

DAILY LIFE CONTEXT BASED DIDACTIC GAMES IN MATHEMATICS LESSONS TO DEVELOP MATHEMATICAL COMPETENCE

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Abstract. *The results of the national centralised examination of Latvia show a lack of students' mathematical knowledge, skills and competences, which can have a negative impact not only on the direction of education in future, but on students' career choice as well, which makes an impact on the number of specialists in STEM (Science; Technology; Engineering; Mathematics) field professions. Employers highlight that a lack of mathematics skills is one of the major barriers to long-term investments in science, technology, engineering, and mathematics. Consequently, the use of appropriate and varied teaching methods, e.g. integrating real-life problem situations through daily life context based didactic games into the mathematics learning process becomes important. Daily life context based didactic games provide more realistic understanding of everyday situations and examples that lead to more effective and meaningful learning of mathematics. The aim of the research is to investigate and clarify the importance of integrating real-life problem situations through daily life context based didactic games in mathematics learning to improve mathematical competence. Theoretical research methods and empirical research methods (student surveys and teacher interviews), data processing and analysis methods (quantitative, graphical data representation, data analysis) are used in the research. The analysis of the student questionnaire highlights that students do not understand the importance of mathematics in everyday life as well as have difficulties explaining the meaning of mathematical competence. While teacher interviews reveal teachers' opinions about the problems of mathematics in everyday life and the possibility of using mathematics to solve everyday problems.*

Keywords: *daily life context based didactic games, mathematics, student, real-life problem situations, problem-solving skills, mathematical competence*

To cite this article:

Gretčina, I. & Ročāne, M. (2024). Daily Life Context Based Didactic Games in Mathematics Lessons to Develop Mathematical Competence. *Education. Innovation. Diversity*, 1(8), 54 - 61. DOI: <https://doi.org/10.17770/eid2024.1.7938>

Introduction

Integrating real-life problem situations through daily life context based didactic games into learning mathematics has become a topical issue nowadays. There is the a necessity to focus on problem-based situations that occur in the student's life in learning process. This also applies to mathematical concepts as understanding and solving problems is based on the awareness of their relevance in personal life (Cotič, Cotič, Felda, & Krmac, 2021).

A lack of connection between mathematics content and real life is one of the main barriers for learning mathematics. This is a reason why students often lose interest in learning mathematics already in the first grades (Brīvība-Dzenuška, 2018). The need to reduce mathematical anxiety and foster positive attitudes towards mathematics can also be highlighted. Mathematics anxiety and the lack of a positive attitude towards mathematics often become the reasons why students do not choose to study mathematics in depth in secondary school (Levine & Pantoja, 2021). Mathematical anxiety can become topical during the transition from the primary education and lower secondary education. Therefore, teenagers are experiencing mathematical anxiety quite often. Mathematical anxiety can be alleviated by students' confidence in their mathematical abilities, as well as by the realisation that mathematics is not too difficult and complex to be used in real-life situations, but it is personally meaningful for each student and linked with real-life. This is a reason, why it is

important for teachers to develop strategies to reduce mathematical anxiety and its consequences (Levine & Pantoja, 2021).

Mathematical competence is recognised in the European Union as one of the key competences needed for personal fulfilment, active participation in civic, social life and successful careers in the 21st century knowledge society (Eurydice, 2012).

By integrating real-life problem situations through daily life context based didactic games students develop mathematical competence, which is necessary in personal life and professional career. Ojose (2011) emphasises that "mathematical literacy is necessary for both: work and everyday life. It is one of the keys to coping with a changing society" (Ojose, 2011, p. 91).

The current research focuses on acquisition of mathematics in lower secondary phase of education, highlighting the necessity of continuation of the implementation of didactic games in the learning process, particularly in the process of learning mathematics.

There are quantitative research methods used in the research: students' survey and structured interviews of teachers with open-ended questions. The gathered data have been analysed, graphically presented, and compared.

The aim of the research is to investigate and clarify the importance of integrating real-life problem situations through daily life context based didactic games in learning the process of mathematics to improve mathematical competence. The aim highlights "concrete relationships between variables", which is consistent with a quantitative research strategy and a correlational design (Pipere, 2016, 107). Therefore, the questionnaire was designed to obtain quantitative data "that can describe, for example, the performance of individuals" (Pipere, 2016, 112). Semi-structured interview was implemented within the research as well.

The aspects of the learning outcomes in mathematics

The aim of the implementation of the content of basic education is a comprehensively developed and proficient student who is interested in his/her intellectual, social-emotional and physical development; lives a healthy and safe life; learns with pleasure and interest; is a socially responsible citizen, who takes initiative and is a patriot of Latvia (Valsts izglītības satura centrs, 2023). It is important to be able to apply the learning outcomes in a specific context, such as education, work, personal or social life. A unifying aspect in the formulation of learning outcomes in all mathematics subject areas is the application of mathematics in the real life, which includes problem solving (Valsts izglītības satura centrs, 2023).

The learning outcomes in mathematics can be described by their complexity.

Mathematical knowledge and skills involves the ability to consciously perform a given operation on the basis of acquired knowledge (Dukurs & Mencis, 1984); understanding of how to apply mathematical knowledge in the real life, as well as transversal skills and value-based habits (Skola2030, 2020); purposeful and successful performance of mathematical operations using rational techniques (Helmane, 2006), and the ability to determine the values of unknown terms in equations and other skills. Metacognition, which includes knowledge about particular topic and regulation of cognition (Nelson & Narens 1994), becomes important as well.

Complexity of the learning outcomes, on the other hand, can be described by student's ability to apply knowledge, skills, and habits in a coordinated way in new and unusual situations. The learning of complex outcomes is demonstrated in action (Skola2030, 2020).

During the process of planning the content of mathematics, it is important to be aware of the interdisciplinarity between subjects. Teachers need to work closely together and develop a common curriculum. This can be done through teachers' collaboration with colleagues on the use of contexts relevant to other subject areas, so that students do not

subsequently develop misconceptions about what they are learning, which leads to transferring and applying of the acquired skills in mathematics to other contexts. Contexts from real life become a didactical tool in the process of learning mathematics. This gives a meaningful basis to the new mathematical concepts students learn (Cooper & Harries, 2002). Solving everyday problems develops transversal skills, e.g. self-direction and problem-solving. Despite the fact that the meaning of the word “problem” has a negative connotation, this word does not always represent something negative. Problems can refer to different situations, challenges, opportunities that often happen in everyday life, which tend to be positive and exciting, even though they may initially cause uncertainty and mathematical anxiety, which can be described by experiencing feelings of panic and helplessness in the situations when person is asked to do tasks, solve problems or just talk about mathematics (Tobias & Weissbrod, 1980). Thus, individual’s attitude towards the problem is the key to solving it.

Nugraheni & Marsigit (2021) highlight the need to develop realistic mathematics education and improve students' problem-solving skills, bringing the opportunities for students to construct their own understanding, while teacher's role is to guide students by giving direction. Using appropriate teaching materials and approaches, students are given the opportunity to think and solve different types of problems using mathematical knowledge. Students improve their problem-solving skills by thinking independently, analysing, and solving situations, thus, reaching learning goals. Teachers' knowledge, support and motivation are invaluable in helping students to find these solutions, it is important to guide students towards the desired outcome, with teachers' support students analyse contexts from daily life, including problem-situations and by applying mathematical knowledge will be able to find solutions more effectively.

Integrating real-life problem situations through daily life context based didactic games

The use of didactic games in learning mathematics provides solutions to real-life problems. Didactic games always have an educational goal (Hedegiš & Hus, 2020). They can be implemented at different stages of education. Integrating real-life problem situations through daily life context based didactic games can be characterised by the activities involved in solving a specific problem. Ability to apply mathematics in different daily life contexts is very important in mathematics education (Blum, Galbraith, Henn, & Niss, 2007). These games improve communication skills, thinking, creativity, etc., and promote the acquisition of new knowledge and experiences (Burtseva & Graznova, 2019). It is important to link didactic games with students' interests and learning needs. In the process of implementation of didactic games, students are not always aware of the results to be achieved, because the actions they take, and enthusiasm become more important. However, it should also be recognised that in real-life situations the result is not always known, it cannot always be predictable. Didactic games develop students' personality, communication, thinking, creativity, and ability to evaluate different situations and come to solutions. Didactic games develop transversal skills, which contributes to the application of mathematical skills in everyday life and solving everyday problem situations, resulting in the development of competences (Hamblin, 1986). It is important that such games give children the opportunity to be active and to find new solutions (Izglītības un zinātnes ministrija, 2020).

Nowadays games have become topical not only in preschool, but at different stages of life. People play games throughout their lives. Didactic games have cognitive, practical, emotional, motor, motivational, creative, fantasy, social, recreational, diagnostic and therapeutic aspects. Games can be individual, pair, small or larger group activities. There are clearly defined rules in the play. Games can focus on cooperation and/or competition (Vankúš, 2005). Vankúš (2012) emphasises that the regular use of didactic games contributes

to a positive emotional background and stress reduction in the learning process, thus, also reducing mathematical anxiety. Didactic games can be used in pedagogical work with students of different age groups (Ersen & Ergul, 2022). The didactic games are also influenced by the readiness of the students to engage in the game, as well as by the purpose of the particular lesson (Root, 1993).

Methodology

There are quantitative research methods used in the research: students' survey and structured interviews of teachers with open-ended questions. The gathered data have been analysed, graphically presented, and compared. Thus the mixed research has been implemented.

The aim of the research (to investigate and clarify the importance of integrating real-life problem situations through daily life context based didactic games in mathematics learning to improve mathematical competence) highlights "concrete relationships between variables", which is consistent with a quantitative research strategy" (Pipere, 2016, 107). Therefore, the questionnaire was designed to obtain quantitative data "that can describe, for example, the performance of individuals" (Pipere, 2016, 112).

Students who learn in grades 7-9 (N=106) in one school of Kurzeme (district in Latvia) are the target group of the survey. The master sample of the survey is 151 respondents. Thus, 70.1% of the general population participated in the survey. A representative sample can be considered to have been made. The survey was conducted online, but the interviews were face-to-face.

The aim of the survey is to analyse and describe respondents' experience of using daily life context problem situations in the process of learning mathematics at school. The master survey questions are about:

- 1) the importance of learning mathematics;
- 2) respondents' views on the relevance of learning mathematics to their personal life;
- 3) respondents' self-assessment of their mathematical competence;
- 4) respondents' views on didactic games and their use.

10-point Likert scale (ranging from 1 (not necessary) to 10 (very necessary)) was used in the survey.

10 teachers of mathematics from 5 different schools in Kurzeme participated in the interview. Their professional work experience is varying from 10 – 25 years.

Semi-structured interview was implemented within the research. This type of the interview was chosen because of the balance between a flexible structure and openness" (Pipere, 2016). The interview selected "participants with expertise on what is happening in an organisation, programme, interest group or in relation to an issue " (Pipere, 2016, 312).

The interview involved 10 primary school mathematics teachers from the 2 schools of the study - 2 schools in Kurzeme (all of them work in the lower secondary phase of education). The interview questions were:

- Do you implement real-life problem situations in mathematics lessons? and if yes, How do you implement real-life problem situations in mathematics lessons?
- Do your students understand the importance of solving real-life problem situations in mathematics lessons?
- Does the use of real-life problem situations in mathematics help your students to learn mathematics?
- How can the use of real-life situations in mathematics learning contribute to the development of students' mathematical competence?
- Do you use daily life context based didactic games in mathematics learning?

- Do daily life context based didactic games help your students to acquire mathematical knowledge, skills and competences more successfully?

Empirical research on the application of daily life context based didactic games in learning mathematics: analysis of teachers` interviews

Interviews with teachers of mathematics reveal a lack of students` understanding of opportunities to link mathematics with real-life contexts. Teachers highlight that more often students` opinion about mathematics is only as about “numbers, equations and theory”, not as the opportunity to apply knowledge and skills gained in mathematics lessons in the real life. Teachers emphasize that in general students do not think about the connections between real life and mathematics on a daily basis: they are just doing the tasks and “thinking about upcoming test”. Teachers also recognise that students` understanding of application of knowledge gained in the lessons of mathematics and particularly in solving the real-life problem situations in the context of mathematics depends on the values of education, the importance of mathematics in the family and students` self-directed learning skills. Another important aspect highlighted by teachers is that students not always see the connections between real life and mathematics, as a significant number of everyday problems, which would require mathematical knowledge and skills nowadays, quite often are solved by smart devices and artificial intelligence.

Respondents admit that the most common situations where students need to apply their mathematical knowledge and skills are everyday situations in which money is involved.

However, teachers also say that their students have interest in real-life situations where they can apply mathematical knowledge and skills.

9 out of 10 teachers say that applying daily life context, including problem-solving, based didactic games in the lessons of mathematics helps students learn more effectively, which gives them the opportunity to understand how to apply mathematics in real life. Respondents admit that it is easier for students to learn if they see the connection between mathematics and their real-life experiences. They also stress that daily life context, including problem-solving, based didactic games in mathematics should be offered to students on a regular basis from pre-primary school onwards, so that students develop critical thinking and are able to act in different situations, recognizing connections that help them to fully evaluate and resolve the situation. Teachers stress that considerable effort is needed to teach students to think, do reasoning, analyse, ask questions. The teachers also highlight that solving real-life problem situations in mathematics promotes logical thinking and motivates students to learn. Teachers emphasise that they often apply real-life problem solving to text tasks and tasks on interest to solve problems about prices, various everyday bills, cooking activities, travelling, repairing, tasks about speed, time, distance, which are everyday mathematical contexts, as well as to geometry, to calculations of areas and volumes of shapes.

The interviewed teachers also believe that it is very important to use mathematical knowledge outside the classroom in real life. However, teachers say that they rarely implement didactic games in lessons of mathematics.

Empirical research on the application of daily life context based didactic games in learning mathematics: survey analysis

The questionnaire was sent to 134 students, however, 106 respondents completed a survey. Thus, convenience sampling can be considered to have been implemented.

79.2% of the respondents said that it is important for them to acquire mathematical knowledge because they think mathematics will be useful for their future success in life and

for their future career choice. On the other hand, 20.8% of the respondents answered that it is not important for them to learn mathematics because they have negative attitude towards mathematics and they have poor results in in this subject as well.

When rating the need to study mathematics on a scale from 1 (mathematics is not important in solving real-life problems) to 10 (mathematics is very important in solving real-life problems). About 27% of the respondents consider mathematics to be only partly related to real life and only 13.3 % of respondents have rated the importance of mathematics from 8-10 (see Figure 1). Thus, the results of the survey highlight the lack of students` understanding of applying the knowledge and skills acquired in mathematics to the real life.

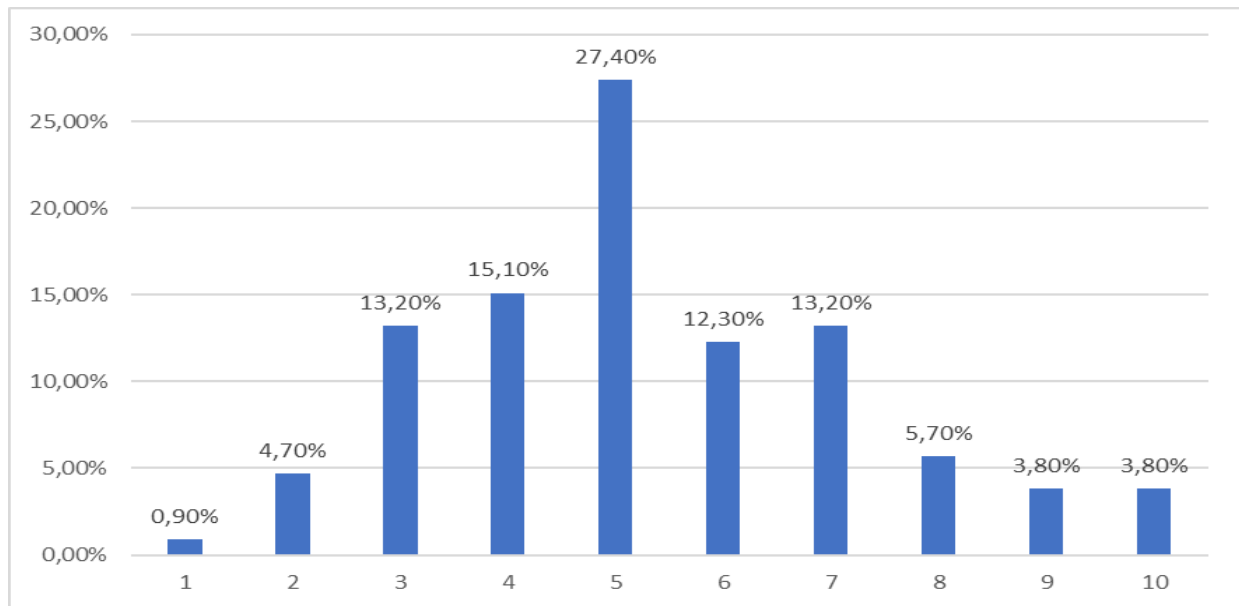


Figure 1 Students` understanding of applying the knowledge and skills acquired in mathematics to the real life

When asked about the impact of mathematics in solving real-life problems, 31.1% of the respondents admit that mathematics helps them in solving real-life problems, stressing that they solve such situations regularly and the lessons of mathematics are important for it. 68.9% of the respondents highlight that knowledge and skills gained in the lessons of mathematics could be useful in solving such situations in future. When referring to specific real-life problems, respondents mentioned “calculating wall and floor space”, “quantities of products needed for cooking”, “prices and discounts in shops”, etc. There are also answers in which students mention calculations involving money, calculating interest and calculating time.

When asked about the use of games in the learning process, 13.2% of the respondents answered that they are involved in playing specific games in mathematics lessons, while 86.8% answered that they do not play games in mathematics lessons. The most frequent games mentioned by respondents in mathematics lessons are implemented using *Kahoot* or *Quizziz* apps.

Conclusions

Mathematical competence becomes important for both work and everyday life as it is one of the key competences for a life in a changing society. A lack of connection between mathematics content and real life as well as mathematical anxiety, which become topical

during the transition from the primary education and lower secondary education; the lack of a positive attitude towards mathematics become the reasons why students quite often lose their interest in studying mathematics. Therefore, the necessity to focus on problem-based situations in the learning process of mathematics has been highlighted by scholars and the contexts from daily life and real-life problem situations, as well as strategies to reduce mathematical anxiety and its consequences become a topical issue nowadays.

The learning outcomes in mathematics can be described by their complexity: mathematical knowledge and skills, understanding of how to apply mathematical knowledge in real life and ability to apply them in unknown real-life situations.

Nowadays games have become topical not only in preschool, but at different stages of life, because the development of digital technologies encourage people to play games throughout their lives. Didactic games can be used in pedagogical work with students of different age groups. Students are not always aware of the results to be achieved in the process of implementation of didactic games. The reason for this is the bigger emphasis put on enthusiasm and positive emotions during the game. It must be admitted that in real-life situations the result is also not always known and cannot always be predictable.

Didactic games develop students' personality, communication, thinking, creativity, transversal skills and ability to evaluate different situations and come to solutions. They give students the opportunity to be active and to find new solutions.

However, the readiness of the students to engage in the game becomes important.

Empirical research highlights that students do not always understand the opportunities to use mathematics in real-life situations. Students also have difficulties in relating mathematics to real-life situations. This creates a gap between theoretical and practical mathematical understanding of everyday situations. The use of modern didactic games and the implementation of real-life tasks in mathematics lessons, e.g. solving problems related to everyday life situations, is becoming an issue.

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