushes children into action within the real-field and disrupts the meaning-field of play (Galasjuk et al., 2023).

Unlike findings from other studies, in our case, teachers seldom took an outsider position, which may be explained by the sample's specific characteristics (self-selection principle) as well as the initial requirement for video submissions (a continuous episode of joint play between children and a teacher). Some teachers assumed roles that supported play development — either as co-players with partial involvement in play or play leaders — meaning they engaged in joint play without imposing external goals, yet without fully transitioning to a partner role that requires a balance of initiatives between adults and children.

The study identified a lack of reflection and difficulties in teachers' understanding of play development specifics: a third of the initial sample submitted videos of quasi-play instead of genuine play, and more than half of the teachers failed to highlight key aspects of play development or articulate pedagogical objectives related to play in their comments.

The analysis of videos and teachers' comments aligns with other research, pointing to two opposing trends in preschool practice: while generally acknowledging the value of children's play, teachers either support it without engaging in it or adopt a utilitarian attitude, attempting to control and totally guide it (Iakshina, Le-van, 2022). This underscores the need to find tools that help teachers shift from didactic position to a mediator role in joint play with children. A telling illustration is one teacher's comment, which reflects the principles of directive pedagogy: *"It's very difficult to organize truly spontaneous play because children's*

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experiences vary, and it's hard to engage everyone."

The findings highlight a gap between teacher training (most teachers hold higher pedagogical degrees) and actual practice, as well as shortcomings in teacher education programs (Samoderzhenkov et al., 2021; Iakshina, Le-van, 2022) and workplace methodological support for educators.

The interrelation between the level of reflection and the quality of play support supports our research hypothesis and suggests that reflective analysis of play and recognizing one's own play-related deficits do not hinder joint play. This connection may indicate that the level of reflection enhances the quality of the activity it is directed at: if a teacher can analyze their own play with children and identify both their own and the children's play deficits, they will engage in joint play more appropriately and support it more effectively.

An alternative interpretation of this correlation, requiring further verification, is also possible: extensive practical experience among play-oriented teachers may provide an intuitive understanding of joint play dynamics, which, in turn, influences the level of reflection, enabling educators to observe more sensitively, discern nuances, and analyze ongoing processes. However, intuition is always a condensed, instantly unfolding, yet not always reflected-upon experience — it may remain unconscious due to a lack of appropriate tools and terminology. Reflective analysis of one's own play equips teachers with a tool that helps transition play support from an intuitive to a conscious and deliberate level, moving from lower to higher forms of behavior.

Conclusion

The design of our study does not allow us to conclusively determine whether a high level of pedagogical reflection influences the transition to a partnership role in joint play. However, we can hypothesize that understanding the specifics of play activities and reflecting on one's own challenges may be among the factors that enhance the quality of play support. The process of reflective analysis is a cognitively guided one that can enrich teacher's intuitive play experience. To effectively facilitate play in a preschool setting, it is essential to appropriately formulate pedagogical goals based on the children's level of play development and their needs, and then align one's actions accordingly. Thus, reflection can be considered one of the factors determining pedagogical competence in supporting play in kindergarten.

Testing this hypothesis could serve as a direction for future research.

Limitations. A limitation of this study is the self-selected nature of the sample (it did not include teachers who are uninterested in supporting children's play or who prefer an outsider position toward play). The data collection procedure assumed that teachers would independently select and submit videos of joint play for the study, which may not fully reflect the broader picture of play support in a given classroom. As a direction for future research, it would be valuable to complement video analysis with an independent external assessment of the quality of play-support conditions in the classroom. Additionally, the study did not account for institutional factors (such as organizational culture, institutional values, or the specifics of methodological support and teacher training), which may influence teachers' play support strategies and level of reflection.

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Contribution of the authors
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Декларация об этике
Участники дали добровольное согласие на участие в исследовании, данные анонимизированы. Родители детей дали согласие на видеосъемку. Все участники могли в любой момент отказаться от участия в исследовании.

Научная статья | Original paper

Assessment of motor skills associations with executive functioning in children of senior preschool age

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Abstract

Context and relevance. The article examines the relationship between motor skills (fine and gross motor skills, motor reaction time) and executive functioning (EF), which is the most important predictor of future academic success. **Objective.** This experimental study is designed to determine the strength and direction of associations between EF components (planning ability, working memory, inhibitory control) and various motor skills (gross and fine motor skills) in older preschool children. **Hypothesis.** In preschool children, EF components (planning ability, working memory, inhibitory control) have close associations with various indicators of motor development, but so far, this has not been unambiguously confirmed in experimental studies. **Methods and materials.** The examination of the participants was conducted within the framework of the project "Study of neurobiological predictors of academic success in children" (Priority 2030) using the hardware and software system SHUHFRIED (Tower of London — Freiburg version, TOL-F; Motor Learning Skills test, short form according to Sturm and Büssing, MLS; Reaction Time test, RT; n = 81, 58 boys, average age 6,42 ± 0,53 years) and the stabilometric complex ST-150 (65 children, 52 boys, average age 6,4 ± 0,52 years). **Results**. According to the correlation analysis of the stabilometry and TOL-F test indices, the lower the gross motor skills (postural stability) indices, the better the planning and working memory indices; however, the inhibitory control index directly correlates with postural stability skills. The results of the fine motor skills and EF tests mostly agree with each other; however, they have lateralization characteristics, and the size of the correlation coefficients does not exceed 0.4. **Conclusions**. The correlations of the fine motor skills test results with EF are mostly weak. Probably, at the preschool education stage, the impact only on the motor sphere (fine motor skills in particular) is not a sufficient condition for the development of EF. Planning and working memory inversely correlate with the gross motor skills development indices, which probably indicates a reciprocal relationship between individual higher cortical functions and gross motor skills in older preschool age.

Keywords: executive functioning, postural stability, fine motor skills, gross motor skills, motor response

Оценка ассоциаций двигательных навыков с показателями исполнительного функционирования у детей старшего дошкольного возраста

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Резюме

Контекст и актуальность. Материалы статьи посвящены проблеме взаимосвязи двигательных навыков (мелкая и крупная моторика, время моторной реакции) с исполнительным функционированием (ИФ), которое является важнейшим предиктором дальнейшей академической успешности. **Цель** данного экспериментального исследования — определить силу и направленность ассоциаций компонентов ИФ (способности к планированию, рабочей памяти, тормозного контроля) с различными моторными навыками (крупной и мелкой моторикой) у детей старшего дошкольного возраста. **Гипотеза**. Предполагалось, что у детей дошкольного возраста компоненты ИФ (способность к планированию, рабочая память, тормозный контроль) имеют тесные ассоциации с различными показателями двигательного развития, т.к. до сих пор это не имеет однозначного подтверждения в экспериментальных исследованиях. **Методы и материалы**. Обследование участников проводилось в рамках проекта «Исследование нейробиологических предикторов академической успешности детей» (Приоритет 2030) с помощью аппаратно-программной системы SHUHFRIED (методика Башня

Лондона, Фрейбургская версия, англ. Tower of London — Freiburg version, TOL-F; тест Навыки моторного обучения, краткая форма по Штурму и Бюссингу, англ. Motor Learning Skills, MLS; тест Времени реакции, англ. Reaction Time, RT; n = 81, 58 мальчиков, средний возраст — 6,42 ± 0,53 лет) и стабилометрического комплекса ST-150 (65 детей, 52 мальчика, средний возраст — 6,4 ± 0,52 лет). **Результаты.** Согласно корреляционному анализу показателей стабилометрии и теста TOL-F, чем ниже показатели крупной моторики (постуральной устойчивости), тем лучше показатели планирования и рабочей памяти, однако показатель тормозного контроля прямо коррелирует с навыками постуральной устойчивости. Результаты тестов на мелкую моторику и ИФ преимущественно согласуются между собой, однако имеют особенности латерализации и размер коэффициентов корреляции не превышает 0,4. **Выводы.** Корреляции результатов тестов на мелкую моторику с ИФ являются преимущественно слабыми. Вероятно, на этапе дошкольного образования воздействие только на двигательную сферу (мелкую моторику, в частности) не является достаточным условием для развития показателей ИФ. Планирование и рабочая память обратно коррелируют с показателями развития крупной моторики, что, вероятно, говорит о реципрокном взаимоотношении отдельных высших корковых функций с крупными моторными навыками в старшем дошкольном возрасте.

Ключевые слова: исполнительное функционирование, постуральная устойчивость, мелкая моторика, крупная моторика, моторная реакция

Introduction

According to research, the most significant cognitive predictors in preschoolers are executive functions (EF) [3; 23; 41]. EF is a general term for cognitive processes that regulate, control, and manage other cognitive processes [2; 6]. The content of EF construct is variable, but most authors highlight working memory, attention (switching and distribution), cognitive flexibility, inhibitory control, planning, error search and correction, and problem-solving behavior [2; 14].

Deficits in EF development predict subsequent academic deficits in elementary

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school: problems with literacy, reading, vocabulary, and mathematics [3; 34; 41; 44]. The predictive power of the EF is maintained when controlling for other factors [23; 33]. Longitudinal studies have shown that EF development helps accelerate the rate of mathematical skills development [25; 40; 44]. Thus, the level of EF development can act as a fundamental predictor of academic success [22].

Other studies have shown a positive correlation between math performance and motor skills (MSs)—fine motor coordination and visual-motor integration [24]. J. Piaget argued that cognitive and motor processes cannot be considered as separate entities, since cognitive development is entirely dependent on motor functioning [37]. According to the Russian neuropsychology school, higher mental functions are functional systems that unite several areas of the brain to implement a particular function [1]. In childhood, the development of MSs is far ahead of the formation of speech and thinking, forming the basis for their formation, in connection with which corrective work should be directed from moving to thinking [5]. P.S. Churchland proposed the existence of a continuum of motor and cognitive functions [15].

There is little experimental evidence to support a *global* association between cognition and MSs. In a meta-analysis, Gandotra et al. (2021) showed significant positive associations of MSs with EF in neurotypical children (32 studies, N=4866), but the effect size of the *global* association of MSs and EF was very small: r=0,18 [26]. According to a systematic review by Malambo et al. (2022) on the relationship between EF and various MSs in preschoolers, the authors found only 15 studies on the topic, of which only half were of high methodological quality [32]. The authors found *weak* correlations or *insuffi-*

cient evidence for an association between the studied MSs and EF. According to Cameron et al. (2012), EF and fine MSs make *independent* contributions to the development of preschoolers' academic skills [12]. Thus, to date, the literature data on the relationship between MSs and EF in older preschoolers remain contradictory. Older preschool age is critically important for preparing a child for school, since it immediately precedes the start of education. Understanding the extent to which MSs and EF indicators are associated with each other at this age, and what the details of these relationships are, is relevant from the point of view of choosing the most effective strategies for preparing children for school.

Hypothesis: In preschool children, components of EF (planning ability, working memory, inhibitory control) may have close associations with various indicators of motor development.

Objective of this study was to analyze the associations of EF components (planning ability, working memory, inhibitory control) with various MSs (gross and fine motor skills) in older preschool children.

Methods and materials

The children were examined as part of the project "The Study of Neurobiological Predictors of Academic Success in Children." Inclusion criteria: written voluntary consent of the parent; child's age of inclusion: 5 years 10 months-7 years 4 months; child's ability to understand and follow instructions. Exclusion criteria: previously diagnosed hearing, vision, and motor disorders; severe mental and neurological disorders diagnosed by a psychiatrist and/or neurologist; concussion within the last year, other traumatic brain injury or neurosurgical intervention; paroxysmal activity on the EEG; alalia (motor, sensory); severe

chronic diseases, malformations, cachexia, hereditary diseases; chronic mental disorders, alcohol and/or drug addiction in parents.

The MSs assessment was carried out using the hardware and software complex (HSC) SHUHFRIED (81 children, 58 boys, average age 6,42±0,53 years, here and further the arithmetic mean±standard deviation) and the stabilometric complex ST-150 (65 children, 52 boys, average age 6,4±0,52 years); the assessment of the EF was carried out using the HSC SHUHFRIED (81 children, 58 boys, average age 6,42±0,53 years).

Stabilometry is one of the basic methods of posturology, which studies the processes of maintaining, controlling, and regulating body balance in its various positions and performing movements [8]. Testing the process of body balance in the basic stance (Romberg test) provides information on the functional state of the musculoskeletal system [8]. Body balance (postural stability) is one of the basic components of gross MSs [39]. As part of this work, a test was performed to assess the stability of the vertical posture — the Romberg test.

Three subtests were analyzed using the HSC SCHUHFRIED (Vienna Test System, Austria):

1. The Tower of London test, Freiburg version (TOL-F). The main variables assessed are planning ability (the ability to cognitively model alternative solutions and evaluate the consequences of an action before it is performed) [9], working memory, and inhibitory control [43] (EF). The validity of the TOL-F was confirmed in the study by Debelak et al. (2016) [18].

2. The MLS test (short form, according to Sturm and Bussing) includes 8 subtests (4 in each hand) and evaluates fine MSs: purposefulness of movements, calmness of the hands/tremor, precision of hand and wrist

movements, dexterity of hands and fingers, and speed of hand and wrist movements, speed of wrist and finger movements.

3. RT (reaction test) is used to assess reaction time and motor reaction time.

To date, data on the experience of using the HSC SCHUHFRIED in Russia for conducting psychological and pedagogical research have been published [7; 9].

Data analysis was performed using the StatSoft Statistica 6,0 package. The data distribution was different from normal (Shapiro-Wilk test), and Spearman's rank correlation coefficient (hereinafter ρ) was used to assess correlations between variables. Correlations were considered significant at a level of p<0,05.

Results

1. The assessment of correlations between the indicators of postural stability and EF is presented in Table 1.

From the analysis of Table 1, it can be noted:

1). The larger the area of the statokinesiogram (S), the better the planning ability and the more correctly 4-move tasks are solved (reflects working memory); however, at the same time, the choice of an unacceptable position (an indicator of inhibitory control) occurs more often. S is an indicator of postural stability: the larger S, the worse the balance skills.

2). The higher the statokinesiogram density (LFS, path length per unit area), the lower the planning ability and the fewer correctly solved tasks, but at the same time there are fewer errors (choosing an inadmissible position). LFS reflects energy expenditure when maintaining a posture; the higher it is, the less energy is expended, which means that balance skills are better developed and auto-

Table 1

Correlation matrix (Spearman) of stabilometric indicators with indicators of executive functioning

Stabilometry indicators	Planning ability	Correctly solved tasks		Invalid position selection	Number of correct decisions
		4 moves	5 moves		
V OE	0,065	0,174	–0,026	0,049	–0,205
V CE	0,059	0,043	0,023	0,119	*–0,251**
S OE	*0,250**	*0,267**	0,216	*0,267**	–0,065
S CE	0,201	0,181	0,152	*0,279**	–0,110
LFS OE	*–0,299**	*–0,286**	*–0,277**	*–0,295**	–0,010
LFS CE	–0,223	–0,147	–0,242	*–0,378***	0,021

Note: * — p < 0,05; ** — p < 0,01; V — the speed of the pressure center movement is the ratio of the length of the trajectory of the center of pressure to a unit of time; the higher the value of this indicator, the less stable is the person's posture on the platform (Skvorcov, 2010); S — statokinesiogram area; LFS — statokinesiogram density; OE — open eyes; CE — closed eyes (tests with open and closed eyes allow one to assess the contribution of the visual and proprioceptive sensory systems to maintaining balance).

mated [8]. Thus, the more effective the postural balance strategy, the lower the planning and working memory indicators, but at the same time there are fewer errors with choosing an inadmissible position (better inhibitory control). LFS is inversely correlated with S; therefore, the correlations of these indicators with EF have the opposite sign.

Thus, according to the analysis of correlations between gross MSs indicators and TOL-F test indicators, the less stable the child is and the more energy he spends on maintaining his posture (the less developed his balance skills), the better he performs on planning and working memory tests but has more erroneous attempts (the less developed his inhibitory control).

2. **The analysis of correlations of the EF indicators with the results of fine MSs testing (MLS test)** is presented in Table 2.

From the analysis of Table 2, it can be noted:

1). Planning ability negatively correlates with the error number and duration of the MLS aiming test (visual motor coordination assessment) with the right hand and is also positively correlated with the number of hits with the right hand.

2). The number of correctly solved TOL-F tasks inversely correlates with the duration of the left-hand hit in the aiming test and with the duration of the left-hand error in the hand stability test and directly correlates with the number of left-hand errors in the stability test. In other words, a greater number of errors with their shorter duration in the stability test and a shorter duration of the hit when aiming, only with the left but not the right hand, corresponds to a greater number of correct solutions in the TOL-F test. In addition, the number of correct TOL-F solutions directly correlates with the number of hits in the tapping test with both hands.

3). The choice of an invalid position in the TOL-F is positively correlated with the number of right-hand aiming errors and negatively correlated with the total duration of the hitting and tracing tasks. That is, the stability and accuracy of task performance in the fine MSs test (MLS) are positively correlated with the inhibitory control score (TOL-F).

Table 2

Correlation matrix (Spearman) of the results of the Tower of London and MLS (Fine Motor Skills Test)

Fine motor skills test scores (MLS)		Planning ability	Invalid position selection	Number of correct decisions
Hit (targeting)	Number of errors, L.	–0,120	0,182	–0,106
	Number of errors, R.	–0,301**	0,255*	–0,174
	Error duration, L., sec	–0,106	0,140	–0,123
	Error duration, R., sec	–0,280*	0,163	–0,199
	Total duration, L., sec	0,160	–0,340**	–0,263*
	Total duration, R., sec	0,102	–0,382***	–0,126
	Number of hits, L.	0,080	–0,129	–0,059
	Number of hits, R.	0,339**	–0,034	0,142
Tracing lines	Total duration, L., sec	–0,013	–0,284*	0,120
	Total duration, R., sec	0,134	–0,239*	–0,014
Hand stability	Number of errors, L.	0,002	–0,041	0,377***
	Error duration, L., sec	–0,065	0,174	–0,303**
	Number of errors, R.	0,034	0,053	0,192
	Error duration, R., sec	–0,010	0,206	–0,207
Tapping	Number of hits, L.	0,068	0,114	0,242*
	Number of hits, R.	0,136	–0,041	0,324**

Note: L. — left hand, R. — right hand; * — $p < 0,05$; ** — $p < 0,01$; *** — $p < 0,001$.

3. **The correlations of EF with the reaction test (RT) indices** are presented in Table 3.

From the analysis of Table 3, it can be noted:

1). The choice of an unacceptable position in TOL-F (indicator of inhibitory control) directly correlates with the time of completing RT tasks—the slower the child reacts in RT, the more often he makes mistakes in choosing a position in TOL-F.

2). The number of correct decisions in TOL-F inversely correlates with the number of missed and incomplete reactions RT and directly correlates with the number of correct reactions RT.

Thus, the results of testing the EF are completely consistent with the results of the

Table 3

Correlation matrix (Spearman) of the results of the TOL-F (Tower of London) test and the RT (reaction time) test

Reaction time (RT) test scores	Planning ability	Invalid position selection	Number of correct decisions
Processing time	–0,064	0,287*	–0,081
Reaction speed	–0,103	0,268*	–0,206
Number of missed reactions	–0,018	0,184	–0,352**
Number of correct reactions	0,080	–0,206	0,367**
Number of incomplete reactions	–0,116	0,145	–0,278*

Note: * — $p < 0,05$; ** — $p < 0,01$.

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RT test: the faster and more accurately the child completes RT, the more correct decisions and fewer mistakes in TOL-F he makes.

Discussion

According to the obtained data, MSs have a *weak* connection with the results of EF testing using TOL-F. All significant correlations do not exceed the absolute value of 0,4, and only a few indicators have a moderate correlation (0,3–0,4). This is not consistent with Piaget's thesis that cognitive development is *entirely* dependent on motor functioning [37], but rather indicates a *weak* association of MSs with EF in older preschool children. Our data are consistent with the results of the meta-analysis by Gandotra et al. [26], in which the authors also obtained data on a *very weak* effect size of the EF association with various MSs. Considering the weak correlations, and even negative ones for some MSs, we can agree with the conclusions of Cameron et al. (2012) [12] about the relative independence of EF from MSs. Probably, each of these areas requires *separate* attention when preparing a child for school, and only motor development (including fine MSs) is not enough for optimal preparation.

A detailed analysis of the obtained results shows that gross MSs have a weak negative correlation with planning and working memory indicators. The worse a child's balance skills are, the better his EF indicators are. This contradicts some studies on the close relationship between basic MSs and academic performance [30], especially in the field of mathematics [18]. However, the authors of the first study [30] assess academic performance as a whole, without singling out mathematics separately, while the authors of the latest study [18] emphasize that performance on *dynamic* motor tests has a greater impact on mathematical performance. The study by

Cook et al. (2019) showed that individual gross MSs and components of EF have different and even opposite associations: inhibitory control is associated with locomotor skills and object manipulation skills. Working memory is associated only with locomotor skills, and physical activity did not correlate with inhibition and switching attention and was inversely correlated with working memory [17]. Ludyga et al. (2019) did not find any associations between cognitive flexibility and MSs in a study of preadolescent children [31]. Thus, our data and the results of other authors indicate that different components of EF have different degrees and directions of associations with individual indicators of gross MSs.

Inhibitory control as measured by the TOL-F is positively correlated with balance skills, which complements the findings of Cook et al. (2019) on the association of inhibition with locomotor skills and manipulation [17]. Our findings are also consistent with the findings of Liu et al. (2022) on the association of gross MSs with inhibitory control in preschoolers [29]. Liu et al. (2022) suggested that this is due to overlapping neural networks in the brain regions responsible for these functions [29].

In modern psychology of cognitive development, there are two theoretical concepts about the relationship between MSs and cognitive skills: reciprocity (development of motor and cognitive skills in close interaction) and automatism (struggle between MSs and cognitive skills for attention) [26]. To perform and improve new MSs, more cognitive resources (attention) are required. However, strengthening of skills leads to automation and reduction of cognitive resource expenditure on their performance. Our data are more consistent with the second concept.

In a large study of the association of cognitive and motor functions in 5–6-year-

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old children (n=378), no relationship was found between global aspects of cognitive and motor functions [42]. Some positive relationships were identified between visual-motor integration and working memory and between quantitative aspects of motor activity and verbal fluency. A study of 5th graders showed that postural stability was associated with linguistic academic achievement but not with mathematical achievement [38]. Another study demonstrated that of all motor functions (gross and fine MSs), only fine MSs (namely, visual-motor coordination) predicted subsequent mathematical achievement (n=38, 5-6 years) [21]. Our results are consistent with these data and suggest that individual EF may develop relatively independently of the development of gross MSs.

In the fine motor skills test (MLS), only the right-hand scores correlate with planning ability, and in the hand stability test (MLS), a higher number of errors with the left, but not the right, hand directly correlates with the number of correct solutions in TOL-F. This may indicate the role of lateralization of hand functions and a greater association of fine MSs of the right hand with EF, which is consistent with the data of the meta-analysis by Gandotra et al. (2021) [25].

The findings of a positive correlation between fine MSs and motor speed tests and EF are consistent with a large body of previously reported data on this topic: performance on fine motor tests is a predictor of division problem solving [16]; visual-motor coordination in preschool age is a significant predictor of mathematical skills [13; 20; 24; 26]. Most researchers note that it is visual-motor coordination that is the key skill that determines future academic performance in mathematics. According to Nesbitt et al. (2019) [35], improvement in mathematical abilities over time correlates with the development of EF and visual-motor integration.

Conclusion

Correlations of fine MSs with EF are weak; therefore, at the preschool stage, the development of the motor sphere alone is probably not sufficient to develop EF indicators. Only inhibitory control directly correlates with gross MSs; planning and working memory have inverse correlations with postural stability, which probably indicates a reciprocal relationship between individual EF (planning) and gross MSs in older preschool age. Thus, the assertion about the global relationship between MSs and EF is not supported by the results of the experimental study. Further detailed studies of the relationship between individual gross and fine MSs with different components of executive functioning are required to optimize the child's preparation for school.

Limitations. The cross-sectional nature of the study does not allow us to speak about the causality of the revealed correlations.

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Научная статья | Original paper

Experiences in the activities and psychological resources of students

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Abstract

Context and relevance. In examining activity experiences, the authors rely on their study on the theory of self-determination, where the question of the connection between experiences in activity and psychological resources remains open. The aim of the study was to examine experiences in educational and professional activity as well as in psychological resources of students. **Hypothesis**. Students whose profile of typical experiences in the process of educational and professional activities is close to optimal will be characterized by a higher level of self-control and self-compassion, as well as lower rates of emotional burnout. **Methods and materials**. One hundred sixty-five university students aged 18 to 22 (M = 19,1, SD = 0,96) participated in the study. The following methods were used: 'Diagnostics of Experiences in Professional Activity' (E.N. Osin, D.A. Leontiev), 'Self-Compassion' (K. Neff, adapted by K.A. Chistopolskaya, E.N. Osin et al.), 'Brief Self-Control Scale' (T.O. Gordeeva, E.N. Osin), and the 'Emotional Burnout Questionnaire' (K. Maslach, S. Jackson, adapted by N.E. Vodopyanova). The **results** showed that the components of optimal experience (pleasure, sense) are positively associated with compassionate attitude towards oneself and self-control, while the experience of emptiness in activity is associated with emotional burnout and negative attitude towards oneself, especially in a situation of failure. It was revealed that students whose profile of typical experiences in the process of educational and professional activity is close to optimal have a greater ability to manage their behavior, emotions and high emotional tone. **Conclusions.** It is shown that studying students' experiences and their psychological resources is promising. The obtained results set the task for the higher education: to find individual trajectories of students' professional development.

Keywords: personality, experience in activity, psychological well-being, life satisfaction, self-compassion, self-control, psychological resources, experience

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Переживания в деятельности и психологические ресурсы студентов

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Резюме

Контекст и актуальность. Рассматривая переживания в деятельности, авторы опираются в своем исследовании на теорию самодетерминации, где остается открытым вопрос о связи переживаний в деятельности с психологическими ресурсами. **Цель**. Выявить переживания в учебно-профессиональной деятельности и психологические ресурсы у студентов. **Гипотеза**. У студентов, чей профиль типичных переживаний в процессе учебно-профессиональной деятельности близок к оптимальному, выше уровень самоконтроля, сочувствия к себе и ниже показатели эмоционального выгорания. **Методы и материалы**. В исследовании приняли участие 165 студентов вузов в возрасте от 18 до 22 лет (M = 19,1, SD = 0,96). Использовались следующие методики: «Диагностика переживаний в профессиональной деятельности» (Е.Н. Осин, Д.А. Леонтьев), «Сочувствие к себе» (К. Нефф, в адаптации К.А. Чистопольской, Е.Н. Осина и др.), «Краткая шкала самоконтроля» (Т.О. Гордеева, Е.Н. Осин), «Опросник эмоционального выгорания» (К. Маслач, С. Джексон, в адаптации Н.Е. Водопьяновой). **Результаты.** Результаты показали, что составляющие оптимального переживания (удовольствие, смысл) положительно связаны с сочувственным отношением к себе и самоконтролем, тогда как переживание пустоты в деятельности связано с эмоциональным выгоранием и негативным отношением к себе, особенно в ситуации неудач. Выявлено, что у студентов, чей профиль типичных переживаний в процессе учебно-профессиональной деятельности близок к оптимальному, более выражена способность управлять своим поведением, эмоциями и высокий эмоциональный тонус. **Выводы**. Показано, что изучение переживаний студентов и их психологических ресурсов является перспективным. Полученные результаты ставят перед высшим образованием задачу поиска индивидуальных траекторий профессионального становления студентов.

Ключевые слова: личность, переживания в деятельности, психологическое благополучие, удовлетворенность жизнью, сочувствие к себе, самоконтроль, психологические ресурсы, переживание

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Introduction

The issues of young people connected with professional growth in the period of getting higher education are being considered through the prism of psychological health more often, as well as through the prism of well-being and experiences in activity. There are several reasons for this cross-over of the two research object fields. In the strategies of self-realization, including the professional sphere, one may find predictors of emotional states and psychological well-being, such as autonomous self-motivation (Gordeeva, Sychev, 2021), metacognitive engagement (Denisova et al., 2022), focus on self-realization (Kabrin et al., 2022). Emotional experiences are assessed as markers of internal motivation for the activity, ensuring a high level of its productivity (Dyachuk, Bocharova, 2021; Kazakova, Koshel, 2022; Klein et al., 2019; Mitina, Isakova, 2022; Finkelstein-Fox et al., 2020).

The construct of "experience in activity" introduced into scientific vocabulary by D.A. Leontiev provides an opportunity not only to study the features of students' experiences during their university years, but also to study the connection of these experiences with psychological resources, including those of students majoring in psychology and pedagogics as future specialists whose activities are related to the "human-human" interaction system.

D.A. Leontiev, when designing and operationalizing a three-dimensional combinatorial model of experience in activity, seeks to capture the concept of "optimal experience" introduced into the scientific worldview by M. Csikszentmihalyi (Osin, Leontiev, 2017; Csikszentmihalyi, 2014). The author identifies the criteria for optimal experiences: optimality as effectiveness (the sum of experiences ensures its objective result), optimality as a positive emotional balance (involvement in an activity and its implementation are associated with the experience of pleasure), optimality as meaningfulness (the activity is understood in the broader context of one's own life). The author considers the experience in activity as a "subjective representation of correlation of the current activity with each of the three criteria" (Osin, Leontiev, 2017, p. 32). In the model context, the optimal experience includes a range of positive emotions (pleasure), and the meaningfulness of one's activity (inclusion in the meaningful contexts of one's own life), and some effort leading to the achievement of the goal facing the subject, while the experience of emptiness marks the absence of control and inability to comprehend life events. It is proposed to consider the optimal experience as a "mental compass" that guides psychological selection, supporting the development trajectory that each person independently builds and follows throughout life (Aleksandrova, 2022, p. 155).

For the current moment, the features of the optimal experience have been studied in various types of activities. Thus, studies have revealed that: participants in a cooperative board game experience significantly more pleasure and meaningfulness and less emptiness than participants in games with competitive actions (Mitina, Isakova, 2022); full-time students rate the experience of pleasure, meaning, and effort higher than students studying in a distance learning format (Kazakova, Koshel, 2022); in the context of a significant proportion of classes in remote format, including some limitations in movement, students experience a decrease in the intensity of complex experiences of joy and flow (Dyachuk, Bocharova, 2021).

Analyzing student engagement as an actual state that can be described through

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absorption in an activity, close to the "flow state", researchers prove that the majority of highly engaged students perceive their lives as quite meaningful, life events as being under their control. They also perceive themselves as autonomous, have a high positive esteem of themselves, of their own professional and personal qualities, and are characterized by a significant experience of life satisfaction (Pavlova, Krasnoryadtseva, Scheglova, 2021).

Studies of optimal experience in various types of activities have shown that it is associated with such psychological resources as motivation and responsibility (Kazakova, Koshel, 2022; Klein et al., 2019; Krasnoryadtseva, Vaulina, Tolmacheva, 2023), a complex experience of joy as a combination of experiences of pleasure and meaning is associated with productive coping strategies (reflexive coping, proactive coping, etc.) (Dyachuk, Bocharova, 2021). Studies note a connection between optimal experience and psychological well-being (Klein et al., 2019; Leontiev et al., 2018; Osin, Leontiev, 2017). The absence of optimal experience is associated with such indicators of psychological distress as negative effect and emotional distress (Osin, Leontiev, 2017).

At the same time, the question of the relationship between experiences in educational and professional activities and other psychological resources of students remains open, which determines the purpose of the work. Following D. Leontiev, we define resources as means, the abundance and sufficiency of which contribute to the sustainability of well-being, goal achievement and high performance results (Leontiev, 2023). Psychological resources include personality and character traits, abilities, mental processes. D. Leontiev identifies five groups of psychological resources: motivational, instrumental, as well

as resources of sustainability, self-regulation and transformation (Leontiev, 2023). The resources provide a person with more opportunities to resist negative development factors and unfavorable living conditions.

The psychological resources considered by the authors of the current article are self-control, self-compassion, emotional tone.

Self-control. Self-control as a regulatory personality trait plays an important role in educational and professional activities (Nevryuev, Sychev, Sarieva, 2022), acts as a predictor of academic performance at all stages of education (Gordeeva et al., 2016; Nevryuev, Sychev, Sarieva, 2022), shows an inverse correlation with a tendency to boredom (Dorosheva, Golubev, 2023) and burnout in students (Nevryuev, Sychev, Sarieva, 2022; Trofimova, Efanova, 2022), which may indicate its important role in preventing burnout and analyzing its role in students' experiences.

Self-compassion. Research shows that a compassionate attitude towards oneself and acts of kindness can potentially have a positive impact on subjective well-being by maintaining motivation for the chosen activity (Chistopolskaya et al., 2020; Leybina, Kashapov, 2022).

Emotional Tone. Emotional tone is expressed in the predominance of positive emotions and productive activity of the individual, in being ready to respond to emerging difficulties and seek resources for overcoming them. Emotional tone is considered in the continuum "high — low". In our opinion, one of the markers of low emotional tone can be emotional burnout, which occurs as a consequence of psychological difficulties in educational and professional activities, such as: establishing a balance between self-development, which requires intensive investment of effort in professional growth, and self-preservation, which

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requires careful use of vital and personal energy; mismatch between the individual idea of obtaining the professional qualification and the training program; search for an individual strategy for completing educational and professional tasks; multitasking of the age stage (training, finding a partner, establishing friendly relations, professional employment) and limited time resources, etc. The arising difficulties can hinder self-development due to difficulties in understanding the changes taking place (Krasnoryadtseva, 2001) and insufficient experience in overcoming unfavorable emotional states (Krasnoryadtseva, Vaulina, Tolmacheva, 2023; Kroencke et al., 2019; Finkelstein-Fox et al., 2020). Emotional burnout comes in the form of disturbances in the emotional personality functioning (decreased emotional response, subjective evaluation of increased efforts when performing activities, symptoms of isolation from others, dehumanization of the relationship sphere).

The conducted scientific and theoretical review allowed us to assume that students whose profile of typical experiences in the process of educational and professional activity is close to optimal have a higher level of self-control, self-compassion and lower rates of emotional burnout. In this regard, the purpose of the research is to identify experiences in educational and professional activity of students, as well as their psychological resources.

According to the work purpose, the following tasks were to be solved:

1) organizing and conducting a psycho-diagnostic study of students in the psychological and psychology-pedagogical departments.

2) analyzing the correlations between the components of experiences in educational and professional activity and the psychological resources of respondents.

3) identifying differences in psychological resources of students with different experience profiles in educational and professional activity.

Methods and Materials

The results of the theoretical analysis were used as a basis for organizing and conducting an empirical study. For this purpose, a set of psycho-diagnostic methods was used to determine the experiences in the educational and professional activities of students and their psychological resources: self-control, self-compassion, emotional tone.

Methods. To study experiences in educational and professional activities, the method of "Diagnostics of Experiences in Professional Activities" has been used (Osin, Leontiev, 2017), which allows to consider the optimal experience through a combination of such scales as "pleasure", "effort" and "meaning of activity", while deviation from the optimal experience is marked by a combination of experiencing emptiness, excessive effort and a decrease in pleasure and meaning of activity. We expanded the instruction: "Here are the statements that describe your feelings in the process of work. Work should be understood as learning and applying the acquired knowledge in practical activities. Please rate how often you go through these experiences using a scale from 1 to 6."

Self-compassion was studied using the "Self-Compassion" method (K. Neff, adapted by K.A. Chistopolskaya, E.N. Osin, and others), which focuses on a benevolent attitude towards oneself, self-acceptance in failures, and careful study of one's feelings without excessively identifying with them. The method includes six subscales: "Kindness towards oneself", "Community with humanity", "Attentiveness", "Self-criticism", "Self-isolation", "Excessive Identity" (Chistopolskaya et al., 2020).

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Since emotional burnout serves as a marker of low emotional tone, the "Emotional Burnout Questionnaire" (K. Maslach, S. Jackson, adapted by N.E. Vodopyanova) was used for its diagnostics. It is aimed at studying the symptoms of emotional, mental exhaustion, physical fatigue, personal detachment and decreased satisfaction with the activity performance (Fetiskin, Kozlov, Manuilov, 2002). The questionnaire has a general scale "Mental Burnout" and three subscales: "Psychoemotional Exhaustion", "Depersonalization" and "Reduction of Personal Achievements".

Self-control was studied using the "Brief Self-Control Scale" (Gordeeva et al., 2016). Self-control reflects individual abilities to manage one's behavior, emotions, thoughtfully respond to current events, and act in accordance with the long-term goals that students face.

Sample. The study involved 165 students from Barnaul universities studying in the psychological and psychology-pedagogical departments. The sample included 33,94% of young men and 66,06% of young women aged 18 to 22 years (M = 19,1, SD = 0,96). By years: 1st year students — 27,29%, 2nd year students — 61,81%, 3rd year students — 10,9%.

Data analysis methods. Methods used for the obtained data analysis: correlation analysis using the Pearson coefficient, Student's T-test for independent samples and hierarchical cluster analysis (the "centroid classification" method). The research results were processed using IBM SPSS Statistics 22,0 software products.

Results

To test the assumption about the connection between the components of experiences in educational and professional activities and the psychological resources of students, we conducted a correlation analysis using the Pearson coefficient, the data of which are presented in Table 1.

The results of the correlation analysis demonstrate significant correlations between the scales of the "Diagnostics of Experiences in Professional Activities" method, the "Brief Self-Control Scale" method, the scales of the "Self-Compassion" method, and the scales of the "Emotional Burnout Questionnaire" method. According to the scales "Pleasure" and "Sense", inverse negative relations (p < 0,01) were found with the scales "Psychoemotional exhaustion" (r = –0,442; r = –0,428, respectively), "Depersonalization" (r = –0,214; r = –0,238), "Reduction of personal achievements" (r = –0,627; r = –0,652), "Mental burnout" (r = –0,544; r = –0,552) and direct positive relations (p < 0,01) with the scale "Self-control" (r = 0,381; r = 0,378), scales "Attention" (r = 0,350; r = 0,335), "Self-compassion" (r = 0,259; r = 0,222). The "Effort" scale revealed direct positive relationships with the "Psychoemotional exhaustion" scale (r = 0,220; p < 0,01) and the "Community with humanity" scale (r = 0,184; p < 0,05). The Emptiness scale has positive correlations (p < 0.01) with the burnout questionnaire scales: Psychoemotional exhaustion (r = 0,383), Depersonalization (r = 0,245), Reduction of personal achievements (r = 0,483), Mental burnout (r = 0,467) and negative correlations with the Self-control scale (r = –0,320; p < 0,01) and the Self-compassion method scales (p < 0,05): Self-isolation (r = –0,186), Attention (r = –0,191), Self-compassion (r = –0,154).

The next stage of data analysis was testing the hypothesis that students with different experiences in their activities may have different psychological resources. The multidimensional nature of the phenomenon of experience in activity becomes the basis for turning

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Table 1

Correlation links of experiences in professional activity with psychological resources of students (N = 165)

	Psychological resources											Experiences in the professional activities				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	–															
2	,654**	–														
3	,458**	,208**	–													
4	,927**	,746**	,689**	–												
5	–,588**	–,439**	–,493**	–,644**	–											
6	–,053	,035	–,197*	–,092	,071	–										
7	–,027	–,089	–,099	–,078	,094	–,213**	–									
8	,052	,147	–,170*	,011	–,097	,286**	–,068	–								
9	–,180*	–,258**	–,160*	–,238**	,186*	–,264**	,601**	–,142	–							
10	–,148	,008	–,434**	–,241**	,195*	,355**	–,068	,393**	,027	–						
11	–,086	–,190*	–,088	–,139	,027	–,252**	,549**	–,108	,692**	–,124	–					
12	–,141	–,133	–,342**	–,246**	,153*	,249**	,666**	,365**	,688**	,414**	,645**	–				
13	–,442**	–,214**	–,627**	–,544**	,381**	,114	,065	,087	,142	,350**	,111	,259**	–			
14	–,428**	–,238**	–,652**	–,552**	,378**	,127	,046	,118	,107	,335**	,032	,222**	,754**	–		
15	,220**	,118	–,019	,152	–,130	–,050	–,083	,184*	–,074	,075	–,046	–,020	–,002	,099	–	
16	,383**	,245**	,483**	,467**	–,320**	,087	–,125	,046	–,186*	–,191*	–,114	–,154*	–,549**	–,524**	,026	–

Note: ** — correlation is significant at the 0,01 level (two-sided); * — correlation is significant at the 0,05 level (two-sided). 1 — Psychoemotional exhaustion; 2 — Depersonalization; 3 — Reduction of personal achievements; 4 — Mental burnout; 5 — Self-control; 6 — Kindness; 7 — Self-criticism; 8 — Community with humanity; 9 — Self-isolation; 10 — Attention; 11 — Excessive identity; 12 — Self-compassion; 13 — Pleasure; 14 — Sense; 15 — Effort; 16 — Emptiness.

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to hierarchical cluster analysis, which allows dividing students into relatively homogeneous groups based on experiences in activity: pleasure, effort, sense, emptiness. To divide the sample into groups, we used hierarchical clustering with the "centroid classification" method, interval measure: squared Euclidean distance. The scaled data, which serve as the basis for clustering, were standardized into z-scores. In the course of the analysis, two cluster structures were considered: a structure consisting of three clusters (35,8%; 48,5%; 15,8% of respondents in each cluster), and a structure of two clusters (51,5%; 48,5% of respondents in each cluster). For further analysis, a structure consisting of two clusters was selected, since one cluster out of three may be completely included in one of the two. Thus, as a result of the hierarchical cluster analysis, two final clusters were obtained. Comparison of the average values for the analyzed scales between the clusters indicates the reliability of their differences, which allowed us to divide the sample into two groups.

The first cluster is formed by respondents (51,5%) with high and average values for the scales "Pleasure", "Sense", "Effort", which reflect the proximity of their typical experiences in educational and professional activities profile to the optimal one. The second cluster is represented by 49,5% of students with high and average values for the scales "Emptiness", "Effort" and low or average values for the scales "Pleasure", "Sense", which reflects the discrepancy between their typical experiences and optimal experience profile. The first group (group 1), which includes students of the first cluster, will be further designated as "Students with pronounced optimal experience", the second group (group 2), which was made up of students of the second cluster, — "Students with non-pronounced optimal experience in activity".

The data from the parametric Student's T-test allowed us to identify reliable differences in the study groups, which are presented in Table 2.

Table 2

Statistical characteristics of comparative analysis of psychological resources of different groups of students (Student's T-criterion) (N = 165)

Psychological resources	Groups	N	M	SD	t	p	Cohen's d
Psychoemotional exhaustion	1	85	15,529	10,119	−5,311	< 0,001	−0,827
	2	80	23,913	10,150			
Depersonalization	1	85	8,541	6,062	−2,941	0,004	0,458
	2	80	11,188	5,454			
Reduction of personal achievements	1	85	11,435	5,225	−8,056	< 0,001	−1,255
	2	80	19,113	6,943			
Mental burnout	1	85	35,506	16,593	−6,990	< 0,001	−1,089
	2	80	54,212	17,783			
Self–control	1	85	44,859	7,448	3,802	< 0,001	0,592
	2	80	40,538	7,132			
Kindness	1	85	3,186	0,780	0,421	0,674	0,066
	2	80	3,135	0,772			
Self–criticism	1	85	3,247	0,851	0,654	0,514	0,102
	2	80	3,160	0,860			

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Psychological resources	Groups	N	M	SD	t	p	Cohen's d
Community with humanity	1	85	3,150	0,858	0,296	0,768	0,046
	2	80	3,112	0,766			
Self–isolation	1	85	3,676	1,004	1,762	0,080	0,274
	2	80	3,406	0,963			
Attention	1	85	3,615	0,736	2,492	0,014	0,388
	2	80	3,353	0,602			
Excessive identity	1	85	3,650	1,038	1,464	0,145	0,228
	2	80	3,428	0,898			
Self–compassion	1	85	3,405	0,429	2,190	0,030	0,341
	2	80	3,257	0,436			

Note: Cohen's d index was used to assess the effect size and the degree of differences between the studied indicators.

Based on the data presented in Table 2, it can be concluded that the students of the first group have less pronounced values on all scales of the "Emotional Burnout Questionnaire" method. At the same time, the size of the statistical effect, estimated using the d-Cohen index, is high (d ≤ 0,80) on the scales of "Psycho-emotional exhaustion", "Reduction of personal achievements", "Mental burnout", and on the scale of "Depersonalization" it is average. Also, the average effect size (d ≤ 0,50) was revealed on the scale of "Self-control", which allows us to dwell on a more pronounced ability in the respondents of the first group to manage their emotions and behavior. Even though the T-test shows reliable differences on the scales "Attention" and "Self-compassion", the power of the d-Cohen criterion is low (≤ 0,20), which does not give grounds to speak about significant differences between the groups of sample subjects on these scales and rather indicates the random nature of the differences obtained.

Debate on the results

Our study was aimed at identifying the relationship of experiences in educational and professional activities with psychological resources in students. The results obtained in it complement other data on the relationship between the components of optimal experience and personality traits (Gordeeva et al., 2016; Denisova et al., 2022; Mitina, Isakova, 2022).

The results of the correlation analysis confirmed the relationship of experiences in educational and professional activities with such psychological resources of students as self-control, compassionate attitude towards themselves and emotional tone. As the experiences of pleasure and meaningfulness in educational and professional activities increase, the compassionate attitude of students towards themselves, attention to the experiences of the self increase as well. Along with the mentioned above, the ability to manage students' behavior and emotions, the value of their activities, interest in them, a sense of competence, and positive self-perception in the activity also increase.

High intensity of students' experiences regarding the efforts spent on achieving the results of their educational and professional activities is associated with emotional and physical fatigue, indifference to others and identification with other people experiencing the same failures. Students associate the experience of emptiness as a feeling of being in

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spontaneous uncontrolled processes of educational and professional activities with the severity of their emotional burnout, isolation from the educational space, self-isolation and negative attitude towards themselves, as well as low self-control.

The study found that pleasure and sense as components of optimal experience are positively associated with a compassionate attitude towards oneself, self-control and high emotional tone, and effort (another component of optimal experience in activity) is associated with a positive attitude towards oneself in a situation of overcoming life's difficulties through identification with other people in a similar situation. The positive relationship between effort and psychoemotional exhaustion once again confirms that excessive efforts, especially without meaningfulness of the activity and pleasure from it, lead to emotional exhaustion. Similar data are presented in the study by E.N. Osin and D.A. Leontiev (Osin, Leontiev, 2017). The experience of emptiness in educational and professional activities is associated with emotional burnout (a feeling of incompetence in one's work, decreased professional and personal self-esteem, emotional exhaustion) and a negative attitude towards oneself, especially in a situation of failure.

Students whose profile of typical experiences in the process of educational and professional activity is close to optimal (group 1) have the ability to manage their behavior, emotions and the prevalence of high emotional tone. Students of the first group are characterized by a positive assessment of the results of their work and opportunities for professional development, as well as higher satisfaction with the result of the activity.

Conclusion

The conducted study shows that the components of optimal experience (pleasure and meaning) demonstrate positive relationships with self-control, indicators of self-compassion and negative relationships with indicators of emotional burnout. Excessive effort without satisfaction and meaningfulness of activity leads to psycho-emotional exhaustion. It was revealed that self-control and high emotional tone are more typical for students with optimal experience in educational and professional activity, while differences in self-compassion between empirical groups were not established.

The results obtained set the task for higher education — to search for individual trajectories of students' professional development through various forms: participation in trainings on self-knowledge, self-efficacy, goal-setting, meaningfulness, as well as participation in various projects (scientific, practical).

Limitations. The limitations of the study are related to the small sample size, which is a prospect for the study (increasing the sample size and expanding the research base). The possibility of extending the findings to a larger category of students is limited by the fact that the study was conducted on a sample of students studying in psychological and psychological-pedagogical fields of study.

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Трофимова Ю.В. — идеи исследования, аннотирование, написание и оформление рукописи; планирование исследования; сбор и анализ данных; применение статистических, математических или других методов для анализа данных; контроль за проведением исследования.

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Ефанова М.И. — сбор и анализ данных; составление базы данных; применение статистических, математических или других методов для анализа данных; написание и оформление рукописи; визуализация результатов исследования.

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Научная статья | Original paper

The influence of blended learning models and internet self-efficacy on digital citizenship attitudes of elementary school students in Indonesia

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Abstract

Context and relevance. The integration of technology in elementary education is essential in developing students' digital citizenship attitudes, as Indonesian children need to learn responsible technology use within Pancasila education to become competent digital citizens in an increasingly connected world. **Hypothesis.** The study hypothesized that there would be significant differences in digital citizenship attitudes between students taught using blended learning versus direct instruction models, between students with high versus low internet self-efficacy, and that there would be an interaction effect between learning models and internet self-efficacy on students' digital citizenship attitudes. **Methods and materials.** Utilizing a quasi-experimental study with a 2×2 factorial format, the research involves 288 fourth-grade students from both public and private schools in Bangkalan, East Java. Data collection includes pre- and post-tests, questionnaires measuring internet self-efficacy and digital citizenship attitudes. **Results.** Statistical analysis revealed that students in the blended learning group demonstrated better digital citizenship attitudes compared to those in the direct instruction group (F = 8,856), students with higher internet self-efficacy showed more positive digital citizenship attitudes than those with lower self-efficacy (F = 21,983), and a significant interaction effect existed between learning models and internet self-efficacy (F = 6,938), indicating that the effectiveness of learning models varies depending on students' internet self-efficacy levels. **Conclusions.** Blended learning improves elementary students' digital citizenship attitudes more effectively than direct instruction, with internet self-efficacy levels significantly influencing these outcomes and interacting with teaching methods, suggesting educators should adopt tailored approaches based on students' technological confidence.

Keywords: blended learning, internet self-efficacy, digital citizenship, elementary education

Влияние моделей смешанного обучения и интернет-самоэффективности на цифровое гражданское поведение учеников начальных классов в Индонезии

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Резюме

Контекст и актуальность. Интеграция современных технологий в систему начального образования играет ключевую роль в формировании у учеников позитивного отношения к цифровому гражданству. В условиях, когда индонезийские дети должны осваивать ответственное использование технологий в рамках концепции Панчасила[1], важно подготовить их к жизни в мире, в котором все становится более взаимосвязанным. Обучение цифровой грамотности является необходимым условием для формирования компетентных и ответственных цифровых граждан. **Гипотеза.** В рамках исследования предполагалось, что между группами учеников, обучающихся по моделям смешанного обучения и традиционного обучения, существуют значительные различия в отношении к цифровому гражданству. Также предполагается, что уровень интернет-самоэффективности, то есть вера учеников в свои способности использовать интернет, влияет на эти отношения. Более того, предполагалось наличие взаимодействия между выбранной моделью обучения и уровнем интернет-самоэффективности, что может усиливать или ослаблять влияние каждого из факторов на отношение к цифровому гражданству. **Методы и материалы.** В исследовании использовался квазиэксперимент с факторной структурой 2×2, в котором приняли участие 288 четвероклассников из государственных и частных школ округа Бангкаланга, Восточная Ява. Для получения данных применялись предварительные и итоговые тесты, а также анкеты для оценки уровня интернет-самоэффективности и отношения к цифровому гражданству. **Результаты.** Анализ показал, что ученики, обучающиеся по модели смешанного обучения, демонстрируют более позитивное отношение к цифровому гражданству по сравнению с теми, кто учится по традиционной модели (F = 8,856). Также было выявлено, что ученики с высоким уровнем интернет-самоэффективности проявляют более положительное отношение к цифровому гражданству по сравнению с теми, у кого уровень ниже (F = 21,983). Кроме того, обнаружено значимое взаимодействие между

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- вера в единого Бога;
- справедливая и цивилизованная гуманность;
- единство страны;
- демократия, направляемая разумной политикой консультаций и народного представительства;
- социальная справедливость.

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моделями обучения и уровнем интернет-самоэффективности (F = 6,938), что свидетельствует о том, что эффективность методов обучения зависит от уровня технологической уверенности учеников. **Выводы.** Модель смешанного обучения оказывается более эффективной в формировании у начальных школьников положительного отношения к цифровому гражданству по сравнению с традиционным формой обучения. Важную роль при этом играет уровень интернет-самоэффективности, так как он существенно влияет на результаты и взаимодействует с выбранными педагогическими подходами. Эти выводы подчеркивают необходимость адаптации методов преподавания с учетом технологической уверенности каждого ученика для достижения максимальной эффективности формирования ответственного цифрового поведения.

Ключевые слова: смешанное обучение, интернет-самоэффективность, цифровое гражданское поведение, начальное образование

Introduction

The rapid development of information and communication technology has transformed education globally (An et al., 2021), expanding learning beyond traditional time and place constraints through widespread online platforms (Kumar et al., 2021) that offer accessibility and flexibility (Alshawish et al., 2021) despite implementation challenges (Abdillah et al., 2020). Technical resource limitations and teacher capabilities remain significant obstacles (Anjelin, Purnomo, 2021), with online learning during COVID-19 causing learning loss in Indonesia (Anggraena et al., 2021) and worldwide (Tahir et al., 2022; Wahyuni, 2021). Blended learning models effectively integrate technology with face-to-face instruction (Abdillah et al., 2020; Lapitan et al., 2021), with countries like India, Oman, Laos, and Vietnam prioritizing this approach (UNESCO, 2021) to help students utilize technology for improved academic outcomes and create educational environments for the common good in global society. Research indicates blended learning is particularly valuable for elementary education (Jiang et al., 2021), enhancing independent learning abilities and providing innovative content (Ashraf et al., 2022; Berga et al., 2021), with studies by Assylzhanova (2022) and Jiang (2021) confirming positive impacts on achievement. Additionally, 21st-century education must address cybersecurity through digital citizenship, defined as appropriate and responsible technology use (Öztürk, 2021), characterized by digital responsibility, safe practices, critical thinking, and productive social engagement (Pangrazio & Sefton-Green, 2021). Digital citizens regularly use technology for information, civic obligations, and economic purposes (Öztürk, 2021), with key issues including digital ethics, online safety, and responsible social media use, requiring attitudes that demonstrate technological behavior intelligence and appropriate choices when using technology (Jaeger, 2021).

The integration of blended learning in Pancasila education at the elementary level enhances student flexibility and control, promoting collaboration and the spirit of mutual cooperation. This educational approach, supported by digital tools, allows students to apply these values in practical contexts such as community service

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and social activities (Dewi et al., 2020). As digital natives, elementary students' frequent interaction with technology makes the integration of these tools into traditional learning essential for improving both academic outcomes and digital citizenship. Pancasila's core values, particularly "The Unity of Indonesia," emphasize unity, solidarity, and social cohesion, which are vital aspects of Indonesian culture. Pancasila education teaches students their civic rights and responsibilities while fostering responsible online behaviour, thereby enhancing their digital citizenship (Mufid et al., 2021). By instilling digital ethics and a sense of responsibility, students develop essential skills for effectively addressing social issues in their everyday lives. This approach supports findings that highlight the importance of nurturing digital citizenship from an early age, preparing students to be responsible, engaged members of their communities (Mulia, 2023).

In this context, Pancasila education needs to be designed to encourage and provide opportunities for students to explore widely and discover knowledge from various learning sources. At the elementary level, Pancasila education should prepare students with a comprehensive set of knowledge, attitudes, and skills necessary to exercise their rights and responsibilities as good citizens (Maisyaroh et al., 2023), establishing a strong foundation in preparing Indonesia's golden generation in accordance with increasingly complex contemporary demands (Law of the Republic of Indonesia Number 20 of 2003 Concerning the National Education System, 2003). These competencies are crucial for every citizen to adapt to the demands of changing times and to solve personal and social problems in everyday life. Utilizing internet-based digital learning resources in Pancasila education can support student learning outcomes by providing access to various relevant information and learning sources (Krisnawati et al., 2023). This study addresses the gap in digital citizenship research by providing empirical data on elementary school students in Indonesia, a perspective often underrepresented in Western-dominated literature. While blended learning research typically focuses on secondary or higher education, this in-

vestigation uniquely examines its effectiveness at the elementary level, particularly regarding digital citizenship attitudes in Indonesian contexts. "Learning that uses the internet as a medium requires students to have adequate skills in using and accessing internet-based information (Kumar et al., 2021)." Internet self-efficacy emerges as a crucial characteristic affecting learning performance in online environments, as "internet self-efficacy is one characteristic of students that can influence learning outcomes in internet-based learning (Dinh & Nguyen, 2022)," referring to students' confidence in their ability to leverage internet resources for educational purposes, which significantly impacts their learning outcomes in developing countries.

Internet self-efficacy, founded on Bandura's social cognitive theory (1978), refers to individuals' beliefs about their ability to complete tasks using specific skills, generating internal motivation and confidence to overcome learning obstacles (Bandura, 1977). In internet-based learning, this concept significantly influences students' abilities to search for relevant information and achieve success, as demonstrated by Panigrahi's (2022) research showing its impact on finding accurate information from reliable sources, and Chuang's research (2015) revealing that students with high internet self-efficacy have greater learning success potential. Based on Bandura's self-efficacy theory (Bandura, 1978), student characteristics related to internet self-efficacy can directly or indirectly affect their willingness to use technology according to their potential, making it a suspected behavioral control factor influencing learning outcomes and digital citizenship attitudes in internet-based learning (Chuang et al., 2015; Guazzini et al., 2022). This study examines the interaction effect between blended learning models and internet self-efficacy to provide empirical evidence on how these factors collaboratively influence learning outcomes and digital citizenship attitudes, comparing blended learning with direct instruction models to gain valuable insights into optimal technology implementation in elementary education, particularly considering internet self-efficacy (high and low) as a moderator variable affecting students' digital citizenship attitudes.

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This research examines the relationship between blended learning and direct instruction models in relation to students' diverse internet self-efficacy levels, providing an empirical framework for optimizing educational approaches in the digital era. The study investigates how different learning models affect students with varying internet capabilities, acknowledging that these differences significantly impact learning outcomes and digital citizenship attitudes (Al-Zahrani, 2015). While blended learning integrates online and face-to-face instruction to provide flexibility (Sari, 2021), direct instruction offers a structured approach beneficial for elementary students requiring additional guidance, particularly those with lower internet self-efficacy (de Jong et al., 2023). The research makes theoretical contributions by introducing a framework that integrates technology factors with blended learning in elementary education, while offering practical insights for teachers to enhance education quality through technology integration, especially for Pancasila teachers seeking to instill mutual cooperation values through collaborative learning in the digital age. Both models can be adapted to students' technological proficiency levels, though further validation is needed to determine specific effects on elementary students' digital citizenship attitudes, with the ultimate goal of supporting educational approaches that address today's students' diverse internet self-efficacy levels.

Materials and methods

This quasi-experimental study employed a 2×2 factorial design to investigate the influence of blended learning versus direct instruction on digital citizenship attitudes among elementary school students in Indonesia, while accounting for varying levels of internet self-efficacy. The research utilized «a factorialized version of the non-equivalent control group design» with two independent variables: the learning model (blended learning or direct instruction) and internet self-efficacy (high or low), with digital citizenship attitudes as the dependent variable. The population comprised elementary school students in Bangkalan District, East Java Province, from which 288 fourth-grade students were selected through random sampling from six schools (three public and three private). Fourth-grade students were chosen as they «are part of Generation Alpha, who started first grade in 2019 (currently aged 11 years), and are already familiar with interacting with the internet in their daily lives» and «are at an ideal age to promote active citizenship through technology use and can thus use technology wisely (Amelia & Santoso, 2022).»

The study employed three primary instruments: an Implementation Observation Sheet, Teacher Activity Assessment, and Student Response Questionnaire, all using a 5-point Likert scale to evaluate various aspects of the learning process. Internet self-efficacy was measured using an adapted Internet Self-Efficacy Survey (ISS) developed by Chuang (2015), while digital citizenship attitudes were assessed through a revalidated version of the Digital Citizenship Scale (DCS) adapted from Al-Zahrani (2015). All instruments underwent validation by three education experts and reliability testing using Cronbach's alpha (minimum acceptable value of 0.70). The research procedure followed a systematic approach beginning with administrative and technical preparations, followed by implementation which included measuring students' internet self-efficacy, administering pre-tests, implementing the designated learning models, collecting student responses, and conducting post-tests. After implementation of both learning models, all participants completed a digital citizenship attitude questionnaire, providing data for comparative analysis of the models' effectiveness.

Results

Research Participants and Initial Equivalence Assessment

This study, conducted across six elementary schools in the Bangkalan district, East Java province, involved 288 students aged 9–10 years divided into two instructional groups: 145 students in the blended learning model and 143 students in the direct instruction model, with participants further categorized by internet self-efficacy levels (high/low) based on their responses to a 5-point scale questionnaire as-

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sessing their internet confidence and competence. Analysis revealed balanced distributions across both models: the blended learning model included 81 students with high internet self-efficacy (40 males, 41 females) and 64 with low internet self-efficacy (25 males, 39 females), while the direct instruction model comprised 80 students with high internet self-efficacy (43 males, 37 females) and 63 with low internet self-efficacy (26 males, 37 females) (Mujtahidin et al., 2025). Initial equivalence was confirmed through ANOVA testing of pre-test scores, with Kolmogorov-Smirnov normality tests indicating normal distributions across all groups (direct instruction: 0,200; blended learning: 0,080; low internet self-efficacy: 0,083; high internet self-efficacy: 0,066), all exceeding the 0,05 threshold, while Levene's Test results demonstrated homogeneous variance (learning model: 0,048, sig. 0,827; internet self-efficacy: 0,726, sig. 0,395). Subsequent independent T-tests revealed no significant differences between direct instruction and blended learning models (sig. 0,548, mean difference 1,014) or internet self-efficacy levels (sig. 0,461, mean difference –1,253) (Mujtahidin et al., 2025), indicating comparable initial conditions and ensuring research validity by confirming that any observed effects could be attributed to experimental treatment rather than pre-existing differences.

Prerequisite Analysis Test

The prerequisite analysis test in this study examined both normality and homogeneity of data distribution, essential conditions for applying parametric statistical methods. Using the Kolmogorov-Smirnov test for normality assessment, results revealed significance values of 0,064 for the direct instruction model and 0,200 for the blended learning model, both exceeding the 0,05 threshold indicating normal distribution across learning models and internet self-efficacy levels (low: 0,084; high: 0,200). Concurrently, homogeneity analysis using the Levene statistic test yielded a value of 0,178 with a significance of 0,673, confirming "homogeneous variances across groups based on both learning models and internet self-efficacy levels" (Mujtahidin et

al., 2025). These comprehensive findings validate data collection integrity and fulfill the fundamental assumptions required for parametric statistical analysis, thereby ensuring the reliability of subsequent statistical analyses examining the influence of learning models and internet self-efficacy on digital citizenship attitudes without bias from non-homogeneous variances.

Research Hypothesis Test

The research hypothesis testing, conducted to statistically validate the proposed hypotheses, utilized MANOVA analysis techniques at a 0,005 significance level through SPSS (Mujtahidin et al., 2025). This comprehensive analysis yielded three significant findings: first, the learning model demonstrated a significant impact on digital citizenship attitudes ($F = 8,856$, $p < 0,05$), with blended learning producing more positive outcomes than direct instruction; second, internet self-efficacy (ISE) levels showed a significant influence on digital citizenship attitudes ($F = 21,983$, $p < 0,05$), with higher ISE correlating to better attitudes; and third, a significant interaction effect emerged between learning models and ISE ($F = 6,938$, $p < 0,05$), indicating that the effectiveness of learning models varies depending on students' ISE levels. The simultaneous testing of these hypotheses revealed that digital citizenship attitudes were generally better in the group taught with the blended learning model compared to direct instruction (Sig. $0,003 < 0,05$), students with high internet self-efficacy demonstrated better digital citizenship attitudes than those with low self-efficacy (Sig. $0,000 < 0,05$), and the impact of the blended learning model on digital citizenship attitudes was dependent on the students' level of internet self-efficacy (Sig. $0,009 < 0,05$).

Discussion

The Influence of Blended Learning Models on Digital Citizenship Attitudes

Analysis of digital citizenship attitudes revealed meaningful differences between instructional approaches, with students using the blended learning model showing a mean score of 68,49 compared to 65,62 for those using

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direct instruction. Statistical analysis yielded an F value of 8,856 with a significance level of 0,003 (p < 0,05), confirming that students taught through blended learning demonstrated significantly higher digital citizenship attitudes than their counterparts in the direct instruction model. These findings align with constructivist learning theory, which addresses learning needs in today's "competitive, complex, and ever-changing world" (Slavin, 2005). Cognitive constructivism theory emphasizes that learning must actively involve students in applying their knowledge to solve real-world problems (Fajri et al., 2021). The implementation of blended learning in Pancasila Education through digital media and internet-based resources successfully guides students toward responsible internet use, helping them understand their rights and responsibilities as digital citizens (Jaeger, 2021).

This research validates blended learning's significant influence on digital citizenship attitudes, responding to contemporary educational needs in the digital era. Digital citizenship encompasses understanding responsible technology use and appropriate behaviors for participation in digital society, aiming to educate students on effective technology utilization in both personal and social contexts (Amelia & Santoso, 2022; Lapitan et al., 2021). These findings corroborate Jaeger's (2021) research, which provides deeper insights into digital citizenship's importance within online learning environments by examining factors including digital literacy, risk perception, and social support. The results also correspond with Novianti's (2020) research, which established a correlation between online learning media use and digital citizenship attitudes in Civics Education, particularly regarding digital access, communication, and etiquette. Furthermore, as Pangrazio (2021) notes, incorporating digital technology in education promotes good digital citizenship by fostering three key attitudes: respect (observing etiquette, rules, and legal frameworks for other digital users), educate (teaching digital literacy and communication methods), and protect (developing awareness of digital responsibility regarding rights, responsibilities, and safety). These find-

ings collectively emphasize the importance of developing Pancasila Education that focuses on students' active and responsible participation in digital environments, with teachers needing to identify elements that influence students' digital engagement to effectively foster digital citizenship attitudes through blended learning.

The Influence of Internet Self-Efficacy on Digital Citizenship Attitudes

Analysis of digital citizenship attitudes revealed significant differences based on internet self-efficacy levels, with students possessing high internet self-efficacy demonstrating a mean score of 69,47 compared to 67,25 for those with low internet self-efficacy. Statistical analysis yielded an F value of 21,983 with a significance level of 0,000 (p < 0,05), confirming that students with high internet self-efficacy exhibit significantly stronger digital citizenship attitudes than their counterparts with low internet self-efficacy. These findings confirm that internet self-efficacy significantly influences students' digital citizenship attitudes, supporting Nawangsih's (2020) research indicating that individuals prioritizing digital identity security show greater willingness to share their digital identity online. Students with high internet self-efficacy demonstrate enhanced understanding of others' perspectives in online communication, practicing greater empathy, attentive listening, and thoughtful responses in digital interactions. These results underscore the importance of adapting Pancasila Education's pedagogical approaches in elementary schools through differentiated learning that accounts for students' internet self-efficacy characteristics—specifically, their confidence in utilizing internet resources for learning (Guazzini et al., 2022). Educators must consider students' psychological conditions and previous experiences with internet use when selecting appropriate learning models that incorporate online resources (Chuang et al., 2015).

The research further reveals that individuals with high internet self-efficacy demonstrate superior understanding of the balance between digital technology utilization and responsibility, evidenced through increased caution with per-

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sonal information sharing, more active participation in quality information exchange, positive social media engagement, enhanced ability to identify and counter cyberbullying and misinformation, and stronger commitment to ethical online conduct. The significant correlation between internet self-efficacy and digital citizenship attitudes underscores the essential need for educational programs designed to enhance students' internet skills and confidence. The study has profound implications for elementary educators, who should focus on developing students' digital citizenship attitudes through diverse activities while implementing a holistic educational approach that emphasizes both technical skills and the development of responsible digital values (Öztürk, 2021). Pancasila Education specifically should integrate internet self-efficacy development with technical and attitudinal training to enhance digital citizenship engagement. Critically, individuals must assess and improve their internet self-efficacy (Panigrahi et al., 2022), with differentiated approaches required—those with high internet self-efficacy may excel with complex, independent material, while those with lower self-efficacy need additional support to develop positive digital citizenship attitudes, ultimately ensuring students become not only technologically proficient but also ethically responsible digital citizens.

The Interaction of Blended Learning Models and Internet Self-Efficacy on Digital Citizenship Attitudes

The interaction between blended learning models and internet self-efficacy on digital citizenship attitudes has been empirically validated through comprehensive statistical analysis, with MANOVA procedures (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root) all yielding significant values (Sig. 0,000 < 0,05), while two-way MANOVA analysis demonstrated an F value of 6,938 with significance at 0,009 < 0,05, confirming the acceptance of the research hypothesis that these factors interact to influence students' digital citizenship attitudes. This finding underscores the critical importance of leveraging inter-

net resources as effective learning tools that enhance students' capacity for independent learning across various digital platforms, aligning with Bandura's self-efficacy theory which posits that individuals' beliefs in their capabilities directly influence their behaviors in pursuit of specific goals — a principle that extends to digital citizenship development. The theoretical framework is further substantiated by research indicating that students with high internet self-efficacy demonstrate superior abilities in searching, evaluating, and productively utilizing online information, a correlation confirmed by previous studies showing that "students' ability to find accurate and useful information from relevant sources correlates with their confidence in using the internet" (Chuang et al., 2015).

This study's findings align with previous research demonstrating the significant relationship between internet self-efficacy and digital citizenship attitudes. Multiple studies, including those by Panigrahi (2022) and Jaeger (2021), have established that students with higher internet self-efficacy and daily technology usage demonstrate more positive digital citizenship behaviors, particularly in protecting themselves and others in digital environments. The research reveals that students who exhibit confidence in their technological abilities and internet usage tend to develop stronger digital citizenship attitudes, characterized by enhanced self-respect, respect for others, and responsible online engagement. These findings are further supported by Amelia's (2022) research, which identified a direct correlation between students' technological attitudes and digital citizenship, ultimately suggesting that students with high internet self-efficacy are more likely to engage responsibly in online learning environments, demonstrate greater motivation for sharing information, and maintain a more positive digital identity compared to those with lower internet self-efficacy levels.

Conclusions

This study reveals several important findings regarding digital citizenship attitudes among elementary school students. First, the statistical analysis shows that students in the blended

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learning group demonstrated different patterns of digital citizenship attitudes compared to those in the direct instruction group. The data indicates a significant difference (F = 8,856, p < 0,05) between these two learning approaches, suggesting potential benefits of blended learning in the context of digital citizenship education. Second, our analysis of internet self-efficacy levels revealed varying associations with digital citizenship attitudes. Students with higher reported internet self-efficacy showed different patterns of digital citizenship attitudes compared to those with lower self-efficacy (F = 21,983, p < 0,05). However, it is important to note that this correlation does not necessarily indicate a causal relationship, as other factors may influence both internet self-efficacy and digital citizenship attitudes. The study also found a statistical interaction between learning models and internet self-efficacy (F = 6,938, p < 0,05).

Limitations. This study is limited by its cross-sectional design, reliance on self-reported data, lack of control for potential confounding variables, and implementation of only one blended learning configuration, suggesting the need for longitudinal research with diverse samples and experimental designs to establish causality and enhance generalizability.

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Recognition of emotional expressions of a face depending on the professional activity of an observer: an experimental study

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Abstract

Context and relevance. In addition to the biological adaptive function, emotions have a significant socio-psychological and communicative role. Accurate recognition of facial expressions and gestures is of great importance for successful communication in social interactions. **Objective.** The research aimed to determine the differences in the accuracy of emotion recognition, based on facial expression, between students of the Faculty of Medicine (FM) and students of the Faculty of Technical Sciences (FTS). **Hypothesis.** It is assumed that faculty students from helping professions (FM) will recognize emotions more accurately than faculty students from the field of non-helping professions (FTS). **Methods and materials.** The sample consisted of students of both genders (N = 145, of which 74 were from the FM, and 71 from the FTS). The Japanese and Caucasian Facial Expressions of Emotion (JACFEE) instrument was used in the research, which contains 56 photos, i.e. eight photos for each of the seven emotions: anger, contempt, disgust, fear, happiness, sadness and surprise. **Results.** Respondents studying FM are more successful in accurately recognizing emotions such as anger, contempt, disgust, fear, and surprise compared to respondents studying FTS. However, subjects studying at FTS are more successful in the accuracy of recognizing the emotion of happiness compared to subjects studying FM. In the accuracy of recognizing the emotion of sadness, there is no statistically significant difference between these two groups of respondents. **Conclusions.** Based on the obtained data, it can be assumed that students who chose a faculty related to the provision of medical services are more interested in people, their emotional state and social interaction. Perhaps, such students have a deeper understanding of interpersonal interaction than students studying in the faculties of non-helping professions, which are more oriented towards working with objects.

Keywords: facial expression of emotions, helping professions, non-helping professions, students

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Распознавание эмоциональных экспрессий лица в зависимости от профессиональной деятельности наблюдателя: экспериментальное исследование

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Резюме

Контекст и актуальность. Помимо биологической адаптивной функции, эмоции имеют значимую социально-психологическую и коммуникативную роль. Точное распознавание лицевой экспрессии и жестов имеет большое значение для успешного общения в социальных взаимодействиях. **Цель**. Выявление различий в точности распознавания эмоций по лицевым экспрессиям между студентами медицинского факультета (МФ) и факультета технических наук (ФТН). **Гипотеза**. Предполагается, что студенты, обучающиеся в области помогающих профессий (МФ), распознают эмоции с большей точностью, чем студенты, представляющие непомогающие профессии (ФТН). **Методы и материалы**. В исследовании приняли участие 145 студентов обоих полов: 74 человека из МФ и 71 — из ФТН. В качестве инструмента использовался тест «Японские и кавказские выражения эмоций на лице» (The Japanese and Caucasian Facial Expressions of Emotion, JACFEE), включающий 56 фотографий — по восемь изображений для каждой из семи эмоций: гнев, презрение, отвращение, страх, счастье, грусть и удивление. **Результаты.** Студенты МФ точнее распознают эмоции гнева, презрения, отвращения, страха и удивления. В то же время студенты ФТН успешнее идентифицируют эмоцию счастья. Между группами не выявлено статистически значимых различий в точности распознавания эмоции грусти. **Выводы**. Исходя из полученных данных, можно предположить, что студенты, выбравшие факультет, связанный с оказанием медицинских услуг, более заинтересованы в людях, их эмоциональном состоянии и социальном взаимодействии. Возможно, такие студенты имеют более глубокое понимание межличностного взаимодействия, чем студенты, обучающиеся на факультетах непомогающих профессий, которые в большей степени ориентированы на работу с предметами.

Ключевые слова: выражение эмоций на лице, помогающие профессии, непомогающие профессии, студенты

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Introduction

Emotions represent a complex phenomenon that, in the context of appraisal theories, are viewed as hypothetical constructs (Lazarus, 1993; Roseman, 2001; Scherer, 2003). An emotional response consists of several key components: 1. a cognitive component — evaluating an event; 2. an emotional reaction, which includes sensory, physiological, and motor elements that prepare one for action. Paul Ekman (Ekman, 1999a; Ekman, 2016) was the first to suggest criteria for distinguishing primary emotions from others. Primary emotions include anger, disgust, fear, happiness, sadness, and surprise. These emotions are identified by universal emotional signals (emotion-specific facial expressions), unique physiological responses, and automatic appraisals consistent with universal emotion-specific antecedents (factors that lead to observable behavior sequences). Other characteristics include typical emergence during development, presence in other primates, rapid onset, short duration, spontaneity, emotion-specific thoughts, memories, imagery, and distinct subjective experiences. According to Ekman, contempt is also classified as a primary emotion. It is noted that evidence supporting the universality of the facial expression of this emotion was gathered from studies involving participants exclusively from civilized cultures who recognized this emotion (Ekman, 1999b; Ekman, 2016). The inclusion of contempt in the list of primary emotions is also reinforced by cross-cultural recognition, despite its recognition rate being the lowest among primary emotions (Elfenbein, Ambady, 2002). Happiness is a positive emotion that

most people pursue (Ekman, Friesen, 1975). In contrast, sadness, anger, fear, and disgust are viewed as negative emotions. Surprise is classified as an ambivalent emotion, as it can elicit both positive and negative responses.

Emotions emerged throughout evolution and serve important adaptive and social functions. Oatley and Jenkins (2007) view emotions as the language of social life, a key to understanding the patterns that connect people to one another. As social beings, humans require interpersonal and social relationships: they form groups, cooperate, and establish control over others (Fischer, Manstead, 2008). According to communicative theories (Oatley, Jenkins, 2007), the primary function of emotions is linked to actions that manifest in social interactions (Morris, Keltner, 2000; Van Kleef, De Dreu, Manstead, 2010). Darwin (Kostić, 2010; Kostić, 2014) and his followers (Ekman, 2011) argued that emotions evolved because of their role in preparing the organism for rapid, automatic resolution of vital tasks. This ability is considered a unique mental process with a pronounced social character compared to other cognitive functions (Petrakova, Mikadze, Raabe, 2021).

Numerous studies (Petrović, Mihić, 2009) have shown that emotion recognition begins to develop at an early age (Kuznetsova, Makurin, 2010). A number of empirical studies on the perception of emotions through facial expressions have found that the average accuracy of recognition is around 60% (Ekman, O'Sullivan, Frank, 1999; Howell, Jorgenson, 1970; Kostić, 2010; Kostić, 2014). Kostić's study (2010) confirmed the reliability of facial expressions as a source of emotional

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information. The results showed that participants successfully recognized all six emotions included in the experiments (happiness, sadness, anger, fear, disgust, surprise). The highest recognition accuracy was observed for happiness, while the lowest was for sadness. Existing data allow us to conclude that facial expressions are a reliable source of information about experienced emotions.

Studying the concept of profession, its key characteristics, and the distinction between helping and non-helping professions is a complex research question. Helping professions are defined as professions aimed at assisting people in solving their life problems. A common feature of all helping professions is personal contact between a client in need and a professional (Ajduković, Ajduković, 1996). Helping professions are those in which a person chooses to act professionally or voluntarily in situations where ordinary forms of mutual aid are insufficient, and additional help and support are required. In contrast, non-helping professions are focused on working with objects and involve a lower degree of interpersonal interaction.

Some authors (Ekman, O'Sullivan, 1991; Ekman, O'Sullivan, Frank, 1999) conducted studies to determine whether the accuracy of emotion recognition through facial expressions depends on one's profession. Participants included members of U.S. intelligence agencies, police officers, judges, psychiatrists, professionals investigating fraud, and psychology students. The data showed that only intelligence agents were able to distinguish between genuine and fake emotional expressions successfully. These results are explained by their professional experience, which involves contact with people from various professions, and the specific training intelligence agents undergo. Similar studies were conducted involving federal of-

ficials, sheriffs, judges, legislators, clinical psychologists who focus on clients involved in deception, clinical psychologists without a focus, and academic psychologists. The results showed that sheriffs were the most successful in recognizing signs of deception, which was also attributed to their professional experience. A study conducted in Serbia (Barjaktarević, 2013) investigated the difference in emotion recognition accuracy between police officers, who are in direct contact with people, and engineers, whose work is more object-focused. The results showed that police officers generally recognized primary emotions in micro facial expressions more accurately (AS = 9,13) than engineers (AS = 5,31). These results are explained by differences in the nature of their work. Police officers are frequently in direct contact with people, are expected to detect deception, and are trained accordingly. In contrast, engineers rarely engage with people; their work is centered on objects, which may explain their difficulties in recognizing emotions through facial expressions. Studies on emotion recognition abilities were also conducted on a sample of 49 police officers in Russia (Padun, Sorokko, Suchkova, Lyusin, 2021), as emotion recognition is considered a vital component of their profession. For example, the ability to recognize anger and aggressive intent on others' faces in a timely manner is crucial for quick reactions in life-threatening situations involving police officers.

Studies on the accuracy of emotion recognition show that the emotion of happiness is recognized with the highest accuracy on the human face (Burgess, Lien, 2022), which is also confirmed when emotions are presented on simplified versions of human faces, such as drawings or emoticons (Kostić, Todić Jakšić, Tošković, 2020). As for professional actors, it is assumed that they express and

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recognize emotions better than most people because they are trained to portray them convincingly to an audience during their studies. For this reason, researchers conducted a study in which standardized facial expressions were shown to both regular respondents and professional actors who follow the mimetic method and the Stanislavski system. The mimetic method is based on the voluntary movement of facial parts to express emotions. The Stanislavski system relies on reading emotional text, allowing the actor to immerse themselves in a specific emotional context. The results of the study showed a clear trend: professionals using the mimetic method recognized emotions more accurately than regular respondents or respondents using the Stanislavski system. The results of another study support the nativist concept. In this study, 54 psychology students and 54 psychology graduate students with therapeutic work experience participated in identifying facial expressions of emotions and the intensity of those emotions. A standardized database of Caucasian and Japanese faces was used (Matsumoto, Ekman, 1988). The results showed no significant difference in emotion recognition accuracy between the two groups of respondents. However, respondents perceived Japanese faces as more emotional. Additionally, there was a clear tendency for respondents to rate emotions expressed on female faces as more intense than the same emotions expressed on male faces (Hutchison, Gerstein, 2012).

Although numerous studies confirm the superiority of helping professions in accurately recognizing emotions, there are also studies in which experienced professionals demonstrate lower recognition accuracy than non-specialists. One such example is a study (Balda et al., 2000), in which the percentage of correct recognition of pain

expressions on infants' faces was lower among medical professionals compared to a non-medical group composed of parents. This raises the question: does the accuracy of recognizing basic emotional expressions depend on innate predispositions, or does experience play a decisive role? Recent research (Gori, Schiatti, Amadeo, 2021), conducted during the global COVID-19 pandemic, confirms the importance of social context in emotion recognition. These findings show a decrease in the accuracy of emotion recognition among respondents aged 3 to 30 when they are unable to see the full face of the interlocutor. The wearing of medical masks led to a general decline in the ability of respondents to recognize others' emotions based on facial expressions. This effect was especially pronounced among children aged three to five, for whom the decrease in emotion recognition accuracy was most noticeable when comparing masked and unmasked faces. These results emphasize that while there may be innate tendencies in recognizing emotions, the social context also plays a crucial role. A study conducted in Serbia (Pejičić, 2020), which considered variables such as age and level of education, showed that healthcare workers were more successful at recognizing primary emotions through facial expressions than electrical engineers, technologists, and production workers. These findings are explained by the fact that healthcare workers frequently face the need to recognize emotions in the course of constant interaction with patients, whereas engineers, who work with objects, are rarely required to assess the emotions of those around them.

Recent studies (Dietl, Meurs, Blickle, 2016) have primarily focused on identifying the link between emotions and career. The

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findings confirm that the ability to recognize emotions correlates with several professional indicators and achievements, such as job performance (Elfenbein, Ambady, 2002), successful negotiations (Elfenbein et al., 2007), effective leadership (Rubin, Munz, Bommer, 2005), and income (Mom, Fourné, Jansen, 2015). However, the general conclusion of these studies is that such correlations may be influenced by intelligence (Kranefeld, Blickle, 2020; Kranefeld, Nill, Blickle, 2021; MacCann et al., 2020) and personality traits (Joseph, Newman, 2010).

Facial expressions of emotions belong to a group of rapid facial signals that occur due to the contraction of facial muscles (Elfenbein, Ambady, 2002; Ekman, Friesen, 1975; Kostić, 2010; Kostić, 2014). The universality of these expressions is supported by findings from studies involving individuals with sensory deprivation, newborns, identical twins, monkeys, as well as a number of cross-cultural studies (Kostić, 2010; Kostić, 2014). We noticed that there had been no assessment of the accuracy of facial emotion recognition between university students studying for helping professions and those preparing for non-helping professions. Based on this, the medical profession (Faculty of Medicine — FM), whose representatives are in constant contact with people and must quickly and accurately recognize patients' emotions, was selected as a helping profession. The engineering profession (Faculty of Technical Sciences — FTS) was selected as a non-helping profession, in which everyday work does not require direct human interaction and is focused on working with objects. Given these factors, we considered it necessary and justified to conduct a study aimed at assessing the ability to recognize emotions depending on the type of professional activity. Our initial hypothesis was that

students studying in fields related to helping professions would more successfully recognize emotions based on facial expressions compared to students pursuing non-helping professions.

Since the time of Charles Darwin's work, it has been known that there is a universal expression of basic facial emotions—that is, their recognition is not dependent on cultural characteristics. Therefore, our study focused only on primary emotions, and the goal was to determine whether there are differences in the accuracy of recognizing basic (universal) facial emotional expressions, independent of cultural factors, between students who chose helping professions and those pursuing non-helping professions.

Materials and Methods

The dependent variable was the accuracy of recognizing facial expressions of seven emotions: anger, contempt, disgust, fear, happiness, sadness, and surprise. The independent variable was the type of profession, a categorical variable with two levels — helping profession (Faculty of Medicine — FM) and non-helping profession (Faculty of Technical Sciences — FTS).

The sample was representative and consisted of students from the University of Priština temporarily located in Kosovska Mitrovica. In the total sample (145 students of both sexes), 51% of respondents were oriented toward working with people (helping profession — FM), while 49% were oriented toward working with objects (non-helping profession — FTS). The age of the respondents ranged from 19 to 36 years (mean age = 22,88 ± 2,43 years).

Analyzing the conflicting results of previous research, we proposed a more systematic stimulus control, i.e., selection of standardized facial expressions of emotions,

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as well as a more homogeneous sample in terms of education and experience. The stimulus material consisted of the Japanese and Caucasian Facial Expressions of Emotion (JACFEE) set (Matsumoto, Ekman, 1988), which includes 56 photographs — eight images for each of the seven emotions: disgust, surprise, anger, happiness, fear, sadness, and contempt (see figure). For each emotion, four photographs featured coders of Asian descent, and the other four featured coders of Caucasian descent (two men and two women in each group). All photographs were coded by Ekman and Friesen (Ekman, Friesen, 1975) using the Facial Action Coding System (FACS), ensuring the validity of the expressions.

The experiment was conducted using the OpenSesame program. The stimuli were presented to the respondents in random order, with the randomization of stimuli automatically handled by the software. The direction of the respondents' gaze was controlled by displaying a fixation cross in the center of the screen for 100 ms. Respondents were positioned 50 cm from the screen (12.3-inch diagonal, 2736 x 1824 ppi resolution, 120 Hz refresh rate). The stimuli were displayed on the computer screen for an exposure time of 10 seconds. The stimuli were centered on the screen, with a size of 904 x 642 pixels. Respondents were asked to indicate on a sheet of paper which of the seven proposed emotions corresponded to each face. The accuracy of emotion recognition was assessed by calculating the mean value of the participants' responses.

Results

The hypothesis that students from the helping professions faculty (FM) would be more successful in recognizing emotions compared to students from the non-helping professions faculty (FTS) was tested. Using the t-test, it was found that respondents oriented toward working with people (FM) demonstrated greater accuracy in recognizing facial expressions of emotions compared to respondents oriented toward working with objects (FTS). Specifically, FM students recognized the emotions of anger, contempt, disgust, fear, and surprise significantly more accurately, while FTS students were more successful in recognizing the emotion of happiness (see table). No differences were observed between the two groups in the accuracy of recognizing the emotion of sadness (see Table 1).

Fig. Depiction of expressions of emotions: disgust, surprise, anger, happiness, fear, sadness, contempt (Matsumoto, Ekman, 1988)

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Table

Differences in the recognition accuracy of facial expressions of emotions between respondents from the Faculty of Medicine (FM) and the Faculty of Technical Sciences (FTS)

Emotions	Occupation	M (SD)	t (df = 143)	p
Anger	FM	6,16 (2,25)	7,34	<0,0001
	FTS	3,52 (2,08)		
Contempt	FM	5,12 (3,38)	5,01	<0,0001
	FTS	2,48 (2,95)		
Disgust	FM	7,54 (1,78)	7,71	<0,0001
	FTS	4,77 (2,49)		
Fear	FM	6,04 (2,92)	2,58	0,011
	FTS	4,92 (2,28)		
Surprise	FM	7,61 (1,8)	3,46	0,001
	FTS	6,46 (2,17)		
Happiness	FM	6,38 (3,13)	-2,02	0,045
	FTS	7,20 (1,39)		
Sadness	FM	6,40 (2,93)	0,03	0,979
	FTS	6,39 (2,06)		

Discussion

As noted by Bryan (2015), one of the key characteristics of helping professions is a high capacity for both verbal and non-verbal communication. He adds that qualities such as active listening, compassion, openness, and honesty are closely linked to empathy, self-awareness, self-respect, patience, and self-discipline. These skills are expected to contribute to more accurate recognition of emotions in others. According to research by Reynolds and Scott (2000), empathy and the ability to perceive and understand the feelings of others are fundamental to quality relationships in the helping professions. Since work in these fields often involves addressing behavioral problems, emotional disorders, and interpersonal conflicts, the role of these professionals centers on active listening and providing support to users in achieving better psychosocial functioning and quality of life (Ćiak, 2014). Moreover, the results of our study may be explained by the fact that medical students participate in numerous educational programs that focus on developing non-verbal communication skills, such as body language, facial expressions, and gestures. These programs become particularly important in the context of increasing population migration and the emergence of language and cultural barriers in multicultural and multilingual environments. In such conditions, non-verbal signals can become a crucial tool for overcoming communication gaps and improving mutual understanding between medical professionals and patients (Khoshgoftar, Zohreh, et al., 2024). An additional explanation for the obtained results may lie in the fact that medical students regularly interact with sick individuals and often work in stressful environments. Empirical studies confirm that the emotional state of the observer increases the accuracy of recognizing congruent emotions on the faces of stimuli (Lyusin, Kozhukhova, Suchkova, 2019; Nikitina, 2021).

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However, an unexpected finding was that students from the Faculty of Technical Sciences (FTS), who are oriented toward working with objects, were more successful in recognizing the emotion of happiness compared to students from the Faculty of Medicine (FM), who are oriented toward working with people. This finding is particularly noteworthy considering that happiness and sadness are traditionally regarded as opposite poles within the basic dichotomy of primary emotions. Upon a more detailed analysis of the data, we found that respondents from both groups were equally successful in recognizing the emotion of sadness. However, when it came to recognizing happiness, FTS students, albeit slightly, statistically significantly outperformed FM students. This may indicate that the lack of live interpersonal interaction limits the development of social skills and the ability to accurately recognize emotions. One possible explanation for the observed differences in recognizing happiness could be the frequency of emoticon use in communication. Emoticons have become an integral part of digital communication and are widely used to express emotions and clarify the meaning of text messages. Previous research has shown that emoticons are more frequently used to convey positive emotions (Zuhdi, Ahmad, et al., 2024). Our data also support this trend, which may explain the FTS students' higher ability to recognize happiness. Supporting our findings, previous studies have shown that police officers are worse at recognizing the emotions of anger, sadness, and fear than they are at recognizing happiness. Thus, working with facts rather than with people may reduce the accuracy of recognizing negative emotions (Padun, Sorokko, Suchkova, Lyusin, 2021). At the same time, frequent interaction with patients during medical training has made medical students more successful

in recognizing negative emotions. In contrast, the absence of a need for detailed analysis of facial expressions in object-focused professions such as engineering may have allowed FTS students to better recognize happiness. Therefore, this study opens up prospects for further research, in which, in addition to analyzing response accuracy, researchers could measure response time. This would allow for the collection of additional data that could significantly deepen our understanding of differences in the perception of basic emotions.

The results obtained suggest the need to develop the ability to recognize emotions through facial expressions, especially among individuals who do not have the opportunity for direct contact with clients in their profession. Thus, individuals who choose helping professions demonstrate a higher level of recognition of basic emotions through facial expressions compared to those who choose non-helping professions. This can be achieved through a range of programs aimed at developing emotional abilities and skills, which include: 1. the ability to quickly notice, assess, and express emotions; 2. the capacity to swiftly perceive and generate feelings that facilitate cognitive processes; 3. the ability to understand emotions and possess knowledge about them; 4. the ability to regulate emotions in order to promote emotional and intellectual growth. Many authors have noted the positive effects of cognitive-behavioral therapy (CBT) on emotional regulation through the use of cognitive restructuring techniques (Gilboa-Schechtman, Azoulay, 2022).

Conclusion

Facial expressions of emotions represent complex behavioral responses that require a high level of attention and accuracy for correct interpretation (Ekman, 2011). The results of conducted studies show that fa-

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cial expressions of basic emotions can be interpreted with a high degree of accuracy regardless of race, gender, age, and cultural background.

A study conducted on a student sample in Serbia (Pejičić, 2020) confirms findings obtained in other countries, indicating the stability of the ability to recognize emotions through facial expressions depending on one's profession. Our results show that students from medical and technical faculties are almost equally successful in recognizing only two basic emotions—sadness and happiness.

However, emotions such as anger, contempt, disgust, fear, and surprise are recognized significantly more accurately by medical faculty students than by their counterparts from the Faculty of Technical Sciences.

Limitations. A limitation of this study is the sample size. In future studies, it is recommended to expand the sample to include students from other helping professions (psychologists, teachers, social workers) and students from other non-helping professions (architects, economists).

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Tijana Todić Jakšić — ideas; annotation, writing and design of the manuscript; planning of the research; control over the research.

Miljana Pavićević — application of statistical data analysis; conducting the experiment; data collection and analysis; visualization of research results.

All authors participated in the discussion of the results and approved the final text of the manuscript.

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The authors declare no conflict of interest.

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Научная статья | Original paper

The effect of extended smartphone screen time on continuous partial attention

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Abstract

Context and relevance. Smartphones have become crucial components of the digital world, including educational interactions. **Objective.** This study examined the effect of prolonged smartphone screen time on continuous partial attention in 103 graduate students by directly measuring their smartphone screen time. **Methods and materials.** This study was designed as an explanatory mixed-methods research. Statistical comparisons of direct measurements of smartphone screen time were followed by a focus group interview to explain the quantitative findings. **Results.** A moderate positive correlation was observed between smartphone screen time and continuous partial attention. However, no significant differences in the average daily smartphone screen time and continuous partial attention were observed across age, gender, and education groups. Similarly, the linear regression results show that daily average smartphone screen time is a significant positive predictor of continuous partial attention, although this effect does not vary significantly by gender, age, or education level. Photo sharing and messaging app were the most commonly used smartphone applications, whereas streaming platform had the highest weekly screen time. Students with the highest total weekly screen time on short video platform had higher continuous partial attention scores. Students attributed this finding to hypnotic algorithms, distracting redundancy, marketing and advertising, passive receiver mode, short video flow, and surprising content. **Conclusions.** After establishing the link between smartphone screen time and continuous partial attention, this study underscores the need for educational interventions and digital literacy programs to mitigate the effects of fragmented attention in academic settings, potentially enhancing learning outcomes and students' well-being.

Keywords: well-being, learning, self-determination theory, motivation, students

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Эффект длительного времени, проведенного за экраном смартфона, на непрерывное распределенное внимание

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Резюме

Контекст и актуальность. Смартфоны играют ключевую роль в цифровом пространстве, включая сферу образования, предоставляя доступ к онлайн-ресурсам и образовательным онлайн-платформам, однако длительное использование смартфонов может негативно влиять на внимание и концентрацию студентов. **Цель.** В данном исследовании был изучен эффект длительного времени, проведенного за экраном смартфона, на непрерывное распределенное внимание у 103 студентов магистратуры путем прямого измерения времени, которое они провели за экраном смартфона. **Методы и материалы.** Исследование было разработано как объяснительное смешанное. Статистические сравнения прямых измерений времени, проведенного за экраном смартфона, были дополнены интервью в фокус-группе для объяснения количественных результатов. **Результаты.** Была обнаружена умеренная положительная корреляция между временем, проведенным за экраном смартфона, и непрерывным распределенным вниманием. Однако значительных различий в среднем ежедневном времени, которое испытуемые проводили за экраном смартфона, и непрерывном распределенном внимании не было выявлено среди различных возрастных, половых и образовательных групп. Аналогично, результаты линейной регрессии показывают, что среднее ежедневное время, проведенное за экраном смартфона, является значимым положительным предиктором непрерывного распределенного внимания, однако этот эффект значительно не варьируется в зависимости от пола, возраста или уровня образования. Социальная сеть Photo Sharing[1] и мессенджер Messaging App были наиболее часто используемыми приложениями на смартфонах, в то время как популярный видеосервис Streaming Platform имел наибольшее время просмотра за неделю. Студенты с самым высоким общим временем использования Short Video Platform (сервис для создания и просмотра коротких видео) за неделю имели более высокие показатели непрерывного распределенного внимания. Сами студенты объяснили это гипотетическими алгоритмами, отвлекающей избыточностью содержания сервиса, маркетингом и рекламой, режимом пассивного восприятия, потоком коротких видео и неожиданным контентом. **Выводы.** После установления связи между временем, проведенным за экраном смартфона, и непрерывным распределенным вниманием можно подчеркнуть необходимость в проведении образовательных мероприятий и программ цифровой грамотности для смягчения последствий фрагментации внимания в учебной среде. Это, в свою очередь, может способствовать улучшению результатов обучения и повышению благополучия студентов.

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[1] Photo Sharing принадлежит компании Meta, признанной экстремистской и запрещенной на территории РФ.

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Introduction

Smartphones have become crucial com-
ponents of the digital landscape. They are the
most commonly used tools in nearly all aspects
of life, from TV to social media and banking to
shopping. The increase in smartphone use has
prompted researchers to investigate its impact
on attention, the cognitive skill most affected by
the acceleration of information flow caused by
information technologies [8; 4; 2].

Continuous partial attention (CPA) describes
the phenomenon in which individuals constantly
monitor several information sources simultane-
ously, often without fully focusing on any one
source. The CPA involves paying minimal si-
multaneous attention to many sources of infor-
mation. This behavior, fueled by technological
advancements, grants access to a vast array of
information. For example, we can check tweets
on our smartphones while watching TV and
checking emails on our personal computers.
Unlike multitasking, CPA may result in poor and
inefficient task performance [21]. While the digi-
tal world offers unlimited information, it is also a
constant source of distraction [25].

The habit of using smartphones and other
devices simultaneously is rapidly rising and
becoming the norm [15]. Approximately 89
percent of interactions with smartphones are
initiated by the user rather than by a notification
[16]. This suggests that the annoyance caused
by smartphones is not caused by the devices
themselves, but rather by the learned behavior
of the users. This, combined with the increasing

amount of screen time in the digital world, is a
major source of attention problems among stu-
dents. To determine how students are affected
by prolonged smartphone use, it is important
to establish a relationship between CPA and
smartphone screen time.

Related Literature

A growing body of research has examined
the effects of prolonged smartphone screen
time (PSST) on attention, showing that it can
negatively affect attention, leading to decreased
concentration and difficulty focusing on tasks.
Related studies have addressed the increasing
prevalence of problematic smartphone use and
its effects on human health, cognition, and psy-
chology [22].

One literature stream suggests minimal ef-
fects of smartphone use on attention [30] and
assumes that PSST will not have long-term con-
sequences [4]. Meanwhile, the other literature
stream argues that PSST exerts negative cogni-
tive and psychological effects on employees. J.
Aru and Rozgonjuk showed that PSST can cause
an inability to exert prolonged mental effort, which
can impair real-world creativity and information
gain [2]. S.M. F ckel found a significant, weak,
positive relationship between smartphone screen
time and depression symptoms among young
adults, regardless of self-control [12].

Studies from both streams of literature have
presented contextual approaches. A. Sela,
N. Rozenboim, and H.C. Ben-Gal identified two
contradictory modes of smartphone use: the un-

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aware mode, in which a smartphone is used in conjunction with other activities, and the aware mode, in which a smartphone represents an active lifestyle [28]. They found that PSST in the unaware mode exerted a negative effect on quality of life. Similarly, A.B. Fortes, P.L. Broilo, and C.S.M.D. Lisboa investigated the relationship between smartphone use and psychological well-being [10]. Their results showed that smartphone use was negatively associated with psychological well-being, but this relationship was weakened by cognitive reappraisal strategies and communication-related smartphone use. Their findings suggest varying implications for smartphone use according to the type of use and emotion regulation strategies employed.

Research has also explored smartphone screen time in different groups. Osailan found that the daily average smartphone screen time (DASST) among participants aged 18–30 years was 7,8 ± 2,2 hours [23]. In S.M. Föckel [12] reported that participants aged 18–29 years had a DASST of 4.7 hours.

PSST has been linked to negative effects on split attention, the ability to simultaneously attend to multiple tasks or information sources [8; 4; 2]. DeWeese reported that PSST is associated with increased multitasking, which can lead to decreased task performance and increased cognitive load [8]. L. Cecutti, A. Chemero, and S.W. Lee found that PSST is linked to an increase in the time required to switch between tasks, which impairs the ability to effectively manage multiple information sources [4]. PSST has also been associated with a decreased ability to filter irrelevant information, which is essential for effective split attention [2]. This drawback may be due to the constant interruptions and distractions provided by smartphones, which can hinder individuals' ability to focus on a single task and filter irrelevant information.

The literature also shows that PSST affects the task performance. C. Stothart, A. Mitchum, and C. Yehnert noted that smartphone interactions lead to poor performance in concurrent tasks [29]. Baumeister and Tierney underline that students with PSST lose motivation to complete cognitively challenging activities as limited at-

tentional resources and capacity must be shared between tasks [3]. This partial attention is insufficient for completing concurrent tasks such as driving. Based on the existing literature, we formulated the main hypothesis of this research as

• H1: PSST is a significant predictor of CPA.

Individuals who engage in continuous partial attention (CPA) tend to have lower levels of cognitive control because they constantly switch between tasks and stimuli. This condition can lead to reduced productivity and an inability to focus on any task for an extended period. CPA can negatively affect attention, as individuals may not fully engage with others when they constantly monitor their devices for new information.

The top apps downloaded globally in Q3 2022 were Photo Sharing, Short Video Platform, Facebook, Messaging App, Snapchat, and Telegram [19]. The negative effects of mobile applications have been examined in the literature. For example, Short Video Platform usage has been studied to determine its influence on attention deficit hyperactivity disorder [31]. Pan et al. examined the active versus passive use of Short Video Platform and its association with female users' self-esteem pertaining to appearance and weight [24]. They found that active use had positive effects, whereas passive use had negative effects. Therefore, it is important to investigate the relationship between smartphone applications and CPA.

Although the existing literature has investigated the effects of prolonged smartphone screen time (PSST) on attention, it has not focused on the effects of CPA, which could be the most likely outcome of PSST. Determining the predictive relationship between PSST and CPA can contribute to the literature on problematic smartphone use.

Current Investigation

This study investigated the impact of PSST on CPA. We compared students' CPA and DASST scores according to age, sex, and education. We then investigated the relationship between smartphone applications and CPA. We formulated two research questions in addition to the main research hypothesis.

1. RQ1: How do CPA and DASST scores vary according to students' age, sex, and education?

2. RQ2: What is the relationship between smartphone applications and CPA?

Methods

Quantitative data were collected and analyzed. We then realized that the quantitative findings needed more in-depth explanation, and the most appropriate method for this was an in-depth inquiry through focus group interviews. Therefore, we collected qualitative data through focus group interviews. Accordingly, this study adopted an explanatory mixed-methods design. The mixed methods research design is suitable for studies in which the findings obtained from the quantitative data collected in the first stage are explained using qualitative data [5]. The conceptual model is illustrated in fig. 1.

To the best of our knowledge, this is the first study to suggest that smartphone screen time may be associated with CPA.

Data Collection

Quantitative data were collected using questionnaires with three sections. The first section gathered demographic information, including the participants' age, sex, and education level. The second section included a single 10-point Likert-type question aimed at assessing continuous partial attention (CPA): 'While I am constantly tracking and engaging with technology, I cannot fully pay attention to what I am actually doing.' Single-item measures, as used here, have been demonstrated to be effective in attention-related constructs [26], particularly when the construct is clear and confined, as is the case with the CPA. This section aimed to measure continuous partial attention (CPA). Single-item measures have been effectively used in various fields [7], such as finance [18], clinical psychology [20], social and personality psychology [1], and occupational psychology [9]. Single-item measures "perform acceptably considering dependability" for simple constructs, although they are not suitable for complex constructs [26]. A single item may be adequate if the construct being assessed, such as future behaviors, is sufficiently confined or clear to respondents [11].

We applied a test–retest method to determine the reliability of the single CPA scale. The Cronbach's alpha for test–retest reliability was 0,899, indicating high reliability [13]. These criteria suggest that correlation and regression analyses can be safely applied to CPA scores.
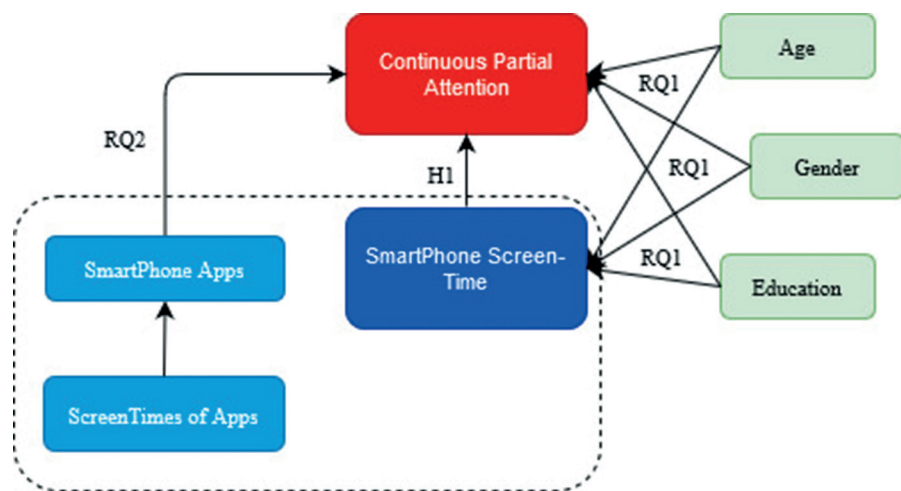
Fig. 1. Research Conceptual Model

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The final section of the questionnaire collected information on the participants' DASST and the apps with the highest weekly screen times. Two questions were asked to measure the participants' screen time, and directions explaining how to access weekly reports on their smartphones were provided. Research using direct screen time data is increasingly common because of the potential for bias and unreliability of self-reported data [14].

Data were collected from eight students through a focus group interview to explain the findings of the quantitative analysis for Research Question 2 (RQ2). The interview was conducted during the second session of a PhD mixed methods research course. The quantitative phase findings were summarized at the beginning of the interviews. A focus group interview was conducted to explain the Short Video Platform findings related to RQ2. The interview lasted for 8 min and 35 s.

Participants

Graduate students were selected as research participants for two reasons. First, we aimed to minimize unaware smartphone use, as identified by A. Sela, N. Rozenboim, and H.C. Ben-Gal [28], and factors such as age range and occupational differences. Second, we aimed to collect accurate smartphone screen time data and the most frequently used applications. Master's and doctoral students are among those who are most open to sharing data for scientific research purposes.

In this study, we followed the Committee on Publication Ethics (COPE). This study and its protocols were approved by the Scientific Research and Publication Ethics Committee of Anadolu University, Turkey. The questionnaire was shared with 120 master's and doctoral students at Anadolu University. A total of 103 students completed the questionnaire. The participants were informed about their voluntary participation via a corresponding form, and they were able to complete the questionnaire without being recorded. Their demographic characteristics were also obtained as shown in Table 1.

Critical case sampling, a purposive sampling technique, was used to identify participants for the qualitative research phase. The focus group interview participants were eight participants with the highest Short Video Platform screen times.

Data Analysis

A Student's t-test was performed to examine the effects of sex and education on the DASST and CPA. ANOVA was used to examine the effects of different age groups on the DASST and CPA. A General Linear Model (GLM) was applied to further investigate the effect of DASST on CPA while controlling for sex, age, and education. These methods were chosen for their robustness in analyzing differences across multiple groups and multiple factors. Descriptive statistics were used to investigate the relationship between smartphone apps and CPA (RQ2). Correlation and regression analyses were performed to test the main hypothesis of this study. Pearson's correlation analysis was used to determine the relationship between the DASST and CPA. Linear regression analysis was conducted to investigate the predictive value of the PSST on students' CPA.

Table 1

Demographic Frequencies

Demographics	Groups	Frequencies (f)	Percentage (%)
Sex	Female	52	51,5
	Male	49	48,5
Education	Master's	58	57,4
	Doctoral	43	42,6
Age	< 30 years	28	27,7
	30–45 years	63	62,4
	> 45 years	10	9,9

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The raw voice recording data obtained from the focus group interview were first transcribed into text. The codes were then generated from the text. Finally, the codes were combined and transformed into themes that were then reviewed. Inductive content analysis was performed using NVivo 12, a qualitative data analysis software, to create the themes.

Results

The DASST of the 103 students was 255 ± 124 minutes, which is within the range of 7,8 ± 2,2 hours reported by A. Osailan [23], but is higher than the average of 4,72 hours reported by S.M. Föckel [12]. The mean CPA score of the students was 5,77 ± 2,47 (on a 10-point Likert scale), indicating moderate levels of continuous partial attention. According to the students, Photo Sharing was the most frequently used smartphone application. This finding is consistent with the Q3 2022 data of Data. ai [19]. The details of the findings from the analyses are presented under the subtitles for the two research questions and the main hypothesis.

RQ1: Demographic Comparisons

No significant differences were observed in CPA or DASST scores across demographic groups (p > 0,05 for all comparisons).

No significant differences were found in the average CPA and DASST scores when analyzed with respect to demographic variables. Students aged above 45 years had the lowest mean CPA and DASST scores. Meanwhile, male students aged under 30 years showed insignificant improvements in overall scores. A GLM was applied to further investigate the effects of DASST on CPA while controlling for students' sex, age, and education. Accordingly, we summarized the statistics for the GLM of CPA in Table 3.

Table 2

Effects of Sex, Age, and Education on DASST and CPA

Demographics	Groups	N	CPA[a] (X)	p	DASST[b] (X)	p
Sex	Female	52	6,13	0,113	261	0,997
	Male	49	5,39		249	
Education	Master's	58	5,67	0,633	268	0,235
	Doctoral	43	5,91		238	
Age	< 30 years	28	5,89	0,121	271	0,101
	30–45 years	63	5,97		259	
	> 45 years	10	4,20		187	

Note: [a] Continuous partial attention; [b] daily average smartphone screen time,

Table 3

Analysis of the Effects of DASST on CPA by General Linear Model

Demographics	Groups	N	CPA[a] (Means)	*p*	η²
Sex	Female	52	6,13	0,205	0,015
	Male	49	5,39		
Education	Master	58	5,67	0,442	0,006
	Doctoral	43	5,91		
Age	< 30 years	28	5,89	0,208	0,03
	30–45 years	63	5,97		
	> 45 years	10	4,20		
Overall Model	$R^2 = 0,1723$, Adj, $R^2 = 0,0595$, F = 1,527, *p* = 0,13 (95% CI), η² = 0,172				

Note: [a] Continuous partial attention,

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We applied a GLM and conducted ANOVA omnibus tests to adjust for age, sex, and level of education. However, the average CPA scores by sex, education, and the three age groups failed to show significant differences. The eta-squared values (η^2) were calculated to show effect sizes. The effect size metric, eta-squared, is frequently used in ANOVA. In an ANOVA model, the effect size is used to calculate the percentage of variation accounted for by each main and interaction effect. The effect sizes revealed small demographic effects on the relationship between CPA and DASST.

RQ2: Smartphone Apps and CPA

The participants identified the smartphone apps with the highest average weekly screen time, as shown in Fig. 2. The two smartphone apps that students most frequently cited as having the highest weekly screen times were Photo Sharing (23), Messaging App (17), Video Sharing (9), Microblogging and Internet Web Browsers (5), Short Video Platform and Streaming Platform (2), and others (1).

Streaming Platform had the highest screen time with an average of 924 min, which is natural as it is a video streaming app; however, the instant chat application Messaging App also had a high average weekly screen time of 326 min.
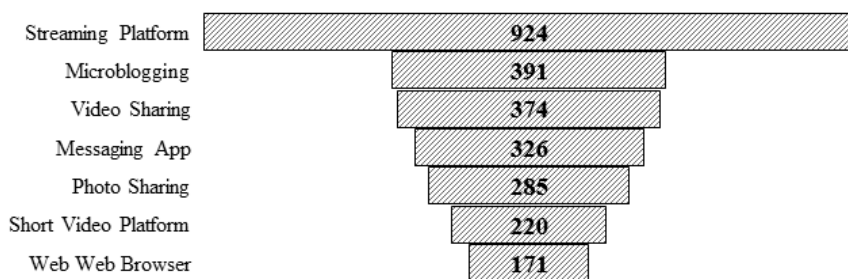
Fig. 2. Average weekly screen time of smartphone apps (in minutes)

Streaming Platform — 924
Microblogging — 391
Video Sharing — 374
Messaging App — 326
Photo Sharing — 285
Short Video Platform — 220
Web Web Browser — 171
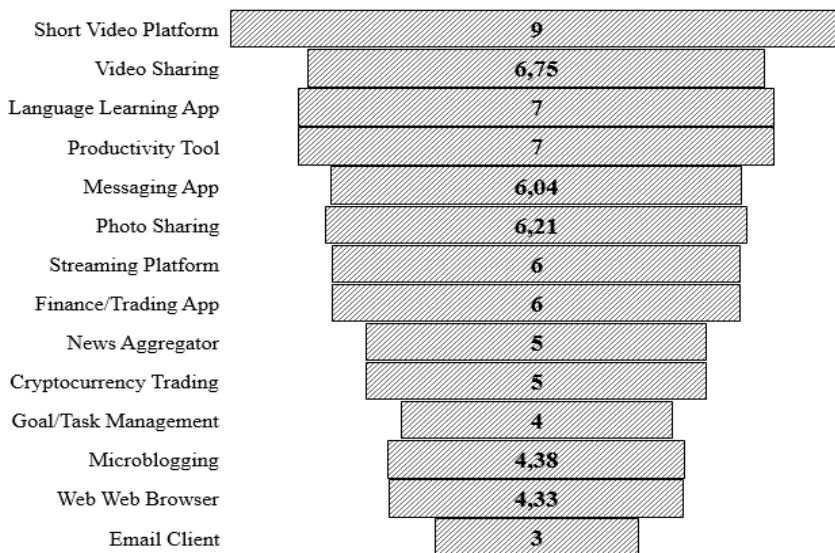
Fig. 3. Average CPA Scores of Smartphone Apps

Short Video Platform — 9
Video Sharing — 6,75
Language Learning App — 7
Productivity Tool — 7
Messaging App — 6,04
Photo Sharing — 6,21
Streaming Platform — 6
Finance/Trading App — 6
News Aggregator — 5
Cryptocurrency Trading — 5
Goal/Task Management — 4
Microblogging — 4,38
Web Web Browser — 4,33
Email Client — 3

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Fig. 3 shows the CPA averages of the apps with the highest weekly average screen time. Short Video Platform had the highest CPA score, which supports the results of Yeung and Abi-Jaoude [31], who found that Short Video Platform causes attention problems among adolescents. The mean CPA scores of the other apps were close to or below average. Future research should investigate the CPA effects of apps using more participants.

Qualitative Findings

A focus group interview was conducted to explain Short Video Platform's impact on CPA. Eight students with the highest Short Video Platform screen times (coded as P1, P2, and so on) were selected for the focus group interview. At the beginning of the interview, the definition of CPA and the findings on the impact of Short Video Platform on CPA were shared with participants. The interview consisted of a single open-ended question ("Based on your experience, why do individuals who spend a long time on Short Video Platform have higher CPA averages than others?"). The following six themes, as shown in Fig. 4, were identified in the content analysis: hypnotic algorithm, distracting redundancy, marketing advertisement, passive receiver mode, short video flow, and surprise content factor. These themes were categorized into content- and system-related themes, respectively.

The students emphasized that Short Video Platform content is distractingly unrelated, lacks integrity, and marketing and advertising elements are distractingly abundant in the content. Both themes were related to the content. The students also stated that Short Video Platform users are passive receivers, the app has no user control other than scrolling, flow is provided by short videos, and a state of self-hypnosis emerges as the app maintains users' attention with surprising content. Two interviewees stated the following:

"...so there is an algorithm behind it. Yeah, it's taking the videos that we spend the most time on, and it's going through content types that are close to that..." (P2)

"I feel like it's out of my control... my control over the whole system is just scrolling." (P5)

These findings support A. Sela, N. Rozenboim, and H.C. Ben-Gal [28] and Pan et al. [24], who reported that prolonged smartphone use in the unaware (passive) mode has a negative effect on quality of life. These findings are also aligned with the related literature highlighting the hypnotic effects of Short Video Platform-like mobile interactions.

H1: PSST predicts CPA

The central hypothesis of this study is that the PSST predicts CPA. To test this hypothesis, we first determined whether the dependent vari-
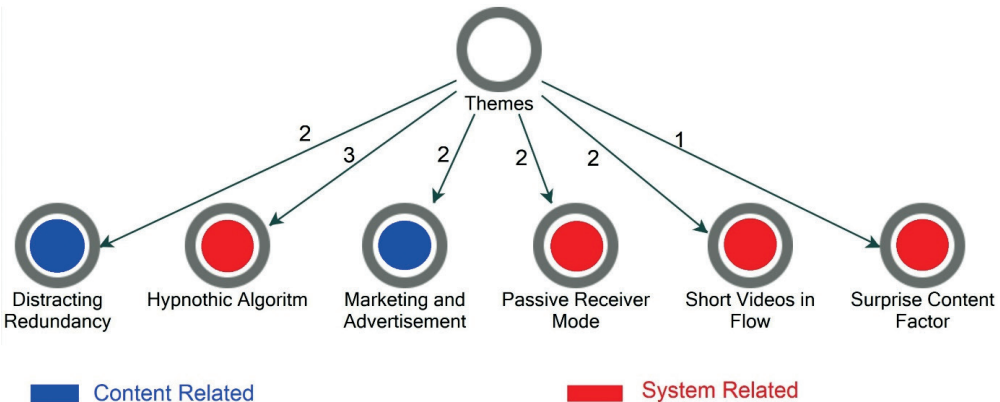
Fig. 4. Themes of Focus Group Interview

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able, CPA scores, was normally distributed using the Shapiro–Wilk test (W = 0,982, *p* = 0,18 > 0,05). We then examined the correlation between smartphone screen time and CPA using Pearson's correlation analysis. In the correlation analysis, we found a positive, moderate relationship between smartphone screen time and CPA (Pearson's *r* = 0,251, *p* = 0,011 < 0,05). We subsequently tested the predictive effect of smartphone screen time on CPA using linear regression analysis. The regression analysis showed that the DASST positively and significantly predicted students' CPA ($F_{(1,99)}$ = 6,64, *p* = 0,011 < 0,05, R^2 = 0,0628, adjusted R^2 = 0,0533). This finding supports the related literature [8; 4; 2], suggesting that excessive smartphone use can lead to a decrease in split attention abilities and a lower level of cognitive control as users are constantly switching between tasks and stimuli. We drew scatterplots to visualize the predictive structure across the age and sex groups, as shown in Fig. 5.

A regression line was used as the fitted line in the scatterplots. Graph analysis revealed that the regression line for students aged 30–45 years was consistent with the average regression line. The same was true for females under the age of 30 years. However, the CPA scores of male students aged under 30 years changed inversely with screen time. This difference among younger students can be investigated in future studies; as only a few participants were aged over 45 years, a comparison could not be made.

Conclusions

This study makes an original contribution by establishing a predictive relationship between prolonged smartphone screen time and continuous partial attention. To the best of our knowledge, this is the first study to explicitly explore this relationship among graduate students using real-time screen data. Our findings advance the understanding of how digital behavior impacts attention span.
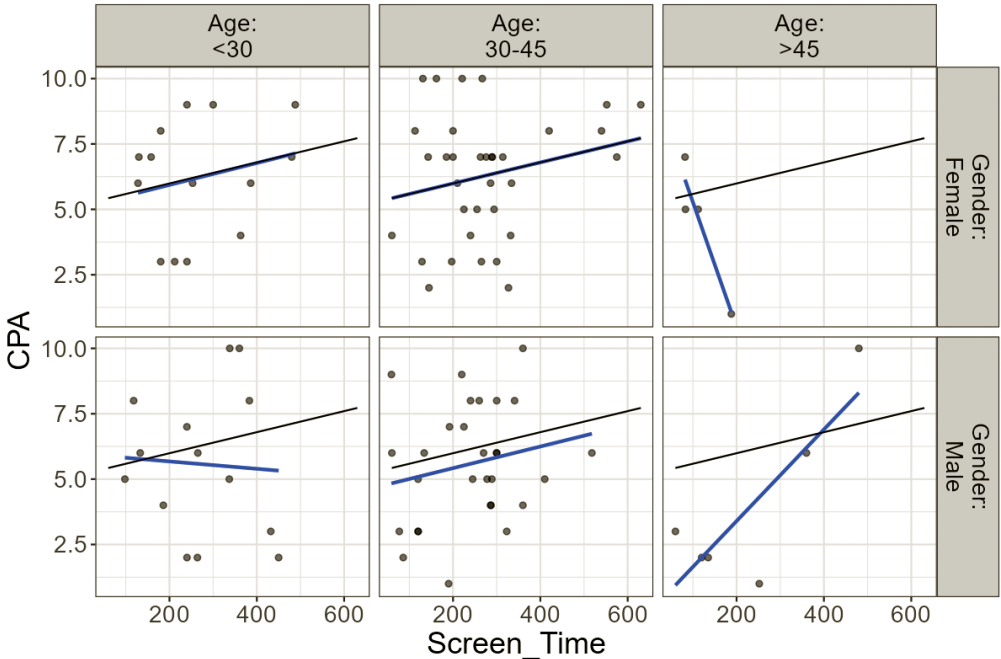
Fig. 5. Scatterplots of Predictive Structure among Age and Sex Groups

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The findings of this research showed that master's and doctoral students had an average of 6 hours and 15 minutes of smartphone screen time per day, which is higher than the averages recently found by A. Osailan [23] and S.M. Föckel [12] for the 18–30 age group. Comparisons by demographic characteristics showed no statistically significant differences between the groups, although those younger than 30 years had a higher screen time and lower mean CPA.

Photo Sharing and Messaging App had the highest total weekly screen time, Streaming Platform had the highest overall screen time, and Short Video Platform had the highest average CPA. In the focus group interview, the students identified four themes related to the Short Video Platform app (hypnotic algorithm, passive receiver mode, short video flow, and surprise content) and two themes related to the content structure (distracting redundancy and marketing and advertising) that could account for the findings.

The main hypothesis of this study is that the PSST predicts CPA. Correlation and regression analyses showed that DASST positively and significantly predicted students' CPA, thus supporting H1 and rejecting H0. However, this predictive impact did not differ significantly according to sex, age, or education level. Interestingly, screen time had a negative correlation with the average CPA of male students younger than 30 years.

The literature presents three main perspectives on the effects of smartphone screen time on attention: a negative effect [2; 12], an insignificant effect [4; 30], and a negative effect depending on the situation [28]. While the predictive relationship between DASST and CPA in this study supported the negative effect perspective, the results of the focus group interview supported the situational effect perspective, emphasizing that this effect occurred in the unaware-use mode.

Limitations

This study had two limitations. First, CPA was measured using a single-item scale. The rationale for this is that valid and reliable measurement techniques for CPA are rare in the literature. Second, this study was based on a specific sample of postgraduate students in a particular country at a specific time.

Recommendations

These findings highlight the practical need for educational interventions focusing on digital literacy and mindfulness training. Such programs could help students manage the cognitive demands of prolonged smartphone use, thereby improving their focus and academic performance.

Future studies should employ direct measurement strategies for CPA. One potential method is to take screenshots of weekly reports with the necessary permissions to reduce errors. One study used a mobile app to automatically record screen time in the background [6]. While the fear of missing out (FOMO) is similar to CPA but focused on fear rather than poor performance due to a lack of focus, FOMO can also be used as a predictor of CPA. H. Scott and H.C. Woods [27] found that FOMO is a key predictor of social media and problematic smartphone use. Huang et al. [17] studied smartphone stress, which is related to prolonged smartphone use and CPA, and identified six contributing factors: poor information and communication, unmet recreational motivation, online learning burden, social worries, pointless and overloaded alerts, and online verbal attacks. Future research should explore the relationship between these factors and CPA using structural equation modeling.

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PSYCHOLOGY OF EDUCATION
ПСИХОЛОГИЯ ОБРАЗОВАНИЯ

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Psychological prerequisites and barriers to innovative activity of teachers

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Abstract

Context and relevance. The success of pedagogical activity partly depends on the availability and level of professional competencies, as well as the initiative in the continuous self-development of teachers. **Objective.** The analysis examines the relationship between the indicators of psychological characteristics of personality and the level of readiness of teachers for innovation. **Methods and materials.** The study participants were teachers of educational institutions in Belgorod (n = 120), of whom: 77 women, 43 men. The study of the current state of teachers' readiness for innovation was conducted using the methodology "Assessment of a teacher's readiness to participate in innovation" (V.A. Slastenin); the questionnaire "Big Five" (5-PFQ) R. McCrae, P. Costa; the questionnaire "Style of self-regulation of behavior-SSP-98" (V.I. Morosanova); questionnaires "Barriers preventing the development of innovations" (T.V. Chirkova). **Results.** The results showed that 33% of teachers of educational institutions are ready for innovation, they are characterized by high rates of self-regulation and regulatory personality traits; openness to experience, extraversion and benevolence. **Conclusions.** A high level of general self-regulation is one of the main conditions for success in the development and implementation of new types of activities. In this regard, the development of self-regulation processes will help to increase the level of psychological readiness of teachers for innovation.

Keywords: innovative activity of a teacher, conscious self-regulation of activity, barriers preventing innovative activity

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Психологические предпосылки и барьеры инновационной активности педагогов

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Резюме

Контекст и актуальность. Успешность педагогической деятельности отчасти зависит от наличия и уровня профессиональных компетенций, а также инициативы в непрерывном саморазвитии педагогов. **Цель.** Выявить связи между показателями психологических характеристик личности и уровнем готовности педагогов к инновационной деятельности. **Методы и материалы.** Участниками исследования выступили педагоги общеобразовательных учреждений г. Белгорода (n = 120), из них: 77 женщин, 43 мужчины. Исследование современного состояния готовности педагогов к инновационной деятельности проводилось посредством методики «Оценка готовности педагога к участию в инновационной деятельности» (В.А. Сластенин); опросника «Большая пятерка» (5-PFQ) Р. МакКрае, П. Коста; опросника «Стиль саморегуляции поведения-ССП-98» (В.И. Моросанова); анкеты «Барьеры, препятствующие освоению инноваций» (Т.В. Чиркова). **Результаты**. Результаты показали, что готовность к инновационной деятельности (ИД) проявляют 33% педагогов общеобразовательных учреждений, им свойственны высокие показатели саморегуляции и регуляторных личностных свойств, открытость опыту, экстраверсия и доброжелательность. **Выводы**. Высокий уровень общей саморегуляции является одним из главных условий успешности в освоении и реализации новых видов деятельности, в связи с чем развитие процессов саморегуляции будет способствовать повышению уровня психологической готовности учителя к инновационной деятельности.

Ключевые слова: инновационная активность педагога, осознанная саморегуляция деятельности, барьеры, препятствующие инновационной активности

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Introduction

1.1. Background

Education, like other sectors of the economy, has been undergoing a complex process of permanent modernization over recent decades. According to a number of Russian and foreign scientists, the success of innovations partly depends on the availability and level of professional competencies, as well as the initiative in the continuous self-development of teachers (Naumtseva, 2016; Slastenin & Podymova, 1997; Aldahdouh, Korhonen, & Nokelainen, 2019; Cai & Tang, 2021; Dziallas & Blind, 2019; Stumbrien , Jevsikova, & Kontvain , 2023, etc.). The preparedness of teachers themselves to work in an innovative environment is also extremely important (Gnezdilova, 2006; Gut et al., 2020; Pinto & Costa-Ramalho, 2023).

Scientists from China, studying innovation processes in the education system, noted that the result of such innovations, besides transformations in the educational space, can be changes in the personal characteristics of participants in the educational process, for example, ways of activity, thinking styles, motivation, and worldview (Hughes et al., 2019; Ilic et al., 2024; Pak, Li, & Chung, 2019).

A teacher constantly has to make optimal professional decisions under conditions of multiple uncertainties, which naturally requires continuous self-development, self-knowledge, harmonization of relationships with people, and enrichment of one's own experience (Sahin & Dursun, 2022). This necessitates not only a high level of professional self-regulation of the teacher but also personal self-regulation at the level of human positioning.

1.2. Theory

Aleksey Osnitsky defined self-regulation of behavior as "the positive operational activity of a person, that is, their active, timely, productive regulation of their behavior, which consists of the activities they carry out and the accompanying impulsive and reactive manifestations" (Osnitsky, 2010, p. 111).

A teacher's activity is far from always amenable to algorithmization or preliminary programming and often requires flexible, non-standard solutions, switching from one strategy to another, and searching for new ways of interacting with learners. In modern pedagogy, innovative, more effective means of interaction with learners are often used, which can serve strategic and tactical goals. Both the possibility of multiple uncertainties and their measure of rationality are taken into account — the correspondence of the content and dynamism of actions to emerging situations (Osnitsky, 2010).

Svetlana Panina believes that " today, the teacher's readiness for innovative activity acquires a new meaning, because the content of the teacher's innovative activity is connected with their ability to manage their professional growth" (Panina, 2017, p. 109).

A teacher's readiness for innovation must be considered as their creative attitude towards their activity, the uniqueness of which lies in the necessity of realizing educational goals under conditions of multiple uncertainty.

Readiness for innovative activity, according to the concept of Ludmila Podymova and Ludmila Dolinskaya, is "a special personal state that presupposes the teacher's motivational-value attitude towards professional activity, mastery of effective ways and means of achieving pedagogical goals, and the ability for creativity and reflection" (Podymova & Dolinskaya, 2016, p. 24).

Vitaly Slastenin and Ludmila Podymova were convinced that teachers' ability to organize, control, and regulate their activities

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needs to be developed during university studies. They considered readiness for innovative activity as a necessary condition for forming the professional preparation of future teachers. In the structure of readiness, the authors of the concept distinguished four main components: motivational, cognitive, operational, and personal (Slastenin & Podymova, 1997).

Krste Angelowski asserted that "readiness for pedagogical activity is determined by a number of factors, the most important of which is the system of methods and goals, the availability of professional knowledge and skills, the direct inclusion of the personality in the activity, during which the needs, interests, and motives for acquiring significant, most up-to-date knowledge and skills are most actively formed" (Angelovski, 1991, p. 107).

According to Yuri Zinchenko and Inna Volodarskaya, the holistic readiness of a teacher for innovative activity is determined by the personal orientation of pedagogical workers towards an innovative approach to teaching and upbringing (Zinchenko & Volodarskaya, 2007).

Russian researchers identify a number of personal factors indicating teachers' readiness for innovative activity. Among them are "readiness for reasonable risk within their competence, readiness to show initiative when a real opportunity arises, the need for novelty, and the level of teachers' awareness regarding innovative developments" (Panina, 2017, p. 110).

Describing her author's model for the development of innovative activity in a teaching staff, Tatiana Razuvaeva identified a number of key psychological conditions: "the team's orientation towards change, ethical readiness to solve school development tasks, and a positive perception of the conditions of innovative activity" (Razuvaeva, 2014, p. 47).

As numerous domestic studies have shown, the systemic process linking various aspects of the interaction of mental, physiological, and physical processes that ensure human behavior both in organizing the professional activity of a teacher and in readiness for implementing innovations is conscious self-regulation of activity (Osnitsky, 2013).

Oleg Konopkin considers conscious self-regulation of activity as "one of the highest levels of regulation of the activity of biological systems, reflecting the qualitative specifics of the realization of its mental capabilities of displaying and modeling reality, in particular, the reflection of the subject of himself, his activity, activities, actions. The basic principles of self-regulation of activity are subjectivity, awareness, consistency, activity" (Konopkin, 2008, p. 30).

According to Alexey Osnitsky, "self-regulation of activity is carried out by a person as a subject of activity and is aimed at bringing human capabilities in accordance with the requirements of this activity" (Osnitsky, 2013, p. 21).

The process of the formation of activity and its regulation develops during the socialization and personal development of the child, as a result of which there is a transition from naturally conditioned reactive and impulsive forms of behavior to mastering the technology of purposefully organized, projected behavior — that is, activity, as defined by Sergey Rubinstein.

When discussing the readiness for innovative activity of teachers and other specialists in the education system, it is useful to recall the words spoken by Sergey Rubinstein as early as 1922 about the principle of creative self-activity as a principle of human development. Later, Rubinstein defined the specificity of understanding human activity as a projected type of activity, mastered in the process of socialization, carried out in the

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unity of consciousness and action using an arsenal of means formed by that time (Rubinstein, 2002).

The unified technology for carrying out transformation and forming new knowledge of new action, mastered by our predecessors, helps us in this: goal-achievement technology. This technology also formed the basis for the formation of self-regulation and, didactically, boiled down to the following: first, one must set a goal; then analyze the conditions, select a method of action or program and appropriate means; then implement this action and evaluate the result obtained; make corrections if necessary. Therefore, it is goals, not needs, that govern our daily behavior in the socially conditioned world. The process of human social functioning is subordinated to solving problems of goal-setting and goal-achievement.

"The principle of creative self-activity," with successful development and socialization involving the mastery of professional work, leads to the formation of an individual style of activity in a person (V.S. Merlin, E.A. Klimov, B.A. Vyatkin), in which the person's existing abilities are used most effectively and insufficiently developed means are compensated for (Osnitsky, 2010).

The discussion of the phenomenology of subjective (i.e., primarily conscious) self-regulation and its role in carrying out activity is conducted both in terms of analyzing its structural and functional properties (Konopkin, 2008; Morosanova, 2004; Osnitsky, 2013) and in terms of personal attributions: the properties that distinguish a person who consciously manages their behavior in professional or amateur activities (Shchukina, 2018).

Both mastery of pedagogical communication and proficiency in didactic methods, features of self-regulation in communication

and activity, and readiness for activity in innovative conditions are paramount professionally important abilities of a teacher. But despite all the similar traits of people whose profession is connected with teaching, we also deal with the presence of individual differences, discovered in the teacher's activity and somehow determining the development of their professional abilities (Lokuge S. et al., 2019; Roberts R. et. al., 2021; Stroh, 2021).

In this study, we set the task of assessing the relationship between indicators of the formation of conscious self-regulation and the expression of general personality traits, as well as tracing possible means to help overcome barriers to the manifestation of innovative activity.

Since self-regulation is required by a teacher not only in solving purely pedagogical tasks but also in regulating reactive and impulsive forms of behavior dictated by the social aspects of the teacher's interaction with management, students, and their parents, the research task included studying the teacher's readiness to work in an innovative environment, as well as studying personality traits in which the features of self-management of one's behavior and the formation of mechanisms for conscious self-regulation of professional activity are accumulated and fixed.

Materials and Methods

Study Sample. Teachers of general educational institutions in the Belgorod district (n = 120), including: 77 women, 43 men; average age — 33,2, SD = 3,9; average work experience in school — 4,7, SD = 3,17. The study was conducted at the district methodological association of subject teachers in the sections for history, physics, and mathematics teachers at the Municipal Educational Institution "Severnaya Secondary School No. 1" in the Belgorod district. Participation in the

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study was voluntary. Informed consent was obtained from all research participants.

Research Methods. 1) The questionnaire "Assessment of a Teacher's Readiness to Participate in Innovative Activity" by Vitaly Slastenin, used to identify the general level of teachers' readiness for innovative activity and analyze the leading components in the structure of readiness; 2) The adapted five-factor personality questionnaire "Big Five" (5-PFQ) by R. McCrae and P. Costa, allowing measurement of the level of expression of basic personality traits manifested in human behavior across a wide range of situations; 3) The questionnaire "Style of Self-Regulation of Behavior-SSP-98" by V.I. Morosanova, necessary for diagnosing the general level of self-regulation of behavior; 4) The questionnaire "Barriers Preventing the Development of Innovations" by T.V. Chirkova, used to analyze the main barriers to innovative activity and identify innovative potential.

Processing of the obtained data was carried out using the IBM SPSS Statistics-25 program: Student's t-test; Pearson's χ^2; Pearson's correlation coefficient r; multiple regression analysis (MRA). Normality testing was performed using the Kolmogorov-Smirnov test; significance level $p < 0{,}2$, therefore, the hypothesis of normality of the existing distribution of random variables is not rejected.

Results

We hypothesized that teachers' readiness for innovative activity could be influenced by such psychological prerequisites as high self-regulation of behavior, responsible attitude towards fulfilling one's duties, conscientiousness, and benevolence.

To test the research hypothesis, we first examined the features of teachers' readiness for innovative activity (RIA). It was found that 32% (average age — 32,8, SD = 4,6; average work experience in school — 4,1, SD = 3,8) of teachers exhibit a low level of readiness for educational innovations. A moderate attitude towards changes in the technology of teaching and upbringing of schoolchildren (average level) is shown by 45% of teachers. Only 23% (average age — 30,2, SD = 4,2; average work experience in school — 3,1, SD = 3,5) exhibited a high level of readiness for innovative activity, indicating the presence of an innovative mindset, manifested in openness to perceiving new things, striving for self-development, etc.

Since the "average level" category included subjects with a total readiness score of 55–70, to balance the sample of teachers with low and high levels of readiness, we selected from teachers with an average level a category "with a tendency towards a high level" those who scored 65–69 points. Such teachers constituted 10% of the total sample. As a result, the proportion of teachers with a high level of innovative RIA was 33%.

Separating teachers with high and low levels of RFI from the entire sample, we conducted a comparative analysis of their personality traits using the "Big Five" questionnaire (see Table 1).

According to the data reflected in Table 1, teachers with a low level of readiness for innovation differ statistically significantly ($p \le 0{,}05$) from teachers with a high level of readiness in the indicators "openness to experience" (temp = 2,321), "extraversion" (temp = 2,124) and "agreeableness" (temp = 2,251), This characterizes them as more rigid, conservative, passive, and less sociable than teachers with high and medium levels of innovative readiness, who are friendly, socially active, and inquisitive. But both groups of teachers do not differ in terms of consciousness and neuroticism. The increased level of the

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Table 1

The expression of the fundamental personality traits of teachers with a high and low level of readiness for innovation

Levels RFI	Personal factors in average scores (SD-standard deviation)				
	Extraversion	Agreebleness	Conscientiousness	Neuroticism	Openness to experience
High M_{x1}	56,7 (2,12)	65,2 (3,15)	52,5 (2,20)	26,4 (2,65)	62,3 (3,21)
low M_{x2}	39,4 (2,34)	48,3 (2,61)	49,7 (2,86)	28,6 (2,19)	37,8 (2,34)
t	2,124*	2,251*	1,536	1,664	2,321*

Note: * — $p \le 0,05$.

"conscientiousness" indicator, identified in both samples, indicates a tendency towards responsibility, commitment and accuracy in fulfilling one's duties. The low values of the neuroticism scale indicate that both groups of teachers are characterized by self-sufficiency and emotional stability.

Next, we compared the levels of self-regulation of behavior, which, in our opinion, is a predictor of teachers' readiness for innovative activity (see Table 2).

Data in Table 2 demonstrate statistically significant differences between the two samples in the indicator "general level of self-regulation of behavior" (Mx1 = 44, Mx2 = 31 at p < 0,01). Teachers with a high level of RFI have a higher level of formed self-regulation of behavior, manifested in independence and awareness in achieving goals, as well as flexibility and adequate response to changing conditions.

Analysis of barriers preventing the development of innovations will allow us not only

to identify the innovative potential of teachers with low and high levels of readiness for innovative activity (by T.V. Chirkova) but also to determine which motives (external or internal) dominate in both samples when carrying out innovative activity (Table 3).

At a statistically significant level of $p \le 0,05$, it was revealed that teachers with a low level, unlike teachers with a high level of readiness for IA, proportionally more often encounter such barriers to innovative activity as: heavy workload (Mx1 = 54%, Mx1 = 63%), lack of material incentives (Mx1 = 54%, Mx1 = 65%), lack of help in mastering innovations within the team (Mx1 = 29%, Mx1 = 64%) and information (Mx1 = 15%, Mx1 = 26%), fear of negative results (Mx1 = 10%, Mx1 = 29%), and the belief that effective teaching can be done in the old way (Mx1 = 12%, Mx1 = 32%). Furthermore, analyzing the overall barrier indicators, we note that teachers with a low level of innovative activity reported significantly more barriers than teachers with a high level, indi-

Table 2

The severity of the level of self-regulation of teachers' behavior with high and low levels of readiness for innovation

Levels RFI	The general level of self-regulation In AS (SD is the standard deviation)
Высокий / High M_{x1}	44 (4,16)
Низкий / low M_{x2}	31 (3,28)
t	2,647**

Note: * — $p \le 0,05$.

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Table 3

Comparative analysis of barriers to innovation among teachers with low and high levels of IA (in %)

Barriers to innovation activity	Levels RFI		χ^2
	igh M_{x1}	ow M_{x2}	
Disagreements, conflicts in the team	5	7	56,9
Lack of help	29	64	102,5*
Little work experience	2	7	63,1
Lack of financial incentives	54	65	92,8*
Feeling fear of negative results	10	29	100,1*
Heavy workload at work	54	63	95,2*
Poor health, other personal reasons	5	3	56,1
The belief that effective teaching can be done in the old way	12	32	99,6*
Poor awareness of innovation in the team	15	26	98,8*

Note: * — $p \leq 0,05$.

cating a low level of their innovative potential.

To confirm our hypothesis and the data obtained from the correlation analysis, we conducted multiple regression analysis to deepen the study of the obtained relationships between the identified RIA indicators, taking into account dependent and independent variables of individual psychological prerequisites (see Table 4).

We attributed RIA indicators to dependent variables, and indicators of psychological prerequisites (self-regulation of behavior, personality traits, barriers preventing the development of innovations) to independent variables, i.e., those determining innovative activity.

In the regression model "Overall RIA Level," statistically significant regression β-coefficients were obtained. Readiness for innovative activity is influenced by the following indicators of psychological prerequisites: "General level of self-regulation of behavior" (r = 0,528, β = 0,703), "Openness to experience" (r = 0,309; β = 0,268), "Agreeableness" (r = 0,347; β = 0,364), "Conscientiousness" (r = 0,398; β = 0,325),

Table 4

Multiple regression and correlation analysis of indicators of psychological prerequisites for teachers' willingness to IA

Indicators of psychological prerequisites	The magnitude of the connection r	The standard coefficient β	t	R-squared
Overall RIA level				
Overall level of self-regulation	0,528**	0,703**	3,462	0,571
Openness to experience	0,309*	0,268*	2,124	0,296
Agreebleness	0,364*	0,347*	1,684	0,397
Conscientiousness	0,398*	0,325*	2,058	0,302
Neuroticism	−0,312*	−0,328*	1,715	0,368
Barriers to innovation (heavy workload)	−0,324*	−0,376*	2,446	0,412

Note: * — $p < 0,05$; ** — $p < 0,01$. The table shows only statistically significant variables.

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"Neuroticism" (r = –0,312, β = –0,328), and "Barriers preventing the development of innovations" (r = –0,324; β = –0,376). This result tells us that teachers who can clearly envision the goals of their activities and implement them in short-term and long-term plans, who show persistence and perseverance, possess readiness for long-term organization of efforts to achieve a goal, and who can balance between means and ends depending on unforeseen situations, distinguished by endurance, persistence, and a desire to develop, will be psychologically ready for IA. Due to the ability to generate new ideas, flexibility of thinking, openness to new experiences, and awareness, the likelihood of career growth increases. Teachers with low openness to experience prefer routine to diversity. Agreeable teachers are non-confrontational, willing to share experiences and learn new things. They are inclined to cooperate and ready to build person-oriented interaction with participants in the educational space. Teachers with low agreeableness are conflict-prone and often exhibit cynicism. The obtained positive correlations indicate that the higher the level of self-regulation of behavior of teachers, their openness to new experiences, and readiness to share them, the higher their RIA. Barriers preventing the development of innovations and neuroticism negatively affect RIA.

Discussion of Results

The goal of our study is to study the features of readiness for innovation among teachers of secondary schools in the Belgorod region, as well as to identify the relationship between their level of readiness for innovation and self-regulation of behavior.

As a result, it was revealed that only 23% of teachers exhibit a high level of RIA. Such teachers are receptive to innovations, are in constant search of themselves in implementing innovations, and experience a need to create something new and transform the existing pedagogical reality.

When analyzing personality traits, it was found that teachers with a low level of RIA have reduced indicators of openness to experience, extraversion, and agreeableness, characterizing them as more rigid, conservative, and less sociable than teachers with a high level of readiness for IA. Low values of neuroticism indicators found in both samples indicate that both groups are characterized by self-sufficiency and emotional stability.

In the research of Muhamed Kabardov, indicators of extraversion have repeatedly correlated with indicators of communication ability (Kabardov, 2018). In studies of the formation of regulatory experience in students and teachers by Alexey Osnitsky, the characteristic of agreeableness was considered as an indicator of a tendency towards cooperation (Osnitsky, 2010).

Differences were also found in indicators of the general level of self-regulation, which is the internal purposeful activity of the teacher. Teachers with a high level of readiness for IA have a higher level of formed self-regulation of behavior, manifested in independence and awareness in achieving goals, as well as flexibility and adequate response to changing conditions. According to Alexey Osnitsky, teacher self-regulation is one of the leading psychological determinants of readiness for innovative activity, since self-regulation processes contribute to the successful implementation of innovative activities through forecasting, planning, developing action programs, analyzing their implementation, and subsequent correction and reflection of innovative actions.

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During the analysis of barriers preventing innovative activity, both common barriers prevalent among both groups of teachers to approximately the same extent and barriers predominantly characteristic only of teachers with low innovative readiness were identified. Among the common barriers were: heavy workload, lack of material incentives, and lack of help in mastering innovations within the team. These barriers can be attributed to external motives.

Barriers predominantly characteristic of teachers with low readiness include: insufficient awareness of innovative events, the conviction that effective teaching can be done in the old way, and fear of negative results of activities. These indicators can be attributed to internal motives of innovative activity.

The data we obtained are consistent with the results of Elena Frantseva, who also believes that the leading barriers for teachers are "fear of the unknown, when preference is given to the familiar; denial of the need for change and fear of obvious losses (e.g., maintaining the same salary with increased labor costs, lack of resources and time, etc.)" (Frantseva, 2017, p. 104).

Esra Firat and Fatma Torun, analyzing factors of innovative activity, concluded that risk-taking propensity is an important predictor of a high level of innovative readiness in teachers. The authors suggest that the training of future teachers should be planned in such a way that they increase their risk-taking behavior during the learning process (Firat & Torun, 2022).

According to Tatyana Chirkova, the author of the questionnaire, the more innovative barriers a teacher notes, the lower their level of innovative potential. Considering the fact that in the group of teachers with a low level of readiness, the frequency indicators for choosing barriers are significantly higher than in the group with a high level of readiness, it can be said that most teachers with a low level of readiness have a very low innovative potential. This manifests itself in a formal attitude towards work, indifference to changes in their work, which can lead to a decrease in the effectiveness of professional activity and also adversely affect the personal development of students.

The obtained significant regression β-coefficients and correlations give us reason to assert the dependence of psychological readiness for innovative activity of teachers on the level of formed self-regulation of behavior, as well as on the level of agreeableness, emotional stability, conscientiousness, and openness to new experiences.

Conclusion

The results of the study showed the following:

1. Teachers with a low level of RIA are characterized by greater rigidity, conservatism, passivity, and less sociability; teachers with a high level of readiness are more agreeable, socially active, and curious; both groups of teachers do not differ in neuroticism and conscientiousness indicators, meaning both groups are characterized by self-sufficiency, emotional stability, and responsibility.

2. The leading barriers to innovative activity for teachers with a low level of readiness are heavy workload, fear, lack of material incentives, and lack of help in mastering innovations. Their innovative activity is hindered by: insufficient awareness of innovative events, the conviction that effective teaching can be done in the old way, and fear of negative results of activities. Such teachers are indifferent to changes in their work; rare innovations may be used solely in cases of "official necessity."

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3. Teachers with a high level of readiness were found to have a higher general level of self-regulation of behavior. Consequently, a high level of readiness for innovation is ensured by higher indicators of the general level of self-regulation.

The initial hypothesis, according to which teachers' readiness for innovative activity can be influenced by such psychological prerequisites as high self-regulation of behavior, responsible attitude towards fulfilling one's duties, conscientiousness, agreeableness, and innovative potential, was confirmed.

Thus, a high level of general self-regulation is one of the leading factors for the successful mastery and implementation of new types of pedagogical activities. Specialists with a low general level of self-regulation exhibit a low level of motivation, a need for the application of external motivation stimuli (material reward, assignment of a higher qualification level, satisfactory working conditions, external positive evaluation from others, relaxation of requirements, control, etc.), psychological relief, and changes in thinking and lifestyle.

In conclusion, it should be noted that the activity of mastering and implementing innovations is not easy for many teachers. Established activity habits, concerns about new working conditions, uncertainty about the benefits for oneself and the necessity of innovations, and much else form negative motivation towards change. The teacher's innovative activity and its effectiveness will largely be determined by whether they understand the personal, professional, and social meaning of applying these innovations, and undertake their search and choice.

This study fills the gap in fundamental research on the problem of professional socialization of teachers under conditions of permanent transformation, in particular the activity of teachers in advanced educational systems, and provides grounds for asserting the need for a critical rethinking of the criteria base for evaluating the process and results of teacher preparation.

Limitations. We recognize that this study has a number of limitations. The study focuses exclusively on teachers of the Belgorod region, which may not reflect the situation in other regions or countries. The cultural context can influence psychological readiness for innovative activity. Also, the analysis of prerequisites and barriers to innovative activity was carried out on a sample size of 120 people. In future studies, it may be possible to involve teachers from other cities to increase the validity and reliability of the results. Despite these limitations, this study may be one of the first to examine the prerequisites and barriers to innovative activity among educators. This makes a new contribution to our understanding of the need to develop the professional socialization of a teacher in the context of transformation and rethinking of the criteria base for evaluating the process and results of teacher training, including readiness for continuing education.

Abbreviations

The following abbreviations are used in this manuscript:

IA innovative activity
RIA readiness for innovative activity

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Все авторы приняли участие в обсуждении результатов и согласовали окончательный текст рукописи.

Conflict of Interest

The authors declare no conflict of interest.

Конфликт интересов

Авторы заявляют об отсутствии конфликта интересов.

Ethics Statement

The study was reviewed and approved by the Ethics Committee of Faculty of Psychology, Belgorod State National Research University (report no, 2022/01/12).

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Научная статья | Original paper

Academic supervision style as predictor of PhD students' motivation and burnout

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Abstract

Context and relevance. The relationship of the PhD student and the supervisor acts as one of the crucial factors of motivation, well-being or dropout. **Objective.** To identify the relationship between academic supervision styles and PhD students' motivation, perseverance, well-being and burnout. **Hypothesis.** Academic supervision styles will be related to motivation, well-being, perseverance, and burnout directly or inversely depending on whether they support or frustrate basic psychological needs. **Methods and materials.** The study involved 142 PhD students (M = 28,8, SD = 5,2, 54% female). The theoretical basis of the work was self-determination theory, which allows us to understand the contribution of styles that support or frustrate basic psychological needs to the motivation and outcomes of PhD students' research activities. The study used the Universal Perceived Locus of Causality (UPLOC) and academic burnout scales, the Questionnaires on Academic Supervision Styles (QA2S) and well-being (The PERMA Profiler). **Results.** The results showed that autonomous and structuring academic supervision styles are the factors of autonomous motivation, whereas controlling and chaotic academic supervision styles are the factors of external motivation and amotivation. The quality of motivation mediates the effect of academic supervision styles on PhD students' perseverance and burnout, specifically cynicism and exhaustion. Autonomous and structuring styles are positively, while chaotic and controlling styles are negatively related to well-being and its aspects. **Conclusions.** Autonomous and structuring styles are the most favourable for PhD students. Mastering them, as well as reducing the use of unfavourable demotivating styles can become targets of work in the organisation of academic supervisors' professional development.

Keywords: academic supervision styles, basic psychological needs, motivation, perseverance, well-being, burnout, self-determination theory, PhD students

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Стиль научного руководства как предиктор мотивации и выгорания аспирантов

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Резюме

Контекст и актуальность. Отношения аспиранта с научным руководителем выступают одним из решающих факторов мотивации, благополучия или отсева. **Цель.** Выявить связь стилей научного руководства с мотивацией, настойчивостью, благополучием и выгоранием аспирантов. **Гипотеза.** Стили научного руководства связаны с мотивацией, благополучием, настойчивостью и выгоранием прямо или обратно в зависимости от того, поддерживают они или фрустрируют базовые психологические потребности. **Методы и материалы**. В исследовании приняли участие 142 аспиранта (M = 28,8, SD = 5,2, 54% женщины). Теоретической основой работы стала теория самодетерминации, позволяющая понять вклад стилей, поддерживающих или фрустрирующих базовые психологические потребности, в мотивацию и внутренние результаты исследовательской деятельности аспирантов. Использованы шкалы типов мотивационной регуляции (UPLOC) и выгорания, опросники стилей научного руководства (СТИНАРУ) и благополучия (The PERMA Profiler). **Результаты.** Показано, что факторами автономной мотивации являются автономный и структурирующий стили научного руководства, тогда как факторами экстернальной мотивации и амотивации являются контролирующий и хаотический стили. Качество мотивации опосредует влияние стилей научного руководства на настойчивость и выгорание аспирантов, а именно — цинизм и истощение. Автономный и структурирующий стили положительно, а хаотический и контролирующий отрицательно связаны с общим показателем и отдельными аспектами благополучия. **Выводы**. Автономный и структурирующий стили наиболее благоприятны для аспирантов, овладение ими, а также снижение использования неблагоприятных демотивирующих стилей могут стать мишенями работы при организации повышения квалификации научных руководителей.

Ключевые слова: стили научного руководства, базовые психологические потребности, мотивация, настойчивость, благополучие, выгорание, теория самодетерминации, аспиранты

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Introduction

Russia is losing its position in the ranking of countries in terms of scientific research, the shortage of young scientific personnel is increasing, and the number of university academic staff is decreasing[1]. PhD students are the talent pool of both academic staff and university teachers. At the same time, they report low levels of psychological health and well-being, high levels of stress and mental disorders (Sverdlik, 2024), and other difficulties such as balancing work and research, preparing and publishing articles, and a lack of academic skills (Zhuchkova, Terentev, 2024). The relationship with the academic supervisor is one of the most important factors influencing PhD students' motivation, well-being and dropout intentions (Sverdlik et al., 2018).

Relationship and academic supervision style

Studies of the relationship between PhD students and their academic supervisors show that the supervisors play an especially important role in predicting the PhD students' well-being and success. An assessment of the effects of three sources of social support (supervisor, peers, and relatives) on positive emotions, perceived progress, and intention to continue studying showed that supervisor support was the only factor that significantly predicted PhD students' academic outcomes (De Clercq et al., 2019). PhD students with moderate social support were more likely to intend to drop out than those with high support (Cornér et al., 2024).

PhD students value academic integrity, constructive feedback, open communication and collaborative working with their supervi-

sors. They prefer supervisors who foster caring relationships to those who focus on instrumental roles (Roach, Christensen, Rieger, 2019). Supportive academic supervision has a positive impact on doctoral students' creativity by encouraging academic engagement and fostering social connections (Zhang et al., 2024).

Many classifications of academic supervision styles have been proposed (Gruzdev, Terentev & Dzhafarova, 2020; Mainhard et al., 2009). The most well-developed approach to motivation and the study of motivating and demotivating interaction styles is self-determination theory (SDT) (Ryan, Deci, 2017). We will use the typology developed within the SDT framework, which distinguishes different supervisor interaction styles based on the satisfaction of three basic psychological needs (BPNs) (Devos et al., 2015; Ryan, Deci, 2017). These needs are considered sources of intrinsic motivation. Accordingly, these needs are categorised as either supportive or frustrating of BPNs for autonomy (feeling in control of one's actions), competence (feeling effective in one's actions) and relatedness (feeling accepted by others). Previously, the main focus of research has been on autonomy-supportive and controlling (non-punitive and punitive) styles of academic supervision (Richer, Vallerand, 1995).

PhD students who successfully completed their studies felt that they had received more support from their supervisors, departments, and peers for their BPNs (Litalien, Guay, 2015). Support for BPN during PhD studies fosters the development of a scientific identity linked to career aspirations (Meuleners, Neuhaus, Eberle, 2023). In a

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[1] https://issek.hse.ru/mirror/pubs/share/1013106714.pdf

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model of PhD student support, BPN for competence is supported through structure and BPN for relatedness is supported through involvement (Devos et al., 2015). Several studies have suggested that the three BPNs play different roles: autonomy and competence support are important for the motivation and well-being of PhD students (Shin, Goodboy, Bolkan, 2022; Marchuk, Gordeeva, 2024), while relatedness is important for the desire to pursue an academic career (Meuleners, Neuhaus, Eberle, 2023).

There is evidence regarding the role of gender among PhD students. Support for the three BPNs is related to mental health in PhD students of both genders; the most important of these is support for the BPN for competence. PhD students require a structured academic environment that provides clear expectations and communication, constructive feedback, attentive guidance, and support to maintain motivation and effort. Women may also benefit from an approach that fosters autonomy rather than control (Wollast et al., 2023).

Well-being, burnout and perseverance of PhD students

Two categories of resources contribute to the well-being of PhD students: personal resources, such as self-efficacy and intrinsic motivation, and environmental resources, such as support from supervisors, departments, families, peers, institutions and public policies (Acharya, Rajendran, 2023). Environmental factors that can negatively affect the psychological health and well-being of PhD students include isolation and difficult relationships with supervisors, colleagues and the department (Jackman, Sisson, 2022).

Burnout is one of the indicators of ill-being. In both the classical model by C. Maslach and S. Jackson and the updated model by W. Schaufeli, burnout is characterised by two components: exhaustion and depersonalisation (cynicism and mental distance). Dissatisfaction with academic supervision, the frequency of contact and the quality of motivation are related to the experience of academic burnout and dropout intentions (Cornér et al., 2021; Devine, Hunter, 2016; Shin, Goodboy, Bolkan, 2022).

The perseverance shown in pursuing a chosen goal is related to success in the activity and the intention to continue learning (Gordeeva, Sychev, 2024), which is also relevant to PhD students. Research in self-determination theory (SDT) shows that autonomy support and basic psychological needs (BPN) satisfaction underpin the intention to continue learning (Litalien, Guay, 2015; Wollast et al., 2023). However, the relationship between academic supervision styles based on BPN satisfaction or frustration and PhD students' perseverance and willingness to put effort into scientific work remains unclear.

The study aimed to identify the relationship between academic supervision styles that support or frustrate PhD students' BPN and their motivation, perseverance, academic burnout, and well-being.

Hypotheses: Autonomous and structuring academic supervision styles that support BPN for autonomy and competence will be directly related, predicting autonomous motivation, perseverance and well-being, while negatively predicting burnout. Chaotic and controlling styles that frustrate BPN will contribute to controlled motivation and burnout.

Participants and methods

Participants: Participants in the study in winter 2023 were 142 PhD students of Russian universities (M=28,8; SD=5,2), including

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54% women: 30% in the first year, 31% in the second year, 24% in the third year, and 14% in the fourth year (Marchuk, 2025).

Methods: The academic supervision styles were assessed by the author's Questionnaire on Academic Supervision Styles (QA2S) (Gordeeva, Marchuk, Butenko, 2024), which was based on the SDT and a study of several similar instruments. Consisting of 14 statements, it assesses four styles: two that support BPNs for autonomy and competence (autonomous and structuring), and two that frustrate these BPNs (controlling and chaotic). Respondents rate the following statements on a 5-point Likert scale «My supervisor…»: «welcomes my contributions to our discussions» (autonomous); «controls me quite tightly» (controlling); «helps me make sense of the scientific ideas, problems, and research» (structuring); and «criticises my work and ideas without explaining how to correct them» (chaotic). The skewness and kurtosis of the questionnaire scales were within ±1,5 (from –0,90 to 1,25 and from –0,71 to 1,47, respectively). Confirmatory factor analysis was used to test the four-factor structure of the questionnaire, showing an acceptable fit with the data ($\chi^2(68) = 131$, $\chi^2/df = 1,93$, $p < 0,001$, TLI = 0,903, CFI = 0,927, SRMR = 0,085, RMSEA = 0,081 [0,060, 0,102]). The reliability of this and other questionnaires is summarised in the table.

The PhD students' motivation was assessed using The Universal perceived locus of causality scales (UPLOC) (Sheldon et al., 2015). Respondents were asked to rate 29 statements on a 5-point Likert scale in response to the question, «Why are you currently working on your thesis/research?». The questionnaire consists of six scales: two scales assess autonomous motivation: intrinsic motivation («Because I enjoy it»)

and identified motivation («Because I feel this is my calling»), three scales assess controlled motivation: positive introjected motivation («Because it is important for me to be successful»), negative introjected motivation («Because I feel ashamed to give up this activity and look unsuccessful») and external motivation («Because I started this activity and now I have to continue») and one scale assesses amotivation («Honestly, I don't know. I feel like I'm just wasting my time»).

Well-being was assessed using the Russian version of the PERMA Profiler questionnaire (Isaeva, Akimova, Volkova, 2022). The study comprised 17 questions ranging from 0 ("none of the time/not at all") to 10 ("all of the time/ extremely") and six scales, five of which corresponded to the PERMA well-being model: positive emotions («How often do you feel joyful?»), engagement: («How often do you lose track of time while doing something you enjoy?»), relationships («To what extent do you receive help and support from others when you need it?»), meaning («To what extent do you lead a purposeful and meaningful life?»), accomplishment («How often do you achieve the important goals you have set for yourself?»).

The Academic Burnout Scale (Cornér et al., 2021) comprises cynicism and exhaustion scales, as well as ten statements that are rated on a seven-point Likert scale. «I have difficulties in finding any meaning to my doctoral dissertation» (cynicism) and « I feel overwhelmed by the workload of my doctoral research» (exhaustion).

Perseverance was measured using a modified version of the 6-item persistence scale (Gordeeva & Sychev, 2024), which was assessed using a 5-point Likert scale. Example statement: «I achieved a goal in

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scientific work that required several years of effort».

Data analysis was carried out using the RStudio and Jamovi statistical packages.

Results

Autonomous and structuring styles are positively related to each other, but negatively related to their opposites. The same applies to chaotic and controlling styles.

The autonomous style is directly related to autonomous forms of motivation (intrinsic and identified) and negatively related to amotivation. The structuring style is only related to identified motivation, reflecting motives of personal value and connection to goals, and is negatively related to amotivation. Chaotic and controlling styles are neg-

atively related to autonomous motivation and directly related to external motivation and amotivation. Autonomous and structuring styles are directly related to perseverance, while controlling and chaotic styles are inversely related.

Autonomous and structuring styles are directly related to well-being and its three dimensions: engagement, meaning and accomplishment. The controlling and chaotic styles are negatively related to accomplishment, meaning and the general well-being, and are not related to engagement. The autonomous style is negatively related to burnout and its components, whereas the structuring style is only related to cynicism. The controlling and chaotic styles are positively related to burnout and its aspects.

Table

Descriptive statistics, scale reliability, correlations between questionnaires scales

Parameters	Autonomous	Controlling	Structuring	Chaotic	M(SD)	Cronbach's α
Autonomous	—				3,96(0,9)	0,85
Controlling	−0,22*	—			1,65(0,63)	0,70
Structuring	0,70***	−0,22*	—		3,48(1,01)	0,85
Chaotic	−0,55***	0,47***	−0,63***	—	1,73(0,71)	0,70
Intrinsic	0,24**	−0,20*	0,16	−0,29***	3,81(0,98)	0,93
Identified	0,32***	−0,31***	0,23**	−0,33***	3,78(0,91)	0,90
External	−0,14	0,33***	−0,07	0,29***	2,29(1,06)	0,83
Amotivation	−0,36***	0,38***	−0,21*	0,36***	2,24(1,16)	0,94
Burnout	−0,27**	0,33***	−0,15	0,28**	3,33(1,33)	0,88
Cynicism	−0,27**	0,29***	−0,20*	0,31***	3,29(1,59)	0,85
Exhaustion	−0,22*	0,29***	−0,08	0,20*	3,36(1,43)	0,85
Perseverance	0,28***	−0,21*	0,22**	−0,19*	3,55(0,70)	0,72
Engagement	0,38***	−0,14	0,29***	−0,14	6,99(1,84)	0,78
Meaning	0,40***	−0,23**	0,26**	−0,20*	7,01(2,07)	0,89
Accomplishment	0,43***	−0,28***	0,34***	−0,30***	7,13(1,62)	0,79
PERMA	0,36***	−0,24**	0,21*	−0,22*	6,86(1,48)	0,92

Note. * — p < 0,05, ** — p < 0,01, *** — p < 0,001.

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The study found no statistically significant differences in the evaluations of academic supervision styles according to the gender of the PhD students (t = 1,52, p = 0,131; t = 0,32, p = 0,753; t = 2,13, p = 0,035; t = −1,19, p = 0,238). Additionally, no statistically significant differences in the variables (figure) by year of study were observed.

To test the assumption that styles and motivation influence burnout and perseverance, a structural model was constructed (see figure). The estimation of this model showed an acceptable fit to the data: $\chi^2 = 1644$; df = 1153 (χ^2/df < 3); p ≤ 0,001; CFI = 0,898; TLI = 0,887; SRMR = 0,076; RMSEA = 0,057; 90% confidence interval for RMSEA: 0,050–0,063.

As the structural model shows, an autonomous academic supervision style positively predicts autonomous motivation (both intrinsic and identified) and negatively predicts controlled motivation (both external and amotivation). The structuring style predicts autonomous motivation. The controlling and chaotic styles are negative predictors of autonomous motivation and positive predictors of controlled motivation. Autonomous motivation positively predicts perseverance and negatively predicts cynicism, whereas controlled motivation predicts both aspects of burnout. These two types of motivation mediate the effects of academic supervision styles on the dependent variables.

Discussion

The styles associated with BPN for autonomy demonstrate the greatest predictive power, which correlates with SDT's general view of the key role of this need in activity. The total number of style effects on the studied variables suggests that environmental factors should first be changed by eliminating unproductive interaction styles (controlling and chaotic), and secondly by teaching interaction styles that support BPNs.

Preferences for BPN supportive supervisory styles for the PhD students' internal
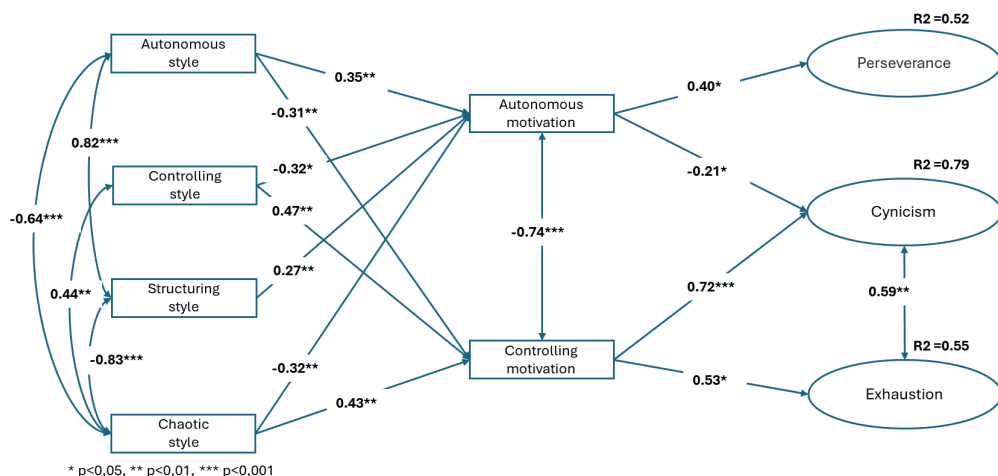

* p<0,05, ** p<0,01, *** p<0,001

Fig. Structural model of the relationship between burnout aspects, perseverance and the academic supervision styles, quality of motivation: * — p < 0,05; ** — p < 0,01; *** — p < 0,001

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outcomes under consideration are consistent with data from a study of PhD student exhaustion and dropout intentions, which showed that positive aspects of interactions with supervisors include advice and training, psychological support, protection, honest interaction and feedback, and a working relationship characterised by interest and enthusiasm (Devine, Hunter, 2016).

The styles that frustrate PhD students' BPNs (controlling and chaotic) are undesirable because they include demotivating aspects of academic supervision. These aspects correlate with study data that showed the negative effects of a lack of responsibility, interest, trust and organisation, as well as overly critical and demanding behaviour, a lack of communication and good treatment, and an inability to advocate for the interests of PhD students or provide mentoring (Devine, Hunter, 2016).

On average, PhD students highly appreciated supervisors using autonomous and structuring styles as opposed to controlling and chaotic styles. This may indicate that relationships are generally built harmoniously despite external obstacles in academic alliances, such as supervisors' lack of professional development and high workloads (Biricheva, Fattakhova, 2021).

Training academic supervisors in mentoring can improve the institution of academic supervision. This training should include the use of motivating styles, reducing the use of frustrating BPNs and demotivating interaction styles, and providing feedback in terms of both academic research and relationship management (Devine, Hunter, 2016; Schmidt, Hansson, 2018).

A limitation of the study is its cross-sectional nature, which does not allow us to be certain of the causality of the associations found.

Prospects for future research could include studying preferred styles at different stages of PhD studies and in different socio-demographic settings, as well as studying the effectiveness of interventions and training that teach supervisors about interaction styles.

Conclusion

Support from supervisors of BPN for autonomy and competence is important for PhD students' current scientific activities, in which BPN in relatedness plays a secondary role. However, it is probably more important for long-term effects. Autonomous motivation and perseverance are associated with autonomous and structured styles of academic supervision, while controlled motivation, amotivation and burnout are associated with controlled and chaotic styles. Academic supervision style is an important predictor of autonomous and controlled motivation, perseverance and well-being, or conversely, burnout, in PhD studies. As autonomous and structuring styles are the most favourable for PhD students, mastering these styles, as well as other ways of supporting BPNs, could be a focus for advanced training programmes for academic supervisors at universities.

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Научная статья | Original paper

Psychological features of interaction of students in grades 7–8 with hypertext: a theoretical and experimental study using an eye tracker

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Abstract

Context and relevance. Currently, hypertext systems are beginning to play an increasingly important role both in the media and in the educational process. Despite a significant array of hypertext studies, most of them are theoretical, and there is a shortage of works on educational hypertext. **Objective.** To present a pilot experimental study aimed at identifying, using an eye tracker, the features of the primary perception of an educational hypertext by 7–8 grade students, their orientation in the text and the distribution of attention in the process of working with the main text and hyperlinks. **Hypotheses:** 1) the first reading of the educational hypertext will be sequential, accompanied by students' familiarization with the content of hyperlinks as they appear in the main text; 2) due to the additional cognitive load that occurs when working with hypertext structures, adolescents will have a relatively low level of hypertext comprehension. **Methods and materials.** Oculographic method, statistical analysis of the oculographic recordings, questionnaire for data collection, authors' diagnostic tool "Hypertext comprehension". The sample included 33 students in grades 7–8 (12 boys and 21 girls, aged 12–15 years (M = 13,8, SD = 0,8)). **Results.** As for attention, the area of greatest intensity included text passages containing specific factual information. Although, due to the immanent properties of the hypertext, adolescents read it non-linearly, the first reading of the text was relatively consistent, without significant text gaps. High and relatively high levels of comprehension were shown by 12,1% of students, average — 48,5%, low and very low — 39,4%. **Conclusions.** In the process of reading, teenagers used not the F-pattern, but the commitment pattern. This result is largely explained by the specifics of working with educational hypertext, when students are given the instruction to read analytically. The prevalence of a low level of understanding indicates that schoolchildren have serious problems in semantic reading in general and reading electronic educational hypertexts in particular.

Keywords: reading and understanding of text, educational hypertext, eye tracker, adolescents, psychological specificity

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Психологические особенности взаимодействия учащихся 7–8-х классов с гипертекстом: теоретико-экспериментальное исследование с использованием айтрекера

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Резюме

Контекст и актуальность. В настоящее время гипертекстовые системы начинают играть все более важную роль и в средствах информации, и в образовательном процессе. Несмотря на значительный массив исследований гипертекста, большинство из них носит теоретический характер, также в дефиците оказываются работы, касающиеся учебного гипертекста. **Цель.** Выявление с помощью айтрекера психологической специфики взаимодействия учащихся 7–8 классов с учебным гипертекстом, а именно следующих особенностей: 1) первичного восприятия текста и следования установке на последовательное аналитическое чтение, 2) распределения внимания учащихся в процессе работы с основным текстом и содержанием гиперссылок, 3) ориентировки в тексте и его понимания. **Гипотезы:** 1) первичное чтение учебного гипертекста будет последовательным, сопровождаться ознакомлением учащихся с содержанием гиперссылок по мере их появления в основном тексте; 2) в силу дополнительной когнитивной нагрузки, возникающей при работе с гипертекстовыми структурами, у подростков будет доминировать недостаточно высокий уровень понимания учебного гипертекста. **Методы и материалы.** Окулографический метод, статистический анализ результатов регистрации окуломоторной активности, анкета с данными испытуемых, авторский диагностический инструментарий «Понимание гипертекста». В выборку вошли 33 учащихся 7–8 классов (12 мальчиков и 21 девочка, возраст — 12–15 лет (M = 13,8, SD = 0,8)). **Результаты.** С точки зрения

внимания в область наибольшей интенсивности попали текстовые отрывки, содержащие конкретную фактуальную информацию. Хотя в силу имманентных свойств, присущих гипертексту, подростки читали текст нелинейно, первичное чтение было относительно последовательным, без существенных текстовых пропусков. Высокий и относительно высокий уровни понимания показали 12,1% испытуемых, средний — 48,5%, низкий и очень низкий — 39,4%. **Выводы.** В процессе чтения подростки применяли не F-паттерн, а паттерн приверженности, что во многом объясняется спецификой работы с учебным гипертекстом, когда учащимся дается установка на аналитическое чтение. Преобладание низкого уровня понимания свидетельствует о наличии у школьников серьезных проблем в области смыслового чтения в целом и чтения электронного учебного гипертекста в частности.

Ключевые слова: чтение и понимание текста, учебный гипертекст, айтрекер, подростки, психологическая специфика

Introduction

Since electronic hypertext emerged in the mid-1960s and especially in the last two decades, psychologists have been studying electronic hypertext quite actively about its specificity and influence on the mental development of students (N. Belyaeva, A. Voyskunsky, O. Arestova, M. Solodov, M. Lebedeva et al., K. Ganel et al., D. Destefano, J. Lefevre, I. Tsumbakh, I. Piksnar, K. Rayner, L. Salmeron). Interest in this issue is determined by the role that hypertext systems play in modern media, representing a real alternative to printed texts and taking an increasingly important place in the educational process.

Among the most important problems of the study of hypertext, psychologists highlight the following: increasing cognitive load on students including interacting with non-linear text (Voiskounskiy, 2017; DeStefano, LeFevre, 2007; Skulmowski, Xu, 2022; Taky-eddine, Madaoui, 2024); the specifics of navigation activities; the influence of the hyperlinks systems on users' attention and text comprehension (DeStefano, LeFevre, 2007; Schurer, Opitz, Schubert, 2023); the use of cognitive and metacognitive strategies for reading hypertext (Berlin Henis et al., 2023; Lebedeva, 2022; Mironova, Borisenko, Shishkova, 2024).

Analysis of relevant publications allowed us to identify a number of provisions that should be relied upon in hypertext research.

1. Hypertext, as one of the digital technologies, differs from classical printed text as hypertextuality is fully realized only in electronic hypertext, which has such characteristics as virtuality, dispersed structure, interactivity, compositional instability, nonlinearity, openness, multimedia etc. (Stroikov, 2024, pp. 16–17).

2. The specifics of hypertext structure determine the peculiarities of its perception and the reader's interaction with it. A virtual structure of an electronic text includes the main text and embedded hyperlinks leading to hypotexts. (The term "hypotext" is used in the most commonly accepted sense: as the minimal text unit of hypertext available after opening a hyperlink (Ryazantseva, 2010, p. 54)). This virtual structure allows for nonlinear reading, fragmentation, and the development of a reader's individual route. A number of scientists note that the reader, especially a novice with insufficient skills in navigating hypertext structures, may "get lost" in cyberspace, following links leading away from the main text and failing to cope with the initial task (Salmerón et al., 2015; Schurer, Opitz, Schubert, 2023).

3. Interaction with hypertext increases cognitive load due to the necessity to integrate and retain information from different information units in working memory. An increased cognitive load can affect the success of task completion negatively (DeStefano, LeFevre, 2007). On the other hand, as the recent studies show, proper organization of the educational process can minimize the negative aspects of interaction with hypertext (such as loss of orientation, wandering from the topic being studied, etc.) and develop a strategy for balancing cognitive load in digital learning (Skulmowski, Xu, 2022; Sweller, van Merri nboer, Paas, 2019).

In general, despite the significant number of studies dedicated to hypertext research, they are mostly theoretical in nature and often duplicate information obtained at the early stages of its study. There is a shortage of research related to educational hypertext, which differs from non-educational (authentic) hypertext primarily by the specifically organized educational and scientific information it contains. Educational hypertext is marked by such features as strict compliance with the educational task set, completeness and integrity, defined structure, and a limited number of hyperlinks that contain reliable information. Due to these properties, educational hypertext allows the schoolchildren, to a certain extent, to manage their cognitive activity.

Another shortcoming of modern hypertext research is the rare use of precise methods. There is a shortage of studies conducted using oculography (eye tracking) method, a technique for recording eye movements. There is a number of such studies that have been performed by foreign scientists (Rayner et al., 2006; Salmerón et al., 2015; Strukelj, Niehorster, 2018), but this method is rarely used with Russian-language samples (see, for example: (Beloedova, 2023; Berlin Henis et al., 2023; Oganov, Kornev, 2018)).

Studying hypertext using the oculographic method is a very promising direction. It allows for the objectification of both the process of text perception and the ways of interacting with the text. The analysis of eye-movement activity makes it possible to study models of reading behavior and its types, as well as reading strategies. However, we should take into account that the practical use of an eye tracker has a number of limitations and difficulties (see Pokhoday et al., 2022 for details), which will be discussed below.

The aim of the research is to identify, using an eye tracker, the psychological specifics of 7th — 8th grade students' interaction with educational hypertext, namely, the following characteristics: 1) the initial perception of the text and the approach to consistent analytical reading; 2) the distribution of students' attention in the process of working with the main text and the content of hyperlinks; 3) navigation in the text and its understanding.

On the basis of the stated goal, the researchers formulated the following hypotheses:

1. Since educational hypertext is distinguished by its special modeling of the infor-

mation presented for organizing and managing students' activities, we assumed that the initial reading of educational hypertext will be consistent and the students will simultaneously read the content of hyperlinks as they appear in the main text.

2. Due to the additional cognitive load that arises when working with hypertext structures, adolescents are likely to demonstrate an insufficient level of understanding of educational hypertext.

Research Materials and Methods

During the study, the researchers conducted an exploratory pilot experiment using the following methods and techniques:

1. Oculographic method. To record eye movements, we used a Gazepoint GP3 eye tracker with a recording frequency of 60 Hz and 9-point calibration before the experiment. Depending on the computers available in schools, the researcher demonstrated the stimulus data on either 14-inch monitors with a resolution of 1920 × 1080 pixels (n = 9) or 17-inch monitors with a resolution of 1280 × 1024 pixels (n = 24). The study participants sat at a distance of 700–800 mm from the screen. The participants' head position was not fixed during the recording. The eye tracker only tracked the recording of the primary reading, work with the diagnostic test was not subject to video recording.

Statistical analysis of the results of oculomotor activity registration was developed using the Python programming language and jamovi software (V. 1.6.23.0).

2. A questionnaire with the subjects' personal data. In the questionnaire, the students indicated their age, gender, and grade.

3. The author's diagnostic toolkit "Understanding Hypertext", based on I.R. Galperin's theory of the types of information in the text

(Galperin, 2007). It implements a gradual-level approach which views understanding not as a binary opposition (understood / did not understand), but as a phenomenon that unfolds stage-by-stage (understood more / less) (Shcherbakova, Obolskaya, 2023). Previously, using this approach, we developed a diagnostic technique to define the level of text understanding by adolescents in the process of comprehended reading from paper and from screen (Mironova, Borisenko, Shishkova, 2024).

As the stimulus material, we chose a fragment from the textbook "Pushkin, his Friends and Contemporaries", dedicated to the ancestors of A.S. Pushkin (Granik, Kontsevaya, Mironova, 2023), since the research was carried out in line with the development of the scientific school of the Russian Academy of Education academician G.G. Granik, in particular, with her research on reading and understanding the text (Borisenko, Mironova, Shishkova, 2022). The book is part of the series "School literary studies on a psychological basis". Based on this text, we developed an experimental educational humanitarian-oriented hypertext, which includes nine hyperlinks of varying size and complexity and an illustrative series of five drawings: a self-portrait of Pushkin in 1829, the Pushkin family coat of arms (in the main text), a portrait of Peter I, and the images of Ethiopia and Cameroon on the map of Africa (in hyperlinks). The hypertext is 4.5 pages long in A4 format (1,058 words). Such a long text was chosen, first of all, due to the need for scrolling and hyperlink navigation. The Flash readability index (FRE) for this text is 44 points[1] — it corresponds to the category of rather complex yet accessible to students of this age group texts.

A specially developed diagnostic toolkit includes tasks for reading two types of text

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[1] See: Readability and naturalness of large texts. URL: https://progaonline.com/textquality/result/c719bc1e-4ca53ed6aff686106308e035 (date of request:15.09.2024).

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information: factual (describing events, place and time of action) and conceptual ("the system of views, thoughts and feelings the author reflected in the text" (Galperin, 2007, p. 27)). It includes 12 tasks, 5 of which are closed-type and 7 are open-type, requiring a short or detailed answer. These tasks were designed so that the subjects could successfully complete them only by reading both the main text and the content of hyperlinks. The criteria for evaluating detailed answers were the completeness of the statement and its adequacy to the original text. Qualitative analysis was based on the method of expert assessments using a three-point scale. The expert group included five specialists (three philologists, two psychologists) with experience of working with adolescent schoolchildren. The consistency of the experts' opinions was assessed with Cronbach's alpha coefficient; the rate was 0,87. As a result, five levels of text comprehension were identified based on the total scores (very low: almost complete distortion of meaning — 0–24% of the maximum possible score; low: superficial comprehension — 25–49%; average: partial comprehension — 50–69%; relatively high: good but not complete and fully accurate comprehension — 70–84%; high: sufficiently complete and accurate comprehension — 85–100%).

Sample. The pilot study conducted in April–May 2024, involved 33 subjects: 7th–8th grade students from two secondary schools in Moscow and the Moscow Region (12 boys and 21 girls, aged 12–15 years (M = 13,8, SD = 0,8); 7th grade, n = 11; 8th grade, n = 22). All participants had normal or corrected to normal visual acuity, and good or excellent academic performance in relevant subjects (Russian language, literature, history).

The empirical study procedure. First, the subjects filled out a questionnaire, and the eye tracker was calibrated. Then, the

students were given instructions. They were told to carefully read the text presented on the computer screen. As they read, they should sequentially open the hyperlinks in the text. After that, they needed to complete reading comprehension tasks. The instructions required analytical reading, focused on revealing the text's content and structure, which, in terms of foreign psychologists (Salmerón et al., 2015), corresponds to deep processing of the text. The reading time, during which eye movements were recorded, was not limited. After reading the text, the subjects answered diagnostic questions in writing with the permission to refer to the text while answering.

The total duration of the experiment for each subject was 35 to 40 minutes.

Results and Discussion

To analyze the data obtained using oculography (for experimental data sets, see (Borisenko, Ganicheva, Mironova, Shishkova, 2025)), we selected the following parameters: the number of fixations and their average duration, the total time of reading the text, the number of clicks on hyperlinks, the duration of viewing relevant hypertext positions, and the distribution of average fixation durations within paragraphs. The selected parameters are generally accepted for analysis in modern eye-tracking studies (Pokhoday et al., 2022; Salmerón et al., 2015; Strukelj, Niehorster, 2018).

During the research, we made an important observation regarding the distribution of attention among the subjects: contrary to widespread assertions that the main strategy of reading from screen is scanning reading, employed mostly according to the principle of the well-known "F-pattern", when the number of visual fixations is concentrated in the upper and left parts of the page (Nielsen, 2006), the F-pattern was not used by the subjects while reading the experimental educational hyper-

text. This is probably due to the fact that the F-pattern describes the behavior of users in the process of viewing web content, but our subjects had a different purpose of reading — not skimming, but analytical educational reading of the hypertext.

Fig. 1 shows an example of a typical heat map of gaze fixations during initial acquaintance with the first page of the stimulus text.

Data visualization shows that the text is being read quite consistently, without significant gaps. In terms of attention, the area of greatest intensity included the second and the third paragraphs containing specific factual information about Pushkin's ancestry. Researchers note that the average duration of fixations increases when low-frequency and less predictable words are fixed and when a section of text contains a greater number of important thoughts (Nazarov, Meshcheryakov, 2009). We can also include in this list hyperlinks (there are four of them in this fragment, all of them have an important meaning-making function) and keywords (great interest in his lineage, the Pushkin family, Boris Godunov, mother's family tree, was a black man).

As a result, the adolescents applied in the process of reading not the F-pattern, but the so-called "commitment pattern", or "compliance with obligations" pattern discovered by researchers from the Nielsen Norman Group in addition to the main F-pattern and along with others (Z-pattern, "layer cake", "spotted pattern" etc.). The essence of the commitment pattern is fixing the gaze on almost every element of the page and reading according to the principle "line by line, paragraph by paragraph". It is noted that this pattern is rarely used, mainly by motivated readers really interested in the content (Pernice, 2017).

So the research revealed that although, in general, due to the inherent properties of hypertext, most schoolchildren read the text non-linearly, following hyperlinks, the initial reading of both the main text and hypotexts was relatively consistent. This sequence of reading is largely explained by the characteristics of this study where the educational hypertext is the object.

Fig. 1. Individual heat map of the initial hypertext page (first three paragraphs): the red squares indicate the locations of mouse clicks

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Now let us consider the procedural aspect of reading some of the most important structural components of hypertext such as the wording of the task and the so-called strong positions of the text, including the heading complex.

The participants kept their eyes on the task formulation for quite a long time (on average 3.8 seconds, the standard error of median (SEM) = 0,75), demonstrating the correct response to the instructions (setting to analytical reading), on the title and subtitle — 2,3 seconds (SEM = 0,40), on the illustrations before the text — 1.4 seconds (SEM = 0,40). At the same time, the participants who used a 14–inch screen read the task significantly slower than the participants who worked with a 17-inch screen (Mann — Whitney criterion, p = 0,002). Stu-

dents who worked with a 14-inch screen also read the main text more slowly (p = 0,003). The results are quite natural: the smaller the screen size, the more difficult the reading process is, and this fact is confirmed by the data available in the literature dedicated to the relation between screen size and reading speed (Lebedeva, 2022; Rayner et al., 2006).

Fig. 2 shows another example of a heat map showing the average duration of fixations on different parts of the top of the home page, the center and the peripheral areas of the screen.

The longer average fixation on text fragments than on illustrations can be explained by the fact that the visual component does not play a significant role for this specific hypertext: all the drawings, except one, have

Fig. 2. Individual heat map of the top of the home page of an educational hypertext, constructed for one student

decorative or illustrative functions and have no significant semantic content.

The average hypertext reading speed is an important indicator. It was calculated with the traditional method (the number of words in the entire hypertext divided by the reading time). For the text presented, the average reading speed was 115 words per minute. So we can see that the speed of reading hypertext is quite slow on average, which is probably due to the additional cognitive load related to clicking on hyperlinks. Foreign scientists in their studies (Rayner et al., 2006; Strukelj, Niehorster, 2018) recorded similar results showing an increase in text processing time (and especially the number of fixations) in the case of analytical reading of a complex text. At the same time, we regard the obtained result as preliminary; analysis of the hypertext reading speed requires additional oculographic research.

Next, let us consider data related to navigational activity and the effectiveness of text comprehension.

The characteristics and effectiveness of hypertext reading are determined by the number of hyperlinks clicked by the user. The more hyperlinks are clicked, the more information becomes available and can be perceived by the reader. The ability to compose an individual reading route is one of the advantages of hypertext structures compared to traditional linear text. This indicator is important for eye-tracking studies of hypertext: it reveals the individuality and effectiveness of interaction with the text. However, in our case, we are talking about interaction with an educational text; accordingly, we tried to minimize the variability of the educational task performance by setting the goal of attentive, analytical reading and the requirement to click all hyperlinks and then return to reading the main page using the "Back" button.

The table shows the number of students who opened different numbers of hyperlinks.

Table

Number of opened hyperlinks

Number of hyperlinks	Number of students who opened hyperlinks (n = 33)
8–9	19 (57,5%)
5–7	6 (18,2%)
2–4	3 (9,1%)
0–1	5 (15,2%)

As we can see, the majority of subjects (75,7%) followed the instructions and clicked the most part of the hyperlinks while reading the text. However, the number of students who followed less than half of the links was also quite large — about a quarter (24,3%). In addition, a small part of adolescents (five people, 15,2%) ignored the instructions and read the material as a regular text, not clicking hyperlinks at all (or clicking only one of them) and, therefore, missing out on more than half of the available information. This indicates either a conscious refusal by the students to follow the instructions or that this group of students did not understand the specifics of hypertext and had no experience working with it.

At the next stage, we analyzed the level of understanding of the hypertext using the developed diagnostic tools. The results were as follows: 13 subjects (39,4%) demonstrated a low or very low level of understanding, 16 people (48,5%) demonstrated an average level, and only 4 (12,1%) demonstrated a high or relatively high level. That is, the hypothesis regarding the predominance of an insufficient level of understanding was confirmed.

It should be noted that we also conducted a parallel comparative study of the comprehension level when reading two versions of educational hypertext, identical in content — electronic and printed. It was found that stu-

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dents who worked with the electronic version coped with the diagnostic test significantly better (p < 0,05) — both in general and with finding factual information in particular. At the same time, no significant differences were found in understanding conceptual information (p > 0,05) (Mironova, Borisenko, Shishkova, 2024). However, just as in the study we present now, the level of comprehension turned out to be quite low: only 9,7% of students were able to understand and formulate the main idea of the text absolutely correctly, and about half (50,5%) failed to complete the task.

In general, we can state stated that 7th–8th grade students have an insufficient level of practical skills necessary for effective interaction with educational hypertext. This is probably due to the fact that the process of mastering the skills for working with electronic text develops spontaneously, and the school currently is not responsible for teaching students digital reading.

Conclusion

In our study, we identified the characteristics of the primary perception of educational hypertext by 7th–8th grade students, their abilities to navigate such a text, and the distribution of attention during the process of working with both the main text and hyperlinks. We revealed the specifics of adolescents' interaction with hypertext in terms of the specifics of reading, navigation activity, and text comprehension, and collected preliminary data on reading speed. New data have been obtained on the procedural and productive aspects of how 7th–8th grade students understand complex educational hypertext.

1. The study revealed that, in general, due to the inherent properties of hypertext, the subjects read the text non-linearly. However, the primary reading recorded by the

eye tracker was relatively consistent, without significant text gaps. The well-known F-pattern was not confirmed in our experiment. The subjects used the opposite pattern — the "commitment pattern", which is characterized by reading the entire text while the gaze is fixed on almost every element of the page.

2. We defined the features of navigational activity of 7th–8th grade students in interacting with hypertext. Contrary to widespread fears that hyperlinks can take the reader away from the main route and lead to loss of orientation, the majority of subjects (75,7%) navigated the links from beginning to end in the given order. However, the number of students who opened less than half of the links or did not open them at all was also significant (24,3%).

3. Generally, in the sample (n = 33), only 12,1% of students demonstrated a high or relatively high level of understanding of the text. In both groups, very low and low levels of understanding predominated (39,4%). The data obtained support our hypothesis that adolescents have certain cognitive difficulties when working with hypertext, which may negatively affect understanding.

The prospects for further study of hypertext are open in several directions, including expanding the sample size, correcting the course of the experiment (performing diagnostics without the access to the previously read text, which will increase the representativeness of the data recorded using an eye tracker), and conducting comparative studies — with electronic and printed hypertext, electronic educational and authentic hypertext, etc.

The limitations of the study are related to the use of two monitors of different sizes, the type of eye tracker, and the small sample size, though sufficient for initial validation.

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Artificial intelligence in school mathematics education: awareness, readiness, and usage among mathematics teachers

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Abstract

Context and relevance. This article presents the results of the study conducted among mathematics teachers — the category of teachers particularly inclined toward critical thinking and evidence-based application of innovations in education. **Objective.** The objective of this study is to identify the awareness of math teachers about the AI capabilities and potential in teaching as well as the practice of their application in the educational process. **Methods and materials.** To achieve this objective, a questionnaire was developed, comprising three main sections: awareness, readiness, and practical application. The survey was conducted online using Yandex Forms. A total of 122 mathematics teachers from 44 regions of the Russian Federation, varying in age and teaching experience, participated in the study. **Results.** The results showed that approximately 70% of the respondents express a willingness to use AI in their teaching process. The directions in which math teachers are most and least inclined to trust AI have been identified. The proportion of teachers currently using AI technologies and specific software products based on AI ranges from 13% to 40%. **Conclusions.** A significant part of teachers is generally aware of AI's potential. However, their knowledge is fragmentary, covering only certain aspects and lacking systematic understanding. Promising directions for further research include examining the issues surrounding the use of AI technologies in the educational process while taking into account their specific characteristics. Special attention is recommended to improving teaching methodologies based on AI technologies and identifying effective ways to apply them for the development of students' cognitive abilities.

Keywords: artificial intelligence, AI in education, neural networks, neural networks in education, mathematics teachers, teacher readiness, digitalization of education

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Искусственный интеллект в школьном математическом образовании: осведомленность, готовность и использование учителями математики

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Резюме

Контекст и актуальность. В статье представлены результаты исследования, проведенного среди учителей математики — категории педагогов, наиболее склонной к критическому осмыслению и доказательно-обоснованному применению новшеств в образовании. **Цель**. Выявить осведомленность учителей математики о возможностях и потенциале искусственного интеллекта, готовность использовать технологии искусственного интеллекта в педагогической деятельности и практику их применения в образовательном процессе. **Методы и материалы**. В соответствии с поставленной целью была разработана анкета, включающая три содержательных раздела (осведомленность, готовность, практика применения). Анкетирование было реализовано онлайн с использованием Yandex Forms. В исследовании приняли участие 122 учителя математики из 44 регионов Российской Федерации, имеющие различный возраст и педагогический стаж. **Результаты.** Анализ результатов анкетирования показал, что порядка 70% учителей выражают готовность использовать искусственный интеллект в педагогической деятельности. Выявлены направления, в рамках которых учителя математики в наибольшей и наименьшей степени склонны доверять искусственному интеллекту. Доля педагогов, уже использующих технологии искусственного интеллекта и отдельные программные продукты, созданные на его основе, составляет от 13% до 40% в зависимости от направления применения. **Выводы**. Значительная часть учителей в целом осведомлена о потенциале искусственного интеллекта, однако знания педагогов обрывочны, затрагивают отдельные аспекты, носят бессистемный характер. Перспективным направлением дальнейших исследований является изучение вопросов использования в образовательном процессе технологий ИИ с учетом их специфических особенностей. Рекомендовано уделить особое внимание вопросам совершенствования методики обучения предмету на основе технологий искусственного интеллекта, а также поиску путей эффективного их применения для развития когнитивных способностей обучающихся.

Ключевые слова: искусственный интеллект, искусственный интеллект в образовании, нейросети, нейросети в образовании, учителя математики, готовность учителей, цифровизация образования

Introduction

Artificial intelligence (AI) and its derivative technologies constitute a prominent focus of contemporary scholarly discourse, with accelerating adoption for pedagogical purposes across tertiary and secondary educational contexts in recent years.

The integration of AI technologies within instructional frameworks has been comprehensively examined in extant literature (Kovalchuk, Taranenko, Ustinova, 2023; Sysoev, Filatov, Sorokin, 2023; Kim, Cha, Kim, 2021; Kohnke, Moorhouse, Zou, 2023; Uygun, 2024). A critical analysis of research trajectories indicates predominant implementation within foreign language education. Scholars have documented diverse applications, including the development of linguistic competencies (Kovalchuk, Taranenko, Ustinova, 2023; Sysoev, Filatov, 2023), facilitation of online language instruction (Junaidi et al., 2020; Liu, Ma, 2023), and enhancement of oral proficiency in different languages.

However, scholarly investigations of AI applications in mathematical education remain comparatively limited. Current research examines AI's pedagogical impact of AI, particularly neural networks, on mathematics instruction (Urazaeva, Zamyadkin, 2024; Shpak, Semenova, Zaburdaeva, 2024; Gao, 2020; Voskoglou, Salem, 2020; Wu, 2021), prospects for the use of modern AI technologies in mathematical education at various levels, and explorations of AI-enabled mathematical problem-solving tools (e.g., MathGPT, ChatMathGPTPro). While AI is broadly conceptualized as facilitating personalized learning and reducing instructional burdens through the automation of routine assessments, extant scholarship insufficiently addresses the methodological implications for developing learners' cognitive capacities. Notably, Freeman (2015, p. 102) cautions that digital technologies may inadvertently "encourage superficial thinking rather than the desire to reflect on the meaning of the information received, having a negative impact on the mental development and interpersonal relationships of children."

Scholarly analysis further indicates that AI-based learning provokes debate, rejection, and concern among a wide range of teachers. Consequently, this research investigates educators' awareness of AI-based educational

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technologies, their perceptions, implementation approaches, and barriers to utilizing AI tools for instructional purposes. (Kalitvin, Frolova, 2020; Cojean et al., 2023; Nazaretsky, Cukurova, Alexandron, 2022; Uygun, 2024; Xuan, Yunus, 2023). This is compounded by a prevalent "lack of systematic understanding of AI's organizational, didactic, and methodological potential" (Sysoev, 2023, p. 28). Meanwhile, researchers have observed predominantly favorable teacher attitudes toward AI in education, while noting significant concerns regarding ethical issues, confidentiality, and implementation workloads deemed disproportionate to educational gains. They concluded that technical and methodological support is essential to maximize AI's potential of AI. Further research is recommended to boost teacher confidence and refine the methodological frameworks for AI implementation. Consequently, researchers have emphasized the necessity of robust technical and methodological support structures.

Crucially, subject-specific receptiveness disparities are evident, with mathematics educators exhibiting pronounced criticality despite their comparatively advanced AI awareness. This disciplinary gap underscores the present study's objective of examining mathematics teachers' (1) AI competency awareness, (2) integration willingness, and (3) current implementation practices.

Materials and methods

An online survey of mathematics teachers was conducted using the Yandex Forms platform to collect data. Respondent recruitment was facilitated by the Association of Mathematics Teachers of the Republic of Karelia, which has engaged educators from multiple Russian regions during its decade-long operation.

The study involved 122 mathematics teachers from general education institutions across 44 constituent entities in the Russian Federation. The largest participant groups were from Moscow and Moscow Oblast (10,7%), the Republic of Karelia (8,2%), and Lipetsk Oblast (6,6%).

Regarding age distribution, the largest cohort comprised teachers aged 40-55 years (67 respondents, 54,9%), followed by those aged ≥56 years (30, 24,6%), 25-39 years (17, 13,9%), and <25 years (8, 6,6%).

The teaching experience distribution showed that most respondents had >20 years of experience (58,2%), while the smallest group had <1 year (0,8%). Teachers with 11–20 years of experience comprised 18% of the participants, 1-5 years: 13%, and 6-10 years: 9%.

Overall, the sample aligned with the national teaching workforce in the country (predominance of 40–55-year-old educators with substantial experience).

To achieve the research objective, a questionnaire was developed containing the following:

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Respondent background section (age, work experience, region) and three substantive sections.

Section 1. Awareness of AI's potential in mathematics education.

Section 2. Willingness to implement AI technology in teaching.

Section 3. Practical applications of AI technologies in teaching.

The survey concluded with an open-ended question: «Additional comments» for remarks and free-form statements on the topic.

Sections 1 and 2 employed a Likert scale for statement evaluation (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).

Section 3 required dichotomous responses (yes/no) to specific statements and included multiple-choice questions.

The questionnaire design was informed by Sysoev's (2023, p. 13) framework of AI applications in education: 1) education management; 2) learning personalization; 3) teacher preparation opti-

mization; 4) instructional process organization; and 5) discipline-specific learning optimization. proposed options.

Since Sysoev's framework targets university instructors, while this study examines school mathematics teachers, the instrument focused on three aspects: "learning personalization; teacher preparation optimization; instructional process organization" (Sysoev, 2023, p. 13). The survey questions incorporated modified statements from Sysoev's work, supplemented with mathematics-specific items.

The study results were analyzed using descriptive statistics and one-way repeated-measures analysis of variance. The database containing the research results is available in the MSPPU RusPsyData Repository (Kuzmenko, 2024).

Results and discussion

The results of the analysis of mathematics teachers' responses to Section 1 of the questionnaire (awareness of the potential of AI technologies) are presented in Table 1.

Table 1

Awareness of mathematics teachers regarding the capabilities and potential of artificial intelligence (N = 122)

Survey question	Response options, %					Statistical characteristics	
	1	2	3	4	5	M_x Mean	M_0 Mode
Organization of the educational and upbringing process and individualization of instruction							
AI can:							
1.1. develop an individualized educational trajectory for the student in learning the subject	7,4	23,0	30,3	37,7	1,6	3,0	4
1.2. develop individualized assignments in accordance with the students' interests, needs, and abilities, as well as determine the sequence of their completion	5,7	21,3	10,7	59,0	3,3	3,3	4

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Survey question	Response options, %					Statistical characteristics	
	1	2	3	4	5	M_x Mean	M_0 Mode
1.3. помочь учителю в решении организационных вопросов (контроль посещаемости, выполнения заданий, проверка письменных работ на плагиат и т.п.) / help the teacher in solving organizational issues (e.g., attendance monitoring, assignment completion, plagiarism checking for written works, etc.)	4,1	12,3	17,2	51,6	14,8	3,6	4
1.4. be utilized in developing virtual assistants to provide immediate feedback on organizational issues (e.g., clarification of homework; clarification of assignment content, etc.)	4,1	7,4	13,9	59,0	15,6	3,7	4
1.5. conduct automated control and assessment of students' assimilation of material (knowledge acquisition, skill development, formation of competencies) or completion of assignments	5,7	22,1	20,5	44,3	7,4	3,3	4
Teacher preparation for lessons							
AI can help the teacher in:							
1.6. planning lessons (series of lessons)	4,1	13,1	29,5	47,5	5,7	3,4	4
1.7. creating teaching materials (textual, visual, presentations, videos, etc.); exercises and assignments	2,5	12,3	16,4	58,2	10,7	3,6	4
1.8. developing assessment tools	3,3	9,0	19,7	61,5	6,6	3,6	4
1.9. preparing and organizing students' project activities	4,1	12,3	28,7	46,7	8,2	3,4	4

The analysis indicates that the modal response for all Section 1 questions was 4. Overall, 37,7-61,5% of educators expressed positive attitudes ("agree" responses). In the "Organization of the educational and upbringing process and individualization of instruction" subsection, the means ranged from 3 to 3.7. The "Teacher preparation for lessons" subsection showed minimal variation (3,4-3,6).

To identify the significance of the differences in the average values of mathematics teachers' awareness of AI capabilities, the method of one-factor analysis of variance for connected selections was used. Analysis was conducted separately for awareness components: instructional process/personalization (items 1,1-1,5) and lesson preparation (items 1,6-1,9).

One-way analysis of variance revealed significant differences in awareness means for items 1,1-1,5: $F_{(4, 605)}$ = 9,66, p < 0,0001. As Table 1 demonstrates, the highest means concerned AI applications for:

Developing virtual assistants providing instant organizational feedback (Mx = 3.7; item 1,4)

Operational organizational feedback systems (Mx = 3,6; item 1,3)

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The lowest mean (Mx = 3,0) was observed for AI's capacity to design individualized learning trajectories (item 1.1).

No significant differences emerged for items 1.6-1.9: F (3, 484) = 2,11, p = 0,098.

We now present the Section 2 questionnaire results (Table 2).

This willingness to adapt reflects their commitment to student-centered learning and continuous professional development. Teachers often seek innovative approaches to make complex mathematical concepts accessible and engaging for diverse learners. By embracing new

Table 2

Readiness of mathematics teachers to use
ai technologies in pedagogical practice (N = 122)

Survey question	BResponse options, %					Statistical characteristics	
	1	2	3	4	5	M_x Mean	M_0 Mean
2.1. I am open to changes in the interest of the students and to using AI in the educational process	4,9	2,5	16,4	52,5	23,8	3,9	4
My use of AI in teaching mathematics is hindered by:							
2.2. lack of knowledge and skills	9,0	11,5	15,6	41,8	22,1	3,6	4
2.3. lack of appropriate equipment and software	9,0	8,2	16,4	45,1	21,3	3,6	4
2.4. a low level of trust in AI	6,6	20,5	31,1	29,5	12,3	3,2	4
2.5. I use AI in my teaching and do not see any obstacles to its use	16,4	27,9	34,4	17,2	4,1	2,6	3
I would like to and am ready to use AI in my educational activities for the following purposes:							
2.6. developing an individualized educational trajectory for students	6,6	9,8	14,8	53,3	15,6	3,6	4
2.7. developing individualized assignments in accordance with students' interests, needs, and abilities, as well as determining the sequence of their completion by students	3,3	6,6	13,1	61,5	15,6	3,8	4
2.8. developing teaching materials, including the selection of textual, visual materials, presentations, etc., on various topics	4,1	7,4	4,1	63,9	20,5	3,9	4
2.9.developing a system/collection of exercises, assignments, or tests	3,3	4,9	9,8	61,5	20,5	3,9	4
2.10. automated control and assessment of students' assimilation of material (knowledge acquisition, skill development, and competency formation) or task completion	7,4	9,8	12,3	52,5	18,0	3,6	4
2.11. preparation and organization of students' project activities	4,1	12,3	15,6	52,5	15,6	3,6	4
2.12. analytical activities aimed at modernizing the educational process	3,3	7,4	23,0	45,1	21,3	3,7	4
The following measures could increase my readiness to use AI in teaching:							
2.13. professional development courses	6,6	4,1	25,4	36,1	27,9	3,7	4

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Survey question	BResponse options, %					Statistical characteristics	
	1	2	3	4	5	M_x Mean	M_0 Mean
2.14. seminars, webinars, and master classes	3,3	4,9	18,0	45,1	28,7	3,9	4
2.15. support from the administration	3,3	4,9	27,9	37,7	26,2	3,8	4
2.16. technical support	3,3	0,8	9,8	52,5	33,6	4,1	4
2.17. exchange of experiences with colleagues	2,5	1,6	12,3	46,7	36,9	4,1	4

pedagogical strategies, mathematics educators can create more inclusive and effective learning environments that cater to various learning styles and abilities of students. Regarding item 2,1, 52,5% agreed and 23,8% strongly agreed. The mean was 3,9 owing to negative responses: 4,9% strongly disagreed and 2,5% disagreed.

The lowest mean (Mx = 2,6) occurred for item 2,5: only 17,2% (agree) and 4,1% (strongly agree) reported unimpeded integration. A one-way analysis of variance for related samples was used to assess readiness differences across the two component groups.

Items 2,2-2,4 (barriers)

Items 2,6-2,12 (readiness)

Significant differences emerged for items 2,2-2,4 (F (2, 363) = 4,50, p = 0,012), with the lowest mean indicating that distrust hinders AI adoption (item 2,4). Knowledge deficits (M = 3,6) and inadequate resources (lack of appropriate hardware and software) were the most prominent barriers.

For items 2,6–2,12, the one-way repeated-measures analysis of variance showed no statistically significant differences (F (6, 847) = 1,91, p = 0,076).

Analysis of open-ended responses revealed three primary concern domains.

1. AI distrust: 41,8% cited distrust as a barrier (item 2,4). A representative comment was, "School implementation requires mature tools, not developmental-stage technologies."

2. Professional development limitations: Teachers criticized the technical focus of training programs over pedagogical integration, citing time constraints for self-directed learning. Technical support (items 2,16-2,17) and peer collaboration were deemed essential.

3. Cognitive development concerns: The third dimension, deemed most critical and warranting targeted examination, reflects teachers' predominant perception of AI as both an automation tool for "skill practice" and a supplementary instructional diversifier. Crucially, mathematics education requires "teaching students proper reasoning" (cit.). Educators have emphasized the pressing need to develop effective AI applications to enhance learners' cognitive abilities.

Overall, most teachers expressed their readiness to implement AI in instruction and lesson preparation. Their pandemic-era remote teaching experience

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with ICT (including their experience they got through distance learning during the pandemic) fosters optimism regarding future AI technology adoption. The focus now shifts to Section 3 of the questionnaire (Fig.1).

Survey analysis indicates that AI tool utilization among educators ranges from 13,1% to 40,2%. Teachers most frequently employed AI technologies for creating instructional materials (textual, visual, etc.) by topic (40,2%) and developing knowledge assessment tasks (32,8%). The lowest adoption rate was for designing individual learning trajectories (13,1%).

Analysis of generative neural networks utilized for educational purposes (Table 3) reveals YandexGPT (27,5%), ChatGPT (25%), Shedevrum (18,3%),

and Kandinsky 3.1 (15,8%) as the most prevalent. Minimal utilization (<1%) was observed for Perplexity, Kaiber, Focus, Khroma, and Stable Diffusion. These disparities may stem from limitations in access, technical constraints, and complexities in implementation.

It should be noted that in the final question, additional comments, none of the teachers supplemented the proposed list of neural networks used.

Conclusion

This study successfully addressed all research objectives concerning mathematics teachers' awareness of AI capabilities and potential, their current readiness to master AI tools for professional practice, and identified problematic areas and future research directions.
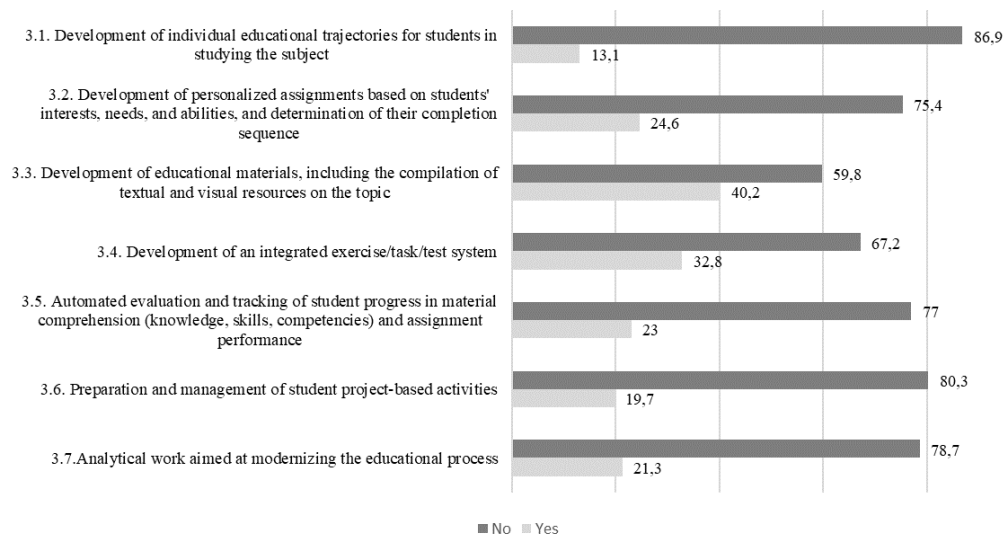
I use AI for the following purposes:

Fig. Practice of using AI technologies by mathematics teachers in pedagogical activities (N = 122)

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Table 3

Neural networks used by teachers for educational purposes (N = 122)

Survey question	Response options, %		
4. I know/use neural networks:	I do not know and have not used it	I know it but have not used it	I know it and use it
YandexGPT	41,7	30,8	27,5
ChatGPT	42,5	32,5	25
Shedevrum	58,3	23,3	18,3
Kandinsky 3.1	62,5	21,7	15,8
Alice	55,8	35	9,2
Midjourney	77,5	14,2	8,3
GigaChat	64,2	28,3	7,5
Gamma	85	11,7	3,3
Lexica	80,8	16,7	2,5
Your Personalized AI Assistant	90,8	7,5	1,7
Perplexity	90,8	8,3	0,8
Kaiber	90	9,2	0,8
Fokus	88,3	10,8	0,8
Khroma	92,5	6,7	0,8
Stable Diffusion	90	10	0

1. The findings on mathematics teachers' awareness of AI applications in education revealed that a significant majority (over 50%) were familiar with core AI implementation areas. However, this knowledge remains fragmented, with varying levels of awareness across applications. One-way repeated-measures analysis demonstrated statistically significant differences in awareness components related to the instructional process organization. The highest mean scores reflect awareness of AI's potential for developing virtual assistants that provide instant organizational feedback, while the lowest correspond to AI's capacity for designing individualized learning trajectories. No significant differences were observed in the lesson preparation components.

2. A positive perception of AI was evidenced by approximately 70% of surveyed teachers expressing a willingness to implement AI in pedagogical practice. One-way repeated-measures analysis identified significant differences among barriers to AI adoption, with teacher distrust showing the lowest mean score. The readiness components showed no statistically significant differences.

3. Most teachers reported that full AI integration in mathematics instruction was hindered by knowledge gaps and insufficient technological resources. Teachers prefer to address these deficiencies through workshops, webinars, peer collaboration, and supported self-study. Educators express dissatisfaction with current professional development

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programs due to the inadequate methodological components.

4. Current AI adoption rates range from 13,1% to 40,2% depending on the application areas, with YandexGPT, ChatGPT, Шедеврум, and Kandinsky being the most-utilized neural networks.

6. Promising research directions include investigating subject-specific AI implementation approaches, developing AI-enhanced pedagogical methodologies, and exploring effective applications for enhancing students' cognitive abilities.

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