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Revija za elementarno izobraževanje
Journal of Elementary Education

Uredniški nagovor ob polnoletnosti *Revije za elementarno izobraževanje*

Spoštovane bralke in spoštovani bralci, cenjene avtorice in cenjeni avtorji, recenzentke in recenzenti ter prijateljice in prijatelji naše revije.

Danes stojimo pred pomembnim mejnikom – *Revija za elementarno izobraževanje* je z zadnjo letošnjo številko (letnik 18, številka 4) postala polnoletna. To ni zgolj številka, temveč simbol zrelosti, vztrajnosti in predanosti, ki so nas vodile skozi vsa leta njenega obstoja.

Ko smo leta 2008 z zanosom in s pogumom stopili na pot, se je odločitev – da bomo letno izdali štiri številke – marsikomu zdela drzna. A prav ta odločitev je bila temelj, na katerem smo gradili našo zgodbo. Od prvih dvojnih številk, skromnih začetkov in omejenih sredstev, do danes, ko revija stoji kot prepoznaven znanstveni forum, smo dokazali, da se vztrajnost in kakovost vedno obrestujeta.

Vsako leto je prineslo nove izzive in nove zmage. Leta 2015 smo pridobili dragocene partnerje – Univerzo na Primorskem in Karlovo univerzo v Pragi. Leta 2019 smo dosegli prelomni trenutek: vključitev v bazo *Scopus*, kar je bilo priznanje našemu delu in hkrati obljuba prihodnosti. Od leta 2020 naprej revija izhaja v petih zvezkih letno, med katerimi je vedno posebna tematska številka, ki odpira nova raziskovalna obzorja.

Danes lahko z zadoščenjem povemo, da je v reviji objavilo več kot 760 avtoric in avtorjev, ki so prispevali preko 550 znanstvenih razprav, recenziranih s strani skoraj 800 strokovnjakinj in strokovnjakov. Tedensko prejmemo več kot deset prispevkov, a zaradi visokih kriterijev jih za objavo zavrnemo povprečno kar 85 %. Prav ta nepopustljiva zavezanost kakovosti je razlog, da je revija od leta 2024 uvrščena v tretjo četrtino (Q 3) svetovne lestvice kakovosti.

Polnoletnost naše revije je več kot le kronološki mejnik – je dokaz, da se je *Revija za elementarno izobraževanje* uveljavila kot zanesljiv sopotnik raziskovalcev, kot prostor dialoga in kot odmev znanstvenih razprav, ki bogatijo področje primarnega izobraževanja. *Revija za elementarno izobraževanje* je vsebinsko raznolika in pokriva širok spekter vidikov izobraževanja na primarni ravni. Ob polnoletnosti apeliramo na vas, spoštovane in spoštovani, da pri pripravi svojih znanstvenih razprav posežete tudi v naš arhiv. Prepričani smo, da boste v njem našli vsebine, ki osvetljujejo nove

vidike razmišljanja in jih lahko vključite v svoje raziskovalno delo. Citiranje prispevkov iz *Revije za elementarno izobraževanje* bo tako prispevalo k večji prepoznavnosti revije v mednarodnem prostoru ter jo dvignilo še više na lestvici kakovosti.

Ob tej priložnosti se iskreno zahvaljujemo vsem, ki ste soustvarjali našo pot: avtoricam in avtorjem, recenzentkam in recenzentom, sodelujočim institucijam in zvestim bralkam in bralcem. Brez vaše podpore bi bila naša zgodba nepopolna. Naj bo polnoletnost začetek novega obdobja, v katerem bomo skupaj gradili še višjo kakovost, širili obzorja in utrjevali pomen znanstvenega raziskovanja.

Naj bo *Revija za elementarno izobraževanje* še naprej svetilnik znanja, ki osvetljuje pot prihodnjim generacijam raziskovalk in raziskovalcev ter pedagoginj in pedagogov.

Za uredništvo *Revije za elementarno izobraževanje*

Glavni urednik
Pedagoška fakulteta Univerze v Mariboru

Revija za elementarno izobraževanje
Journal of Elementary Education

Editorial Address on the Coming of Age of the *Journal of Elementary Education*

Dear readers, esteemed authors, reviewers, and friends of our journal, today we stand before an important milestone – with the last issue of this year (Volume 18, Issue 4), the *Journal of Elementary Education* has officially come of age. This is not merely a number, but a symbol of the maturity, perseverance, and dedication that have guided us through all the years of our existence.

When we set out on this path in 2008 with enthusiasm and courage, the decision to publish four issues per year seemed bold to many. Yet that very decision became the foundation upon which we have built our story. From the first double issues, humble beginnings, and limited resources, to the present day, when the journal stands as a recognized scientific forum, we have proven that perseverance and quality always pay off.

Each year brought new challenges and new victories. In 2015, we gained valuable partners – the University of Primorska and Charles University in Prague. In 2019, we reached a turning point: inclusion in the Scopus database, which was both a recognition of our work and a promise for the future. Since 2020, the journal has been published in five issues per year, including special thematic issues that open new research horizons.

Today, we can proudly say that more than 760 authors have published in our journal, contributing over 550 scientific papers, reviewed by nearly 800 experts. We receive more than ten submissions weekly, yet because of our high publication standards, we reject an average of 85%. It is precisely this unwavering commitment to quality that has led to our inclusion in the third quartile (Q3) of the global quality ranking as of 2024.

The coming of age of our journal is more than a chronological milestone – it is proof that the *Journal of Elementary Education* has established itself as a reliable companion to researchers, as a space for dialogue, and as an echo of scientific discourse that enriches the field of primary education. Our journal covers a wide range of topics related to primary-level education. On this occasion, we call on colleagues, professors, and researchers to explore our archive when preparing their scientific

contributions. We are confident that they will find content that sheds light on new perspectives and can be incorporated into their research. Citing articles from the JEE will contribute to the journal's international recognition and elevate it further on the quality scale.

On this occasion, we extend our sincere gratitude to all who have co-created our journey: the authors, reviewers, partner institutions, and loyal readers. Without your support, our story would be incomplete. May this coming of age mark the beginning of a new era in which we continue to strengthen quality, broaden horizons, and reinforce the importance of scientific inquiry.

May the *Journal of Elementary Education* continue to be a beacon of knowledge, illuminating the path for future generations of researchers and educators.

For the Editorial Board of the Journal of Elementary Education

Editor-in-Chief
Faculty of Education, University of Maribor

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PARENTAL ATTITUDES TOWARDS SCHOOL AND EVERYDAY MATHEMATICS AND THEIR ENGAGEMENT IN CHILDREN'S MATHEMATICAL ACTIVITIES

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Abstract/Izvleček

Although parental involvement plays a crucial role in children's mathematical education, few studies examine how their attitudes towards mathematics influence their participation in specific activities. This study investigates the relationship between parental attitudes towards mathematics in school and in everyday contexts and their engagement in these activities. Results from a survey of 245 Slovenian parents reveal that most parents exhibit a neutral attitude towards school mathematics, while they generally hold a positive attitude towards the practical use of mathematics. Parents with less positive attitudes towards school mathematics tend to assist their children more often, whereas a positive attitude towards everyday mathematics is associated with greater parental involvement in daily mathematical activities at home.

Keywords:
parental attitudes, mathematics education, parental engagement, school mathematics, everyday mathematics.

Odnos staršev do šolske matematike in matematike v vsakdanjem življenju ter njihova vključenost v matematične dejavnosti otrok

Vključenost staršev ima ključno vlogo pri matematičnem izobraževanju otrok, vendar obstaja le malo raziskav o vplivu odnosa staršev do matematike na njihovo vključenost v specifične aktivnosti. V raziskavi proučujemo povezavo med odnosom staršev do matematike v šolskem in vsakodnevnem kontekstu ter njihovim sodelovanjem pri teh aktivnostih. Rezultati med 245 slovenskimi starši kažejo, da večina izraža nevtralen odnos do šolske matematike, medtem ko imajo večinoma pozitiven odnos do praktične uporabe matematike. Starši z manj pozitivnim odnosom do šolske matematike pogosteje pomagajo otrokom, pozitiven odnos do vsakodnevne matematike pa je povezan z večjo vključenostjo staršev v vsakodnevne matematične aktivnosti doma.

Ključne besede:
odnos staršev, matematično izobraževanje, vključenost staršev, šolska matematika, vsakodnevna matematika.

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Introduction

Parental involvement in children's mathematical education is widely recognized as a critical factor influencing students' mathematics performance, as supported by numerous studies (Fan and Chen, 2001; Hill and Tyson, 2009; Wang and Wei, 2024). Parents contribute to their children's mathematical learning through a variety of activities, including everyday tasks, board and card games, and shared reading activities (Jöran et al., 2022; Vandermaas-Peeler et al., 2018; Zhang et al., 2020). These interactions frequently emphasize practical, informal mathematics rather than formal school mathematics, with a sizeable portion of research focusing on homework support (e.g., Gonida and Cortina, 2014; Silinskas and Kikas, 2017; Wu et al., 2022).

LeFevre et al. (2009) categorize parental mathematical activities into two types: direct activities, involving explicit teaching of computational skills, and indirect activities, which foster mathematical understanding through tasks such as counting games or household measurements. Both the frequency and type of parental involvement have been shown to correlate with children's mathematics performance (Blevins-Knabe and Musun-Miller, 1996). However, the effectiveness of these interactions depends on the quality of the activities and the context in which they occur.

Parents' mathematical experiences during their own education significantly shape their involvement in their children's education. Skwarchuk (2009) argues that parents with positive math experiences are more likely to share their knowledge and incorporate math-related activities into daily life. Similarly, Blevins-Knabe et al. (2000) found that parents who enjoy mathematics tend to engage more frequently in math activities with their children. Zhao and Singh (2011) highlight that parental behaviour is often guided by their beliefs and expectations, which subsequently influence their children's mathematical experiences and attitudes. Expanding on this, Antolin Drešar and Lipovec (2017) conducted a comparative study on parental involvement in mathematics between mathematicians and non-mathematicians. Their findings revealed that mathematician parents provided a broader range of mathematical activities with greater depth and complexity compared to non-mathematician parents.

Parental Attitudes Towards Mathematics

Parental attitudes towards mathematics play a pivotal role in shaping not only the type and extent of their engagement with their children but also children's attitudes towards and performance in mathematics. Attitudes are commonly defined as psychological constructs that encompass emotional responses, cognitive beliefs, and behavioural tendencies in relation to a particular object, idea, or activity (Eagly and Chaiken, 1993). In mathematics, attitudes include feelings such as enjoyment or anxiety, beliefs about its value or difficulty, and the tendency to engage with mathematical tasks (Zan and Di Martino, 2007). These components are influenced by subjective experiences, social interactions, and cultural norms (Bishop, 1993; Eccles and Jacobs, 1986).

Research in the affective domain broadens the concept of attitudes to include related constructs such as beliefs, emotions, and values. For example, self-confidence, self-efficacy, and motivation are critical factors influencing parental engagement (DeBellis and Goldin, 2006; McLeod, 1992). Eccles and Jacobs (1986) argue that attitudes develop through a complex interplay of subjective experiences, societal norms, and expectations, which are often transmitted from parents to children. Similarly, Bishop (1993) emphasizes that attitudes evolve over time, shaped by the educational environment and by interaction with significant others. Positive attitudes encourage persistence and enjoyment in learning mathematics, while negative attitudes, such as math anxiety, hinder both parental involvement and children's performance.

Parental Attitudes and Children's Mathematics Attitudes

Research shows a significant relationship between parents' attitudes towards mathematics and their children's attitudes. Mohr-Schroeder et al. (2017) identified positive correlations between parental and student attitudes, emphasizing the importance of fostering favourable parental attitudes to shape children's perceptions of mathematics. Similarly, Simmons et al. (2024) found that parental mathematics anxiety and attitudes predicted children's attainment, particularly in their first year of schooling. This relationship was independent of parental mathematics attainment and unaffected by the frequency of preschool number experiences in the home. Their findings suggest that fostering positive attitudes may be more impactful than direct involvement, such as homework assistance.

Areepattamannil et al. (2015), using data from the 2012 PISA study, reported that adolescents who perceived their parents as valuing mathematics exhibited greater motivation, self-efficacy, and achievement. However, excessive emphasis on career relevance increased mathematics anxiety, highlighting the complexity of parental influence. Vidal Olivares and Ceglie (2020) also found that parents' self-efficacy and the value they placed on mathematics strongly influenced children's beliefs, creating cycles of positive or negative engagement.

Gender differences in parental attitudes have also been observed. Fathers tend to exhibit more positive attitudes than mothers, and parents often hold higher expectations for male children in mathematics compared to female children (Visser, 1987). Interestingly, Simmons et al. (2024) found that maternal mathematics anxiety was more strongly associated with girls' attainment than boys', illustrating gender-specific dynamics in parental influence.

Parental Attitudes and Children's Mathematics Performance

Numerous studies highlight the significant relationship between parental attitudes towards mathematics and their children's performance. Using data from the TIMSS 2015 survey, Cui et al. (2023) demonstrated that parental involvement in early childhood learning activities and positive attitudes toward mathematics significantly enhanced children's mathematics achievement by fostering their interest in learning. Conversely, negative parental attitudes or math anxiety can lead to lower performance, as children may internalize these attitudes and develop apprehensions about the subject (Simmons et al., 2024). Similarly, Becker et al. (2021) found that parents' math anxiety negatively impacted preschool children's mathematical progress. Peixoto et al. (2024) further observed that fixed mindsets and negative attitudes in parents were associated with poorer outcomes in children's motivation and achievement.

Wen and Dubé (2023) emphasized the multidimensional nature of mathematics attitudes, identifying components such as confidence, enjoyment, anxiety, and self-concept. Their findings revealed that positive attitudes were strongly linked to higher achievement, while negative factors like anxiety and gender stereotypes were associated with poorer performance. These results underscore the importance of targeted interventions aimed at improving attitudes in both parents and children to foster better mathematical outcomes.

Current Study

While the broader concept of parental involvement in children's education has garnered substantial research interest globally and, to some extent, in Slovenia (e.g., Berčnik and Devjak, 2018; Tekavc and Vončina, 2023), the specific focus on parental involvement in mathematics education within the Slovenian context remains underexplored. Despite growing recognition of the pivotal role parental attitudes play in shaping children's mathematical experiences, limited attention has been given to understanding how these attitudes influence parental engagement in both school-based and everyday mathematical activities.

Most existing research examines parental attitudes towards mathematics as a general concept, often failing to distinguish between formal, school-related mathematics and informal, everyday mathematical contexts. This distinction is crucial, since parents' engagement strategies, confidence levels, and perceptions can vary significantly across these domains (Civil, 2001). While a few studies have indirectly addressed this perspective (e.g., Antolin Drešar and Lipovec, 2017; Kastelic, 2016), a comprehensive understanding of how parental attitudes influence engagement in these distinct settings is still lacking.

This study seeks to address this gap by examining the relationship between parents' attitudes towards mathematics—encompassing both school-based and everyday contexts—and their involvement in their children's education. By adopting this dual perspective, the research aims to provide valuable insights into how parental attitudes shape various forms of support, including homework assistance, test preparation, and participation in informal mathematical activities.

Methodology

Research Design

This study employed a descriptive and causal-nonexperimental research design to examine the relationships between parents' attitudes towards mathematics and their involvement in both school-based and everyday mathematical activities. A survey questionnaire was used to collect data, enabling an efficient and practical exploration of various dimensions of parental involvement and attitudes.

The study was guided by the following research questions:

1. What are parents' attitudes towards school mathematics and everyday mathematics?
2. How do parents' attitudes towards school mathematics and everyday mathematics relate to their involvement in school-related mathematics activities?
3. What is the relationship between parents' attitudes towards school mathematics and everyday mathematics and their participation in non-school mathematical activities?

By addressing these questions, the research design aimed to uncover significant patterns and relationships that contribute to understanding parental involvement in mathematics education.

Sample Description

A total of 245 parents participated in the study, reflecting a non-random sample. The majority (72.7%) were female, with males comprising 27.3%, consistent with trends of greater maternal involvement in school-related matters. Fathers' participation, however, added valuable insights.

Participants' ages ranged across five categories, with 67.3% in the 41–50 age group, followed by 25.7% in the 31–40 age group. The remaining groups (25–30 and 51–60) each accounted for 6% or less, while one participant was in the 61–70 age range. This distribution aligns with typical parenting ages for middle school children.

Educational qualifications were categorized into three levels: below level 5 (12.7%), level 5 or 6 (45.7%), and level 7 or higher (41.6%). This diverse educational background provides a rich context for examining variations in parental engagement and attitudes toward mathematics.

Parents reported on their children's grade levels and mathematics achievement, offering additional context for parental involvement. The sample included students from 6th, 7th, and 8th grades, with fewer ninth-grade students because of logistical constraints in questionnaire distribution. The analysis focused primarily on the first child reported by parents, since preliminary results indicated no significant differences across siblings.

Parents also reported their children's mathematics grades from the previous school year, offering additional context for understanding parental involvement. The highest proportion of students achieved a grade of 5 (39.9%), followed by those who

received a grade of 4 (33.7%). The grade distribution varied slightly by grade level, with eighth-grade students more frequently receiving a grade of 4 than one of 5.

Data Collection

A dual-mode data collection approach combined paper-based surveys at two primary schools in central Slovenia and online questionnaires distributed via email networks. This strategy enhanced accessibility and participation, yielding 245 completed surveys (177 paper-based and 68 online).

The final version comprised twenty-eight items across four sections. The Demographic Information section collected data on parents' age, sex, educational background, number of children, and their child's mathematics grade. The Parental Attitudes Toward Mathematics section (2 items, $\alpha = 0.52$) measured attitudes toward school mathematics (e.g., "How do you feel about the mathematics your child learns in school?") and everyday mathematics (e.g., "How do you feel about using mathematics in daily life?"). The Parental Involvement in School Mathematics section (3 items, $\alpha = 0.81$) assessed parental assistance with homework, test preparation, and additional support in mathematics compared to other subjects. The Parental Involvement in Non-School Mathematics section (2 items, $\alpha = 0.80$) captured parental engagement in mathematical activities outside school settings. Responses were recorded using 4-point Likert scales.

Reliability analysis based on pilot study data ($N = 31$) indicated good internal consistency for both school mathematics involvement ($\alpha = 0.81$) and non-school mathematics involvement ($\alpha = 0.80$). The attitude scale had moderate reliability ($\alpha = 0.52$), likely reflecting the distinction between perceptions of school-based and everyday mathematics. Future research could refine this scale by incorporating additional items to improve consistency.

Data Analysis

Data were processed using SPSS. The chi-square (χ^2) test was employed to identify significant relationships between parental attitudes and their involvement in school-based and everyday mathematical activities. This analytical approach enabled the detection of statistically significant patterns, providing a foundation for the study's key findings.

Results

Overview of Parental Attitudes Towards Mathematics

We analysed parents' attitudes towards mathematics, examining their perspectives on both school-based mathematics and its application in everyday life. Table 1 summarizes the distribution of these attitudes.

Table 1
Distribution of Parents' Attitudes Towards Mathematics

Attitude	School Mathematics	Everyday Mathematics
Strongly Dislike	9 (3.7%)	7 (2.9%)
Dislike	39 (15.9%)	26 (10.6%)
Neutral	156 (63.7%)	146 (59.6%)
Strongly Favour	41 (16.7%)	66 (26.9%)
Total	245 (100%)	245 (100%)

Most parents reported neutral attitudes towards both school mathematics (63.7%) and everyday mathematics (59.6%). However, 26.9% of parents strongly favoured everyday mathematics, compared to only 16.7% for school mathematics. Fewer parents expressed negative attitudes towards everyday mathematics (10.6%) than school mathematics (15.9%).

These findings suggest that parents generally hold more favourable attitudes towards the practical application of mathematics in everyday life than towards its academic counterpart. The results underscore the importance of context in shaping perceptions of mathematics. Parents value mathematics more when it has clear, tangible applications, which may have implications for strategies to enhance parental engagement in mathematics education.

As a crucial aspect of our study, we examined parental involvement in mathematics education relative to their attitudes towards the subject. For analysis, we grouped responses indicating *strongly dislike* and *dislike* as "negative attitudes," and *neutral* and *strongly favour* as "positive attitudes."

Parental Involvement in School Mathematics Based on Attitudes Towards School Mathematics

We examined parental involvement in school mathematics in relation to their attitudes, focusing on assistance with schoolwork, test preparation, and additional

support in mathematics compared to other subjects. Firstly, we will present findings on parental involvement in school mathematics in terms of their attitudes towards school mathematics (Table 2).

Table 2
Parental Engagement in School Mathematics by Attitudes Towards School Mathematics

		Parents' Attitude Towards School Mathematics						
		Negative Attitude		Positive Attitude		Total		χ^2 (P-value)
		f	f %	f	f %	f	f %	
Assistance in School Mathematics	Do Not Assist	31	64.6	155	78.7	186	75.9	4.195 (0.041)
	Assist	17	35.4	42	21.3	59	24.1	
	Total	48	100.0	197	100.0	245	100.0	
Assistance in Preparation for Math Tests	Do Not Assist	29	60.4	135	68.5	164	66.9	1.147 (0.284)
	Assist	19	39.6	62	31.5	81	33.1	
	Total	48	100.0	197	100.0	245	100.0	
Assistance in Mathematics More Than in Other Subjects	Do Not Assist	33	68.8	148	75.1	181	73.9	0.813 (0.367)
	Assist	15	31.3	49	24.9	64	26.1	
	Total	48	100.0	197	100.0	245	100.0	

The findings indicate that most parents (75.9%) do not assist their children with school mathematics, regardless of their attitudes towards the subject. However, parents with a negative attitude towards school mathematics were more likely to provide assistance (35.4%) compared to those with a positive attitude (21.3%), a difference that is statistically significant ($p = 0.041$). This suggests that parents who struggle with or dislike school mathematics may feel a greater need to support their children, possibly owing to concerns about their child's difficulties or their own negative experiences with mathematics.

In contrast, for test preparation and additional support in mathematics compared to other subjects, the differences between parental groups were not statistically significant ($p > 0.05$). While it might have been expected that parents with negative attitudes towards school mathematics would be more engaged in test preparation, driven by concerns over their child's struggles or their own difficulties with the subject, this was surprisingly not observed in the data. One explanation is that test preparation may be influenced more by external factors, such as school expectations,

teacher recommendations, or standardized assessment practices, rather than by parental attitudes alone. Additionally, parents may perceive mathematics as equally important as other subjects, leading to similar levels of support across disciplines, regardless of their attitudes towards the subject.

Parental Involvement in School Mathematics Based on Attitudes Towards Everyday Mathematics

Our study also examined the connection between parents' attitudes towards everyday mathematics and their involvement in school-related mathematics activities.

Table 3
Parental Engagement in School Mathematics by Attitudes Towards Everyday Mathematics

		Parents' Attitude Towards Everyday Mathematics						
		Negative Attitude		Positive Attitude		Total		χ^2 (P-value)
		f	f %	f	f %	f	f %	
Assistance in School Mathematics	Do Not Assist	23	69.7	163	76.9	186	75.9	0.807 (0.369)
	Assist	10	30.3	49	23.1	59	24.1	
	Total	33	100.0	212	100.0	245	100.0	
Assistance in Preparation for Math Tests	Do Not Assist	20	60.6	144	67.9	164	66.9	0.691 (0.406)
	Assist	13	39.4	68	32.1	81	33.1	
	Total	33	100.0	212	100.0	245	100.0	
Assistance in Mathematics More Than in Other Subjects	Do Not Assist	21	63.6	160	75.5	181	73.9	2.073 (0.150)
	Assist	12	36.4	52	24.5	64	26.1	
	Total	33	100.0	212	100.0	245	100.0	

The results indicate that parents with negative attitudes towards everyday mathematics were slightly more likely to assist their children with school-related mathematics activities, such as homework or test preparation, compared to those with positive attitudes. However, these differences were not statistically significant ($p > 0.05$), suggesting that attitudes towards the practical use of mathematics in daily life do not strongly influence parental engagement in their children's school-based mathematics learning.

One explanation for this finding is that parents may perceive everyday mathematics and school mathematics as distinct domains, each requiring different forms of engagement. While everyday mathematics involves intuitive, applied skills used in

daily activities, school mathematics follows a structured, formal curriculum that may not directly relate to how parents use math in their daily lives. As a result, even parents who lack confidence or interest in applying mathematics in real-world contexts may still recognize the importance of supporting their child's school-based learning.

Parental Involvement in Non-School Mathematics Activities Based on Attitude

Finally, we explored the potential connection between parental engagement in non-school math activities and their attitudes towards both school mathematics and everyday mathematics.

Table 4

Parental Involvement in Non-School Mathematics Activities by Their Attitude Towards Mathematics

		Parents' Attitude Towards School Mathematics						
		Negative Attitude		Positive Attitude		Total		χ^2 (P-value)
		f	f %	f	f %	f	f %	
Non-School Math Activities	No	31	64.6	148	75.1	179	73.1	2.180 (0.140)
	Yes	17	35.4	49	24.9	66	26.9	
	Total	48	100.0	197	100.0	245	100.0	
		Parental Attitude Towards Everyday Mathematics						
		Negative Attitude		Positive Attitude		Total		
		f	f %	f	f %	f	f %	4.254 (0.039)
Non-School Math Activities	No	29	87.9	150	70.8	179	73.1	
	Yes	4	12.1	62	29.2	66	26.9	
	Total	33	100.0	212	100.0	245	100.0	

No significant differences were observed between attitudes towards school mathematics and parental involvement in non-school mathematical activities ($p = 0.140$), suggesting that parental perceptions of school mathematics do not strongly influence their engagement in informal mathematical activities with their children. However, a significant difference was found for attitudes towards everyday mathematics and their involvement in non-school mathematical activities ($p = 0.039$). Parents with positive attitudes towards everyday mathematics were more likely to engage in non-school mathematical activities (29.2%) compared to those with negative attitudes (12.1%). This suggests that parents who value mathematics in daily life are more inclined to incorporate mathematical concepts into informal learning experiences, such as games, practical tasks, or real-world problem-solving

activities with their children. The contrast between school and everyday mathematics attitudes highlights an important distinction in parental engagement. While school mathematics is often viewed as an academic requirement, everyday mathematics is more connected to practical, real-life applications. As a result, parents who appreciate the relevance of mathematics in daily life may be more motivated to integrate it into informal learning opportunities, fostering a more natural and engaging approach to mathematical exploration outside the classroom.

Discussion

This study provides insights into parents' attitudes towards mathematics in both school and everyday contexts, as well as their involvement in their children's mathematical education. A notable finding is the predominance of neutral attitudes towards school mathematics, with only 16.7% of parents expressing strong positive attitudes. This neutrality may reflect past educational experiences, indicating limited enthusiasm for formal mathematics education (Ingram and Meaney, 2021). In contrast, a higher proportion of parents (26.9%) strongly favour the practical application of mathematics in everyday life, suggesting a more favourable disposition towards its real-world utility. These findings align with previous research emphasizing the context-dependent nature of parental attitudes towards mathematics (Fan and Chen, 2001).

Despite their attitudes, most parents do not actively assist their children with school mathematics, a finding consistent with Berčnik and Devjak (2018), who noted a discrepancy between teachers' and parents' perceptions of responsibility in education. While their study focused on general parental involvement rather than specifically on mathematics, it emphasizes the crucial role of teacher-led initiatives to engage parents in mathematics. Vidić, Klasnić, and Đuranović (2022) highlighted the role of teacher support and enthusiasm in fostering student confidence and reducing mathematics anxiety, emphasizing the value of teacher-parent collaboration. Another explanation for limited parental involvement could be that parents perceive no need to assist if their children are not struggling, as noted by Antolin and Lipovec (2017).

Interestingly, our study shows that parents with negative attitudes towards school mathematics are slightly more likely to assist their children compared to those with positive attitudes. This suggests that parental involvement may be driven more by concern over their children's performance than by a personal affinity for the subject.

Hoover-Dempsey and Sandler (1997) similarly noted that parental involvement is often motivated by concern for academic success rather than by personal attitudes towards the subject. Consistent with this, research by Simmons et al. (2024) found that children of parents with negative attitudes towards mathematics tend to have lower attainment in the subject, particularly in early schooling, which may explain the greater need for parental assistance.

Parental involvement patterns remained consistent across specific types of assistance, such as helping with math tests or providing more support in mathematics than in other subjects. Regardless of their attitude towards school mathematics, most parents were unlikely to provide targeted assistance in these areas.

The study also reveals that parents' positive attitudes towards everyday mathematics did not significantly influence their involvement in school-related math activities. While parents may appreciate the practical aspects of mathematics, this does not necessarily lead to greater engagement in formal school math. However, there was a significant relationship between parents' attitudes towards everyday mathematics and their involvement in non-school math activities. Parents with a positive attitude towards everyday mathematics were significantly more likely to engage in non-school math activities, suggesting that an appreciation for the real-world relevance of math fosters a positive mathematical environment at home. This aligns with Murphy et al. (2023), who emphasized the importance of practical applications in shaping positive parental attitudes and engagement. Similar findings by Antolin and Lipovec (2017) underscore the importance of integrating mathematics into daily life. Furthermore, Abdullah (2024) emphasizes how strong family dynamics enhance children's academic engagement. Collectively, these findings suggest that positive attitudes towards everyday mathematics contribute to a supportive environment that fosters both academic and personal growth.

The results of this study have important implications for educational strategies. The fact that most parents exhibit a neutral attitude towards school mathematics raises concerns about the potential impact on children's learning experiences. Neutral attitudes might lead to reduced enthusiasm for mathematics at home, potentially influencing children's perceptions of its importance.

To address these challenges, we recommend the development of structured workshops or guidance sessions for parents that emphasize fostering positive attitudes toward mathematics (Eccles and Jacobs, 1986; Hoover-Dempsey and Sandler, 1997).

These initiatives could equip parents with practical strategies to support their children's learning while emphasizing the integration of everyday mathematics into home-based activities (Murphy et al., 2023). Importantly, raising awareness about the significance of parental involvement in mathematics should begin in early childhood settings, where educators can actively encourage parents to engage in mathematical interactions with their children. This emphasis should then continue throughout schooling, reinforced by teachers and schools through ongoing communication, parental engagement initiatives, and school-home collaboration strategies.

We stress the need for educators to guide parents in actively supporting their children's mathematical development—not by focusing solely on helping with school mathematics, but rather by emphasizing the importance of engaging in everyday mathematical experiences. While parents should provide assistance with school mathematics only when needed, their primary role should be to foster informal mathematical activities that naturally integrate mathematics into daily life. This includes playing games, involving children in measurement and problem-solving, and creating opportunities to explore mathematical concepts in real-life contexts. By shifting the focus toward the beauty and practical relevance of mathematics, parents can help cultivate a more engaging and positive mathematical environment for their children.

Notably, Slovenia currently lacks nationally coordinated programs specifically aimed at enhancing parental attitudes and engagement in mathematics education. Establishing such programs on a national scale could fill this gap, providing parents with the tools and knowledge needed to create a supportive mathematical environment at home, ultimately contributing to improved student outcomes.

This study has several limitations that should be acknowledged. The relatively small sample size and limited demographic diversity may restrict the generalizability of the findings. Additionally, the reliance on self-reported data from parents introduces the possibility of response bias, since participants may have provided socially desirable answers rather than fully accurate accounts of their attitudes and behaviours.

Another limitation concerns the four-point Likert scale design, which omitted a midpoint option. While this approach aimed to reduce central tendency bias and encourage firmer responses (Chyung et al., 2017), it may have constrained the ability to capture mildly positive attitudes. Research suggests that excluding a neutral category can lead to response polarization (Weijters et al., 2010) but may also mitigate social desirability bias (Garland, 1991). However, the high percentage of

neutral responses in this study suggests that some parents may have been hesitant or ambivalent rather than predominantly positive. Future studies could explore the impact of alternative Likert scale designs, including those with a midpoint option, to determine whether it better differentiates parental attitudes towards school and everyday mathematics.

Despite these limitations, the study offers a novel perspective by distinguishing between parental attitudes towards school-based and everyday mathematics, an often-overlooked distinction in research. By examining how these attitudes influence formal and informal parental engagement, this study provides valuable insights into the nuanced ways parents support their children's mathematical education. Future research could explore the long-term impact of parental attitudes through longitudinal designs or interventions aimed at fostering positive attitudes and behaviours. Expanding research to include diverse samples across socio-economic and cultural contexts could further enrich understanding and applicability.

Conclusion

This study underscores the crucial role of parental attitudes in children's mathematics education and highlights strategies to enhance parental engagement. By addressing both school-based and everyday mathematics, this research provides a nuanced understanding of how parental attitudes influence children's learning environments.

The findings reveal that parental attitudes towards mathematics are complex and multifaceted. While positive attitudes—whether directed at school-based or everyday mathematics—are associated with higher academic performance in children, they do not always translate into active parental involvement in mathematical education. This underscores the need for a deeper exploration of the motivations and barriers influencing parental engagement (Fan and Chen, 2001; Hoover-Dempsey and Sandler, 1997).

A particularly notable finding is the more favourable disposition of parents towards the practical application of mathematics in everyday life compared to formal school mathematics. Despite prevalent neutral attitudes towards school mathematics, parents with negative attitudes were found to be slightly more likely to assist their children, possibly driven by concern about their children's academic performance.

These insights reinforce the need for educational strategies that encourage parental engagement beyond school-based mathematics assistance.

Strengthening home-school collaboration and emphasizing the role of everyday mathematical experiences may help foster more meaningful and sustained parental involvement. Future research should explore targeted interventions to promote positive parental attitudes and investigate how different forms of engagement influence students' long-term mathematical development.

In conclusion, this study highlights the significant role of parental attitudes in shaping engagement in mathematics education. Educational initiatives that connect school mathematics with real-world applications can foster a more supportive and engaging learning environment. These efforts have the potential to enhance children's mathematical outcomes while making the subject more relatable and meaningful for both parents and students. Future research should focus on interventions to promote positive parental attitudes and expand involvement across diverse educational contexts.

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REVIJA ZA ELEMENTARNO IZOBRAŽEVANJE
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INVESTIGATING ELEMENTARY SCHOOL TEACHERS' KNOWLEDGE TRANSFORMATION IN PROJECT-BASED EXPERIENTIAL STEAM LEARNING

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Abstract/Izvleček

Successfully implementing project-based experiential science, technology, engineering, arts, and mathematics (STEAM) learning hinges on the teachers' comprehension of fundamental concepts. This study investigates elementary school teachers' knowledge transformation of project-based experiential STEAM learning after participating in a focused STEAM education workshop. Through an investigative exploration with the participation of five elementary school teachers, this study reveals that participating teachers better comprehend STEAM as an educational approach after the workshop. Meanwhile, their understanding of project-based learning decreased, and experiential learning remained unchanged. This study suggests an integrated form of training that equally addresses the interconnected components of STEAM, project-based, and experiential learning.

Preučevanje preoblikovanja znanja osnovnošolskih učiteljev pri projektno zasnovanem izkustvenem učenju znanosti, tehnologije, inženirstva, umetnosti in matematike (angl. STEAM) Uspešno izvajanje projektnega izkustvenega učenja znanosti, tehnologije, inženirstva, umetnosti in matematike (angl. STEAM) je odvisno od učiteljevega razumevanja temeljnih konceptov. V študiji raziskujemo transformacijo znanja osnovnošolskih učiteljev o projektnem izkustvenem učenju STEAM po udeležbi na izobraževalni delavnici, osredinjeni na STEAM. S preiskovalno raziskavo, v kateri je sodelovalo pet osnovnošolskih učiteljev, ugotavljamo, da sodelujoči učitelji po delavnici bolje razumejo STEAM kot izobraževalni pristop. Medtem se je njihovo razumevanje projektnega učenja zmanjšalo, izkustveno učenje pa je ostalo nespremenjeno. Na osnovi ugotovitev predlagamo integrirano usposabljanje, ki enako obravnava medsebojno povezane komponente STEAM, projektnega in izkustvenega učenja.

Keywords:
teacher knowledge, project-based learning, experiential learning, STEAM learning, hands-on activities.

Ključne besede:
znanje učiteljev, projektno učenje, izkustveno učenje, učenje STEAM, praktične dejavnosti.

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Introduction

Science, technology, engineering, arts, and mathematics (STEAM) education has gained prominence as an approach to interdisciplinary learning. It fosters critical thinking, creativity, and problem-solving skills (De Vries, 2021; Liao, 2016). Among the most effective methods of engaging students in STEAM learning, project-based experiential learning (Kolb, 2015; Krajcik and Blumenfeld, 2006) encourages students to explore and apply concepts through hands-on activities. This approach enhances their understanding of theoretical principles and promotes collaboration, adaptability, and innovation as students work on real-world challenges. STEAM education supports a holistic learning environment by integrating the arts into STEM disciplines; at the same time, it nurtures diverse perspectives and bridges the gap between technical knowledge and creative expression. Such approaches prepare students to thrive in a rapidly evolving world where interdisciplinary skills are increasingly essential for success in various fields.

The successful implementation of project-based experiential STEAM learning hinges on the teachers' comprehension of the relevant fundamental concepts. Teachers are pivotal in guiding students through experiential learning processes (Avalos, 2011). Nevertheless, many educators face challenges in adopting this learning approach because of a lack of understanding and resources. Without a solid foundation in the interdisciplinary nature of STEAM, teachers may struggle to design and facilitate activities that effectively integrate the various disciplines. Additionally, limited access to professional development opportunities and insufficient instructional materials can hinder their ability to fully embrace STEAM pedagogy's potential.

Several studies have suggested strengthening teachers' understanding of new pedagogical approaches to ensure robust practice. For instance, Darling-Hammond, Hyler, and Gardner (2017) emphasize that targeted workshops or professional development can enhance teachers' capacity to implement innovative instructional methods effectively. Similarly, Desimone and Garet (2015) highlight the importance of sustained, collaborative training that focuses on practical application and reflection to deepen pedagogical understanding. (Guskey, 2002) argues that teachers must be prepared for any instructional practice changes to meet teachers' needs and student learning goals. The greater the comprehension of specific pedagogies, the better the classroom practice.

The present study investigates elementary school teachers' knowledge transformation of project-based experiential STEAM learning after participating in a focused STEAM education workshop. Two research questions were posed:

1. How did elementary school teachers change their knowledge of project-based experiential STEAM learning after participating in a focused STEAM education workshop?
2. How did elementary school teachers understand STEAM learning after participating in a focused STEAM education workshop?

Through an investigative exploration, the present study contributes to the growing literature on teachers' comprehension of an interdisciplinary learning approach that integrates science, technology, engineering, arts, and mathematics through experiential projects. A key novelty of this study lies in its focus on the conception of STEAM learning implemented through project-based and experiential learning. Following the introduction, this article addresses the underlying theoretical framework, reports the methodology used, presents results and critical discussion, and offers a reflective conclusion.

Conceptual Background

Project-based experiential STEAM learning integrates the principles of project-based learning (PBL) and experiential learning within the interdisciplinary context of STEAM education. This approach emphasizes hands-on, real-world tasks that engage students in applying science, technology, engineering, arts, and mathematics through meaningful, inquiry-driven projects (Diego-Mantecón et al., 2021; Ge et al., 2015). By fostering creativity, critical thinking, collaboration, and problem-solving, it offers a dynamic, student-centred learning environment that enhances engagement and deepens conceptual understanding. Figure 1 illustrates the project-based experiential STEAM learning stages, which combine the cycle of project-based (Kokotsaki et al., 2016) and experiential learning (Kolb, 2015).

Figure 1 illustrates cyclical and interconnected project-based experiential STEAM learning phases that cover orientation, active experimentation, concrete experience, reflective observation, abstract conceptualization, and presentation. The orientation of learning aims, materials, processes, and examination initiates project-based experiential STEAM learning. Subsequently, it turns to the experiential learning cycle by planning, doing, reviewing, and concluding projects.

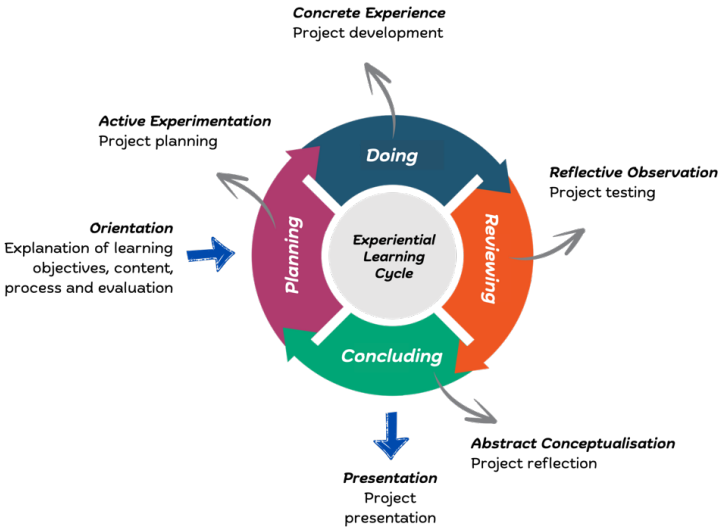

Figure 1
Project-based Experiential STEAM Learning Stages

Active experimentation reflects the planning and application of new ideas in the following experience or situation. Concrete experience refers to engagement in a hands-on activity. Reflective observation initiates reflection on and review of the experience. Abstract conceptualization forms conclusions and theories based on reflection. Finally, it is finished by presenting the developed projects and sharing experiences. The project-based experiential STEAM learning phases indicate how experience is transformed into knowledge through reflection, conceptualization, and experimentation in interdisciplinary hands-on activities.

To enhance conceptual clarity, it is important to differentiate between project-based learning (PBL), experiential learning, and STEAM education, as each represents a distinct yet potentially overlapping pedagogical framework. Project-based learning emphasizes student-driven inquiry through extended, real-world tasks that culminate in a tangible product or presentation (Kokotsaki, Menzies, and Wiggins, 2016). Experiential learning, rooted in Dewey and Kolb's theories (Kolb, 2015), focuses more broadly on learning through direct experience, reflection, and active engagement, regardless of whether the learning is organized around a specific project. STEAM education, on the other hand, integrates science, technology, engineering, the arts, and mathematics, aiming to foster interdisciplinary or even transdisciplinary learning experiences that encourage creativity and innovation (Liao,

2016). While STEAM approaches often utilize PBL and experiential methods, the frameworks should not be conflated, as each brings unique theoretical foundations and instructional goals.

Methods

An investigative exploration through a focused workshop was conducted to introduce the notion of project-based experiential STEAM learning. Consequently, the exploration measures elementary school teachers' changing knowledge of project-based experiential STEAM learning and understanding of STEAM learning in common. Stebbins (2001) describes investigative exploration as an inquisitive process of examining and investigating social science matters, which aligns with the qualitative approach adopted in this study. The primary concern was teachers' comprehension of an interdisciplinary learning approach, since misconceptions can hinder effective classroom practice. Introducing teachers to the conception of project-based experiential STEAM learning and assessing their understanding was thus essential. In line with Moser and Korstjens (2018), purposive sampling, structured data collection, and thematic analysis were employed to ensure rigour in capturing and interpreting the teachers' professional learning experiences.

Participants

This study involved elementary school teachers from a private school in Pangkalpinang, Kepulauan Bangka Belitung, Indonesia. The school was purposefully selected because it had just initiated STEAM programs at the beginning of 2024. Background information for the participating teachers is provided in Table 1.

Table 1
Participating Teachers' Profiles

Teachers	Gender	Age	Education	Teaching Experience	STEAM Familiarity
T1	Male	<25	Bachelor	<5 years	Not very familiar
T2	Male	36-45	Bachelor	5-10 years	Not at all familiar
T3	Male	25-35	Bachelor	<5 years	Not at all familiar
T4	Male	25-35	Bachelor	<5 years	Not very familiar
T5	Female	25-35	Bachelor	<5 years	Not very familiar

Table 1 describes the profile of elementary school teachers who participated in this study. Most teachers were male, and only one female teacher was involved. The school principal selected them based on their interest in STEAM education. They each have a bachelor's degree, teaching experience of at most 10 years, and limited familiarity with STEAM education.

Purposive sampling was employed in this study to intentionally select participants who met specific criteria relevant to the research focus. As shown in Table 1, the participating elementary school teachers were selected by the school principal based on their expressed interest in STEAM education and their willingness to engage in professional development. All participants held a bachelor's degree, had no more than ten years of teaching experience, and reported limited prior exposure to STEAM education. These characteristics made them well-suited to explore how early-career teachers with minimal STEAM background begin to conceptualize and engage with project-based experiential STEAM learning. This targeted sampling approach aligns with the study's exploratory aims, as it enables in-depth insight into the learning processes of a specific, relevant teacher group rather than aiming for broad generalizability. Figure 2 also describes their personal and professional backgrounds and characteristics in responding to innovation.

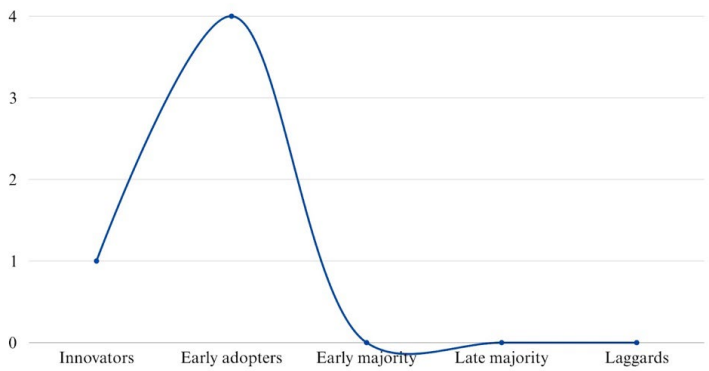

Figure 2
Teachers' Characteristics in Responding to Innovation

Figure 2 describes the characteristics of participating teachers in responding to innovation. It was categorized based on diffusion on innovation theory (Rogers, 2003). It is clear from the figure that four out of five teachers are early adopters, meaning they are quick to embrace and implement new instructional strategies, tools,

or technologies. One teacher is identified as an innovator, indicating they are even more proactive in seeking and experimenting with novel ideas, often taking risks to pioneer new approaches before others in their schools. Knowing their attitude in accepting innovation allows researchers to tailor strategies for further introducing STEAM education pedagogies.

Procedures

Research procedures outline the systematic steps or methods used to conduct a study. Investigation procedures guide researchers in collecting, analysing, and interpreting data (Moser and Korstjens, 2018). The detailed process of this study is illustrated in Figure 3.

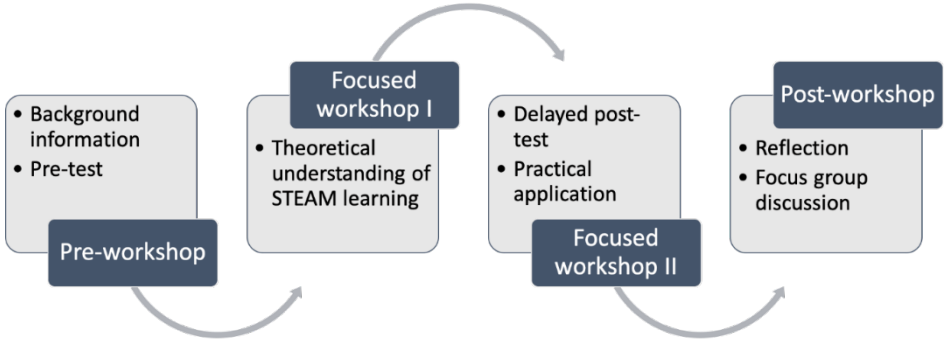

Figure 3
Investigative Exploration Stages

Figure 3 describes the procedures of current investigative exploration. It started with a pre-workshop activity that gathered background information and conducted preliminary tests for teachers. Afterward, the first focused workshop was implemented to introduce teachers to the theoretical considerations of STEAM learning. This was followed by the second focused workshop, which provided delayed post-tests and worked on developing STEAM activities, namely kirigami, tessellation, and educational robotics. The stage was concluded by a post-workshop consisting of reflection and focus group discussion.

Data Collection and Analysis

This study administered preliminary and delayed post-tests to generate data. The pre-test consists of multiple-choice questions to assess their initial knowledge of project-based experiential STEAM learning before the first workshop. The delayed post-test contains the same questions as the pre-tests, but the order was shuffled and there was an open question. After the first workshop, a delayed post-test was applied to examine the teachers' knowledge of project-based experiential STEAM learning. Meanwhile, the open question was asked to measure teachers' general understanding of STEAM learning. The generated data was analysed descriptively (Holcomb, 2016). Descriptive data analyses promote a clear understanding of a dataset's patterns, trends, and key characteristics. Unlike inferential analysis, which seeks to draw conclusions or make predictions about a population, descriptive analysis focuses on understanding the generated data.

To enhance analytical rigour and strengthen the validity of findings, this study employed method triangulation by combining quantitative data from pre- and post-workshop knowledge tests with qualitative data derived from participants' open-ended reflections. This mixed-method approach enabled a more comprehensive understanding of changes in teachers' knowledge and perspectives related to project-based experiential STEAM learning.

Ethics

The present study adheres to the Helsinki Declaration (Carlson et al., 2004) for human participation research. The teachers voluntarily participated, and issues about research ethics were communicated. They were informed that their involvement was confidential. Researchers agreed with the teachers that their participation would not influence any appraisal related to teaching performance. The workshop activities and all data generated from the study were used exclusively for scientific purposes.

Results

An investigative exploration was administered to introduce the idea of project-based experiential STEAM learning. Respecting the posed research question, this section presents findings related to teachers' changing knowledge of project-based experiential STEAM learning and understanding of STEAM learning in general.

Teachers' Changing Knowledge

Teachers' knowledge of project-based experiential STEAM learning evolves as they deepen their understanding of interdisciplinary teaching and adapt to emerging tools, pedagogical strategies, and student needs. Figure 4 presents teachers' knowledge transformation as a result of the focused workshop.

Figure 4 reveals the changes in teachers' knowledge about project-based experiential STEAM learning. Their understanding of STEAM learning delivered experimentally by the project increases in the delayed post-test in most respects.

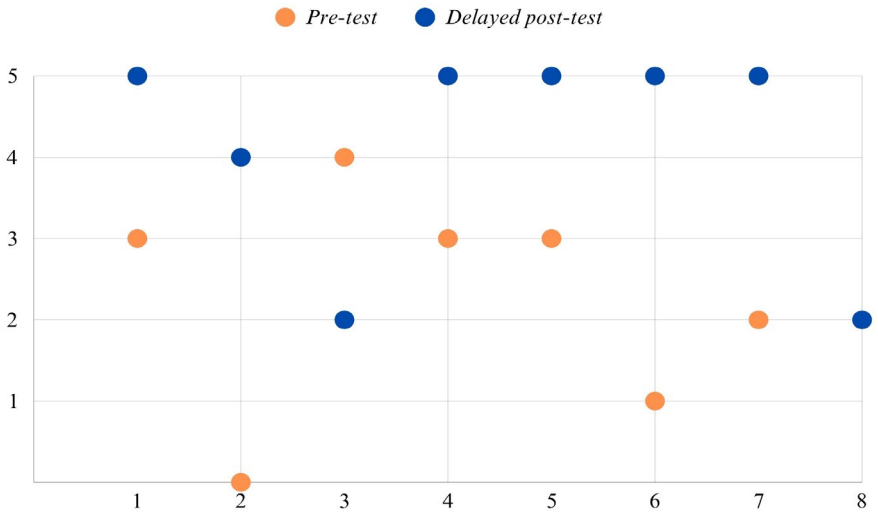

Figure 4

Transformation of Teachers' Knowledge of Project-based Experiential STEAM Learning

Aspects:

1. The abbreviation of STEAM
2. The basic concept of STEAM
3. The role of project-based learning in STEAM
4. The reason for arts inclusion in the STEM approach
5. The basic concept of kirigami
6. The basic concept of tessellation
7. The basic concept of educational robotics
8. The focus of experiential learning

Meanwhile, A decline in teachers' knowledge and constant comprehension can also be found. Before the workshop, none of the participating teachers understood the basic concept of STEAM as a learning approach. Only one gave a correct answer regarding the fundamental concept of tessellation. Following the workshop, all teachers have correct answers about the fundamental concept of STEAM and tessellation, the abbreviation STEAM, the reason for arts inclusion in the STEM approach, the basic concept of kirigami, and educational robotics. Nevertheless, project-based learning falls from four to two teachers with correct answers. The number of teachers that correctly answered the experiential learning aspect remained the same before and after the workshop.

Teachers' Understanding

Teachers' understanding of STEAM learning is crucial in effectively implementing this interdisciplinary approach. They need to understand that STEAM involves teaching these subjects in isolation and integrating them to solve real-world problems. Table 2 provides a summary of teachers' understanding of STEAM learning.

Table 2

Teachers' Understanding of STEAM Learning

Teachers	Statements	Remarks
T1	As the name implies, science, technology, engineering, arts, and mathematics (STEAM) learning is based on science, technology, engineering, arts, and mathematics.	Limited description, similar to its abbreviation
T2	A learning approach that studies science, technology, engineering, and mathematics is combined and processed with arts to make learning easier and more enjoyable.	Emphasis on integration, arts component, and enjoyable learning
T3	A learning strategy that helps teachers explain material in a fun way and does not quickly make students bored with learning.	Emphasis on enjoyable learning
T4	STEAM stands for science, technology, engineering, arts, and mathematics. It is also an approach that can be used for learning.	Recognition of the learning approach
T5	An interdisciplinary learning approach that contains science, technology, engineering, art, and mathematics.	Emphasis on interdisciplinary learning approaches

Table 2 describes the basic understanding of STEAM learning by participating teachers. From their perspectives, STEAM learning is an approach that promotes enjoyable learning. One teacher provides limited elaboration on STEAM learning. Teachers also mentioned concerns regarding integration and interdisciplinary approaches.

Discussion

This study investigated elementary school teachers' knowledge transformation of project-based experiential STEAM learning and comprehension of STEAM learning after participating in a focused STEAM education workshop. Five teachers participated in the investigative exploration, which revealed several key findings.

Prior to the workshop, none of the participating teachers demonstrated an understanding of the fundamental concept of STEAM as an educational approach. This finding indicates a critical need for essential knowledge regarding STEAM education by participating elementary school teachers. It is in line with the studies of Shernoff et al. (2017) and Yakman and Lee (2012), which reveal that although STEAM education is relatively popular worldwide, teachers tend to recognize it as a teaching method and strategy. After the focused workshop, teachers better understand STEAM as an approach to learning instead of methods or strategies. It is crucial to promote a shared perspective towards the basic concept of STEAM education (Belbase et al., 2022). Assuring their understanding is inevitable because teachers may need an appropriate understanding of STEAM education as a learning approach to design and facilitate interdisciplinary learning experiences that integrate science, technology, engineering, arts, and mathematics.

The number of teachers demonstrating a correct understanding of the role of project-based learning in STEAM education decreased from four to two following the workshop. This unexpected decline warrants careful interpretation. Rather than indicating a failure of the workshop, this shift may reflect a process of conceptual reorganization, as participants confronted and reconsidered prior assumptions in light of more nuanced understandings of PBL within a STEAM context. Barron et al. (2014) note that effective PBL requires deep pedagogical shifts, including the integration of inquiry, collaboration, and sustained problem solving—elements that may initially challenge teachers' established practices. Similarly, Herro, Quigley, and Cian (2019) highlight that implementing STEAM-based PBL can expose tensions in instructional planning and content integration, especially when teachers are new to

interdisciplinary approaches. The decline in self-reported understanding may indicate a productive phase of cognitive dissonance as teachers moved from surface-level familiarity toward a more critical and reflective engagement with the complexities of project-based experiential STEAM learning.

The number of teachers providing correct answers regarding experiential learning remained unchanged before and after the workshop. This stability suggests that while the workshop may have reinforced existing knowledge among some participants, it did not lead to significant knowledge transformation in this respect. One possible explanation is that experiential learning (Kolb, 2015; Morris, 2020) may have been unfamiliar to these teachers. On the other hand, the workshop content might not have adequately emphasized or clarified this component in the context of STEAM learning. To avoid misconceptions and inappropriate practices, it is pivotal to further introduce pedagogical innovation (Rahmadi and Lavicza, 2021) in terms of experiential learning application in STEAM educational activities.

Regarding their understanding of STEAM learning, the teachers recognized STEAM as an enjoyable educational approach, and this constitutes one positive outcome of the workshop. This shift in perception is significant, as teachers' attitudes toward a pedagogical method can significantly influence their willingness and enthusiasm to implement it in their classrooms (Herro et al., 2019). Viewing STEAM as enjoyable reflects its potential to create a dynamic and interactive learning environment. It suggests that the workshop succeeded in conveying the creative and exploratory nature of STEAM education. Another key outcome of the workshop was teachers' acknowledgment of the integration and interdisciplinary aspects of STEAM learning. This recognition is crucial, reflecting a deeper understanding of how STEAM transcends traditional subject boundaries to create a cohesive learning experience (Lavicza et al., 2018; Liao, 2016). By identifying integration as a core element, teachers demonstrate an awareness of how STEAM connects science, technology, engineering, arts, and mathematics to solve real-world problems collaboratively and creatively.

To strengthen the theoretical foundation of this study, we further elaborate on STEAM as an integrated and transdisciplinary educational approach. STEAM education moves beyond the mere inclusion of discrete disciplines, instead promoting the synthesis of science, technology, engineering, the arts, and mathematics to foster holistic and innovative thinking. As Yakman and Lee (2012) suggest, effective STEAM education is grounded in a transdisciplinary framework where subject boundaries are intentionally blurred, enabling learners to engage in

authentic, real-world problem solving. Similarly, Perignat and Katz-Buonincontro (2019) emphasise that successful STEAM integration involves not only curriculum design but also pedagogical strategies that support creative inquiry, critical thinking, and collaboration. This theoretical grounding informs the design and analysis of the present study, as it aims to capture how teachers conceptualise and begin to apply integrated approaches to teaching and learning within the context of a project-based experiential STEAM workshop.

In conclusion, this study highlights teachers' growing understanding of project-based experiential STEAM learning within the context of a focused STEAM education workshop. This evolving understanding can be interpreted through the lens of Pedagogical Content Knowledge (PCK), as participants demonstrated increasing ability to integrate content and pedagogy in meaningful ways (van Driel, Verloop and de Vos, 1998). Furthermore, the workshop design aligned with key principles of effective professional development outlined by Desimone and Garet (2015), supporting adult learning through active engagement, content focus, and collaborative reflection.

The present study is limited in some respects. It focuses on probing teachers' knowledge transformation in relation to project-based experiential STEAM learning and STEAM education generally as a result of a focused workshop. This investigative exploration involved mainly teachers from one school. Future studies could consider investigating their changing knowledge from longitudinal professional development workshops or programs and inviting teachers from other schools.

Conclusions

The present study has revealed the alteration of elementary school teachers' comprehension of project-based experiential STEAM learning. The main aim of this study was to investigate their knowledge development after receiving a focused workshop on the STEAM educational approach supported by project-based and experiential learning. Results of this study reveal that, after the workshop, teachers better understood STEAM as an approach to learning. Meanwhile, their comprehension of project-based learning decreased, and experiential learning remained unchanged. An implication of this is to provide integrated training that equally addresses the interconnected components of STEAM, project-based, and

experiential learning to achieve a holistic and lasting improvement in teachers' pedagogical knowledge of project-based experiential STEAM learning. The current study has focused on investigating the growing knowledge of elementary school teachers from a single school and a one-time workshop. Further work must be done to facilitate longer workshops involving teachers from multiple schools.

Acknowledgment

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CAREER ASPIRATIONS OF SLOVENIAN NINTH GRADERS: THE INFLUENCE OF PERSONAL FACTORS AND ATTITUDES TOWARDS ENGINEERING PROFESSIONS

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Abstract/Izvleček

The study examines the career aspirations of Slovenian ninth-grade students and analyses how these are influenced by personal factors and their attitudes towards engineering professions. Regression analyses on a sample of 779 students show that interest in outdoor work is a significant predictor of engineering career aspirations across all educational levels. Physical demands positively influence aspirations for engineering occupations requiring secondary or elementary education, while intellectual demands and employment opportunities encourage interest in engineering occupations at the tertiary level. A positive perception of engineering professions as interesting is a key factor for all levels of education. The results emphasise the importance of fostering interest in technical careers.

Poklicne želje slovenskih devetošolcev: vpliv osebnih dejavnikov in odnosa do tehniških poklicev

V raziskavi smo preučevali poklicne želje slovenskih devetošolcev in analizirali, kako nanje vplivajo osebni dejavniki ter njihov odnos do tehničnih poklicev. Rezultati regresijskih analiz na vzorcu 779 učencev so pokazali, da je zanimanje za delo na prostem pomemben napovednik poklicnih želja v tehničnih poklicih na vseh ravneh izobrazbe. Fizična zahtevnost pozitivno vpliva na izbiro tehničnih poklicev s srednješolsko ali z osnovnošolsko izobrazbo, medtem ko intelektualna zahtevnost in zaposlitvene možnosti spodbujajo zanimanje za tehnične poklice z univerzitetno izobrazbo. Pozitivno dojemanje tehničnih poklicev kot zanimivih je ključni dejavnik za vse ravni izobrazbe. Rezultati poudarjajo pomen spodbujanja zanimanja za tehnične poklice.

Keywords:
ninth grade students, career aspirations, engineering professions, personal factors influencing career choice, attitudes towards engineering professions.

Ključne besede:
učenci devetega razreda, poklicne želje, tehnični poklici, osebni dejavniki vplivanja na poklicne želje, odnos do tehniških poklicev.

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Introduction

According to Sternberg (2004, p. 287), "wisdom is the application of intelligence, creativity and knowledge to the common good by balancing intrapersonal (one's own), interpersonal (others) and extrapersonal (institutional or other larger) interests over the long and short terms, through the mediation of values, so as to adapt to, shape, and select environments". Combining these words with the means of solving environmental problems proposed by Heberlein (Heberlein, 2012), according to which management actions must simultaneously introduce three "solutions" -- cognitive, technological, and structural, one can conclude that solving many global and local problems requires a solid educational background (UNESCO, 2020). However, we observe the trend that the lack of trained professionals in technical fields is one of the fundamental challenges for societal development, and many countries are already struggling with a shortage of qualified personnel in engineering professions (Šorgo and Ploj Virtič, 2020). Professions that are currently in short supply or could soon become so are often referred to as STEM (science, technology, engineering and maths) professions. The shortage of STEM professionals is not just a local problem, but a global challenge that has persisted for years (Ivanova et al, 2019; Kozak, 2019; National Science Board, 2018; OECD, 2022; Ploj Virtič and Šorgo, 2022; Šorgo and Ploj Virtič, 2020). Consequently, attracting and inspiring young people to engineering professions at an early stage of their education should be a priority for any society. However, attractiveness is only a first step that must be followed by measures to maintain interest. Any study that sheds light on the factors that influence certain choices is therefore to be welcomed. Teachers can be recognised as ambassadors who connect the world of school with the extra-curricular sphere. It is widely recognised that teachers and teaching practises play a crucial role in shaping students' career aspirations (Ploj Virtič and Šorgo, 2022). However, research also points to a lack of adequately trained STEM teachers, which could affect their ability to positively influence students' perceptions of engineering professions (Dolenc et al., 2021). Furthermore, the gender gap in STEM fields continues to be an issue. Košak et al. (2024) found that technical and engineering professions are significantly more attractive to boys than to girls. These findings emphasise the need for measures that promote gender equality in career choices.

In addition to education, social influences also impact career aspirations. Studies suggest that family background, socioeconomic status and academic performance have a decisive influence on students' career aspirations (Borrego et al., 2018;

Cleaves, 2005; Davenport et al., 2020; Gero and Abraham, 2016; Jiang et al., 2019; Košak et al., 2022; Košak et al., 2024; Ploj Virtič and Šorgo, 2022; Šorgo and Ploj Virtič, 2020; Wei-Cheng et al., 1998; Woolnough, 1994; Woolnough et al., 1997). A deeper understanding of these factors is essential for developing effective strategies to address the shortage of STEM professionals.

Students' career aspirations develop over the course of their school years (Ginzberg et al., 1951). One of the most important milestones in this process is the end of compulsory elementary school, when young people must choose their future educational path. Recent research in Slovenia (Košak et al., 2024) suggests that students with higher academic performance are more likely to aspire to professions that require a university degree, while students with lower academic performance often opt for vocational education or engineering professions.

Given these findings, it is important to develop evidence-based strategies that guide young people towards sustainable career choices that match both their interests and the demands of the labour market.

Aim and Scope

The main objective of this study was to understand the career aspirations of students after completing nine years of elementary education, in particular their propensity to enrol in secondary education programmes that open up pathways to engineering and technological careers. This includes enrolment in upper secondary vocational education or, later, in higher vocational education and university studies in the field of engineering at technical colleges and universities.

To achieve this goal, the study aimed to investigate whether personal factors and students' attitudes towards engineering professions have a statistically significant influence on the career aspirations of Year 9 students.

The research question of the study:

Can personal factors related to career choice and students' attitudes towards engineering professions statistically significantly predict 9th grade students' career aspirations for technical careers?

Methodology

Sample and Sampling

The study is part of a large doctoral research project conducted between March and May 2022 (Košak, 2024). The study was conducted with a sample of 9th grade

students from elementary schools in Slovenia. A link to the questionnaire, which was created using the open-source online application 1KA, was sent to fifty-nine elementary schools. The questionnaire was anonymous and did not collect any sensitive personal data.

To ensure a systematic and representative sample, schools were selected that included students from all ten statistical regions of Slovenia (Pomurska, Podravska, Savinjska, Koroška, Zasavska, Posavska, Osrednjeslovenska, Jugovzhodna, Goriška and Obalno-kraška). In addition, the sample was distributed proportionally according to the size of the settlement (villages, small towns, and large cities). A total of thirty-five elementary schools took part in the study, and 779 9th grade students answered the questionnaire.

The sample size was large enough to conduct further statistical analyses (Kline, 2015; Wolf et al., 2013).

Statistical Analysis

The collected data was analysed using Jamovi, a free and open-source statistical software (The Jamovi Project, 2023). The following statistical analyses were performed:

- Descriptive statistics were used to examine all variables included in the study.
- Regression analyses (Field, 2013) were conducted to analyse the effects of different factors:
  - Career aspirations in engineering professions,
  - The intention to pursue a technical career, and
  - The choice of an educational pathway.

The predictive models were visualised using graphic representations.

Development of the Instrument

The questionnaire used to assess students' career aspirations and the factors influencing their career choice consisted of several sections (Košak, 2024). In the first section, demographic data was collected. The second and third sections of the data were designed according to the theoretical starting points, as shown in Table 1.

Table 1
Details of the Second and Third Sections of the Instrument

Instrument	Number of statements /scales	Sources
The second section "Personal Factors Influencing Career Choice"	26 statements, measured on a 7-point Likert scale (from *strongly disagree* to *strongly agree*).	Ajzen (1991) Gray and O'Brien (2007) Lent et al. (1994) Liao et al. (2009) Šorgo et al. (2018)
The third section "Attitudes Toward Engineering Professions"	13 statements, measured on a 7-point semantic differential scale (e.g., *engineering professions are very uninteresting – very interesting*).	Ajzen (1991) Lent et al. (1994)

The "Personal Factors Influencing Career Choice" instrument was developed to capture a broad range of potential determinants — both internal and external — that may influence students' career paths to their desired professions. The instrument is based on several theoretical frameworks (Ajzen, 1991; Bandura, 2005; Gray and O'Brien, 2007; Lent et al., 1994; Liao et al., 2009; Ploj Virtič and Šorgo, 2022; Šorgo et al., 2018), all of which have been integrated into the context of career decision-making.

The personal factors included in this instrument are as follows (Košak et al., 2022; Košak, 2024):

- Self-efficacy — an internal factor representing a person's belief in their own ability to perform a particular occupation (Lent et al., 1994; Bandura, 2005).
- Attitudes towards professions — a person's general perception of various occupational characteristics (Liao et al., 2009).
- Subjective norms — the perception of how others, especially those influential to the individual, view their career choice (Ajzen, 1991).
- Aspiration for success — the extent to which a person sets achievement-oriented goals in a particular occupation (Gray and O'Brien, 2007).
- Perceived ease of work — the ease with which a person perceives a particular occupation (Liao et al., 2009).
- Educational pathway to an occupation — the willingness to invest time and effort to complete the necessary education for a chosen career (Gray and O'Brien, 2007; Ploj Virtič and Šorgo, 2022; Šorgo et al., 2018).
- Additional external factors that are independently included in the instrument are financial incentives (e.g., high salary), employment opportunities, travel

opportunities, work environment (e.g., clean workplace, outdoor work) and the possibility of employment in the hometown.

The "Attitudes Toward Engineering Professions" instrument provides a comprehensive insight into individuals' perceptions of engineering professions and integrates both internal and external factors that influence these attitudes. The development of this instrument is based on theoretical foundations (Ajzen, 1991; Lent et al., 1994) that are directly linked to career-related attitudes (Košak, 2024).

Attitudes towards engineering professions are captured by experiential attitudes that reflect how a person perceives engineering professions (e.g., as enjoyable, demanding, etc.), stereotypical attitudes that assess whether technical careers are perceived as gender-specific (e.g., technical careers are only for men), or external factors that assess whether financial rewards or labour market opportunities influence attitudes towards technical careers (e.g., excellent salary) (Košak, 2024). All items of the instrument "Attitudes Toward Engineering Professions" can be found in Table 2.

The fourth section of the questionnaire, titled "Career Aspirations" (Košak et al., 2024), consists of seventeen statements. Respondents indicate their interest in a particular career on a 7-point scale ranging from 1 (not at all interested) to 7 (very interested), with an additional option: "I do not know this career".

The professions in this section are divided into three groups according to the level of education required:

- Professions requiring a university degree — 10 occupational categories.
- Professions requiring a secondary school degree — 5 occupational categories.
- Professions requiring an elementary school degree — 2 occupational categories.

Each category is further subdivided into occupational fields, such as military and police professions or engineering and technology professions (e.g., mechanical engineering, civil engineering, electrical engineering, computer science). All items in the "Career Aspirations" instrument can be found in Table 3.

Research Hypotheses

Before conducting the study, we formulated the following hypotheses:

- H1: The career aspirations of 9th grade elementary school students towards engineering professions are influenced by personal factors.

- H2: The career aspirations of 9th grade elementary school students towards engineering professions are influenced by their attitudes towards technical careers.

Results

The results of the descriptive statistics for the instrument "Personal Factors Influencing Career Choice" have already been presented in a previous publication (Košak et al., 2022). Since this study is part of a broader research project from which both publications emerged, the results for the instrument "Personal Factors Influencing Career Choice" (N = 769, Cronbach's alpha = 0.86) remain consistent and are not repeated in this article but summarised here. Students rated their level of agreement with twenty-six statements on a 7-point Likert scale (from 1 - strongly disagree to 7 - strongly agree). The descriptive results show that the most important personal factors influencing 9th grade students' career choices (median ≥ 6) are as follows: "… where I find the work interesting", "… in which I will enjoy working", "… that will fulfil my life ambitions", and "… that provides challenges." Conversely, the least important factors (median = 3) are "… that has been recommended to me by others" and "… that will make me famous."

The results of the descriptive statistics for the "Attitude Towards Engineering Professions" instrument are shown in Table 2. Students expressed their attitudes towards engineering professions using a 7-point scale between two opposing statements (e.g., engineering professions are very uninteresting – very interesting) and rated 13 statements.

The results from Table 2 show that the students' attitude towards engineering professions is above 4 (neutral) for all statements. The statements "Engineering professions are very important" and "Engineering professions offer many challenges" stand out with a mean value of over 5. At the bottom of the table is the statement "Engineering professions raise reputations."

Table 2
Attitudes of Elementary School Students in Year 9 Towards Engineering Professions, Sorted by Median Value (N = 769, Cronbach's alpha = 0.89)

Engineering professions…	**Mean**	**Med**	**Mod**	**SD**
... are very important.	5.4	6	7	1.8
... they offer many challenges.	5.0	5	7	1.7
... they are physically demanding.	5.0	5	6	1.7
... offer great job opportunities.	4.9	5	5	1.7
The people I value have a good opinion of engineering professions	4.8	5	4	1.7
... they are mentally demanding.	4.7	5	5	1.6
... require a lot of continuous training.	4.7	5	4	1.5
Education for an engineering profession is demanding.	4.6	5	4	1.6
... are respected.	4.5	4	4	1.7
... are well paid.	4.5	4	4	1.6
... are interesting.	4.4	4	4	1.9
... raise reputations.	4.3	4	4	1.6
... are for women only.	3.7	4	4	1.4

The results of the descriptive statistics for the "Career Aspirations" instrument are shown in Table 3. The students rated their career aspirations on a scale from 1 (I would not like to do this profession at all) to 7 (I would definitely like to do this profession).

The results from Table 3 show that the most popular professions among 9th grade students are those that require a university degree. Preferred fields include sports and culture (e.g., musician, actor, writer, sports coach, etc.), healthcare (e.g., doctor, dentist, etc.), engineering and technology professions (e.g., mechanical engineer, civil engineer, electrical engineer, computer scientist, etc.), social sciences and humanities (e.g., archaeologist, historian, geographer, translator, psychologist, etc.), and law (e.g., lawyer, jurist, judge, etc.).

Table 3
Career Aspirations of 9th Grade Elementary School Students, Sorted by Popularity of Occupational Groups (N = 769)

Career Aspirations (required education qualification)	*n*	missing	Mean	Med	Mod	SD
Professions in Sport and Culture (UNI)	736	33	3.7	4	1	2.1
Health Professions (UNI)	729	40	3.5	3	1	2.0
Engineering and Technological Professions (UNI)	**738**	**31**	**3.3**	**3**	**1**	**2.1**
Professions in Law (UNI)	734	35	3.3	3	1	1.9
Social sciences and humanities professions (UNI)	726	43	3.3	3	1	1.8
Clerical, managerial, economist (UNI)	722	47	3.2	3	1	1.8
Health professions (SEC)	736	33	3.2	3	1	2.0
Mathematical and natural science professions (UNI)	725	44	3.1	3	1	1.8
Education professions (UNI)	719	50	3.0	3	1	1.9
Military or police occupations (UNI)	739	30	3.0	3	1	1.9
Occupations in the hospitality, tourism, and commerce sectors (SEC)	734	35	2.9	3	1	1.7
Office occupations (SEC)	733	36	2.8	3	1	1.6
Engineering and technological occupations (SEC)	**728**	**41**	**2.8**	**2**	**1**	**1.9**
Occupations in agriculture (UNI)	702	67	2.7	2	1	1.9
Agricultural occupations (SEC)	717	52	2.4	2	1	1.7
Engineering and technological occupations (Elementary)	**717**	**52**	**2.4**	**2**	**1**	**1.8**
Elementary occupations (Elementary)	707	62	1.9	1	1	1.4

Note: UNI – university qualification, SEC – secondary school qualification, Elementary – elementary school qualification

Among the professions that require a secondary school qualification, the most popular are healthcare professions (e.g., nurse, medical technician, etc.).

To examine whether personal factors influencing career choice and attitudes towards engineering professions significantly predict students' career aspirations in engineering professions, we conducted an ordinal logistic regression analysis. The results are shown in Tables 5 and 6.

The results from Table 4 show that the predictors of career aspirations in engineering professions vary according to the level of education required. Only one personal factor significantly ($p < .05$) and positively predicts career aspirations in all engineering professions: "*I will choose an occupation that is performed outdoors*".

Table 4

Results of the Logistic Ordinal Regression to Explain Career Aspirations in Engineering Professions Based on the Personal Factors that Influence Career Choice

Forecast	**Career preferences of 9th-grade elementary school students for engineering occupations requiring ...**					
	university qualification		**secondary school qualification**		**elementary school qualification**	
Personal factors for career choice I will choose a profession ...	**Regression estimation**	*p*	**Regression estimation**	*p*	**Regression estimation**	*p*
... for which I will easily be able to complete the required training.	.08	.137	.05	.373	.08	.145
... where I will be interested in the work.	.01	.937	.11	.289	- .02	.875
... which I will enjoy.	- .03	.755	- .07	.547	- .11	.346
... which offers challenges.	.10	.169	- .01	.903	- .03	.717
... which requires teamwork.	- .06	.310	.04	.460	.04	.514
... which helps me to help others.	**- .20**	**< .001**	- .02	.695	- .12	.064
... which will fulfil my ambitions in life.	- .13	.074	**- .17**	**.014**	- .07	.328
... which others have advised me to do.	.02	.740	.02	.706	**.10**	**.041**
... which pays well.	.06	.345	.01	.867	- .07	.293
... providing sufficient quality job opportunities.	**.18**	**.010**	.09	.234	.07	.380
... allowing plenty of travel.	- .03	.529	- .05	.358	- .06	.285
... which takes place in a clean environment.	**- .16**	**.004**	**- .16**	**.007**	- .11	.072
... which takes place outdoors.	**.10**	**.041**	**.13**	**.010**	**.11**	**.046**
... which provides employment in the hometown.	.08	.093	.06	.191	**.11**	**.046**
... which is physically strenuous.	.03	.526	**.18**	**< .001**	**.25**	**< .001**
... mentally demanding.	**.20**	**.002**	.05	.386	.00	.970
... requiring special talents.	- .05	.399	.02	.696	- .07	.287
... which is well thought of by people I respect.	- .09	.133	- .06	.272	- .06	.362
... which will enhance my reputation.	.08	.190	.05	.409	.02	.805

...which will make me famous.	- .09	.087	.00	.949	.01	.852
... for which I am willing to study hard.	- .09	.091	**- .17**	**.003**	- .09	.122
... which I will get to as quickly as possible.	.09	.058	**.11**	**.027**	**.16**	**.003**
... in which I will have to continually improve myself.	- .06	.333	- .07	.273	**- .14**	**.030**
...in which I will lead other employees.	**.15**	**.021**	.05	.415	.02	.754
... in which I will teach other employees.	.07	.272	.02	.761	.08	.243
...where I will put extra energy into promotion.	.02	.719	- .06	.399	$-4.78e^{-4}$	.995
Variance explained (R^2)	.04		.04		.06	

Note: Results in bold are statistically significant predictors of career aspirations for engineering occupations
($p < .05$).

Among the strongest positive predictors ($p < .001$) for career aspirations in engineering professions that require a secondary or elementary school degree, the following personal factor stands out: "*I will choose an occupation that is physically demanding.*"

There are two statistically significant ($p < .05$) positive predictors for career aspirations in engineering occupations that require a university degree: "*I will choose an occupation that offers sufficiently high-quality employment opportunities*" and "*I will choose an occupation that is intellectually demanding*".

Table 5
Results of the Logistic Ordinal Regression to Explain Career Aspirations in the Engineering Professions on the Basis of Attitudes Towards the Engineering Professions

Forecast	**Career preferences of 9th-grade elementary school students for engineering occupations requiring ...**					
	university qualification		**secondary school qualification**		**elementary school qualification**	
Attitudes towards engineering professions Engineering professions ...	**Regression estimation**	***p***	**Regression estimation**	***p***	**Regression estimation**	***p***
... are very interesting.	**.73**	**< .001**	**.57**	**< .001**	**.40**	**< .001**
... they offer many challenges.	- .04	.520	- .05	.331	.04	.441
... they are very respected.	.08	.115	.01	.899	.04	.413
... they are very important.	- .03	.588	- .09	.098	**- .12**	**.038**

... they are for women only.	.04	.525	**.16**	**.007**	.08	.171
... they are very well paid.	.12	.053	.04	.576	.04	.541
... offer very good job opportunities.	.03	.621	.05	.466	.05	.473
... require a great deal of continuous training.	**- .15**	**.028**	- .10	.147	**- .19**	**.007**
... are physically very demanding.	**- .11**	**.042**	- .03	.634	.04	.450
... are very demanding mentally.	.06	.391	- .04	.503	- .02	.770
Education for an engineering profession is very demanding.	- .12	.070	.04	.525	- .07	.299
The people I respect have a good opinion of engineering professions.	.05	.352	.02	.706	.01	.909
... raises their reputation.	.01	.883	.00	.978	.08	.205
Variance explained (R^2)	.13		.08		.05	

Note: Results in bold are statistically significant predictors of career aspirations for engineering occupations
($p < .05$).

The results from Table 5 show that the predictors for career aspirations in engineering professions differ depending on the level of education required. Only one predictor significantly ($p < .05$) and positively predicts career aspirations for all engineering professions. This is the attitude towards engineering professions: "Engineering professions are very interesting".
The prediction model to explain the career aspirations of students in engineering professions is shown in Figures 1 and 2.

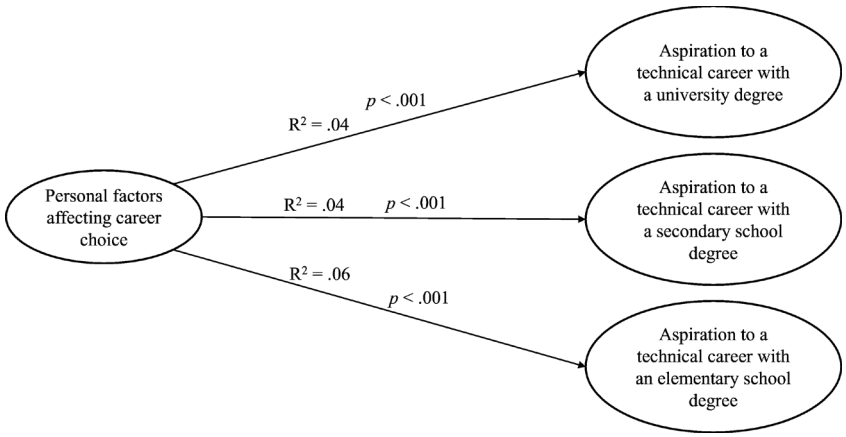

Figure 1
Prediction Model for Career Aspirations in Engineering Occupations Based on Personal Factors Influencing Career Choice

The results from Figure 1 show that personal factors influencing career choice have a significant influence ($p < .001$) on career aspirations in engineering professions. However, they account for only around 5% of the variance in career aspirations at the individual educational levels.

The prediction model confirms H1 (*We hypothesise that personal factors significantly influence the career aspirations of 9th grade students in engineering professions*), but only for certain personal factors (see Table 4).

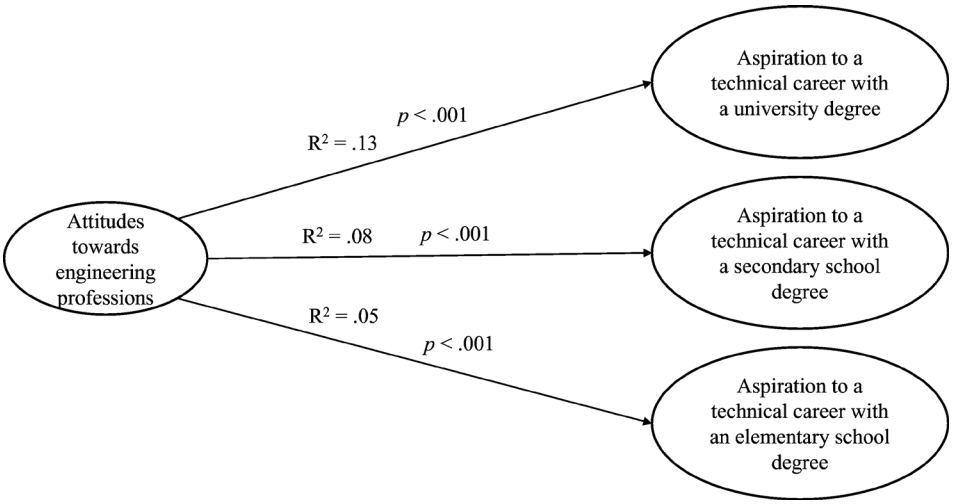

Figure 2
Predictive Model for Career Aspirations in Engineering Professions Based on Attitudes Toward Engineering Professions

The results from Figure 2 show that attitudes towards engineering professions have a significant influence ($p < .001$) on career aspirations in engineering professions. More specifically, attitude explains:

- 13% of the variance in career aspirations for engineering professions that require a university degree,
- 8% of the variance in career aspirations for engineering professions that require a secondary school qualification,
- 5% of the variance in career aspirations for engineering professions that require an elementary school qualification.

The prediction model confirms H2 (*We hypothesise that 9th grade students' attitudes towards engineering professions significantly influence their career aspirations in engineering professions*), but only for certain attitudinal statements (see Table 5).

Discussion

The results show that two predictors have a significant and positive influence on career aspirations in engineering and technology professions across all required educational levels: (1) the personal factor "*I will choose a profession that is performed outdoors*" and (2) the attitude towards engineering professions "*Engineering professions are very interesting*". The latter predictor is consistent with previous research (Chan et al., 2019; Chen et al., 2024; Smit et al., 2021).

A statistically significant and positive predictor of career aspirations in engineering and technology professions that require a secondary or elementary school degree is the personal factor "*I will choose an occupation that is physically demanding*". For career aspirations in engineering professions that require a university degree, there are two significant personal factors: "*I will choose an occupation that provides sufficient high-quality employment opportunities*" and "*I will choose an occupation that is intellectually demanding*". These predictors were expected based on stereotypical assumptions. Low-skilled engineering and technology professions and occupations requiring a secondary school degree tend to be more physically demanding, which attracts or discourages individuals for whom this factor is relevant. Similarly, engineering and technology professions that require a university degree are more intellectually demanding and therefore appeal to people who value this aspect.

The results can primarily be explained by external motivational factors, since elementary school students have no influence on the characteristics of the professions. Another possible explanation arises from the self-determination perspective, where students select a range of professions in which they believe they could be successful.

Career aspirations cannot be explained by a single theory (e.g., Lent et al., 1994) as too many factors are involved, from personal factors in the psychological sciences (e.g., Deci and Ryan, 2012) to numerous social and economic factors in the social sciences (e.g., Lent et al., 1994), to the objective realities of living conditions and the environment. If bridging the gap between career aspirations and actual career choices in STEM careers is a genuine goal of society and its subsystems, it is insufficient to delegate this problem to schools alone.

Conclusion

The main objective of this study was to investigate whether personal factors and attitudes towards engineering professions predict the career aspirations of Slovenian 9th grade students for technical careers in a statistically significant way. The research sought to answer the question: What personal factors and attitudes influence students' interest in engineering professions across different educational pathways? The results show that career aspirations in engineering professions are influenced by different factors depending on the level of education. Across all levels, interest in working outdoors proved to be a consistently positive predictor. Physical demands were identified as an important motivator for professions requiring a secondary or elementary school degree, while intellectual demands and employment opportunities were the most important factors for careers requiring a university degree. Furthermore, the perception of engineering professions as "very interesting" was a universal predictor for all levels of education.

These findings underscore the importance of fostering positive attitudes towards engineering professions and aligning educational strategies with students' personal interests and perceptions of career characteristics. By addressing these factors, educational institutions and policy makers can better support students in making informed decisions about their future careers in engineering fields.

Limitations of the study

The study has several limitations on different levels. One of its limitations, but also a strength, is its novelty both in the Slovenian and international context. Therefore, the results of the study cannot be directly compared with previous research or identical foreign studies. Given the broad scope of the research problem, numerous constructs derived from established theories were not considered, which could serve as a direction for future research. Further limitations arise from the voluntary nature of participation in the survey, which may affect the representativeness of the sample and therefore the generalisability of the results to the wider population or international context. Further limitations arise from the online nature of the survey with all its known advantages and limitations. Although the interpretation of the results was conducted with the utmost care and scientific rigour, some interpretations suggest the need for further research.

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IZZIVI PRI PREPOZNAVANJU IN PODPORI DVOJNO IZJEMNIH UČENCEV V IZOBRAŽEVALNEM PROCESU

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Abstract/Izvleček

Dvojno izjemni učenci, ki imajo nadarjenost v kombinaciji s posebnimi vzgojno-izobraževalnimi potrebami, so pogosto spregledani, kar ovira zagotavljanje ustrezne podpore v izobraževalnem procesu. V prispevku analiziramo stališča in usposobljenost strokovnih delavcev za delo s to skupino učencev ter načine pridobivanja znanja na področju dvojne izjemnosti. Rezultati raziskave kažejo, da se večina respondentov zaveda pomena prepoznavanja dvojne izjemnosti, vendar le redki sistematično in dosledno vključujejo ustrezne pedagoške pristope v prakso. Znanje na tem področju se večinoma pridobiva z neformalnimi viri in izmenjavo izkušenj, saj je ponudba formalnih strokovnih izobraževanj skromna. Poudarjena je potreba po razvoju specializiranih programov usposabljanja, ki bi izboljšali prepoznavanje in učinkovito podporo tej specifični skupini učencev.

Ključne besede:
dvojno izjemni učenci, nadarjenost, posebne potrebe, prepoznavanje, usposobljenost.

Challenges in Recognizing and Supporting Gifted Students with Dual Exceptionalities in the Educational Process

Twice-exceptional students, who have giftedness combined with special educational needs, are often overlooked, which hinders the provision of appropriate support in the educational process. This paper analyses the attitudes and competences of professionals working with this group of students, as well as the ways knowledge is acquired in this field. The research results show that most professionals recognize the importance of identifying twice-exceptionality, yet only a few systematically incorporate appropriate pedagogical approaches into practice. Knowledge in this area is mostly gained through informal sources and experience sharing, since formal professional training is limited. The need for developing specialized training programs is emphasized to improve the identification and effective support of this specific group of students.

Keywords:
dual exceptional students, giftedness, special needs, recognition, teacher training.

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Introduction

Dvojno izjemni učenci predstavljajo kompleksno skupino v vzgoji in izobraževanju, saj združujejo visoke kognitivne sposobnosti in različne primanjkljaje, kot so učne težave, motnje pozornosti ali avtistični spekter (Baum, Schader in Owen, 2021). V slovenskem prostoru so opredeljeni kot učenci, pri katerih je na enem področju ali več področjih prepoznana izjemnost (npr. visoki intelektualni potenciali in/ali talenti), hkrati pa imajo tudi različne primanjkljaje, ovire ali motnje (Ančimer Aljaž in Juriševič, 2018). V širši definiciji sem prištevamo še učence iz deprivilegiranega okolja, begunce itd. (Lep, 2020). Njihova edinstvena kombinacija močnih in šibkih področij lahko povzroči izzive pri prepoznavanju in ustreznem pedagoškem pristopu, saj mnogi med njimi ostanejo neidentificirani, kar vodi v pomanjkljivo pedagoško-psihološko podporo (Reis, Baum in Burke, 2014).
Kljub svojemu visokemu potencialu za določene dosežke številni dvojno izjemni učenci ne uspejo v celoti razviti svojih sposobnosti, saj šolski sistemi pogosto niso prilagojeni njihovim specifičnim potrebam (Foley-Nicpon idr., 2011). Raziskave kažejo, da učitelji pogosto nimajo dovolj znanja o dvojni izjemnosti, kar lahko vodi do neustreznih pedagoških praks (Beckmann in Minnaert, 2018).
Njihova prepričanja in stopnja osveščenosti pomembno vplivajo na način, kako prepoznavajo in podpirajo dvojno izjemne učence v učilnici (Bianco, 2005). V prispevku preučujemo stališča učiteljev o dvojno izjemnih učencih ter učinkovitost obstoječih sistemov podpore. Analiziramo tudi, v kolikšni meri so učitelji seznanjeni z značilnostmi te skupine učencev ter kako dodatna izobraževanja vplivajo na njihovo pripravljenost za diferencirano poučevanje. Kot ugotavljata Lovett in Sparks (2011), ustrezno strokovno izobraževanje učiteljev močno prispeva k prepoznavanju in podpori dvojno izjemnih učencev, kar omogoča učinkovitejšo inkluzivno izobraževanje. Z raziskavo želimo prispevati k širšemu razumevanju dvojne izjemnosti in spodbujanju inkluzivne prakse v slovenskem šolstvu. Identifikacija in prilagojen pristop sta ključna za zagotavljanje ustreznih izobraževalnih strategij, ki bodo dvojno izjemnim učencem omogočile doseganje njihovega polnega potenciala (Trail, 2022).

Dvojno izjemni učenci: izzivi, prepoznavanje in podpora

Dvojno izjemni učenci (ang. »2e« oz. Twice-Exceptional) so posamezniki, pri katerih so prisotne tako nadpovprečne intelektualne sposobnosti kot tudi učne težave, kot

so disleksija, ADHD (ang. Attention-deficit/hyperactivity disorder), avtizem ali druge nevrološke motnje. To stanje je pogosto spregledano zaradi navideznega nasprotja med njihovimi nadpovprečnimi sposobnostmi in specifičnimi težavami, kar otežuje prepoznavanje in ustrezno podporo (Baum, Schader in Owen, 2021). Kot opozarja Lep (2015), sta prepoznavanje otrok s posebnimi vzgojno-izobraževalnimi potrebami in identifikacija nadarjenosti dva ločena postopka, zaradi česar ni skupnih, enotnih evidenc in vpogleda v učenčevo dvojno izjemnost. Ob tem izpostavi tudi, da učenčevi primanjkljaji, ovire oziroma motnje lahko prikrivajo potenciale oziroma nadarjenost ali obratno, kar otežuje ustrezno prepoznavo obeh področij. Ugotavlja tudi, da strokovni delavci v šolah zaznavajo učence s posebnimi vzgojno-izobraževalnimi potrebami večinoma kot tiste, ki imajo zgolj težave, s čimer se pogosto spregleda morebitna prisotnost nadarjenosti.

Dvojno izjemni učenci predstavljajo edinstvene izzive za učitelje, svetovalce in starše, saj njihovo identifikacijo pogosto preprečuje neenakomerna narava njihovih sposobnosti in težav (Reis, Baum in Burke, 2014). Dvojno izjemni učenci imajo visoke intelektualne sposobnosti, vendar se hkrati soočajo z učnimi težavami, to pa lahko vpliva na njihovo šolsko uspešnost in prepoznavanje njihovih potencialov. To vključuje visoko raven ustvarjalnosti in napredno razmišljanje, vendar tudi težave pri organizaciji, koncentraciji in socialnih interakcijah.

Razumevanje njihovih posebnosti zahteva celostno obravnavo, ki upošteva tako njihove prednosti kot pomanjkljivosti. Dvojno izjemni učenci pogosto izkazujejo visoko stopnjo radovednosti in ustvarjalnosti, njihovo divergentno mišljenje omogoča reševanje kompleksnih problemov, vendar je to pogosto neprepoznavno, saj so lahko njihova šibka področja, kot je pomanjkanje organizacijskih spretnosti, bolj očitna (Trail, 2022). Poleg visokih intelektualnih sposobnosti se pogosto soočajo z učnimi težavami, kot so težave s spominom, koncentracijo in izvršilnimi funkcijami (Montgomery, 2015). Ta neenakomerna akademska uspešnost lahko povzroča frustracije, saj učenci na nekaterih področjih izstopajo, medtem ko na drugih močno zaostajajo. Zaradi neustreznega prepoznavanja svojih sposobnosti se lahko počutijo nerazumljene, kar lahko vodi v čustvene in vedenjske težave (Neihart, 2003; 2008).

Prepoznavanje dvojno izjemnih učencev je lahko izjemno zahtevno. Dvojna izjemnost namreč pogosto ostane neopažena, ker so njihovi visoki potenciali prikriti zaradi njihovih učnih in drugih težav. Pomanjkanje enotnega pristopa k diagnostiki in oceni teh učencev povzroča, da pogosto ostanejo v senci drugih, bolj očitnih potreb (Reis idr., 2014). Zaradi napačne identifikacije učenci ne dobijo ustrezne podpore, to pa v nadaljevanju pogosto pomeni, da ne morejo doseči svojega polnega

potenciala (Mullet in Rinn, 2015). Za učinkovito podporo dvojno izjemnim učencem je nujno sprejeti prilagoditve v učnem okolju. Kljub temu da so izzivi številni, jim je mogoče zagotoviti ustrezno podporo s prilagoditvami učnih metod, vsebin in ciljev. Diferencirano poučevanje omogoča, da se učencem zagotovi priložnost za napredovanje na močnih področjih, hkrati pa se jim nudi podpora pri šibkih področjih. Ta pristop omogoča prilagoditve učnih nalog, ki ustrezajo njihovim potrebam, in sicer z namenom ustvariti izzive, ki jih bodo spodbudili k napredku (Tomlinson, 2014; 2017).

Za učence z dvojno izjemnostjo je treba razviti personalizirane izobraževalne načrte, ki upoštevajo tako njihove nadpovprečne sposobnosti kot tudi učne težave. V slovenskem izobraževalnem prostoru trenutno obstajata dva ločena mehanizma za podporo učencem z različnimi potrebami: za nadarjene učence je predviden personalizirani načrt vzgojno-izobraževalnega dela (PeNAD), ki izhaja iz koncepta bogatitve in razvijanja potencialov (Strokovna izhodišča posodobitve koncepta odkrivanja nadarjenih otrok, učencev in dijakov ter vzgojno-izobraževalnega dela z njimi, 2019), medtem ko se za učence s posebnimi potrebami oblikuje individualizirani program (IP), osredinjen predvsem na prilagoditve in odpravljanje primanjkljajev (ZUOPP-1, 2011).

Smiselno bi bilo razmisliti o vzpostavitvi integriranega in individualiziranega načrta podpore, prilagojenega potrebam dvojno izjemnih učencev. Tak načrt bi temeljil na povezovanju elementov obeh obstoječih modelov – PeNAD in IP – ter omogočal uravnoteženo, usklajeno in razvojno naravnano podporo. Ključno vlogo pri oblikovanju in izvajanju takšnega načrta naj imajo učitelji, starši in strokovni delavci, ki skupaj oblikujejo konkretne cilje ter strategije za učenje in napredek učenca. Poleg akademske podpore je bistvenega pomena tudi zagotavljanje čustvene podpore in spodbujanje razvoja socialnih veščin, saj se dvojno izjemni učenci pogosto srečujejo s čustvenimi stiskami in socialno izolacijo (Kaufman, 2018). Zaradi pomanjkanja sistemskih rešitev in celostnega pristopa ni predviden integrirani načrt, ki bi celovito naslovil oba vidika učenčevega razvoja, čeprav raziskave (npr. Baum, Schader in Owen, 2021; Kaufman, 2018) jasno poudarjajo potrebo po uravnoteženi podpori, ki hkrati spodbuja razvoj sposobnosti in nudi ustrezne prilagoditve za premagovanje težav.

Skupine dvojno izjemnih učencev

(i) Pri dvojno izjemnih učencih z avtizmom je podpora pogosto pretežno usmerjena v njihove posebne vzgojno-izobraževalne potrebe, zaradi česar področja njihove nadarjenosti pogosto ostanejo prezrta in se ne razvijajo ustrezno. Čeprav se ti učenci soočajo z različnimi izzivi, povezanimi z avtizmom, pogosto izražajo izrazite specifične interese, v katere vlagajo veliko časa in truda – ti interesi zato zahtevajo prepoznavo in ciljno spodbudo. Zanje je značilna tudi visoka sposobnost osredinjanja na podrobnosti, kar jim omogoča doseganje izjemnih rezultatov na ozko usmerjenih področjih. Vendar pa je pri delu z njimi nujno tudi načrtno razvijanje socialnih veščin, prilagoditvenih spretnosti ter zagotavljanje podpore na njihovih šibkejših področjih (Madaus idr., 2022; McFadden, 2017).
(ii) Dvojno izjemni učenci z motnjami vida imajo željo po učenju na izbranem interesnem področju, so motivirani in učinkoviti pri nalogah. Zanje je pomembno prilagoditi okolje, dostop do informacij in učne pripomočke, da se lahko razvijajo v svojih močnih področjih, kot so abstraktno mišljenje, spomin na zvoke in občutljivost na glasbo (Rooks in June Maker, 2009).
(iii) Dvojno izjemni učenci z motnjami sluha: nadarjenost pri učencih z motnjami sluha je pogosto spregledana, kljub temu pa se lahko izraža v izjemnem spominu, razviti sposobnosti reševanja problemov in močnih interesih za posamezna področja (Hermon, 2002). Da bi se ti potenciali lahko ustrezno razvijali, je treba zagotoviti prilagoditve, ki učencem olajšajo dostop do učnih vsebin in komunikacije. Težave, kot so učne, jezikovne in pozornostne motnje, pa zahtevajo individualizirani pristop, ki upošteva tako njihove močne kot šibke strani ter jim omogoča optimalen učni in osebni napredek (Gharashi, 2015).
(iv) Dvojno izjemni učenci s težavami na gibalnem, psihomotoričnem in senzomotoričnem področju: motorične težave se lahko pojavijo na različnih stopnjah, vendar imajo lahko ti učenci dobre kognitivne sposobnosti in zmožnosti reševanja problemov, prav tako so lahko zelo spretni na področju socialnih veščin. Glede na značilnosti njihove oviranosti je pomembno, da se jim ustrezno prilagodi učno okolje in zagotovi dostopnost in aktivno udeležbo v šolskih in obšolskih dejavnostih, hkrati pa se spodbuja njihov napredek tudi na področjih njihovih primanjkljajev (Reis in Renzulli, 2004).
(v) Dvojno izjemni učenci s splošnimi in specifičnimi učnimi težavami se pogosto soočajo z izzivi na področju izvršilnih funkcij, procesiranja informacij in samega učnega procesa. Njihove težave se lahko kažejo v obliki disleksije, disgrafije,

disortografije, diskalkulije ali dispraksije. Zanje je značilen izrazito nesinhron razvoj – ob pomembnih primanjkljajih hkrati izkazujejo tudi izrazita področja nadarjenosti. Takšno neravnovesje pogosto povzroča frustracije in sproža obrambne mehanizme, saj učenci brez ustreznih strategij za kompenzacijo šibkih področij težko uresničujejo svoje inovativne zamisli. Visoka pričakovanja okolice v kombinaciji s pogostimi učnimi neuspehi pogosto vodijo v zmanjšano samopodobo ter v izogibanje šolskim nalogam in obveznostim. Ključno je, da učitelji prepoznajo njihove sposobnosti in jih usmerijo v področja, kjer lahko izražajo svojo nadarjenost, s čimer se krepita njihova motivacija in samospoštovanje. Ob tem pa je nujno zagotoviti tudi ustrezno podporo za premagovanje učnih primanjkljajev in razvoj izvršilnih spretnosti (Beckley, 1998; Magajna, 2007).

(vi) Dvojno izjemni učenci z motnjo pozornosti s hiperaktivnostjo (ADHD) predstavljajo specifično skupino, saj več kot polovica nadarjenih učencev izpolnjuje diagnostična merila za to motnjo. Pogosto izkazujejo izjemno kreativno mišljenje ter sposobnost t. i. hiperfokusa – intenzivne in dolgotrajne osredinjenosti na dejavnosti, ki jih zanimajo in v katerih uživajo. Kljub tem izrazitim kognitivnim prednostim pa njihova nadarjenost pogosto ostaja neopažena zaradi pogostega motečega vedenja, ki ga okolje pogosto interpretira kot problematično. Ti učenci so praviloma zelo občutljivi na zunanje in notranje dražljaje, zato potrebujejo varno, sprejemajoče in spodbudno okolje ter zahtevne, kompleksne naloge, ki jih motivirajo. Zaradi težav z izvršilnimi funkcijami pa se pogosto soočajo s težavami pri načrtovanju, organizaciji in dokončevanju nalog. Pomembno je, da jim zagotovimo ustrezne intelektualne izzive ter hkrati učinkovito podporo na področju čustvenega in socialnega razvoja (Lee in Olenchak, 2015; Neihart, 2003).

Vse skupine dvojno izjemnih učencev se soočajo z edinstvenimi izzivi in potrebujejo prilagoditve, ki omogočajo tako prepoznavanje in razvijanje njihovih nadarjenosti kot tudi ustrezno podporo pri obvladovanju primanjkljajev, ovir ali motenj. Pomembno je, da učitelji izražajo naklonjenost, prepoznavajo močna področja teh učencev ter so pripravljeni nuditi podporo pri premagovanju njihovih šibkosti.

Delo z dvojno izjemnimi učenci

Delo z dvojno izjemnimi učenci v osnovni šoli zahteva celosten in integrirani pristop, ki upošteva tako izobraževanje nadarjenih učencev kot učencev s posebnimi vzgojno-izobraževalnimi potrebami. V slovenskem izobraževalnem sistemu je za učence s posebnimi potrebami predviden individualizirani program (IP), ki naj bi bil

specifičen, merljiv, izvedljiv, realen in časovno opredeljen, skladno z metodo SMART (ang. Specific, Measurable, Achievable, Relevant, and Time-bound; Kiswarday, 2018; Watson, 2019). Vendar pa sta vsebina in obseg IP po Zakonu o usmerjanju otrok s posebnimi potrebami (ZUOPP-1, 2011) pogosto premalo natančno opredeljena, kar predstavlja izziv za učinkovito načrtovanje in izvajanje podpore. Pri dvojno izjemnih učencih, ki imajo hkrati nadarjenost/ posebne talente in specifične primanjkljaje, ovire ali motnje, pa se pojavlja dilema glede ustreznosti obstoječih načrtov pomoči. Namreč, za nadarjene učence obstaja koncept personaliziranega načrta vzgojno-izobraževalnega dela, ki se osredinja na razvijanje potencialov, medtem ko IP naslavlja predvsem potrebe po prilagoditvah in podpori pri premagovanju učnih težav. Zaradi ločenega obravnavanja teh področij v praksi pogosto učenci prejmejo le enega od obeh načrtov, kar ne omogoča celovite in usklajene podpore.

Zato je za učinkovito delo z dvojno izjemnimi učenci nujno upoštevati tri ključna področja: (i) izobraževanje nadarjenih učencev, (ii) podpora učencem s posebnimi vzgojno-izobraževalnimi potrebami in (iii) integracijo obeh pristopov za celostno obravnavo (Košnik idr., 2023). V okviru načrtovanja podpore je zato priporočljivo oblikovati integrirane individualizirane programe, ki bodo vključevali tako cilje razvoja nadarjenosti kot tudi strategije za obvladovanje učnih ovir, s čimer se zagotovi uravnotežen in prilagojen pristop k učenčevemu razvoju in uspehu (Neumann, 2004). Tudi pri delu z dvojno izjemnimi učenci je ključen timski pristop med različnimi strokovnimi delavci na šoli, ki prispevajo svoj razmislek glede na različna področja, kjer se srečujejo in delajo z dvojno izjemnim učencem. Ključno vlogo v ožji strokovni skupini, ki sodeluje pri načrtovanju, izvajanju in evalvaciji individualiziranega programa (IP) za dvojno izjemnega učenca, ima svetovalni delavec ali drugi strokovni delavec šole, ki opravlja naloge koordinatorja za delo z nadarjenimi. S svojim strokovnim znanjem in izkušnjami prispeva dragocen vpogled v učenčevo nadarjenost ter aktivno sodeluje pri oblikovanju ciljev, prilagoditev in drugih oblik podpore, ki so prilagojene individualnim potrebam učenca (Košnik, 2025).

Raziskovalni problem, namen in cilji

Raziskava prvenstveno izhaja iz premise, da je na področju prepoznavanja in zagotavljanja ustreznih prilagoditev za dvojno izjemne učence še veliko možnosti za izboljšave (Kiswarday, 2017). Namen raziskave je proučiti stališča učiteljev glede

dvojne izjemnosti in njihovih izkušenj z njenim prepoznavanjem v šolskem okolju. Raziskovalni cilji so: (i) ugotoviti, kako osveščeni so učitelji za prepoznavanje in delo z dvojno izjemnimi učenci; (ii) raziskati, kako učitelji ocenjujejo lastno usposobljenost za delo z dvojno izjemnimi učenci; (iii) ugotoviti, ali je ponujenih dovolj izobraževanj na področju dvojne izjemnosti.

Raziskovalne hipoteze

H1: Večina učiteljev je seznanjena z značilnostmi in odkrivanjem dvojno izjemnih učencev. H2: Večina učiteljev meni, da za delo z dvojno izjemnimi učenci niso dovolj usposobljeni.

H3: Večina učiteljev meni, da je na voljo premalo dodatnih izobraževanj s področja dvojne izjemnosti.

Raziskovalne metode

Raziskava je temeljila na kvantitativnem raziskovalnem pristopu, pri čemer sta bila uporabljeni deskriptivna in kavzalno-neeksperimentalna metoda. Deskriptivna metoda je omogočila zbiranje podatkov o stališčih in izkušnjah strokovnih delavcev, medtem ko je kavzalno-neeksperimentalna metoda omogočila analizo medsebojnih povezav med različnimi dejavniki, ki vplivajo na prepoznavanje in podporo dvojno izjemnim učencem.

Raziskovalni vzorec

V raziskavi je sodelovalo 150 strokovnih delavcev, ki so bili predstavniki različnih delovnih mest v šolah: 20 % (30 anketirancev) učiteljev razrednega pouka; 34 % (51 anketirancev) učiteljev predmetnega pouka; 27 % (40 anketirancev) učiteljev za dodatno strokovno pomoč; 8 % (13 anketirancev) učiteljev v oddelku podaljšanega bivanja/jutranjem varstvu; 11 % (16 anketirancev) svetovalnih delavcev. Uporabljen je bil neslučajnostni priložnostni vzorec.

Pripomočki

Za zbiranje podatkov je bil uporabljen spletni anketni vprašalnik, to je omogočilo dostop do širšega kroga strokovnih delavcev in poenostavilo postopek zbiranja podatkov v omejenem časovnem okviru. Spletna anketa je bila izbrana kot glavni pripomoček, saj omogoča enostavno distribucijo in zbiranje odgovorov anketirancev v različnih geografski lokacijah, s tem pa povečuje reprezentativnost vzorca.

Postopek zbiranja podatkov

Zbiranje podatkov je potekalo junija in julija 2024. Podatke o stališčih in osveščenosti učiteljev o dvojno izjemnih učencih smo zbirali s pomočjo spletnega anketnega vprašalnika, ki je bil objavljen v zaprtih pedagoških skupinah na družbenih omrežjih

Obdelava podatkov

Podatki so bili obdelani s pomočjo računalniškega programa IBM SPSS Statistic 26, pri čemer so bile izvedene analize deskriptivne in inferenčne statistike. Za preverjanje hipotez in ugotavljanje statistične pomembnosti so bili uporabljeni različni statistični preizkusi, kot so Kolmogorov-Smirnov test normalnosti porazdelitve, Mann-Whitneyjev test, Hi-kvadrat test in Kruskal-Wallisov test.

Omejitve raziskave

Pri interpretaciji rezultatov je treba upoštevati določene omejitve raziskave. Ena ključnih je uporaba neslučajnostnega priložnostnega vzorca, kar lahko vpliva na omejeno možnost posploševanja ugotovitev na širšo populacijo strokovnih delavcev. Poleg tega je bil delež anketiranih svetovalnih delavcev sorazmerno nizek, to pa predstavlja pomembno omejitev, saj imajo prav ti strokovnjaki v šolskem okolju ključno vlogo pri prepoznavanju dvojno izjemnih učencev ter zagotavljanju podpore drugim strokovnim delavcem na tem področju. Zaradi tega raziskava morda ne odraža v celoti perspektiv in izkušenj vseh relevantnih strokovnjakov.

Rezultati in razprava

Poznavanje in razumevanje pojma dvojne izjemnosti

Rezultati kažejo, da večina strokovnih delavcev (78 %) pravilno razume pojem dvojne izjemnosti kot kombinacijo nadarjenosti in posebnih potreb, kar je ključno za ustrezno podporo tej skupini učencev. Kljub temu pa le 19 % prepozna dvojno izjemnost kot kombinacijo nadarjenosti in specifičnih učnih težav. Razlogi za nepoznavanje pojma dvojne izjemnosti med strokovnimi delavci so večplastni. Ena od ključnih omejitev je pomanjkanje specializiranih izobraževanj in strokovnih usposabljanj, ki bi omogočila poglobljeno razumevanje tega kompleksnega področja. Poleg tega v slovenskem pedagoškem prostoru še vedno primanjkuje enotnih in jasnih strokovnih smernic za prepoznavanje ter podporo dvojno izjemnim učencem,

kar vodi v različne interpretacije in nejasnosti. Tradicionalno ločeno obravnavanje nadarjenosti in posebnih vzgojno-izobraževalnih potreb v šolskem sistemu otežuje celosten pristop k učencem, ki izkazujejo obe značilnosti hkrati. Dostopnost do strokovne literature o dvojni izjemnosti je dodatno omejena zaradi prevladujoče tujejezičnosti virov, to pa predstavlja izziv za širšo strokovno rabo v slovenskem okolju. Nenazadnje pa praktične omejitve, kot so pomanjkanje časa, kadrovskih virov in podpore v šolskem okolju, zmanjšujejo možnost, da bi strokovni delavci sledili novim spoznanjem in učinkovito naslavljali specifične potrebe dvojno izjemnih učencev.

Izkušnje pri poučevanju dvojno izjemnih učencev

Rezultati kažejo, da je več kot polovica anketirancev (56 %) ocenila, da ima izkušnje pri poučevanju dvojno izjemnih učencev, medtem ko 44 % takšnih izkušenj ni prepoznalo oziroma jih ni zaznalo. To ne pomeni nujno, da teh učencev v njihovem delu ni bilo, temveč kaže na možnost, da nekateri učitelji niso prepoznali dvojne izjemnosti pri učencih, s katerimi so delali. Kot opozarjata Lep (2012; 2015) in Magajna (2010), lahko učenci z visokimi sposobnostmi prikrijejo svoje učne težave, zaradi česar je prepoznavanje dvojne izjemnosti oteženo. Iz tega izhaja potreba po večji ozaveščenosti in strokovni usposobljenosti učiteljev, da znajo prepoznati in ustrezno podpreti učence z dvojno izjemnostjo tudi takrat, ko simptomi niso očitni.

Vir znanja za delo z dvojno izjemnimi učenci

Najpogostejši viri pridobivanja znanja za delo z dvojno izjemnimi učenci so izmenjava strokovnih izkušenj znotraj strokovne skupnosti (28 %), strokovna literatura (21 %), študijski programi (19 %) ter izobraževanja in delavnice (12 %). Rezultati kažejo, da je pridobivanje znanja močno odvisno od sodelovanja in izmenjave informacij ter uporabe strokovne literature. Ta ugotovitev poudarja potrebo po izboljšani dostopnosti kakovostnih strokovnih izobraževanj in formalnih usposabljanj, ki bi sistematično krepila strokovne kompetence za delo z dvojno izjemnimi učenci.

Ocena lastne usposobljenosti za prepoznavanje in delo z dvojno izjemnimi učenci

Povprečna ocena lastne usposobljenosti za prepoznavanje dvojno izjemnih učencev znaša 3,0 ($\bar{x} = 3{,}0$), kar kaže, da anketiranci svojo usposobljenost na tem področju

ocenjujejo kot dobro. Standardni odklon (σ = 1,10) nakazuje relativno visoko razpršenost ocen, kar pomeni, da mnenja o lastni usposobljenosti med anketiranci precej nihajo. Kar 40 % jih ocenjuje svoje kompetence kot dobre, 28 % kot prav dobre, medtem ko 25 % ocenjuje svojo usposobljenost kot zadostno ali slabo. Le 7 % anketirancev svojo usposobljenost ocenjuje kot odlično. Ti rezultati kažejo na prisotno visoko stopnjo samoocene in raznolikost v zaznavanju lastnih sposobnosti za prepoznavanje dvojno izjemnih učencev.

Delo z dvojno izjemnimi – Povprečna ocena usposobljenosti za delo z dvojno izjemnimi učenci znaša 3,0 ($\bar{x}$ = 3,0), kar kaže, da anketiranci svojo usposobljenost ocenjujejo kot dobro. Standardni odklon (σ = 0,98) kaže na zmerno razpršenost odgovorov, pri čemer so ocene večinoma osredinjene, vendar so prisotne tudi izrazite razlike med posamezniki. Največji delež anketirancev (46 %) ocenjuje svojo usposobljenost kot dobro, kar kaže na solidno osnovno raven kompetenc za delo s to specifično skupino učencev. Kljub temu približno 22 % anketirancev (9 % kot slabo in 13 % kot zadostno) ocenjuje, da njihova usposobljenost ni zadostna za učinkovito delo z dvojno izjemnimi učenci. Dodatnih 27 % anketirancev svojo usposobljenost ocenjuje kot prav dobro, medtem ko le 5 % meni, da je njihova usposobljenost odlično razvita. Ti podatki kažejo, da le omejen delež strokovnih delavcev ocenjuje, da so popolnoma pripravljeni za delo z dvojno izjemnimi učenci.

Stališča strokovnih delavcev do dvojne izjemnosti in dvojno izjemnih učencev

Strokovni delavci v raziskavi so izrazili stališče o različnih vidikih dela z dvojno izjemnimi učenci, zlasti glede na njihove potrebe, prepoznavanje in podporo. Najvišje ocenjena trditev je bila, da je pri delu z dvojno izjemnimi učenci treba večji poudarek nameniti njihovim močnim področjem, ne pa samo primanjkljajem ($\bar{x}$ = 3,7, σ = 0,96). To kaže, da strokovni delavci razumejo pomen osredinjanja na močna področja učencev, to pa je ključno za spodbujanje njihove motivacije, samopodobe in učnega napredka (Obed idr., 2020). V tem kontekstu se strokovni delavci zavedajo tudi težav pri prepoznavanju dvojne izjemnosti, saj je trditev, da so ti učenci pogosto spregledani, zaradi neodkritja ($\bar{x}$ = 3,6, σ = 0,99), dobila visoko povprečno oceno. Po drugi strani pa so se strokovni delavci nekoliko bolj distancirali od trditev, da dvojno izjemni učenci nimajo učnih težav ($\bar{x}$ = 1,9, σ = 0,66) ali da zmorejo sami premagovati primanjkljaje brez pomoči ($\bar{x}$ = 2,0, σ = 0,69).

To kaže na razumevanje, da dvojno izjemni učenci potrebujejo ustrezno podporo, da lahko razvijajo svoje učne sposobnosti in premagujejo ovire, ki jih spremljajo zaradi kombinacije nadarjenosti in posebnih potreb (Kiswarday, 2017). Prav tako so strokovni delavci razumeli, da slabi učni uspehi teh učencev niso posledica premalo truda, temveč so povezani s težavami, ki izhajajo iz njihovih specifičnih potreb in primanjkljajev ($\bar{x}$ = 2,0, σ = 0,84). Raziskava je prav tako pokazala pomanjkanje dodatnih izobraževanj za strokovne delavce na področju nadarjenosti, posebnih potreb in dvojne izjemnosti. Kar 87 % anketiranih strokovnih delavcev meni, da ni dovolj razpoložljivih izobraževalnih priložnosti s teh področij. Kljub temu se je le tretjina strokovnih delavcev (33 %) v zadnjih desetih letih udeležila dodatnih izobraževanj na teh področjih, kar nakazuje potrebo po večjih prizadevanjih za profesionalni razvoj v tem specifičnem segmentu. Povečanje števila usmerjenih učencev, predvsem zaradi naraščajočih odločb za učence z ADHD in drugimi primanjkljaji, zahteva širitev znanja strokovnih delavcev, da bi bili pripravljeni na učinkovitejše delo z dvojno izjemnimi učenci (Vovk Ornik idr., 2023).

H1: Večina učiteljev je seznanjenih z značilnostmi in odkrivanjem dvojno izjemnih učencev.

Tabela 1

Analiza variance za razlike v oceni lastne usposobljenosti za odkrivanje dvojno izjemnih učencev glede na poznavanje pojma dvojno izjemni učenci.

Pojem dvojne izjemnosti	**n**	$\bar{x}$	**s**	**Levenov preizkus enakosti varianc**				**Analiza variance**	
				F	g_1	g_2	P	F	P
Nadarjeni učenci in učenci s posebnimi potrebami.	116	3,10	1,098	0,280	2	147	0,756	2,052	0,132
Nadarjeni učenci in učenci s specifičnimi učnimi težavami	29	2,86	1,060						
Otroci s posebnimi potrebami znotraj dveh skupin otrok s posebnimi potrebami ali več	5	2,20	1,095						
Skupaj	150	3,03	1,099						

Iz preglednice 1 lahko razberemo, da lastno usposobljenost za odkrivanje dvojno izjemnih učencev najvišje ocenjujejo strokovni delavci, ki trdijo, da so dvojno izjemni učenci tisti, ki so prepoznani hkrati kot nadarjeni učenci in učenci s posebnimi potrebami ($\bar{x}$ = 3,10); sledijo strokovni delavci, ki trdijo, da so dvojno izjemni učenci tisti, ki so prepoznani hkrati kot nadarjeni učenci in imajo specifične učne težave ($\bar{x}$ = 2,86). Najnižje pa lastno usposobljenost za odkrivanje dvojno izjemnih učencev ocenjujejo tisti strokovni delavci, ki trdijo, da so dvojni izjemni učenci tisti, ki so prepoznani kot otroci s posebnimi potrebami znotraj dveh skupin otrok s posebnimi potrebami ali več ($\bar{x}$ = 2,20). Spričo upravičenosti predpostavke o homogenosti varianc (F = 0,280, g1 = 2, g2 = 147, P = 0,756) smo opravili še preizkus analize variance. Vrednost F (F = 2,052) za ANOVA-test (ang. Analysis of Variance) kaže, da je bila izvedena analiza variance med temi tremi skupinami. Vrednost P (P = 0,132) je večja od 0,05, kar pomeni, da ni statistično pomembne razlike v povprečnih ocenah teh treh skupin. To kaže, da ni pomembnih razlik v stališčih strokovnih delavcev glede dvojne izjemnosti med omenjenimi skupinami. χ^2-preizkus hipoteze enake verjetnosti za oceno lastne usposobljenosti za odkrivanje oz. prepoznavanje dvojno izjemnih učencev med vsemi strokovnimi delavci. Vrednost P (P = 0,001) je manjša od 0,05, kar pomeni, da obstajajo statistično pomembne razlike med dejanskimi in pričakovanimi pogostostmi v ocenah usposobljenosti strokovnih delavcev za prepoznavanje in delo z dvojno izjemnimi učenci. Vrednost χ^2 = 56,267 je dovolj visoka, da podpira zaključek, da se distribucija ocen razlikuje od pričakovane, kar pomeni, da so mnenja strokovnih delavcev raznolika glede na njihovo oceno lastne usposobljenosti. Rezultati χ^2-preizkusa kažejo, da strokovni delavci niso enotni pri oceni svoje usposobljenosti za prepoznavanje in delo z dvojno izjemnimi učenci. Statistična pomembnost teh razlik kaže, da bi bilo smiselno nadaljevati z raziskavami o dejavnikih, ki vplivajo na te ocene, ter spodbujati dodatna izobraževanja in podporo za strokovne delavce.

H2: Večina učiteljev meni, da za delo z dvojno izjemnimi učenci niso dovolj usposobljeni.

Kolmogorov-Smirnov preizkus normalnosti porazdelitve je statistično pomemben (2P = 0,000) kar pomeni, da se ocene usposobljenosti strokovnih delavcev za delo ne porazdeljujejo normalno. Rezultati analize ocene usposobljenosti za delo z dvojno izjemnimi učenci kažejo, da so povprečne ocene strokovnih delavcev na splošno sorazmerno visoke, saj je aritmetična sredina 3,04, kar nakazuje, da se večina anketirancev ocenjuje kot "dobro" usposobljene za delo z dvojno izjemnimi učenci.

Tabela 2
Osnovna deskriptivna statistika in rezultat Kolmogorov-Smirnovega preizkusa za spremenljivko ocena usposobljenosti za delo z dvojno izjemnimi učenci

Spremenljivka	**N**	**Min**	**Max**	$\bar{x}$	**KA**	**KS**	**Preizkus normalnosti porazdelitve**	
							Z	2P
Ocena usposobljenosti za delo	150	1	5	3,04	–0,382	–0,035	0,257	0,000

Poudariti je treba, da kurtoza znaša –0,382, pomeni, da se ocene ne koncentrirajo zgolj okoli sredine, temveč so porazdeljene bolj enakomerno. Vendar pa preizkus normalnosti porazdelitve (Z = 0,257 in P = 0,000) kaže, da porazdelitev ocen ni popolnoma normalna. P-vrednost 0,000 (manjša od 0,05) kaže, da so rezultati statistično značilni in odstopajo od normalne porazdelitve, kar nakazuje, da so ocene usposobljenosti bolj razpršene in niso enakomerno porazdeljene. Ugotavljamo, da se nekateri strokovni delavci ocenjujejo kot zelo usposobljeni, drugi pa kot manj usposobljeni, to pa izpostavi raznolikost mnenj in izkušenj, ki jih imajo anketiranci pri delu z dvojno izjemnimi učenci.

H3: Večina učiteljev meni, da je na voljo premalo dodatnih izobraževanj s področja dvojne izjemnosti.

Rezultati analize prikazujejo, da je le 13 % anketiranih strokovnih delavcev opravilo ustrezno usposabljanje za delo z dvojno izjemnimi učenci, medtem ko velika večina (87 %) takšnega usposabljanja ni imela. Ta podatek jasno kaže na pomanjkanje formalnih izobraževanj in usposabljanj na tem področju, to pa lahko vpliva na učinkovitost prepoznavanja in podpore tej skupini učencev. Statistična analiza s preizkusom hi-kvadrat (χ^2 = 80,667, g = 1, P = 0,000) kaže, da je razlika med skupinama (tisto, ki se je usposabljala, in tisto, ki se ni) statistično značilna (P < 0,05). To pomeni, da je razkorak med strokovnimi delavci, ki imajo, in tistimi, ki nimajo ustreznega znanja, zelo izrazit. Ti podatki potrjujejo potrebo po sistematičnem uvajanju dodatnih izobraževanj in strokovnega usposabljanja, saj velika večina učiteljev trenutno nima zadostnega znanja za prepoznavanje in podporo dvojno izjemnim učencem. Brez ustrezne strokovne podpore obstaja tveganje, da ti učenci ne bodo deležni ustreznih prilagoditev in podpore, to pa bi lahko negativno vplivalo na njihov učni uspeh in socialno vključevanje.

Sklepne ugotovitve

Z raziskavo potrjujemo, da so strokovni delavci na splošno seznanjeni z osnovnimi značilnostmi dvojno izjemnih učencev, vendar se soočajo s pomanjkanjem usposobljenosti za učinkovito delo z njimi. Dvojno izjemni učenci so tisti, ki se soočajo tako z nadarjenostjo na določenih področjih kot tudi z učnimi težavami ali specifičnimi učnimi težavami, kar zahteva kompleksen in diferenciran pristop pri poučevanju (Ančimer Aljaž in Juriševič, 2018; Košnik, 2025; Lep, 2020; Pemberton, 2004).

Ugotovitve raziskave kažejo, da je le majhen delež strokovnih delavcev v osnovni šoli zmožen prepoznati dvojno izjemne učence, saj skoraj četrtina respondentov ni bila seznanjena s to terminologijo. Glavni vir znanja o dvojni izjemnosti je izmenjava izkušenj med kolegi, vendar je dostop do formalnih izobraževalnih priložnosti omejen (Baum, Olenchak in Owen, 2004). Raziskava obenem ugotavlja, da več kot polovica strokovnih delavcev poroča o izkušnjah z delom z dvojno izjemnimi učenci, a mnogi učitelji teh učencev niso prepoznali, kar kaže na nezadostno sposobnost pravočasnega prepoznavanja dotične skupine otrok (Winebrenner, 2003). Treba je torej povečati dostopnost strokovnih usposabljanj za učitelje, da bi omogočili bolj ciljno usmerjeno obravnavo teh učencev. Na osnovi ugotovitev poudarjamo nujnost sprememb v usposabljanju strokovnih delavcev za zgodnje prepoznavanje dvojne izjemnosti, kar bi prispevalo k večji podpori teh učencev v vzgojno-izobraževalnem procesu.

Strokovni delavci morajo biti že v zgodnjih fazah izobraževanja ustrezno usposobljeni za prepoznavanje in podporo dvojno izjemnim učencem. To zahteva razvoj pedagoških pristopov, ki hkrati obravnavajo učne težave in spodbujajo nadarjenost, kot je navedeno v Navodilih za prilagojeno izvajanje izobraževalnega programa osnovne šole z dodatno strokovno pomočjo za delo z učenci s posebnimi vzgojno-izobraževalnimi potrebami (Košnik, 2025). Rezultati raziskave poudarjajo potrebo po sistemskih spremembah v strokovnem znanju strokovnih delavcev, predvsem z vključitvijo ciljno usmerjenih programov usposabljanja, ki bi jim omogočili učinkovitejšo podporo dvojno izjemnim učencem in s tem povečali njihove možnosti za uspeh.

Summary

This research explores the recognition and support of twice-exceptional students—those who exhibit both giftedness and specific learning disabilities—within the educational system. Educational systems often focus on identifying deficits and disorders, but twice-exceptional students require an approach that simultaneously nurtures their strengths while addressing their challenges. The study's purpose is to evaluate teachers' understanding of twice-exceptionality, their self-assessment of competence in working with these students, and the availability of professional training on the subject. The research utilized a quantitative approach, collecting data through a questionnaire distributed to 150 educational professionals across various segments of the school system. Data collection occurred in June and July of 2024, using closed educational groups on social media. The data were analyzed using descriptive and inferential statistical methods with the aid of IBM SPSS Statistics 26. Key findings from the study show that a majority of educational professionals (78%) understand twice-exceptionality as the combination of giftedness and special needs, which is crucial for providing appropriate support. However, only 19% of teachers specifically recognize twice-exceptionality as the combination of giftedness and learning disabilities. This gap highlights the need for clearer definitions and consistent use of terminology in educational literature in Slovenia. More than half of the respondents (56%) reported having experience working with twice-exceptional students, while 44% had not.

Teachers predominantly acquire knowledge about twice-exceptionality informally. The most common sources of knowledge were discussions with colleagues (28%), professional literature (21%), academic studies (19%), and training sessions (12%). This reliance on informal learning points to a significant gap in formal professional development opportunities. Teachers rated their competence in identifying twice-exceptional students as moderate (average score of 3.0), with 40% assessing their competence as good, while 25% rated it as insufficient or poor. Only 7% considered themselves highly competent. Similar results were found regarding their self-assessed competence in teaching these students. Despite relatively high self-assessment scores, 22% of teachers expressed concern about their ability to work effectively with twice-exceptional students. The majority (87%) of respondents felt that more professional training opportunities were necessary to improve their ability to support these students. Additionally, only a third of the respondents had attended formal

training on the topic in the past decade, underscoring the urgent need for more accessible professional development.

The study highlights the gap in both the recognition and support of twice-exceptional students, revealing a clear need for systemic changes in teacher education and professional development. Enhancing teachers' understanding and skills through more focused training could significantly improve the academic and personal outcomes for twice-exceptional students.

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INTEGRATING ADVANCED TECHNOLOGIES IN EDUCATION: EMPOWERING YOUTH FOR A SUSTAINABLE FUTURE THROUGH NEW LITERACIES

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Abstract/Izvleček

The quasi-experimental study explores how contemporary technologies, such as artificial intelligence and humanoid robots, enhance sustainability education for pre-service teachers. The study, involving 112 participants, assessed the effectiveness of these technologies compared to traditional methods in improving sustainability literacy. Pre- and post-tests revealed significant improvements in understanding sustainability concepts, with humanoid robots increasing response variability. Results highlight the technologies' ability to engage educators in sustainability topics, promoting new literacies critical for addressing environmental challenges.

Vključevanje naprednih tehnologij v izobraževanje: opolnomočenje mladih za trajnostno prihodnost s pomočjo novih pismenosti

Kvazi-eksperimentalna študija raziskuje, kako sodobne tehnologije, kot sta umetna inteligenca in humanoidni roboti, izboljšujejo izobraževanje za trajnostni razvoj pri bodočih učiteljih. Študija, v kateri je sodelovalo 112 udeležencev, je ocenjevala učinkovitost teh tehnologij v primerjavi s tradicionalnimi metodami pri izboljševanju trajnostne pismenosti. Predtest in potest sta pokazala pomembne izboljšave v razumevanju trajnostnih konceptov, pri čemer so humanoidni roboti povečali raznolikost odzivov. Rezultati poudarjajo potencial sodobnih tehnologij za vključevanje učiteljev v trajnostne teme ter spodbujajo nove pismenosti.

Keywords:
advanced technologies, digital competence, humanoid robots, sustainability education, teacher training.

Ključne besede:
digitalne kompetence, humanoidni roboti, napredne tehnologije, trajnostno izobraževanje, usposabljanje učiteljev.

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Introduction

The rise of advanced technologies, such as artificial intelligence (AI) and humanoid robots (HRs) has reshaped education, in some contexts prompting global adaptations (Timotheou et al., 2023) while shaping a sustainable future. This article explores how technologies like ChatGPT and HRs empower youth to engage in sustainability initiatives and address environmental challenges. It assesses how effective these tools are compared to traditional methods in fostering environmental awareness, focusing on future teachers. The study also identifies essential new literacies for leveraging these technologies to promote sustainability.

The research questions are as follows:

- RQ1: How do advanced technologies compare to traditional methods in enhancing youth awareness of environmental sustainability?
- RQ2: How do learning methods influence variability in shaping and transmitting sustainable values, particularly among future teachers?
- RQ3: What new literacies, knowledge, and skills are essential for young educators to effectively promote sustainability using advanced technologies?

The paper is structured as follows: Section 2 reviews the literature on AI, HRs, and sustainability education; Section 3 outlines the methodology; Section 4 presents results, and Section 5 discusses findings and implications for future research.

Literature Review

Advanced Technologies in Sustainability Education

The rapid development of digital technology has transformed everyday reality, enabling people to connect, access information, and express themselves in diverse ways. Digital technology is now integral to everyday life, including AI integrated into contemporary communication processes (Starc and Komninos, 2023). AI and HRs in sustainability education can enhance learning outcomes and understanding of environmental challenges, aiding in achieving Sustainable Development Goals (SDGs) (Vinuesa et al., 2020). To maximize the benefits of AI and HRs in environmental education (EE) requires an understanding of how they support learning.

They offer dynamic, interactive experiences, making abstract concepts tangible and adapting in real time (Xu and Ouyang, 2022). Integrating these tools into the curriculum promotes a multidisciplinary approach, combining computer science, environmental studies, and critical thinking (Mishra et al., 2021).

Integrating AI-driven platforms like ChatGPT and HR into EE can improve sustainability understanding and introduce new paradigms in education. Their interactivity and personalization encourage young people to develop innovative solutions to environmental issues, strengthening their role as sustainability innovators (Niu et al., 2024; Okulich-Kazarin et al., 2024). Holistic integration of these tools into educational practices is critical, rather than simply adding them to existing methods.

Literacies for Integrating Advanced Technologies in Education

Education for various forms of literacy has become essential in preparing individuals to engage in planning, problem solving, and informed decision-making. This is particularly important as literacy is essential for responsible and effective technology use (Lemut Bajec, 2023). Emerging forms of literacy are increasingly essential for addressing technological and environmental challenges. These new literacies involve skills for understanding and using advanced technologies, empowering youth to create sustainable strategies. They extend beyond traditional definitions, incorporating multimodal forms of expression that support lifelong learning and global collaboration (Barut Tugtekin and Koc, 2020).

New literacies include the ability to critically evaluate and use diverse information and communication technologies, preparing learners for a dynamic technological environment. This evolution demands adapting educational methods, environments, and assessment strategies to meet contemporary needs (Reilly, 2009). Digital technologies, increasingly prominent in education, can support more engaging and efficient learning resources (Sila and Klančar, 2024). As advancements redefine the skills needed, educators must equip students with tools fostering adaptability, problem-solving, and critical thinking.

The European Commission's Digital Competence Framework for Citizens (DigComp) provides a comprehensive outline of essential digital skills, including information literacy, communication, content creation, safety, and problem-solving (Vuorikari et al., 2022).

These competences are key to preparing learners for the challenges of the digital world. Advanced technologies like AI and HRs can make learning more accessible, engaging, and globally relevant (Relmasitra et al., 2023).

Advanced Technologies in Environmental Education

Advanced technologies, particularly AI and HRs, offer innovative tools for fostering youth engagement in sustainable development. By supporting inquiry-based and problem-solving approaches, these technologies may enhance environmental awareness and responsibility (Chen et al., 2023; Hajj-Hassan et al., 2024). Integrating these tools with EE promotes a holistic understanding of the interconnection between technology and sustainability (Bonnett, 2019).

Personalized, learner-centred methods foster individual engagement and social skills but may limit broader social interactions and collective environmental consciousness (Aberšek, 2018; Aberšek et al., 2014). Emotional intelligence, a key factor, enables individuals to align behaviours with sustainability principles, fostering self-awareness and responsibility (Herič et al., 2019; Oe et al., 2022).

Young people, 30% of the global population, are vital to achieving SDGs. Despite this, they are often excluded from the decisions shaping their future (Omotosho et al., 2023). Integrating sustainability into education and preparing future educators are both essential for building long-term responsibility (Robinson et al., 2019).

Positive attitudes towards sustainability and technology-enhanced learning promote responsibility, participation in initiatives, and effective technology use (Kerneža and Zemljak, 2023; Kougias et al., 2023). Global frameworks like The 2030 Agenda for Sustainable Development (UNESCO, 2015) and The Berlin Declaration on Education for Sustainable Development (2021) stress integrating digital and green technologies into education to promote critical thinking and sustainability values. Society 5.0 also highlights technology's role in a sustainable future (Deguchi et al., 2020).

Materials and Methods

This section outlines the methodology of the study, providing a comprehensive overview of the research design, participants, measures, and data analysis methods used to explore sustainability education.

Study Participants and Procedure

The sample was purposively selected with partial random allocation. Participants included pre-service teachers aged 19–24 enrolled in the Elementary Education program at the faculty of education of one of the Slovenian universities. In Slovenia, pre-service teachers are university students in initial teacher education programs, combining subject specific knowledge, pedagogy, and practical training, who have not yet entered full-time teaching employment, comparable to initial teacher training in other European countries. These future educators were chosen for their key role in shaping sustainable educational strategies. Of 112 initial participants, 95 completed the study; 17 withdrew due to lack of interest or uncertainty regarding integrating new technologies.

A quasi-experimental design (Cooper, 2009) integrated advanced technologies into research-based sustainability learning. Participants first answered the question: "How can I contribute to improving environmental sustainability?" They then engaged in group work to explore the question, while the control group pursued unrelated activities.

Participants were divided into seven groups, each further split into pairs or trios for 15-minute exploration tasks using different methods (Table 1).

Table 1
Participant Allocation by Research Method with Detailed Group Instructions

Research Method	Group Tasks	N (groups/ participants)
ChatGPT 3.5*	Used ChatGPT for questions, ideas, and feedback to enhance sustainability efforts. Participants were trained in chatbot usage (Kerneža, 2023).	6/17
HR*	Operated an AlphaMini robot with ChatGPT to explore sustainability topics; trained for effective operation (Kerneža, 2023).	6/17
Google**	Applied Internet Reciprocal Teaching method to verify sources and compare sustainability views (Leu et al., 2008), as practiced in coursework.	6/17
School Library Books	In-depth study using library books.	5/15
Frontal Teaching	Lecture on theoretical foundations of sustainability.	6/17
Peer Discussion	Shared experiences and explored sustainability collaboratively.	6/15
Control Group	Unrelated activities.	6/15

The AlphaMini HR with ChatGPT integration used four AI models–speech synthesis, speech recognition, ChatGPT integration, and voice activity recognition–allowing Slovenian-language integration. This created interactive, accessible discussions on sustainability, promoting critical thinking.

After completing their tasks, participants revisited the initial question to reflect on how the intervention influenced their sustainability perspectives. These reflections were central for evaluating the impact of each method.

The study used systematic observations based on the Digital Competence Framework for Citizens (DigComp) (Vuorikari et al., 2022). Researchers documented 21 competences observed during participants' work with different methods, analysing how knowledge, skills, and attitudes were applied. Results were organized into tables for clarity.

Measures

Data collection involved written answers to a single open-ended question before and after the intervention. Responses were coded into thematic categories from prior research and pilot testing:

- Carbon footprint reduction (public transport, walking, cycling, reducing car usage, use of electric vehicles).
- Sustainable usage and recycling (recycling of waste, use of products for multiple uses, reducing plastic usage, buying second-hand clothes).
- Resource conservation (saving water and electricity, turning off lights, turning off the tap during tooth brushing).
- Sustainable food and agriculture (buying locally produced food, growing one's own food, using natural fertilizers, reducing meat consumption).
- Awareness and education (educating others about sustainability, training on sustainability topics, participating in cleaning actions, supporting sustainable organizations).
- Energy efficiency and renewable sources (using renewable energy sources, energy-efficient devices, digitization to reduce paper usage).
- Sustainable waste management (composting, proper waste segregation, reducing food waste).

Coded responses were analysed for common themes and variations, assessing the effects of learning methods on sustainability awareness.

Competences were classified as either "fundamental" (developed in analogue settings) or "comprehensive" (aligned with DigComp 2.2 (Vuorikari et al., 2022)). Table 2 shows the knowledge, skills, and attitudes observed.

Table 2
*Knowledge, Skills and Attitudes According to Key Components of Digital Competence**

Information and data literacy	Communication and collaboration	Digital content creation	Safety	Problem solving
1–3	4–9	10–13	14–17	18–21

*Note. Specific knowledge, skills and attitudes are numbered to show the results in Table 11. The competences are as follows: 1 – Browsing, searching, and filtering data, information and digital content; 2 – Evaluating data, information and digital content; 3 – Managing data, information and digital content; 4 – Interacting through digital technologies; 5 – Sharing through digital technologies; 6 – Engaging in citizenship through digital technologies; 7 – Collaborating through digital technologies; 8 – Netiquette; 9 – Managing digital identity; 10 – Developing digital content; 11 – Integrating and re-elaborating digital content; 12 – Copyright and licenses; 13 – Programming; 14 – Protecting devices; 15 – Protecting personal data and privacy; 16 – Protecting health and well-being; 17 – Protecting the environment; 18 – Solving technological problems; 19 – Identifying needs and technological responses; 20 – Creatively using digital technologies; 21 – Identifying digital competence gaps.

Data Analysis

Data were anonymized and stored securely to maintain confidentiality and ethical standards. Responses were analysed using descriptive coding (Saldana, 2009), redefined iteratively. Codes were transformed into numerical scores representing the number of distinct categories mentioned per participant in pre- and post-tests. After checking normality and variance homogeneity, the assumptions for parametric analysis were met, allowing repeated measures ANOVA.

Scores served as the dependent variable, enabling comparison of pre–post challenges across methods. Greenhouse–Geiser corrections were applied for sphericity violations (Bauer and Bai, 2018) and Bonferroni adjustments for multiple comparisons.

Thematic analysis identified trends and unique literacy applications; quantification included frequency analysis and cross-tabulation to link competences with methods.

Results

This section presents the findings of the study, highlighting the effects of various learning methods on participants' understanding and application of environmental sustainability concepts.

Comparative Analysis of Pretest and Post-test Scores Across Learning Methods

The impact of different learning strategies on participants' understanding of environmental sustainability was assessed through pretest and post-test scores. Using repeated measures ANOVA, this study compared the effectiveness of contemporary technologies and traditional approaches. The results are summarized in Table 3.

Table 3

Mean Scores and Standard Deviations by Learning Method for Pretest and Post-test Results

Test	Source of learning	Mean	Std. Deviation	Min	Max	N
Pretest	ChatGPT	4.00	.756	3	5	15
	HR	4.31	1.195	3	7	16
	Google	4.36	1.598	2	8	14
	Books	3.91	1.044	2	5	11
	Peer Discussion	3.50	1.834	1	8	12
	Frontal Teaching	3.60	1.404	2	6	15
	Control Group	4.50	1.834	2	7	12
	Total	4.03	1.410	1	8	95
Post-test	ChatGPT	9.93	2.915	6	18	15
	HR	11.81	6.921	6	30	16
	Google	11.29	5.165	6	24	14
	Books	6.64	2.942	2	12	11
	Peer Discussion	7.17	2.980	3	14	12
	Frontal Teaching	8.60	4.579	4	19	15
	Control Group	5.50	2.780	2	12	12
	Total	8.95	4.850	2	30	95

The repeated measures ANOVA, corrected with Greenhouse–Geiser adjustments, revealed statistically significant changes between pre- and post-test scores across all groups ($F(36.218, 8.697) = 26{,}938$, $p < .001$), indicating improvement across all methods. Standard deviations varied notably, especially in the HR (SD = 6.921) and Google (SD = 5.165) groups, showing higher post-intervention variability. While the Bonferroni post-hoc test showed no statistically significant differences between groups ($p > .05$), a borderline difference appeared between the HR group and the control group ($p = .05$). Given the conservativeness of Bonferroni adjustments, small but meaningful differences may not have been detected (Asan and Soyer, 2022).

Effect of Learning Methods on Response Variability

This section explores differences in variability across specific sustainability categories, noting the statistical significance does not necessarily indicate practical or pedagogical superiority.

Carbon Footprint Category

ANOVA results indicated statistically significant differences between learning methods ($F(6, 88) = 2.607$, $p = .023$) and a significant intercept ($F(1, 88) = 224{,}565$, $p < .001$). The R2 value of 3.81% indicates that learning method explained only a small portion of variability, suggesting other contributing factors. Detailed results are presented in Table 4.

Table 4

Mean Scores and Standard Deviations by Learning Method for Carbon Footprint Variability

Test	Method	Mean	Std. Deviation	Min	Max	N
Pretest	ChatGPT	1.13	.352	1	2	15
	HR	.69	.602	0	2	16
	Google	1.21	.802	0	3	14
	Books	1.55	1.215	0	4	11
	Peer Discussion	.75	.622	0	2	12
	Frontal Teaching	1.00	.000	1	1	15
	Control Group	.83	.718	0	2	12
Post-test	ChatGPT	1.20	.414	1	2	15
	HR	.69	.602	0	2	16
	Google	1.36	.929	0	3	14
	Books	1.64	1.362	0	4	11
	Peer Discussion	.92	.515	0	2	12
	Frontal Teaching	1.20	.414	1	2	15
	Control Group	.83	.718	0	2	12

A post-hoc Tukey HSD test revealed a significant difference between the HR and books groups (MD = -.90, SE = .270, p = .020, 95% CI [-1.72, -.09]). No other pairwise comparison showed statistically significant differences.

Sustainable Usage and Recycling

ANOVA revealed a statistically significant intercept ($F(1, 88) = 233.426$, $p < .001$) but no significant differences between methods ($F(6, 88) = 1.752$, $p = .118$; R2 = 10.7%).

Table 5
Mean Scores and Standard Deviations for Sustainable Usage and Recycling

Test	Method	Mean	Std. Deviation	Min	Max	N
Pretest	ChatGPT	1.27	1.100	0	3	15
	HR	2.12	.719	1	3	16
	Google	1.36	.633	0	2	14
	Books	1.36	1.286	0	4	11
	Peer Discussion	1.25	1.422	0	5	12
	Frontal Teaching	1.07	.961	0	3	15
	Control Group	1.58	1.240	0	3	12
Post-test	ChatGPT	2.60	1.352	1	5	15
	HR	2.63	.885	1	4	16
	Google	3.71	1.326	1	6	14
	Books	1.73	1.191	0	4	11
	Peer Discussion	2.00	2.045	0	7	12
	Frontal Teaching	2.00	1.813	0	5	15
	Control Group	1.58	1.240	0	3	12

While some post-test mean differences were notable – for example Google scored higher than books or frontal teaching – these differences were not statistically significant (Table 5). This suggests that, for this category, method choice had limited measurable impact on outcomes.

Resource Conservation

ANOVA showed significant differences between learning methods ($F(6, 88) = 3.568$, $p = .003$) and a statistically significant intercept ($F(1, 88) = 201.338$, $p < .001$) with $R2 = 19.6\%$ indicating a moderate effect of method choice (Table 6).

Post-hoc Tukey HSD indicated a significant difference between the HR and Books groups (MD = -.90, SE = .020, 95 % CI [-1.72, -.09]). Other pairwise comparisons were not significant, suggesting that while HR stood out compared to Books, no other clear differences emerged among the remaining methods.

Table 6
Mean Scores and Standard Deviations by Learning Method for Resource Conservation Variability

Test	Method	Mean	Std. Deviation	Min	Max	N
Pretest	ChatGPT	1.13	.834	0	2	15
	HR	.31	.602	0	2	16
	Google	.36	.497	0	1	14
	Books	.45	.522	0	1	11
	Peer Discussion	.50	.522	0	1	12
	Frontal Teaching	.73	.458	0	1	15
	Control Group	.83	.718	0	2	12
	ChatGPT	1.73	.884	0	3	15

	HR	1.69	1.138	0	4	16
	Google	.93	.616	0	2	14
Post-	Books	.64	.505	0	1	11
test	Peer Discussion	.83	.389	0	1	12
	Frontal Teaching	1.27	.704	0	2	15
	Control Group	.83	.718	0	2	12

Sustainable Food and Agriculture

ANOVA showed a significant intercept ($F(1, 88) = 38.578$, $p < .001$), confirming the overall relevance of the model in this category, but no statistically significant differences between methods ($F(6, 88) = 1.110$, $p = .363$; $R2 = 7.04\%$), indicating a limited influence by instructional approach.

Table 7

Mean Scores and Standard Deviations by Learning Method for Sustainable Food and Agriculture Variability

Method		Pretest		Post-test		
Test	Method	Mean	Std. Deviation	Min	Max	N
	ChatGPT	.20	.561	0	2	15
	HR	.00	.000	0	0	16
	Google	.14	.535	0	2	14
Pretest	Books	.18	.405	0	1	11
	Peer Discussion	.17	.389	0	1	12
	Frontal Teaching	.27	.458	0	1	15
	Control Group	.42	.515	0	1	12
	ChatGPT	.60	.737	0	2	15
	HR	.13	.342	0	1	16
	Google	.57	1.016	0	3	14
Post-test	Books	.82	.874	0	3	11
	Peer Discussion	.33	.651	0	2	12
	Frontal Teaching	.67	.816	0	2	15
	Control Group	.42	.515	0	1	12

The detailed means and standard deviations, as presented in Table 7, show minimal variation attributable to method, suggesting that improvements in this category may be driven more by individual motivation or prior knowledge than by the specific instructional strategy.

Awareness and Education

ANOVA revealed a significant intercept ($F(1, 88) = 73.603$, $p < .001$), reinforcing the relevance of the model in assessing awareness and education, with differences between methods approaching statistical significance ($F(6, 88) = 2.037$, $p = .069$). The R2 value of 12.19% suggests a modest influence on the part of instructional methods.

Table 8
Mean Scores and Standard Deviations by Learning Method for Awareness and Education Variability

Method	Pretest	Post-test				
Test	Method	Mean	Std. Deviation	Min	Max	N
Pretest	ChatGPT	.00	.000	0	0	15
	HR	.44	.892	0	3	16
	Google	.57	.646	0	2	14
	Books	.09	.302	0	1	11
	Peer Discussion	.33	.651	0	2	12
	Frontal Teaching	.13	.352	0	1	15
	Control Group	.50	.905	0	3	12
Post-test	ChatGPT	1.93	.704	1	3	15
	HR	.69	.946	0	3	16
	Google	1.14	1.231	0	3	14
	Books	.18	.603	0	2	11
	Peer Discussion	1.42	.900	0	3	12
	Frontal Teaching	.93	1.163	0	3	15
	Control Group	.50	.905	0	3	12

Table 8 shows relatively uniform learning outcomes, with no method clearly outperforming the others, indicating that awareness and education may be enhanced through diverse teaching strategies, provided they actively engage learners.

Energy Efficiency and Renewable Sources

Analysis revealed a statistically significant intercept ($F(1, 88) = 64.046$, $p < .001$) and notable method differences ($F(6, 88) = 4.172$, $p < .001$; $R2 = 22.15\%$), indicating that the instructional approach influenced learning outcomes in this category.

Table 9
Mean Scores and Standard Deviations by Learning Method for Energy Efficiency and Renewable Sources Variability

Method	Pretest	Post-test				
Test	Method	Mean	Std. Deviation	Min	Max	N
Pretest	ChatGPT	.00	.000	0	0	15
	HR	.25	.447	0	1	16
	Google	.21	.426	0	1	14
	Books	.09	.302	0	1	11
	Peer Discussion	.17	.389	0	1	12
	Frontal Teaching	.07	.258	0	1	15
	Control Group	.00	.000	0	0	12
Post-test	ChatGPT	.60	.507	0	1	15
	HR	.87	.619	0	2	16
	Google	.79	.975	0	3	14
	Books	.09	.302	0	1	11
	Peer Discussion	.42	.515	0	1	12

	Frontal Teaching	.06	.507	0	1	15
	Control Group	.00	.000	0	0	12

Post-hoc Tukey HSD tests revealed significant gains between HR and Books (MD = -.47, SE = .140, p = .019, 95% CI [-0.90, -0.05]), HR and the control group (MD = -.56, SE = .137, p = .002, 95% [-.98, -.15]), and Google and the control group (MD = -.50, SE = .141, p = .011, 95% CI [-.93, -.07]). These results (Table 9) indicate that HR and Google were more effective in promoting energy efficiency awareness compared to Books and the control group. While these differences are statistically significant, causal interpretation should be approached with caution due to potential contextual influences.

Sustainable Waste Management

ANOVA showed a significant intercept ($F(1, 88) = 51.959$, $p < .001$), but no statistically significant differences between methods ($F(6, 88) = 0.654$, $p = .686$), with an R2 of 4.27%, indicating minimal influence on the part of instructional approach.

As shown in Table 10, mean scores were consistent across all methods, suggesting that no particular approach demonstrated a clear advantage in enhancing waste management competences.

Table 10

Mean Scores and Standard Deviations by Learning Method for Sustainable Waste Management Variability

Method	Pretest	Post-test				
Test	Method	Mean	Std. Deviation	Min	Max	N
Pretest	ChatGPT	.27	.458	0	1	15
	HR	.50	.632	0	2	16
	Google	.50	.650	0	2	14
	Books	.18	.405	0	1	11
	Peer Discussion	.33	.492	0	1	12
	Frontal Teaching	.33	.488	0	1	15
	Control Group	.33	.492	0	1	12
Post-test	ChatGPT	.40	.507	0	1	15
	HR	.50	.632	0	2	16
	Google	.79	.893	0	2	14
	Books	.36	.809	0	2	11
	Peer Discussion	.50	.522	0	1	12
	Frontal Teaching	.53	.516	0	1	15
	Control Group	.33	.492	0	1	12

The Role of New Literacies in Empowering Youth

This section explores how new literacies equip youth with the skills needed for a sustainable future through advanced technologies. The study highlights the importance of competences in both digital and analogue learning environments, aligned with the DigComp 2.2 framework, which outlines 21 key competences. Table 11 compares how different learning methods contribute to these competences, distinguishing between comprehensive digital skill development and foundational knowledge acquisition.

Table 11
Knowledge, Skills and Attitudes by Learning Method

Method of Learning	Identified Competences	Competency Depth
ChatGPT	1–21	Comprehensive
HR	1–21	Comprehensive
Google	1–21	Comprehensive
Books	1–21	Fundamental
Peer Discussion	1–21	Fundamental
Frontal Teaching	1–21	Fundamental
Control Group	None	Non-applicable

*Specific knowledge, skills and attitudes according to key components of digital competence are numbered and thus explained in Table 2.

Contemporary methods (e.g. ChatGPT, HR, and Google) support broad engagement across all 21 competences, enhancing not only digital literacy but also critical thinking, creativity, and collaboration, making them valuable tools in sustainability education. Traditional methods, such as books, peer discussion, and frontal teaching, focus on foundational competences. While they do not provide the same depth as digital methods, they establish essential groundwork that supports the later integration and development of advanced digital skills.

Together, these findings underscore the complementary roles of digital and traditional approaches. Digital methods drive comprehensive literacy development, whereas traditional methods ensure a strong foundational base, preparing students to engage effectively with advanced technologies in meaningful ways.

Discussion

The study contributes to existing literature by examining how advanced technologies, such as generative language models and HRs, support sustainability

and EE. The findings suggest that these technologies can be as effective as, and sometimes more effective than, traditional methods (RQ1), in line with Burbles et al. (2020) and Mian et al. (2020), which emphasize the transformative potential of digital tools in education. HRs demonstrated significant improvement in response variability (RQ2), complementing studies on the role of digital technologies in fostering engagement with sustainability goals (Portuguez Castro and Gomez Zeremeno, 2020; Schina et al., 2020).

The integration of advanced technologies appears to enhance environmental awareness and digital competences, fulfilling the DigComp framework's competences (RQ3). While digital methods promote comprehensive, multi-domain competency development, traditional approaches provide essential foundational skills, highlighting the synergistic relationship between these two educational strategies.

Young future teachers play a crucial role in promoting sustainability, as their perspectives shape long-term educational strategies. Equipping them with expertise in advanced technologies is essential for fostering sustainable education.

Limitations of the study include its focus on a geographically and culturally limited sample of Slovenian future teachers, which may reduce generalizability.

The quasi-experimental design limits causal inferences, and the study examines only short-term impacts, leaving long-term effects unexplored. Future research should focus on the sustained impact of contemporary technologies on sustainability education and young educators' ability to lead sustainable initiatives. Broadening the sample diversity could also enhance representativeness.

In the context of global sustainability efforts, this research highlights the strategic importance of educational technologies in empowering young people to address environmental challenges. The digital age offers innovative, interactive opportunities for active and critical learning that go beyond traditional methods, making technological integration a key enabler for achieving sustainable development goals.

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ROLE OF WHATSAPP IN IMPROVING L2 LEARNER'S COMMUNICATIVE SKILLS AT INTERMEDIATE LEVEL IN THE CITY OF D. G. KHAN

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Abstract/Izvleček

Learning English is difficult in all non-English speaking countries, including Pakistan, because learning another language after the mother tongue is difficult. This research aimed to improve L2 learners' communication skills through WhatsApp. This research was experimental; sixty average scoring students were selected through pre-tests for this experiment; then, using the fishbowl random sampling technique, two groups, control and experimental, were formed with 30 students each. It was found that the students who were taught with the help of WhatsApp had excellent communication skills in L2 as compared to those students who were taught by traditional methods without WhatsApp.

Keywords:
WhatsApp; L2 learners; communicative skills; technology; AV-aids; WhatsApp in communicative skills.

Vloga aplikacije WhatsApp pri izboljšanju tujejezikovnih komunikacijskih spretnosti dijakov na ravni B1 v mestu D. G. Khan

Osnovni namen pričujoče raziskave je analizirati razvijanje tujejezikovnih komunikacijskih spretnosti pakistanskih dijakov s pomočjo aplikacije WhatsApp. Za ta namen smo izvedli eksperimentalno raziskavo, v kateri je sodelovalo šestdeset dijakov s povprečnimi rezultati, ki so bili izbrani na podlagi predtesta. Sledilo je oblikovanje kontrolne in eksperimentalne skupine, vsaka je zajela 30 učencev, in sicer z uporabo t. i. akvarijske tehnike naključnega vzorčenja. Pri kontrolni skupini smo uporabili tradicionalni pristop poučevanja tujega jezika, medtem ko je eksperimentalna skupina pri pouku uporabljala aplikacijo WhatsApp. Na osnovi rezultatov eksperimenta lahko zaključimo, da so v primerjavi z dijaki kontrolne skupine dijaki, ki so pri pouku uporabljali aplikacijo WhatsApp, pokazali boljše komunikacijske spretnosti v tujem jeziku.

Ključne besede:
aplikacija WhatsApp, učenje angleščine kot tujega jezika, komunikacijske spretnosti, tehnologija v izobraževanju.

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Introduction

Language is a complex and specialized skill that develops in the child spontaneously, without conscious effort or formal instruction, is deployed without awareness of its underlying logic, is qualitatively the same in every individual, and is distinct from more general abilities to process information or behave intelligently (Zubkov, 2020; Pinker, 2003). Learners who have been exposed to various languages and cultures are seen has a stronger base for learning a further language than the student who hasn't had such experiences. As is common knowledge, teaching English at all of Indonesia's educational institutions has been given the status of second language instruction (Kandati and Tatipang, 2021). The challenge is determining how to appropriate and modify the source language culture to fit the target language culture. To accomplish the objectives of the teaching and learning process, it is necessary to find a solution to the problem using any available approach, strategy, or medium (Jabbarov, 2020; Pardede, 2020).

Reading, listening, writing, and speaking are the four fundamental language abilities that should be learned by anyone who is learning English (Xolmurodova, 2021). Among these, speaking is often considered the most important skill. Because it demands that learners think and talk simultaneously, speaking is universally acknowledged as the skill that presents the most significant challenge. Sometimes, learners have a lot of thoughts running through their head, but they struggle to articulate them since they are thinking in the target language. In addition, Hughes (2002) states that one of the primary challenges inherent in speaking research is that it intersects with many other domains and activities. This is cited as one of the major issues inherent in the study of speaking. The ability to talk well may be broken down into four components in its most basic form. According to Richards and Renandya's (2002) explanation, grammatical competence, discourse competence, sociolinguistic competence, and strategic competence are all components of communicative competence.

A lecturer needs to distinguish between teaching speaking and utilizing speaking as a teaching tool. One must be distinct from the other. The topic of whether a teacher is involved in "teaching the spoken form of a language" or "teaching a language through speaking" is, therefore, an important one to consider (Hamad et al., 2019). The communicative method is always relevant when it comes to teaching speaking. The communicative approach, which is also known as communicative language teaching, can be understood as a set of principles concerning the goals of language

teaching, how students learn a language, the types of classroom activities that most effectively facilitate learning, and the roles that teachers and students play in the classroom setting (Richards and Rodgers, 2002). Interaction is emphasized as both the method through which one learns a language and the end objective of the process under the communicative language teaching (CLT) methodology.

Technology is crucial to the current teaching and learning process in schools. Most students report feeling more motivated to learn English when they make use of technology. According to Brown (2000), motivation is arguably the catch-all term used most frequently to explain the success or failure of nearly any problematic undertaking. As a result, it is not difficult to fall into the trap of believing that success in any endeavour is only attributable to the fact that a person is driven.

The pace at which new technologies are developed is quickening. Most people know that the desktop computer is no longer considered cutting-edge technology. The modification of many programs available in the App Store has provided a new source of inspiration for all learners, making it easier for them to acquire information related to science and knowledge. In addition, the study of the English language is subject to the effect of the advancement of technology (Hamad et al., 2019).

The ubiquitous availability of digital technology and its impact on people's daily lives make it imperative that educators consider using various technological tools in instructional settings. Whether speaking of individual low- or high-tech tools for learning and teaching or the collective grouping of various resources, technology can favourably affect students' learning and instruction (Hamad et al., 2019). Technology is in a prime position to play a significant role in developing a novel approach that may be more efficient than previous approaches. The current strategy places more emphasis on the pupils than the instructor. How students present themselves confidently and engagingly can positively impact their learning experience, making them feel more engaged and connected to the classroom environment. However, the physical attractiveness of students doesn't directly influence their ability to learn English (Aprianto, 2020).

WhatsApp Messenger is an instant messaging program, available only on mobile devices, that is cross-platform and uses encryption. It uses the Internet to communicate regular cellular mobile numbers to other users to receive audio messages, text messages, documents, photos, video, and user position information. It has become one of the most popular social networking programs. It is used for conversation with other people.

Younger people are currently leading the trend of using this communication tool. This program is more straightforward than others, requiring several methods or procedures to get started (Hamad et al., 2019).

This research aimed to investigate the role of the WhatsApp Mobile Tool in developing students' communication skills and student enthusiasm for learning English as a second language (Mandasari and Aminatun, 2020).

Mobile Assisted Language Learning (MALL), one of the most important application areas in mobile learning, has improved as a result of the rapid rise in mobile devices (Aprianto, 2020; Mandasari and Aminatun, 2020; Kukulska-Hulme, 2012). In a recent study examining how mobile technology may be used to learn a second language, researchers found that mobile phones are the most popular device (67%) among all portable gadgets (Persson and Nouri, 2018). Learners of second languages (L2) can exploit the potential presented by the widespread ownership of smartphones and participate in casual conversations outside the classroom (Kukulska-Hulme and Shield, 2007). At the tertiary level, the growing body of research on the use of smartphone applications in classroom instruction has been overwhelmingly favourable (Abugohar et al., 2019). A brief overview of the relevant literature will be given to place the current study into its proper perspective within the larger body of research on MALL (Aprianto, 2020).

Related Literature

The affordances that WhatsApp provides have been unambiguously emphasized as the primary reasons for its appeal, according to studies on the app. Among these are capabilities for real-time messaging, simple accessibility, rapid information exchange, free audio and video chatting, a sense of belonging and sociability, and speedy information dissemination (Mandasari and Aminatun, 2020; Church and Oliveira, 2013). In addition, features such as group chatting, broadcasting, texting, audio, and video messaging, capturing and sharing photos and videos, sharing documents, making video and voice calls, creating groups with up to 256 members, and group chatting all offer a rich potential for transforming language learning into the most engaging learning experience possible (Ahmed, 2019).

WhatsApp is a promising platform for collaborative learning, informal learning, and interaction in the target language (Ahmed, 2019). This is because most MALL applications were developed with individual learning as their primary focus, and only a few applications offer CL opportunities. Studies on popular instant messaging

services such as WeChat have demonstrated a good outcome in enhancing people's ability to communicate in their second language in China (Mandasari and Aminatun, 2020; Shi et al., 2017). The current research investigates the WhatsApp platform's effect on L2 speaking and the participants' perspectives on the criteria for evaluating speaking ability. It also considers the diversions and uncontrolled bits of information that Ahad et al. (2014) mention by communicating the study's goals to every participant.

Learning to speak a second language via interaction with other people is essential. It might be challenging for students to develop the self-assurance necessary to talk effectively and confidently in the target language if they do not have adequate opportunities to engage in it. There is a strong correlation between interacting with others and gaining knowledge (Gass and Mackey, 2007). Finding individuals who can communicate with learners in the target language for learning and practice is the best environment for obtaining L2 speaking abilities. This is because it allows learners to practice speaking the target language (Mandasari and Aminatun, 2020; Kukulska-Hulme, 2016). One of the most significant issues that English professors must face is the creation of an atmosphere outside of the classroom that is conducive to interaction in a second language.

When instructors in the role of facilitators can use WhatsApp as a platform to create constructive student involvement, WhatsApp provides a great deal of help in creating a favourable environment for L2 learning (Mohamed, 2019; Pike, 2011). It makes it easier to create an optimal atmosphere for collaborative learning in groups with a sense of identity, a shared goal, and confidence in one another.

Formal learning using WhatsApp makes learning more student-centred, leading to increased learner autonomy through collaborative learning with classmates (Jasrial, 2019). In addition, it assists in effectively engaging students by giving them much-needed exposure to and engagement in the target language outside of the classroom setting (Mohamed, 2019; Lam, 2015). The findings of previous research studies, which found that learning a second language through casual conversation was beneficial, provide support for this point of view (Keogh, 2017). Earlier research on WhatsApp concentrated on acquiring language skills inside of a classroom setting; however, the present study focuses on the influence of WhatsApp on L2 speaking abilities outside the classroom through formal learning (Jasrial, 2019).

Statement of the Problem

Much of the existing research on students learning English as a foreign or second language in Pakistan has identified communication challenges. Most of the difficulties with communication that these investigations have uncovered are linked to two distinct types of problems: linguistic and non-linguistic. The issues with linguistics may be broken down into four categories: phonology, syntax, coherence and cohesiveness, and vocabulary. The challenges that are not related to language have to do with the limited time allotted to students in the class to work on their communicative skills and the methods teachers use to instruct students on improving their communicative skills. These problems lead to several additional issues related to anxiety, personality traits, self-esteem, a poor environment for communication outside the classroom, and inhibition in which students feel afraid of making mistakes. These problems also lead to several additional issues.

Given the earlier research findings that highlighted EFL students' challenges, language learning specialists must instruct students on overcoming the obstacles they confront while attempting to communicate in English. There have not been many studies in Pakistan that thoroughly assesses the challenges associated with communicative skill. Few studies explore the influence of Task-based Language Teaching (TBLT) on increasing communicative ability.

Given the lack of prior research on the topic of English communicative difficulties experienced by students in higher secondary education, the purpose of the present study is first to identify the communicative problems encountered by Pakistani students and then evaluate the impact of WhatsApp on EFL learners' communicative skill in English classrooms using an experimental study of the perspectives of students in an intermediate class.

Objectives of the Study

Objectives of the study included exploring the role of WhatsApp in improving L2 learners' communicative skills to analyse the impact of teaching with the help of WhatsApp on EFL learners' communicative skills in English classrooms at the intermediate level. In addition, we sought to compare teachers' and students' perspectives about teaching through WhatsApp and its impact on EFL learners' communicative skills in English classrooms and to provide recommendations about methods for all stakeholders at the intermediate level.

Research Hypotheses

The following null hypotheses of the research were tested through experiment; two groups were made: one was the control group, which received no treatment, and the second was the experimental group, which used WhatsApp.

Ho.1: WhatsApp has no role in improving L2 learners' communicative skills at the intermediate level.

Ho.2: There is no impact from the use of WhatsApp in teaching on EFL learners' communicative skills in English classrooms at the intermediate level.

Ho.3: There are no perceptions of teachers and students about WhatsApp teaching EFL learners' communicative skills in English classrooms at the intermediate level.

Significance of the Study

This research would benefit all parties concerned, particularly those whose work focuses on formulating educational plans and policies relating English instruction to the communicative skills of other languages. It would help students and instructors at the school level better comprehend acquiring English as a foreign language (EFL) through WhatsApp. This inquiry may also serve as a starting point for other researchers working on comparable problems. The findings of this study have important implications for English instruction. The study suggests that the new teaching method may be an effective approach to improving students' English communication skills, which could also enhance their ability to communicate in other languages. The study's findings could be used to inform the development of new teaching materials and professional development programs for English teachers. The findings of this study are also significant for students and parents. The study suggests that students who have access to the new teaching method may be more likely to succeed in mathematics. Parents can use the findings of the study to advocate for their children to have access to the new teaching method.

Delimitations of the Study

This study was delimited to the following groups:

1. Higher secondary school boys at Tehsil Kot Chutta.
2. Only 2nd-year students.

Research Methodology

The researcher used the following research methodology in this study.

Study Design

The research was experimental and was conducted in the Government Higher Secondary Boys School Kot Chutta among 2nd-year students. The researcher first took a pre-test of all the students, checking their communicative skills; we observed how the children communicated orally in English and through WhatsApp. Two groups of 30 students each were formed, omitting students with the highest and lowest marks. Only average achieving students were selected for the experiment. Students were randomly assigned to groups, one being an experimental group, and the other a control. The researcher exposed the experimental group to WhatsApp and taught the other group by traditional methods. This treatment lasted for three months. Both groups were then given a post-test, including questions about communicative skills. Then, the test score was calculated as the mean value and standard deviation. The significance level was checked by applying an independent sample t-test to the mean values of these two groups.

Table 1
Experimental Design

Population	Pre-tested	Sample	Control Group (Group 1)	Experimental Group (Group 2)	Treatment
130 Students	130 Students	60 Average Scoring Students	30 Students	30 Students	3 Months
Post-tested	-	-	30 Students	30 Students	Compared

Validation of the Research Tool

The research tool was tested and validated through two methods;

Expert opinion: The developed tool was presented before the institute's experts, language experts, and principals. Some extra statements were added according to the WhatsApp context, some were updated, and some were omitted.

Pilot testing: The tool was pilot tested on 20 students, excluding the sample. In this way, the reliability proved to be excellent, at .89.

Reliability of the Tool

Students' scale possesses good reliability, i.e., Cronbach's alpha was 0.89; it was tested through data collection in a pilot study, and results were obtained through SPSS.

Results

Table 2

Factor Analysis (Descriptive)

Group Statistics					
Skills	groups	N	Mean	Std. Deviation	Std. Error Mean
Communicative Skills	Without WhatsApp	30	1.58	.506	.092
	WhatsApp	30	4.35	.578	.106
Reading Skills	Without WhatsApp	30	1.45	.337	.062
	WhatsApp	30	4.47	.516	.094
Writing Skills	Without WhatsApp	30	1.53	.346	.063
	WhatsApp	30	4.55	.589	.107

Table 2 states both groups' results; it was found that the mean value of the factor "communication skills" (4.35) was better in the experimental group, while the mean value (1.58) was poor in the control group. The mean value of the factor "reading skills" (4.47) was found to be better in the experimental group, while the mean value (1.45) was poor in the control group. The mean value of the factor "writing skills" (4.55) was found to be better in the experimental group when compared to the mean value (1.53) in the control group.

Table 3
Factor Analysis (Inferential)

Independent Samples Test								
		t-test for Equality of Means						
Skills		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Communicative Skills	Equal variances assumed	-19.725	58	.000	-2.767	.140	-3.047	-2.486
	Equal variances not assumed	-19.725	56.986	.000	-2.767	.140	-3.048	-2.486
Reading Skills	Equal variances assumed	-26.808	58	.000	-3.017	.113	-3.242	-2.791
	Equal variances not assumed	-26.808	49.969	.000	-3.017	.113	-3.243	-2.791
Writing Skills	Equal variances assumed	-24.202	58	.000	-3.017	.125	-3.266	-2.767
	Equal variances not assumed	-24.202	46.879	.000	-3.017	.125	-3.267	-2.766

Table 3 describes both groups' results; it was found that the factor "communication skills" t-test was significant at (.000). The factor "reading skills" t-test was significant at (.000). The factor "writing skills" t-test was significant at (.000).

Discussion

Ho.1 WhatsApp played a significant role in improving L2 learners' communication skills at the intermediate level in D. G, Khan. The null hypothesis was rejected.

Ho.2 WhatsApp had a considerable impact, and the null hypothesis was rejected.

Ho.3 There were highly positive perceptions among teachers and students about WhatsApp teaching EFL learners' communicative skills in English classrooms at the intermediate level. The null hypothesis was rejected.

It was found that WhatsApp has a serious impact on improving L2 learners' communicative skills. Noorani and Salehi (2019), in a study titled "*The Impact of Using WhatsApp on Iranian Intermediate EFL Learners' Acquisition of Compound Nouns: Gender in Focus,*" concluded that WhatsApp played a vital role in learning compound words

of L2, and that students had a positive attitude towards using WhatsApp to increase their academics marks and enhance communicative skills. Another study by Oye and Cisneros (2021) titled "*Effect of voice messages and short videos through WhatsApp application to enhance the communicative skills of EFL B1 learners between the age of 18 to 25 in an Ecuadorian University"* yielded similar results that students learn a lot through WhatsApp. Students increase their communicative skills with the help of voice messages and short videos. In research titled "*Whatsapp* [sic] *and an Academic Wordlist (Awl) Have A Synergistic Impact on L2 Vocabulary Learner,"* Gurmani et al. (2022) found that L2 learners profited from WhatsApp because WhatsApp provided help to access correct pronunciation. Students enhance their writing skills, reading skills, and communicative skills with the help of WhatsApp. WhatsApp and other social media Apps provide many opportunities to enhance student's communication skills and improve their English language. Ying et al. (2021), in research titled "*The Challenges of Learning English Skills and the Integration of Social Media and Video Conferencing Tools to Help ESL Learners Coping with the Challenges During COVID-19 Pandemic: A Literature Review,"* established that WhatsApp provided students with conference call capacities. Group sharing is effortless for teachers to communicate at once and share notes in a group, and everyone can download a copy of documents shared by teachers in WhatsApp groups. It also provides teachers with audio and video for better communication, and L2 learners enhance their communication skills through WhatsApp.

Conclusions

WhatsApp has a massive role in improving L2 learners' communicative skills at the intermediate level. Teachers deliver the lesson and tasks in WhatsApp groups at any time; it is the fastest mode of communication. When students have difficulty, they can ask in the WhatsApp group; the WhatsApp group is a moving classroom, facilitating time savings and reducing tension. Children can communicate in English in WhatsApp groups, which improves their English writing and reading skills. Children also talk via audio, which improves their speaking and listening skills. Teaching can be significantly improved by using WhatsApp, which is also a modern way of teaching.

It is suggested that teaching methods should be adapted to take advantage of modern technology; WhatsApp is a modern mobile application that provides fast transfer of Word and PDF files in addition to audio and video. Therefore, it is essential to make

WhatsApp groups mandatory for learning English communication skills at an intermediate level. It is recommended that teachers and content writers develop and share reading materials in soft form. The cell phone is a modern technology that can hold a whole book library in soft form. Print books are heavy and need light to be read, but a phone has its own light and no weight, so students can comfortably open books and notes on the phone and read comfortably. Therefore, WhatsApp technology should be promoted for the improvement of education.

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NAVODILA AVTORJEM

Osnovni namen revije je povezati širok spekter teoretičnih izhodišč in praktičnih rešitev v izobraževanju ter tako spodbujati različne metodološke in vsebinske razprave. Uredniški odbor združuje strokovnjake in raziskovalce iz več evropskih držav in s tem želi ustvariti možnosti za živahen dialog med raznovrstnimi disciplinami in različnimi evropskimi praksami, povezanimi z izobraževanjem.

Revija za elementarno izobraževanje torej objavlja prispevke, ki obravnavajo pomembna, sodobna vprašanja na področju vzgoje in izobraževanja, uporabljajo primerno znanstveno metodologijo ter so slogovno in jezikovno ustrezni. Odražati morajo pomemben prispevek k znanosti oziroma spodbudo za raziskovanje na področju vzgoje in izobraževanja z vidika drugih povezanih ved, kot so kognitivna psihologija, razvoj otroka, uporabno jezikoslovje in druge discipline. Revija sprejema še neobjavljene članke, ki niso bili istočasno poslani v objavo drugim revijam. Prispevki so lahko v slovenskem, angleškem ali nemškem jeziku.

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Pri pripravi besedila prispevka upoštevajte naslednja navodila:

1. Tipkopis oddajte kot dokument v programu Microsoft Windows. Nabor pisave je Times New Roman, velikost črk 12 za osnovno besedilo in 10 za povzetka v slovenskem in angleškem jeziku, literaturo in citate, če so daljši od treh vrstic, razmik med vrsticami pa je 1,5. Velikost pisave v tabelah in naslovih tabel ter grafov je 10; razmik med vrsticami pa enojni. Širina tabele naj ne presega 12,5 cm. Besedilo naj bo obojestransko poravnano. Vodilni naslovi naj bodo zapisani krepko, prvi podnaslovi ležeče, drugi podnaslovi pa navadno. Naslovov in strani ne številčite in ne uporabljajte velikih tiskanih črk.
2. Besedilo prispevka naj ne presega 38.000 znakov s presledki, vključno s povzetki, literaturo in ključnimi besedami.

3. Naslov prispevka naj ne presega 15 besed in naj bo v slovenskem in angleškem jeziku.
4. Prispevek naj ima na začetku povzetek v slovenskem jeziku ter njegov prevod v angleškem jeziku (oziroma obratno) in naj ne presega 100 besed. Za povzetkom naj bo 5 ključnih besed. Poleg povzetkov naj prispevek na koncu prispevka, pred literaturo, vsebuje daljši povzetek (500-700 besed) v angleščini, če je članek napisan v slovenščini.
5. V prispevku ne uporabljajte ne sprotnih ne končnih opomb.
6. Vire navajajte v skladu s standardom APA (American Psychological Association). V seznam literature vključite samo v tekočem besedilu navedene vire, ki jih uredite po abecednem vrstnem redu.
7. V posebnem dokumentu pošljite naslednje podatke: ime in priimek avtorja, akademski naziv, organizacijo, kjer je avtor zaposlen, elektronski naslov, naslov bivališča in naslov prispevka.

Primeri:
Knjige: priimek, začetnica imena avtorja, leto izida, naslov, kraj, založba.
Duh, M. (2004). *Vrednotenje kot didaktični problem pri likovni vzgoji.* Maribor*:* Pedagoška fakulteta.

Članki v revijah: priimek, začetnica imena avtorja, leto izida, naslov prispevka, ime revije, letnik, številka, strani.
Planinšec, J. (2002). Športna vzgoja in medpredmetne povezave v osnovni šoli. *Šport*, *50*(1), 11–15.

Prispevki v zbornikih: priimek, začetnica imena avtorja, leto izida, naslov prispevka, podatki o knjigi ali zborniku, strani, kraj, založba.
Fošnarič, S. (2002). Obremenitve šolskega delovnega okolja in otrokova uspešnost. V M. Juričič (ur.), *Šolska higiena: zbornik prispevkov* (str. 27–34). Ljubljana: Sekcija za šolsko in visokošolsko medicino SZD.

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