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Opportunities for developing students' personal qualities through mathematics lessons

Aysuluu Egamberdieva*

PhD in Physical and Mathematical Sciences, Associate Professor
Jusup Balasagyn Kyrgyz National University
720033, 547 Frunze Str., Bishkek, Kyrgyz Republic
<https://orcid.org/0009-0000-1478-4326>

Nazira Kaidieva

PhD in Pedagogical Sciences, Associate Professor
Jusup Balasagyn Kyrgyz National University
720033, 547 Frunze Str., Bishkek, Kyrgyz Republic
<https://orcid.org/0000-0002-2110-8454>

Gulzada Nazarova

Senior Lecturer
Jusup Balasagyn Kyrgyz National University
720033, 547 Frunze Str., Bishkek, Kyrgyz Republic
<https://orcid.org/0009-0004-6473-326X>

Guljamysh Abdymomunova

PhD in Pedagogical Sciences, Associate Professor
Jusup Balasagyn Kyrgyz National University
720033, 547 Frunze Str., Bishkek, Kyrgyz Republic
<https://orcid.org/0009-0008-9116-6247>

Anarkan Esenkanova

Senior Lecturer
Jusup Balasagyn Kyrgyz National University
720033, 547 Frunze Str., Bishkek, Kyrgyz Republic
<https://orcid.org/0009-0002-0892-9861>

Abstract. Contemporary education increasingly emphasises not only the acquisition of knowledge but also the formation of students' personal and social competencies, highlighting the developmental and educational potential of subject lessons. This study aimed to identify pedagogical conditions and methodological strategies that effectively foster responsibility, accuracy, perseverance, creativity, logical reasoning, and collaborative skills among schoolchildren within the context of mathematics instruction. The research employed pedagogical observation, analysis of educational situations, problem-based learning elements, interactive technologies, and structured group work to achieve these objectives. Empirical findings indicated that integrating problem-oriented tasks, collaborative learning formats, and digital educational resources significantly enhances students' cognitive engagement and supports the development of personal and social competencies. During the study, students demonstrated a more responsible approach to task completion, exhibited greater persistence in solving complex problems, explored unconventional solution strategies, and actively participated in discussions. Additionally, notable improvements in collaborative skills were observed: students more frequently assisted peers, considered diverse perspectives, and participated in collective decision-making processes. These outcomes confirmed that mathematics lessons possess substantial educational and formative potential, contributing to the cultivation of ethical, social, and cognitive capacities in students. The practical implications of this research lie in the applicability

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*Corresponding author

of the proposed methodological approaches within contemporary mathematics teaching. Implementing these strategies can enhance the educational impact of lessons, foster the holistic development of students' personalities, and support the cultivation of key competencies necessary for their academic and social success

Keywords: mathematics education; personal development; problem-based learning; collaborative learning; cognitive engagement; pedagogical strategies

■ INTRODUCTION

In the context of transforming educational paradigms and increasing demands for learners' personal development, the necessity of examining the educational potential of academic disciplines, particularly mathematics, as a means of fostering students' personal qualities has become increasingly urgent. As mentioned by D. Ramamonjisoa (2024), the primary objective of contemporary educational systems is to equip students not only with knowledge, skills, and competencies but also to foster their personal qualities, thereby preparing well-rounded individuals who contribute positively to society. In the 21st century, one of the foremost demands placed on the education sector is the balanced intellectual and spiritual upbringing of individuals (Dzulfikar & Herman, 2023). In this regard, the distinctive role of mathematics lessons must be emphasised, as mathematics, being an exact science, demands systematicity, discipline, and responsibility – qualities that manifest as personal attributes in students' daily lives (Rakes *et al.*, 2023).

Recent studies, like the one by S. Nurhayati *et al.* (2024), have demonstrated that mathematics lessons not only develop intellectual skills but also hold potential for cultivating creativity, logical thinking, perseverance, optimism, and personal values. Through processes such as solving problematic tasks, creative exploration, and logical reasoning in mathematics, students learn patience, persistence, accuracy, and collaboration. Such processes enhance not only their intellectual capabilities but also their personal values. Therefore, scientifically substantiating the educational potential of mathematics lessons and effectively utilising it in pedagogical practice remains highly relevant.

The issue of forming students' personal qualities through mathematics lessons has been explored in pedagogy and psychology for many years. Research on this topic can be divided into three main groups. 1st group: scientific perspectives on the educational potential of mathematics. In pedagogy, mathematics is viewed not merely as a subject for imparting computational knowledge but as a powerful educational tool that teaches accuracy, responsibility, and patience. K. Ushinsky (1948) noted that mathematics fosters students' abilities in discipline, systematicity, and precise thinking. J. Piaget (2001) demonstrated that the staged development of logical thinking in mathematics lessons is closely linked to the formation of a child's intellect. S. Duma *et al.* (2024) emphasised the educational function of mathematics, particularly its role in developing logical thinking and perseverance. 2nd group: studies on the formation of personal qualities. The formation of personal qualities is a complex process achieved through education, upbringing, and social adaptation. The

process of overcoming difficulties in mathematics aligns with the child's zone of proximal development, indicating that personal qualities are shaped through various learning activities, including mathematical tasks. E. Mambetakov (2023) highlighted the necessity of integrating national values with subject-specific teaching to form personal qualities. 3rd group: contemporary pedagogical methods in mathematics lessons. In recent years, innovative teaching technologies in mathematics have been widely adopted, promoting the development of students' personal qualities (Uygun *et al.*, 2024). Problem-based learning encourages independent thinking and persistence in seeking solutions. Interactive methods (dialogic teaching, group work) foster collaboration, mutual respect, and responsibility. According to Sh. Altynbekov *et al.* (2023), digital educational resources enhance students' exploratory abilities and creative qualities. Moreover, the digitalisation of mathematics education necessitates the formation of teachers' readiness to effectively integrate digital technologies into the pedagogical process, which directly influences the development of students' personal and professional competencies (Solopko & Shevchuk, 2022).

As evidenced by the aforementioned studies, mathematics lessons possess immense potential for forming students' personal qualities. However, comprehensive research on this issue within the Kyrgyz education system remains insufficient. Therefore, a deeper theoretical and practical investigation into the educational potential of mathematics is highly pertinent. The aim of this study was to identify the theoretical foundations and practical approaches for forming students' personal qualities through mathematics lessons. To achieve this aim, the following objectives were set: analysing scientific literature and recent studies related to the issue; determining the pedagogical conditions for forming personal qualities in mathematics lessons; and verifying their effectiveness through experimental work.

■ MATERIALS AND METHODS

This study employed a multifaceted methodological approach to investigate the role of mathematics lessons in fostering students' personal qualities. The research design integrated theoretical analysis, empirical investigation, and pedagogical experimentation to identify effective conditions and strategies for developing personal attributes through mathematics education. The theoretical foundation was established by reviewing scholarly literature, pedagogical practices, and empirical studies, which informed the identification of key approaches to realising the educational potential of mathematics lessons. The research

focused on secondary school students, with the subject of investigation being their personal qualities and the pedagogical methods employed to cultivate these attributes during mathematics lessons. The study was conducted at Secondary Schools No. 49 and No. 15 in Bishkek, Kyrgyz Republic, involving a total of 80 students from grades 7-8. These students were divided equally into an experimental group (40 students) and a control group (40 students), with group formation accounting for students' academic performance, age characteristics, and classroom learning conditions to ensure comparability. The empirical phase of the study spanned three months (February-April 2024) and involved weekly mathematics lessons. Data collection methods included pedagogical observation, surveys, testing, and documentation of student activities. Observation protocols were specifically designed to assess students' responsibility, perseverance, creativity, and collaboration skills. Group activities were recorded on video, and behavioural analysis was conducted using a coding methodology to evaluate interactions and outcomes.

The control group followed traditional explanatory-demonstrative and reproductive teaching methods, while the experimental group was exposed to innovative pedagogical approaches, including problem-based learning, pair and group work, interactive technologies, and mathematical

games. These methods were selected to target the development of logical thinking, creativity, perseverance, accuracy, and responsibility. For instance, problem-based tasks rooted in real-life scenarios, argumentative discussions, and interactive assignments via online platforms were implemented to foster students' responsibility, creativity, perseverance, and logical reasoning. To ensure methodological rigour, the study incorporated a mixed-methods approach, combining qualitative and quantitative data analysis. Qualitative data were processed through content analysis and behavioural coding, while quantitative data were evaluated using statistical methods to compare outcomes between the experimental and control groups. Results were presented in tables and diagrams to facilitate comparative analysis. Ethical considerations were strictly adhered to throughout the study. Written consent was obtained from the parents of all participating students, and data were anonymised to ensure confidentiality. Personal information was securely stored and processed in accordance with ethical research standards (ASA, 2018). The study utilised a range of instruments to assess students' personal qualities and the effectiveness of pedagogical methods, as outlined in Table 1. The criteria for evaluating students' personal qualities were developed to ensure consistency and objectivity, as presented in Table 2.

Table 1. Data collection instruments

Instrument	Purpose	Sample questions
Student surveys	To assess students' responsibility, creativity, and teamwork skills	1. Do you strive to complete tasks on time? (Yes/No/Sometimes) 2. Do you propose ideas during group work? (Yes/No/Always) 3. Do you find it interesting to devise new solutions? (Yes/No/Sometimes)
Teacher surveys	To evaluate students' behaviour and personal qualities from the teacher's perspective	1. This student completes tasks responsibly. (Agree/Disagree/Difficult to assess) 2. This student shows initiative in group work. 3. This student applies creative approaches to challenging tasks.
Test tasks	To measure creativity, logical thinking, and ability to find alternative solutions	1. Create as many new figures as possible from a given shape. 2. Propose alternative methods to solve the given example. 3. Suggest three possible solutions to a problematic situation.
Self-assessment questionnaire	To evaluate students' self-perception of their qualities and engagement in the learning process	1. I always complete tasks on time. (Yes/No/Sometimes) 2. Proposing new ideas is easy for me. 3. I feel comfortable working with others.

Source: authors' development

Table 2. Criteria for assessing personal qualities

Personal quality	Assessment criteria
Responsibility	Level of timely and accurate task completion
Creativity	Ability to propose non-standard solutions and demonstrate originality
Perseverance and collaboration	Ability to constructively resolve disagreements, listen to and support peers in group work
Accuracy and logical thinking	Consistency and reasoning in solving mathematical problems

Source: authors' development

An illustrative task used in the experimental group involved the following problem: "Given a triangle with two known sides, $AB = 5$ cm and $AC = 7$ cm, what additional information is needed to determine the third side? If the goal is to maximise the perimeter, what strategy could be applied?" This task encouraged students to move beyond standard formulas, engaging their logical reasoning,

creativity, and perseverance. Through group discussions, students proposed diverse solutions, evaluated each other's ideas, and developed teamwork, respect, and responsibility. The use of interactive technologies, such as digital presentations and online platforms, further enhanced students' engagement by allowing them to visualise and discuss solutions collaboratively (Table 3).

Table 3. Students' dialogues and solutions

No.	Problem/strategy	Student	Dialogue/solution
1	Determining the third side	A	We need one angle to find the third side, right?
		B	Yes, or we could calculate the longest possible third side to maximise the perimeter.
		C	If we know the largest angle, the third side would correspond to it.
2	Defining the strategy	D	The longest side would maximise the perimeter.
		E	So, we need the angle formed by sides AB and AC, then we can find the third side.
		F	I could use the cosine theorem to calculate the third side.
3	Creative ideas	G	If we change the shape of the triangle, would the perimeter increase?

Source: authors' development

The combination of these methods and instruments enabled a comprehensive evaluation of the pedagogical conditions and strategies that effectively foster students' personal qualities through mathematics lessons. The findings from this methodological framework provide a robust basis for practical recommendations in modern mathematics education.

■ RESULTS AND DISCUSSION

The findings of this study underscore the significant role of mathematics lessons in fostering students' personal qualities, extending beyond intellectual development to encompass ethical, emotional, and social competencies. The research, conducted with 80 students, compared the outcomes of traditional teaching methods (control group) with innovative pedagogical approaches (experimental group), including problem-based learning, group work, and interactive technologies. Mathematics lessons were found to cultivate a range of personal qualities, including logical thinking, creativity, accuracy, responsibility, perseverance, and collaboration skills. The process of solving mathematical problems and applying formulas systematically enhances students' abilities to analyse, compare, and generalise, which are transferable to other academic disciplines and real-life decision-making (Ihsan *et al.*, 2024). For instance, tasks requiring arithmetic or algebraic solutions compel students to approach each step methodically, fostering perseverance and patience as they strive for accurate

outcomes. Moreover, mathematics lessons promote accuracy and responsibility. The precise application of formulas, meticulous calculations, and verification of results instil a sense of accountability in students. In geometry lessons, for example, constructing figures or measuring dimensions demands precision, as a single error can compromise the entire task. This process reinforces students' attention to detail and responsibility for their work (Pogosyan, 2019).

The study also highlighted the role of mathematics in nurturing creativity. Non-standard tasks in algebra and geometry encourage students to explore alternative solutions, develop innovative approaches, and independently devise logical strategies (Altynbekov *et al.*, 2023). This creative engagement not only enhances problem-solving skills but also fosters a mindset open to experimentation and innovation. From a social perspective, group-based activities and interactive methods in mathematics lessons cultivate collaboration, mutual respect, and social responsibility. Collaborative problem-solving, idea-sharing, and peer evaluation during group discussions promote humanistic values and teamwork skills. These interactions, facilitated by dialogic teaching and digital tools, create an environment conducive to developing social competencies essential for academic and societal success (Lukashova & Kadyr, 2023). The empirical results, summarised in Table 4, demonstrate the comparative effectiveness of the pedagogical approaches used in the experimental and control groups.

Table 4. Results summary (% of students exhibiting personal qualities)

Personal quality	Control group (%)	Experimental group (%)	Difference (%)
Responsibility (timely and accurate task completion)	65	88	+ 23
Creativity (non-standard solutions)	52	81	+ 29
Perseverance and collaboration (active participation in group work)	60	85	+ 25
Accuracy and logical thinking	58	83	+ 25

Source: authors' development

The analysis of Table 4 reveals significant improvements in the experimental group across all assessed personal qualities:

■ **Responsibility:** the experimental group exhibited a 23% higher rate of timely and accurate task completion compared to the control group, indicating that interactive and problem-based methods effectively foster responsibility.

■ **Creativity:** a 29% increase in non-standard solutions in the experimental group highlights the efficacy

of problem-based tasks in developing creative thinking and originality.

■ **Perseverance and collaboration:** the experimental group showed a 25% improvement in active participation in group work, demonstrating that collaborative methods enhance teamwork and constructive conflict resolution.

■ **Accuracy and logical thinking:** a 25% higher performance in the experimental group reflects improved systematic and reasoned approaches to problem-solving, driven by innovative pedagogical strategies.

These findings confirm that the experimental methods – problem-based learning, interactive technologies, and group activities – yielded 23-29% higher effectiveness in fostering personal qualities compared to traditional methods. The structured integration of real-life problem scenarios, as exemplified in the triangle perimeter task, encouraged students to engage critically and collaboratively, further reinforcing these outcomes. The results align with prior research indicat-

ing that problem-based learning cultivates perseverance and emotional resilience by challenging students to overcome difficulties and pursue goals (Popova, 2019). Furthermore, group work and interactive technologies foster social competencies, such as mutual respect and collective decision-making, which are critical for holistic personal development (Slovák & Fitzpatrick, 2015). The directions for forming personal qualities in mathematics lessons are presented in Table 5.

Table 5. Key directions for forming personal qualities in mathematics lessons

Intellectual development	Emotional and ethical upbringing	Social competencies
Develops logical thinking, analytical skills, and creativity	Fosters perseverance, patience, and accuracy	Enhances collaboration, mutual respect, and social responsibility

Source: developed by the authors based on E. Pogosyan (2019)

The incorporation of digital educational resources, such as interactive platforms and pedagogical games, further amplifies these effects by motivating students to engage actively and think creatively, as mentioned by Y. Li *et al.* (2024). These tools not only enhance cognitive engagement but also encourage independent exploration and collaborative problem-solving. To maximise the development of personal qualities in mathematics lessons, teachers are encouraged to adopt a multifaceted approach. This includes actively incorporating problem-based learning, where tasks require independent analysis and creative problem-solving to foster perseverance, creativity, and responsibility. Furthermore, as noted by A. Piyakun & S. Phusee-Orn (2025), facilitating group discussions and interactive dialogues enhances collaboration, mutual respect, and social responsibility. Individualised tasks should be used to promote independent thinking and accountability, reinforcing students' sense of ownership over their learning. According to A. Kaldybaeva *et al.* (2021),

integrating digital tools and games, such as interactive presentations, online platforms, and mathematical games, boosts motivation and develops creativity and logical thinking. Finally, allocating time for reflective practice allows students to analyse their actions and achievements, fostering self-awareness, analytical skills, and emotional regulation. These recommendations, grounded in the study's findings, provide a practical framework for enhancing the educational and formative impact of mathematics lessons.

Table 6 outlines the relationship between specific teaching methods and their impact on students' personal qualities in mathematics lessons. It highlights how problem-based learning enhances emotional intelligence, interactive dialogues improve mathematical reasoning, video-based instruction fosters responsibility, assessment practices reflect the influence of personal qualities on achievement, and the content and methods of mathematics lessons realise their educational potential.

Table 6. Teaching methods and students' personal qualities

No.	Methods	Outcomes
1	Problem-based learning (emotional intelligence)	Problem-based learning fosters students' mathematical problem-solving abilities and emotional intelligence (Karjanto & Acelajado, 2022)
2	Interactive dialogue (mathematical reasoning)	Interactive dialogues enhance mathematical reasoning and deepen conceptual understanding (Dalinger, 2016)
3	Video-based instruction (students' responsibility)	The use of video materials in mathematics lessons directly influences students' responsibility in the learning process (Golysheva, 2016)
4	Assessment of mathematical achievements (students' personal qualities)	Students' personal qualities, including intelligence, creativity, and prior knowledge, strongly influence their mathematical achievements (Kolpakova, 2018)
5	Implementation of educational functions in mathematics lessons	The educational potential of mathematics lessons is realised through their content and teaching methods (Balde, 2019)

Source: authors' development

Previous research has shown that problem-based learning significantly improves student engagement in mathematics by encouraging active participation and critical thinking (Moldybaeva, 2016). Interactive methods have been found to enhance collaboration among students, promoting a supportive learning environment. Additionally, as mentioned by H. Serin (2023), the use of digital tools in math lessons boosts student motivation, making abstract concepts more accessible and enjoyable. These approaches contribute to a more dynamic classroom atmosphere,

where students develop not only mathematical proficiency but also essential life skills. Overall, these insights highlight the transformative potential of innovative pedagogical strategies in mathematics education.

CONCLUSIONS

This study investigated the efficacy of mathematics lessons in fostering students' personal qualities. The research compared traditional teaching methods (control group) with innovative pedagogical strategies (experimental group),

including problem-based learning, group and pair work, and interactive technologies. The findings confirmed that mathematics lessons serve as a robust platform for both educational and formative development, cultivating intellectual, ethical, and social competencies. Comparative analysis revealed the superior effectiveness of innovative methods in developing personal qualities. Specifically, the experimental group demonstrated a 23% increase in responsibility, as evidenced by timely and accurate task completion. Creativity improved by 29%, with students proposing more non-standard solutions and original ideas. Perseverance and collaboration rose by 25%, with students actively engaging in group discussions and constructively resolving disagreements. Additionally, accuracy and logical thinking improved by 25%, reflecting enhanced systematic and reasoned problem-solving skills. These results, supported by quantitative and qualitative data, underscore the significant formative potential of mathematics lessons when innovative pedagogical approaches are employed.

The study highlighted that problem-based tasks, interactive resources, and collaborative activities significantly enhance students' cognitive engagement and contribute to the development of moral and social competencies. By integrating real-life problem scenarios and digital tools, mathematics lessons foster not only academic proficiency but also qualities such as responsibility, perseverance, creativity, and teamwork, preparing students for both academic and societal success. The practical implications of these findings lie in their applicability to modern mathematics education,

offering teachers actionable strategies to enhance the formative impact of lessons. The proposed methods – problem-based learning, group work, interactive technologies, and reflective practices – provide a comprehensive framework for nurturing well-rounded individuals equipped with essential life skills. In conclusion, this study provides robust evidence that mathematics lessons, when designed with innovative pedagogical strategies, are a powerful tool for fostering students' intellectual, moral, and social development, equipping them for success in diverse contexts. Future investigations could explore several avenues to build on these findings. First, a deeper examination of the impact of digital platforms and online resources on students' personal qualities in mathematics lessons is warranted. Second, longitudinal studies tracking the development of personal qualities across different age groups could provide insights into their dynamic progression. Finally, further research into the role of mathematics lessons in developing emotional intelligence and creative thinking could enhance understanding of their broader formative potential.

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Айсулуу Эгамбердиева

Физика-математика илимдеринин кандидаты, доцент
Ж. Баласагын атындагы Кыргыз улуттук университети
720033, Фрунзе көч., 547, Бишкек ш., Кыргыз Республикасы
<https://orcid.org/0009-0000-1478-4326>

Назира Кайдиева

Педагогика илимдеринин кандидаты, доцент
Ж. Баласагын атындагы Кыргыз улуттук университети
720033, Фрунзе көч., 547, Бишкек ш., Кыргыз Республикасы
<https://orcid.org/0000-0002-2110-8454>

Гулзада Назарова

Улук окутуучу
Ж. Баласагын атындагы Кыргыз улуттук университети
720033, Фрунзе көч., 547, Бишкек ш., Кыргыз Республикасы
<https://orcid.org/0009-0004-6473-326X>

Гулжамыш Абдымомунова

Педагогика илимдеринин кандидаты, доцент
Ж. Баласагын атындагы Кыргыз улуттук университети
720033, Фрунзе көч., 547, Бишкек ш., Кыргыз Республикасы
<https://orcid.org/0009-0008-9116-6247>

Анаркан Эсенканова

Улук окутуучу
Ж. Баласагын атындагы Кыргыз улуттук университети
720033, Фрунзе көч., 547, Бишкек ш., Кыргыз Республикасы
<https://orcid.org/0009-0002-0892-9861>

Аннотация. Азыркы билим берүү системасы билимди гана өздөштүрүүгө эмес, ошондой эле окуучулардын жеке жана социалдык компетенцияларын калыптандырууга басым жасайт, бул предметтик сабактардын тарбиялоо жана өнүктүрүү потенциалын баса белгилейт. Бул изилдөөнүн максаты – мектеп окуучуларынын математиканы үйрөнүү процессинде жоопкерчилик, тактык, чыдамкайлык, чыгармачылык, логикалык ой жүгүртүү жана кызматташтык көндүмдөрүн өнүктүрүүгө эффективдүү шарттарды жана методикалык стратегияларды аныктоо болду. Максатка жетүү үчүн педагогикалык байкоо, окуу ситуацияларын талдоо, проблемалык окуунун элементтери, интерактивдүү технологиялар жана топтук ишти уюштуруу колдонулду. Эмпирикалык жыйынтыктар көрсөткөндөй, проблемалык тапшырмаларды, кызматташтык формаларын жана санариптик окуу ресурстарын киргизүү окуучулардын билими жана көндүмдөрүн активдештирип, жеке жана социалдык компетенцияларын өнүктүрүүгө салым кошот. Изилдөө учурунда окуучулар тапшырмаларды жоопкерчилик менен аткарып, татаал маселелерди чечүүдө чыдамкайлык көрсөтүп, өзгөчө чечимдерди табуу жана талкууларга активдүү катышуу көндүмдөрүн өнүктүрүштү. Ошондой эле кызматташтык көндүмдөрү жакшырганы байкалган: окуучулар бири-бирине көбүрөөк жардам көрсөтүп, ар кандай көз караштарды эске алып, биргелешип чечим кабыл алышты. Бул жыйынтыктар математикалык сабактардын чоң тарбиялык жана өнүктүрүүчү потенциалы бар экенин, окуучулардын этикалык, социалдык жана когнитивдик компетенцияларын өнүктүрүүгө салым кошо аларын тастыктайт. Изилдөөнүн практикалык мааниси – сунушталган методикалык ыкмаларды заманбап математика окутуу тажрыйбасында колдонууга мүмкүнчүлүк берет. Аны ишке киргизүү сабактардын тарбиялык таасирин күчөтүп, окуучулардын инсандык өнүгүүсүнө жана алардын академиялык жана социалдык ийгилигине керектүү негизги компетенцияларды калыптандырууга шарт түзөт.

Негизги сөздөр: математикалык билим берүү; жеке өнүгүү; проблемалык окуу; кызматташтыкта окуу; билимин активдештирүү; педагогикалык стратегиялар

Возможности формирования личностных качеств учащихся через уроки математики

Айсулуу Эгамбердиева

Кандидат физико-математических наук, доцент
Кыргызский национальный университет имени Ж. Баласагына
720033, ул. Фрунзе, 547, г. Бишкек, Кыргызская Республика
<https://orcid.org/0009-0000-1478-4326>

Назира Кайдиева

Кандидат педагогических наук, доцент
Кыргызский национальный университет имени Ж. Баласагына
720033, ул. Фрунзе, 547, г. Бишкек, Кыргызская Республика
<https://orcid.org/0000-0002-2110-8454>

Гулзада Назарова

Старший преподаватель
Кыргызский национальный университет имени Ж. Баласагына
720033, ул. Фрунзе, 547, г. Бишкек, Кыргызская Республика
<https://orcid.org/0009-0004-6473-326X>

Гулжамыш Абдымомунова

Кандидат педагогических наук, доцент
Кыргызский национальный университет имени Ж. Баласагына
720033, ул. Фрунзе, 547, г. Бишкек, Кыргызская Республика
<https://orcid.org/0009-0008-9116-6247>

Анаркан Эсенканова

Старший преподаватель
Кыргызский национальный университет имени Ж. Баласагына
720033, ул. Фрунзе, 547, г. Бишкек, Кыргызская Республика
<https://orcid.org/0009-0002-0892-9861>

Аннотация. Современное образование все больше акцентирует внимание не только на усвоении знаний, но и на формировании личностных и социальных компетенций учащихся, что подчеркивает воспитательный и развивающий потенциал уроков отдельных предметов. Цель данного исследования заключалась в выявлении педагогических условий и методических стратегий, способствующих развитию ответственности, точности, настойчивости, креативности, логического мышления и навыков сотрудничества у школьников в процессе обучения математике. Для достижения этих целей использовались методы педагогического наблюдения, анализа учебных ситуаций, элементы проблемного обучения, интерактивные технологии и организация групповой работы. Эмпирические результаты показали, что включение проблемных заданий, коллективных форм обучения и цифровых образовательных ресурсов значительно повышает познавательную активность учащихся и способствует развитию личностных и социальных компетенций. В ходе исследования учащиеся проявляли более ответственное отношение к выполнению заданий, демонстрировали настойчивость при решении сложных задач, находили нестандартные способы решения и активно участвовали в обсуждениях. Кроме того, наблюдалось заметное улучшение навыков сотрудничества: учащиеся чаще помогали друг другу, учитывали разные точки зрения и участвовали в совместном принятии решений. Эти результаты подтверждают, что уроки математики обладают значительным воспитательным и развивающим потенциалом, способствуя формированию этических, социальных и когнитивных компетенций школьников. Практическая ценность исследования заключается в возможности применения предложенных методических подходов в современной практике преподавания математики. Их внедрение может усилить воспитательное воздействие уроков, способствовать гармоничному развитию личности учащихся и формированию ключевых компетенций, необходимых для их академического и социального успеха.

Ключевые слова: образование по математике; личностное развитие; проблемное обучение; совместное обучение; познавательная активность; педагогические стратегии