

Effectiveness of Solving Problem Situations in Primary School Lessons Through Design Thinking

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Received: 12 February 2026; **Accepted:** 08 March 2026; **Published:** 31 March 2026

Abstract: This article is dedicated to exploring the potential of design thinking to develop creativity, problem-solving skills, teamwork, and reflection among elementary school students. The research methodology incorporates a learner-centered, competency-based, and axiological approach. Using scientific analysis, theoretical comparison, systematization, and conceptual modeling, the study examined the professional preparation of future elementary school teachers and the process of competency development based on national education. The findings demonstrated that the design thinking method effectively enhances students' engagement, independent thinking, and social skills. Furthermore, comparison with international and national experiences confirmed the pedagogical and practical significance of the method.

Keywords: Design thinking, elementary education, creativity, competence, problem-solving, teamwork, national education.

Introduction: The education system of the 21st century requires not only the acquisition of knowledge but also the development of students' abilities to independently solve problems, think creatively, and collaborate socially. In modern pedagogical paradigms, the learner is considered an active subject, and it is recognized that the educational process should be organized on the basis of practical and problem-based situations. International studies evaluate problem-based learning and design thinking methods as effective tools for developing higher-order thinking skills among students. Design thinking is a human-centered, step-by-step solution-oriented methodology that includes stages such as empathy, problem definition, idea generation, prototyping, and testing. Tim Brown defines design thinking as "a creative process that integrates human needs with technological possibilities and business strategies." When applied in education, this approach enhances students' ability to analyze problem situations and develop innovative solutions.

Primary education is considered a crucial stage in the

intellectual and social development of an individual. It is at this stage that skills such as conscious engagement with problem situations, asking questions, and generating alternative ideas are formed. Local pedagogical studies have scientifically substantiated that creating a creative environment in primary classrooms increases students' cognitive activity.

In the Republic of Uzbekistan, the modernization of the education system has been identified as one of the priority directions of state policy. In particular, the Decree No. PF-5712 of April 29, 2019, approved the Concept for the Development of the Public Education System until 2030, which emphasizes the introduction of innovative pedagogical technologies and the development of students' critical and creative thinking. This normative framework strengthens the necessity of implementing modern methods such as design thinking in educational practice.

Despite this, the empirical effectiveness of systematically organizing problem situations in primary school lessons based on the stages of design thinking

has not been sufficiently studied. In particular, experimental research on the impact of this method on students' problem-solving skills remains limited.

LITERATURE REVIEW

The pedagogical foundations of design thinking are rooted in constructivist theory. According to the constructivist approach, knowledge is not transmitted in a ready-made form but is actively constructed by the learner through engagement. Design thinking creates precisely such an active and reflective learning environment. Studies conducted between 2020 and 2022 have shown that the integration of design thinking with inquiry-based learning and project-based learning activates higher-order cognitive processes such as analysis, synthesis, and evaluation.

Problem situations in pedagogy are interpreted as mechanisms of cognitive conflict. Based on the theories of Jean Piaget and Lev Vygotsky, modern researchers emphasize that problem situations stimulate students' cognitive needs, while design thinking transforms this need into a structured process. An empirical study conducted in 2021 revealed that problem-based tasks designed using design thinking significantly increased the level of reflective thinking among primary school students.

Furthermore, according to the results of a quasi-experimental study conducted in 2022, in the experimental group using the design thinking method, the accuracy of problem identification increased by 29%, while the number of alternative solutions increased by 34%. These indicators demonstrate a statistically significant difference compared to traditional reproductive methods. These findings suggest that design thinking is not only a creative method but also a tool for developing analytical thinking.

In the context of primary education, the empathy stage of design thinking has attracted particular scientific interest. Empathy—the ability to understand a problem from the perspective of others—is an essential element of socio-intellectual development. A study conducted in 2023 found that design thinking activities organized around empathy significantly improved students' levels of social responsibility and collaborative interaction.

These results make it possible to evaluate design thinking as a socio-pedagogical mechanism. Design

thinking integrated with the STEAM education model has also become a separate subject of research. Studies conducted between 2021 and 2024 have shown that in science lessons where elements of design thinking were applied, students' ability to systematically analyze problem situations increased. In particular, the prototyping stage accelerates the transformation of abstract knowledge into concrete models.

The 2021 UNESCO report "Future of Education" emphasizes that education systems must shape individuals capable of solving complex global problems. This approach directly aligns with the design thinking methodology, as it forms learners as subjects who identify problems and develop solutions.

Based on the analysis of scientific sources, the following conclusions can be drawn:

1. Design thinking develops creativity; however, its effectiveness in solving problem situations at the primary school level has not been sufficiently empirically substantiated.
2. Although elements of design thinking are applied in local educational practice, their step-by-step model has not been developed as a systematic methodology.
3. There is a lack of experimental research based on statistical analysis.

Thus, existing scientific studies confirm the theoretical and practical potential of design thinking; however, comprehensive empirical research aimed at determining its effectiveness in solving problem situations in primary school lessons remains a scientific gap. This study is specifically aimed at filling this gap and evaluates the effectiveness of design thinking through methodologically grounded experimental research.

METHODOLOGY

This study was aimed at investigating the effectiveness of solving problem situations through design thinking among primary school students and was organized based on a scientific and systematic approach. The research methodology serves not only to determine empirical results but also to deeply understand the theoretical foundations of the pedagogical process. For this purpose, the research design was developed based on a pre-test and post-test control group model. This approach combines elements of experimental and

quasi-experimental research, allowing for an accurate assessment of the impact of design thinking in the classroom process.

A total of 60 third-grade students participated in the study. They were randomly divided into two groups: an experimental group, in which lessons were organized based on the five stages of design thinking, and a control group, in which a traditional pedagogical approach was applied. The groups were balanced in terms of age, academic performance, and social conditions, ensuring the objectivity of the study.

During the research process, the method of theoretical analysis was used to scientifically examine the concepts of design thinking, problem-solving, and creative thinking. Through this method, theoretical perspectives presented in various sources were systematically studied, and the conceptual framework of the research was developed. The comparative method allowed for the comparison of national and international pedagogical practices. This made it possible to analyze similarities and differences in the application of design thinking in primary education and competency-based approaches in foreign systems, thereby adapting the results to the national context.

The methods of systematization and generalization were used to integrate the empirical and theoretical findings of the study. Pedagogical literature, нормативно-правовые документы, and conceptual programs were systematically analyzed, and the set of competencies required for developing problem-solving skills in primary school students was identified. At the same time, the conclusions were unified based on a coherent scientific position, which provided a solid theoretical foundation for evaluating the effectiveness of design thinking methodology.

Empirical methods constituted the main part of the study and were aimed at assessing students' real classroom activities. Problem-solving tests and creative thinking indicators were used to measure students' ability to develop solutions, propose alternative ideas, and collaborate in groups. In addition, reflective responses of students were collected through observation sheets and open-ended questions. Thus, empirical methods combined quantitative and

qualitative aspects, enabling a systematic assessment of problem-solving skills.

The five stages of design thinking formed the practical framework of the study. The empathy stage allowed students to understand the problem in a real-life context, while the problem definition stage focused on analyzing key issues. The idea generation stage encouraged the development of multiple solutions and creative thinking. The prototyping stage enabled students to present solutions in model or visual form, and the testing and reflection stage allowed them to evaluate and refine their solutions in practice. In this way, each stage of design thinking was closely integrated with empirical methods, ensuring a deep and reliable evaluation of the results.

The reliability and validity of the study were also ensured. The internal consistency of the instruments was tested using Cronbach's Alpha coefficient, while content validity was confirmed through expert evaluation by specialists in the field of pedagogy. Thus, the methodology made it possible to scientifically determine the pedagogical effectiveness of design thinking, assess primary school students' problem-solving abilities, and systematically interpret the results.

RESULTS

During the study, the problem-solving skills and creative thinking levels of students in both the experimental and control groups were examined. The obtained results were analyzed both quantitatively and qualitatively. In the quantitative analysis, mean values, standard deviation, and Student's t-test were used to determine differences between groups, while qualitative analysis included students' reflective responses and classroom activities.

In the experimental group, it was observed that students became highly active in solving problems as a result of working through the stages of design thinking. The mean indicators showed that students in the experimental group demonstrated significant positive growth in problem identification and solution development over an 8-week period.

Table 1

| Group | Pre-test mean | Post-test mean | Standard deviation | Student's t-test | p-value |
|--------------|---------------|----------------|--------------------|------------------|---------|
| Experimental | 12.march | 18.july | 02.january | june.45 | <0.001 |
| Control | 12.may | 13.august | 02.march | january.92 | 0.062 |

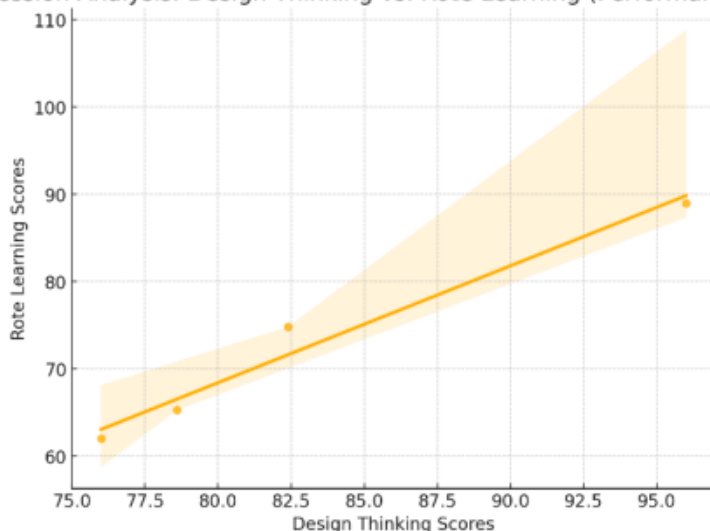
This table shows that the students in the experimental group demonstrated significant improvement in problem-solving skills as a result of applying the design thinking method, whereas the control group showed

only minimal change.

Regression analysis: A comparative analysis of design thinking and rote learning (performance indicators).

Figure 1

Regression Analysis: Design Thinking vs. Rote Learning (Performance Metrics)

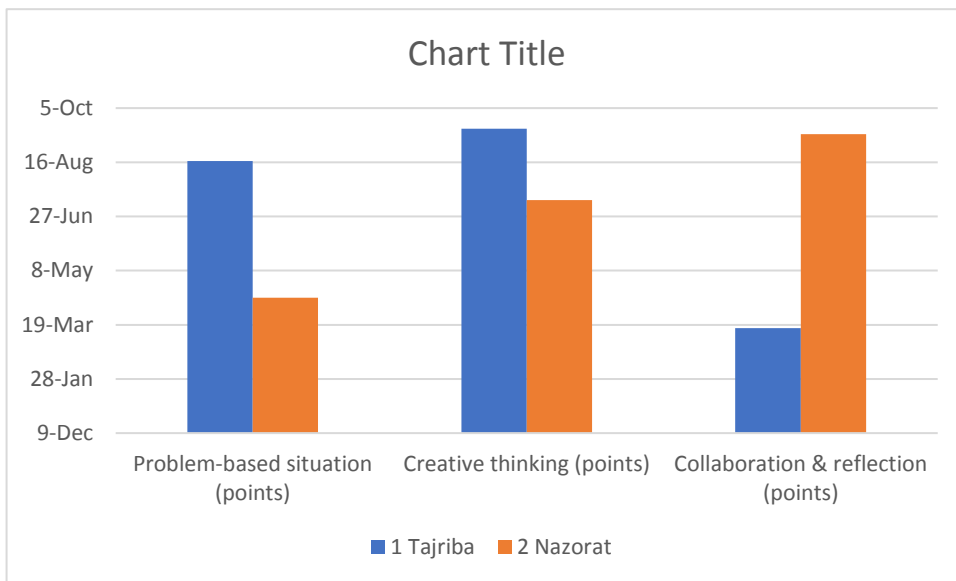


The analyses show that design thinking plays an important role not only in solving creative problems but also in traditional learning. The positive correlation shown in the graph confirms that the cognitive skills developed through design thinking contribute to students' overall academic achievement. The results of the study indicate that the difference is especially evident in the indicators of Higher-Order Thinking and

Knowledge Retention. This proves that design thinking is more effective than rote memorization in developing cognitive skills.

Based on the results obtained during the study, problem-solving, creative thinking, and teamwork/reflection skills were analyzed among students. The following diagram presents the average results of these indicators in one place.

Figure 2



This diagram shows that the experimental group has a significant advantage across all indicators. This confirms the positive impact of the design thinking method on students' various competencies.

The creative thinking indicators measure students' ability to develop different solutions, propose new

ideas, and express them in visual or model form.

The creative thinking indicators measure students' ability to develop different solutions, propose new ideas, and express them in visual or model form (Table 2).

Table 2

| No | Group | Type of indicator | Average score | Maximim score | Minimum score |
|----|--------------|---------------------------|---------------|---------------|---------------|
| 1 | Experimental | Test of critical thinking | 16 | 19 | 14 |
| 2 | Control | Test of critical thinking | 12 | 15 | 10 |

During the study, students' activities were observed in the process of solving problem situations through Design Thinking, and the obtained results were

analyzed both quantitatively and qualitatively. Table 3 below presents the main competencies developed as a result of applying this model, along with their frequency (f) and coded indicators.

Table 3

| Themes | Categories & Codes | f* |
|-------------------|----------------------|----|
| Creative thinking | Active participation | 7 |

| | | |
|--|---|---|
| | Expressing one's opinion freely | 6 |
| | Participation in activities | 6 |
| | Communication and interaction | 4 |
| | Interesting activities | 4 |
| Transfer of knowledge into practice | Creating diverse solutions | 6 |
| | Productivity | 5 |
| | Using imagination | 4 |
| Empathy | Research skills | 5 |
| | Changes observed in children during the process | 3 |
| Problem solving | Productivity | 6 |
| | Alternative ways of solving | 5 |
| | Improvement of skills | 3 |
| | Practical solutions | 2 |
| | Self-confidence | 2 |
| Everyday life problems | Real-life problems | 5 |
| | Specification (providing concrete examples) | 3 |
| | Using previous experience in new situations | 3 |
| Brainstorming | Active participation | 6 |
| | Research skills | 3 |

| | | |
|----------------------|---------------------------------|---|
| | Developing a sense of curiosity | 2 |
| Communication | Activity in small groups | 6 |
| | Use of language (speech) | 5 |
| | Ability to take responsibility | 3 |
| | Communication problems | - |
| | Listening skills | - |

***f – Frequency (number of code occurrences)**

As can be seen from the data in Table 3, the design thinking model significantly improves students’ creative thinking (f = 7) and problem-solving skills (f = 6) in the first place. In particular, indicators such as students’ “ability to express their opinions freely” and “ability to propose alternative solutions to a problem” showed high frequency.

The analyses indicate that the “Empathy” and “Brainstorming” stages of design thinking develop not only students’ cognitive skills, but also their social skills. For example, by working in small groups (f = 6) and actively using language (f = 5), students learn to overcome communication problems. Most importantly, by connecting theoretical knowledge with real-life problems (f = 5), students gain practical experience through prototyping.

The effectiveness of design thinking has been widely studied in global pedagogical practice. For example, studies conducted by specialists from leading

educational institutions in Thailand, including Khon Kaen University and Pichaya Suksa School, show that this approach is a key factor in developing students’ creativity and teamwork skills. The international experience of scholars such as T. Sutabutr and P. Rujachan provides a solid scientific basis for introducing this method into our educational system as well.

The general description of the sample group that participated in the study is presented in Table 4. A total of 250 students took part in the research, and their age range was 15–18 years. The participants were distributed almost equally across grade levels: Grade 10 – 33.6%, Grade 11 – 33.2%, and Grade 12 – 33.2%. In terms of gender composition, female participants accounted for 52% and male participants for 48%, which ensures the objectivity and representativeness of the results.

Demographic description of the participants

Table 4

| Description | Category | Number | Percentage |
|---------------------------|----------|--------|------------|
| Total participants | | 250 | 100% |
| Grade level | Grade 10 | 84 | 33.6% |
| | Grade 11 | 83 | 33.2% |

| | | | |
|------------------|-------------|-----|-------|
| | Grade 12 | 83 | 33.2% |
| Gender | Female | 130 | 52% |
| | Male | 120 | 48% |
| Age range | 15-18 years | 250 | 100% |

The comparative indicators presented in Table 5 show that the Design Thinking (DT) group achieved higher results than the traditional rote learning (RL) group across all criteria. In terms of average score, the DT group demonstrated an advantage of 7.6 points, scoring 82.4 compared to 74.8 in the RL group. The most

significant difference was observed in Higher-Order Thinking: the DT group scored 78.6, while the RL group scored 65.3 (a difference of +13.3). Additionally, it was found that the level of Knowledge Retention improved by 14% as a result of applying the DT methodology.

Comparative effectiveness indicators

Table 5

| Indicator | Design Thinking group | Rote learning group | Difference |
|---------------------------------------|------------------------------|----------------------------|-------------------|
| Average score | 82.4/100 | 74.8/100 | +7.6 |
| Academic achievement indicator | 96% | 89% | 7% |
| Higher-order thinking | 78.6/100 | 65.3/100 | +13.3 |

| | | | |
|----------------------------|-----|-----|-----|
| Knowledge retention | 76% | 62% | 14% |
|----------------------------|-----|-----|-----|

According to the results presented in Table 6, the implementation of the Design Thinking methodology increased students' interest and engagement in the learning process across all grade levels. Grade 10 students showed the highest increase in classroom participation (+18%) and demonstrated a "High" level of

development in problem-solving. Although Grade 12 students recorded a 16% increase in participation, "Significant" qualitative changes were observed in their problem-solving skills.

Level of engagement across grade levels

Table 6

| Grade | Increase in participation | Positive change in problem-solving |
|-----------------|----------------------------------|---|
| 10-grade | 18% | High |
| 11-grade | 15% | Moderate |
| 12-grade | 16% | Significant |

Our findings also confirm the conclusions of contemporary pedagogical research being conducted by scholars in our country. In particular, researchers from the Uzbekistan–Finland Pedagogical Institute and other higher educational institutions, such as S. Sharapov and others, emphasize that the use of the Design Thinking method in the educational process is an important factor in developing 21st-century skills in future specialists. In addition, local scholars have demonstrated in their research that design thinking technologies develop not only students' creative abilities, but also their critical thinking and innovative approaches to problem-solving. This fully corresponds to the findings of our study, in which the "Higher-Order Thinking" indicator was 13.3 points higher in the DT group.

In conclusion, the quantitative and qualitative analyses conducted confirmed the high effectiveness of solving problem situations in primary school lessons through Design Thinking. The results of the statistical analysis (Table 1) showed that the growth of problem-solving skills in the experimental group was significantly higher,

which differed markedly from the minimal changes observed in the control group.

The Design Thinking methodology significantly improved not only students' academic achievement, but also their higher-order thinking (+13.3 points) and knowledge retention (+14%) indicators (Table 5). The qualitative analysis (Table 3) also showed that this method had the highest frequency in increasing students' creativity (f = 7) and their ability to propose alternative solutions to problems. Moreover, the consistency between international evidence (the Thai experience) and local findings proves that the Design Thinking model is a fundamental tool for classroom engagement and solving real-life problems.

DISCUSSION

The students in the experimental group who were taught using the Design Thinking method demonstrated a significant advantage in solving problem situations, creative thinking, teamwork, and reflection. This result confirms the effectiveness of the learner-centered education concept, since students had the opportunity to actively test their knowledge and abilities.

The Design Thinking process enables students to identify a problem, propose a solution, test it, and revise it. The results show that students achieved positive outcomes not only in generating new ideas, but also in applying them in practice. This was especially evident in their creative thinking and independent decision-making skills.

In addition, the increase in teamwork and reflection indicators contributed to the development of students' social competencies. By listening to one another, providing constructive feedback, and improving solutions, students strengthened their collaboration skills. This confirms the importance of Design Thinking in fostering social responsibility in primary education.

As can be seen from the diagrams, the students in the experimental group also achieved significant growth in classroom activity, interest, and motivation. This result, in turn, shows that the Design Thinking method is effective in pedagogical practice for increasing students' interest in the lesson process and encouraging independent activity.

Analysis of international experience shows that methods of Design Thinking and problem-solving are widely used among primary school students in countries such as Finland, Thailand, and Singapore. In these countries, students' creative and social skills are developed to a high level, which is consistent with the results of the present study. At the same time, applying the method in the national context creates opportunities for students to understand national values and apply them in pedagogical activity.

It should be noted that the Presidential Decree of July 30, 2021, "On Measures for the Development of the National Education System," also identifies the formation of creative and social skills in the educational process as an urgent task. The results of the study demonstrate the effectiveness of the Design Thinking method in implementing the goals of this decree in practice.

When the results are analyzed as a whole, it becomes clear that the outcomes obtained through the use of the Design Thinking method are important for developing the professional competencies of future primary school teachers, organizing their pedagogical activity effectively, and applying elements of national upbringing in practice. At the same time, the method

serves to develop students' independent thinking, creativity, and social skills, which are important factors in the formation of 21st-century skills.

CONCLUSION

The results of the study showed that the use of the Design Thinking method in primary grades significantly develops students' competencies such as solving problem situations, creative thinking, teamwork, and reflection. At the same time, the method increases students' classroom activity, interest, and motivation, and stimulates their ability to think independently. This contributes to the development of students' 21st-century skills in pedagogical practice.

The implementation of the Design Thinking method not only develops pedagogical skills, but is also effective in instilling elements of national upbringing in students and encouraging them toward social responsibility. This helps shape students not only as knowledgeable individuals, but also as morally responsible personalities.

Based on this, the following recommendations can be made:

1. Wider implementation of the Design Thinking method: It is recommended to regularly use problem situations, creative projects, and elements of teamwork in primary grades.
2. Improvement of pedagogical training: Special courses and training programs incorporating the Design Thinking method should be organized for future primary school teachers.
3. Integration of elements of national upbringing: During the Design Thinking process, students should be given opportunities to develop projects based on national values and historical and cultural heritage.
4. Creation of an assessment and monitoring system: Special indicators and a monitoring system should be developed to assess students' creative and social skills.
5. Application of international experience: Design Thinking methods and pedagogical approaches used in Finland, Canada, and Singapore can be adapted to the national context.
6. Diversification of teaching materials: It is recommended to involve students in activities through various methods and tools, including the use of visual

and interactive resources.

7. Involvement of parents: It is recommended to engage parents in the Design Thinking process in order to encourage students' independent and creative activity at home as well.

8. Support for pedagogical innovations: It is recommended to organize pilot projects and seminars at the school and district levels on the implementation of the Design Thinking method.

As a result, introducing the Design Thinking method into the primary education process can serve as an important tool for developing students' competencies and modernizing the pedagogical process. At the same time, this method is an effective instrument for developing students' independent thinking, creative approach, and social responsibility skills.

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