

CRITICAL THINKING IN LEARNING PROCESS OF MATH IN GRADES 5-6 IN LATVIA

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Abstract

The study was carried out to investigate the ability of students in grades 5-6 to think critically and creatively, analyse, evaluate and reason when solving mathematics problems, contributing to the dynamics of learning outcomes. To develop mathematics tasks and suggestions for their design to improve critical and creative thinking skills. To develop support material and recommendations for teachers to implement critical thinking skills in solving mathematics tasks. Theoretical research on critical thinking is summarised, and a brief look at the history of the Latvian education system is given. Methods and approaches for the implementation of critical thinking in schools are summarised, based on the materials of the Latvian education reform and the latest scientific knowledge in modern pedagogy. The use of critical thinking tasks in mathematics for pupils in grades 5-6 is analysed and the results of the study are summarised. Research methods: analysis of scientific literature and documents, observation, survey and interviews. Results of the study: recommendations for teachers on the use of tasks that improve the critical thinking skills of pupils in grades 5-6. Applicability of the work: development of a support material for teachers to improve critical thinking and creativity skills in mathematics of pupils in grades 5-6. The material consists of sample tasks and methodological suggestions on how to modify the tasks found in pupils' textbooks so that they require critical thinking, reasoning and analysis from pupils.

Keywords: *Critical thinking, analysis, competence, judgement, evaluation.*

1. Introduction

The topic of this study is "Developing critical thinking in 5th-6th grade pupils in mathematics lessons in Latvia". The topic was chosen on the basis of the author's experience of working in schools for more than 30 years, teaching mathematics and being actively involved in the approbation of the new competency-based curriculum of the educational reform in Latvia.

Today's education focuses on the development of a wide range of skills, but one of the most fundamental is to reason, think, evaluate critically and make decisions. The changes in pedagogy and teaching methods that are currently taking place in the world and in Latvia mark a shift from the acquisition of knowledge and the "hammering out of facts" to the acquisition and development of competences that are strategically needed in the 21st century. Through various projects, teachers learn practical methods and real-life examples of how to design learning tasks so that students can purposefully develop the skills that are so relevant today and, more importantly, know how to apply them. Currently, Latvian students are generally good at tasks that require them to remember or act in familiar situations, but they lack the skills and experience to delve into and process diverse data, work in teams, propose solutions to non-standard situations, make connections between what they have learned in theory and what they have experienced in real life, analyse what they have done and set goals for future work. Students lack the skills to implement their ideas in new circumstances. The author's research has shown that the development of critical thinking skills cannot be studied in isolation from other skills. Perceptual skills play a special role in a student's growth, helping to retain knowledge in different contexts through different ways of thinking and self-directed learning, reinforcing its connection to personal experience. Students develop skills that are used in different learning domains and are able to solve a problem independently.

According to the National Centre for Education, Grade 9 pupils are able to complete half of the tasks correctly. In the last three years (2017-2019), the percentage of completed tasks is 58%, 54% and 56%. The author wants to investigate the reasons why students avoid solving text-based tasks and work in everyday life at school, to conduct research on how students can improve their academic performance by developing critical thinking skills.

Aim of the study: to investigate the skills of pupils in grades 5-6 to think critically and creatively, analyse, evaluate, justify when solving mathematics problems, promoting the dynamics of pupils' mathematics learning achievements and to develop a set of tasks and recommendations for the design of tasks to strengthen these skills.

Research base: 103 students and 3 teachers in grades 5-6 at School X.

2. Theoretical characteristics of critical thinking

The ideas of critical thinking date back to the 18th-19th centuries and many philosophers and educators have been working on it. In the 18th century, The Enlightenment theorised that a rational, enlightened person would be able to solve all the problems of his life and would create opportunities for the moral growth and economic development of humanity. (Rubene, 2008) The idea of social progress based on the use of critical reason, unrestricted faith in the possibilities of the developing mind, was emphasised.

Z. Rubene (2008) analysed the insights of various authors: Emanuel Kant believed that the main goal of critical thinking in moral education is to develop the faculties of the mind that would cultivate spiritual maturity and he was joined by J.F. Herbart in linking the basic principles of transcendental critique of the mind with the ordering of the contradictory experience of learning processes - the formation of self-responsible action as the goal of pedagogical activity. P. Notorps also puts forward the idea of using critical reasoning in social and pedagogical practice (Rubene, 2009).

From a learning perspective, critical thinking is characterised by reasoned, purposeful judgement and the use of cognitive strategies and skills that increase the reliability of the result obtained from the thinking activity. It can be developed through specific learning and applied in a wide variety of situations.

One of the pressing problems in contemporary pedagogy is to clarify the possibilities of developing critical thinking. Critical thinking is a concept in Latvian pedagogy that is the subject of much debate. It has involved both the part of the Latvian society connected with the theory and practice of pedagogy that supports the introduction of critical thinking into schools and the part that believes that this pedagogical model has been exported from America and is rather sceptical about the possibilities of its adaptation in Latvia. However, despite the polarisation of opinions, since the 1920s, the European Union has been the most active in the field of critical thinking. Critical thinking has been an important phenomenon in pedagogical practice in Latvia since the mid-1990s.

3. Key ideas and objectives of competence education in mathematics in Latvia

Critical thinking can be developed through moderate learning and through independent reflection on one's own work, by analysing mistakes and setting new goals, by analysing one's own experiences, the student develops critical reasoning. During lessons, the author has observed, the teacher does not always have enough time for feedback, but this is of great importance for the pupil's further development. Critical thinking is a question-oriented way of thinking where students are encouraged to think and express themselves critically. Critical thinking helps to develop decision-making and problem-solving skills. (Explanatory Dictionary of Educational Terms, 2000)

Latvia's schools are rapidly introducing new key ideas of competence education, which focus on the dynamics of student achievement, self-growth and self-fulfilment. Everything is being done to ensure that our schools produce young citizens who can not only adapt to the new demands of life, but also create new added values.

In the daily work of teachers, it is important to find a methodology that helps the pupil to develop. The basic aim of the process is to create the conditions to develop the ability to think critically. The teacher's task is to observe a number of conditions that help the pupil to develop the basic skills of critical thinking.

The method of critical inquiry helps students to tune their own minds to a particular scientific system. The critical method is a rule of thought that can only be obeyed by willingly accepting it. According to S. Hessen (cited in Rubene, 2009), it is not possible to assess whether a pupil has mastered the critical method either by questioning him or by asking him to solve one or more problems. (Rubene, 2009) Each subject uses the method in a unique way, discovering new features. To master the scientific method of thinking means to use it to solve a wide variety of questions, to be able to access new knowledge oneself. In the critical thinking approach, the key element of pupils' work is the performance of cognitive tasks, i.e. the acquisition and development of thinking activities. In parallel, the pupil develops his/her own system of attitudes, orientations and values. This is a huge body of skills and knowledge for which it is very difficult to find evaluation criteria.

Only through independent learning, independent reflection on one's own experience, can one develop critical reasoning skills; only by oneself can one learn to think critically (Rubene, 2008).

4. Analysis and data processing

To investigate how critical thinking tasks contribute to students' academic achievement, a study was carried out in primary mathematics classes at School X. The author conducted the study in grades 5-6 and collaborated with mathematics teachers at School X. Most of the research was carried out in the author's classroom, where mathematics is also taught. Daily life with these pupils and several mathematics lessons per week made it possible to carry out the study by observing the pupils in different situations and to see the realisation of each day's outcome and the dynamics of pupils' growth.

Participants were selected to include pupils in Year 5 who are in Year 6. The teachers involved in the study are mathematics teachers of the respective grades.

The research base was variable, as the diagnosis was carried out in all four classrooms, the observation and the task validation in one classroom, where the author works.

The work will lead to the development of support material for teachers to improve students' critical thinking skills in mathematics lessons for pupils in grades 5-6. The material will include sample tasks and methodological suggestions on how to modify the tasks in textbooks to engage students in critical thinking, reasoning, analysing, evaluating. In order to achieve the objective of the work, a set of activities is required. The author gained new theoretical insights from the research, which she used in her daily work at school, teaching mathematics to 5th and 6th grade students. The research was planned in stages and analysed.

Stage 1 - observation, document study and analysis, diagnostic work 1 in grades 5. While working in mathematics class 5b at school X, the author carried out research and observation of pupils. In her daily work it is important to understand the abilities, skills and knowledge of each pupil. An observation sheet was used for the observation.

The diagnostic work was prepared for all 5th grades of School X. A group of experts worked on the preparation of the work. The distribution of tasks was aimed at testing students' basic skills to see how well they have mastered the mathematics curriculum in Grades 1-4. After the test, an analysis of pupils' achievements by year group was carried out. The mathematics teachers at X School evaluated the pupils' work and organised the follow-up work according to the assessment of each class.

Stage 2 - observation, document research, task preparation. The author carried out observation in the classroom throughout the school year and used various critical thinking tasks, jigsaw tasks, open-ended tasks in her daily work.

Stage 3 - observation, document analysis, task preparation and validation, diagnostic work 2. Working with the class already in the 6th grade programme, the author continued the observation and used different types of tasks in the lessons, including for the development of critical thinking skills. Tasks requiring students' experience, ability to reason, explain, evaluate increased from 10% to 25%.

Seeing the big differences in the students' growth dynamics, the author was very interested to find out whether Teachers A and B worked on critical thinking or open-ended tasks.

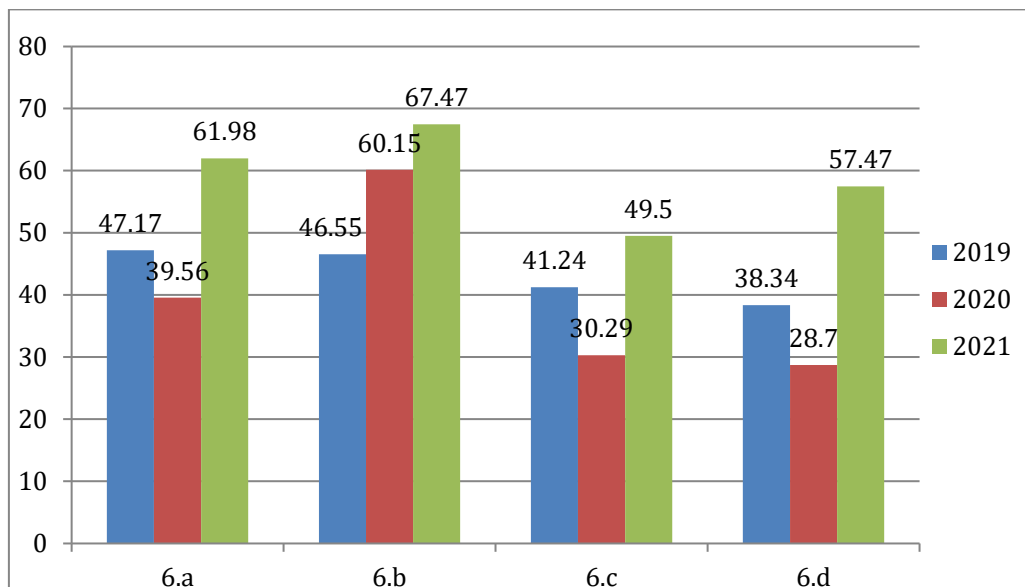
In the questionnaire, both colleagues wrote that lack of time and lack of materials in the teaching book, stressing that recently the situation is improving, in the Skola2030 materials you can find ideas, especially in the 4th and 7th grade groups, that can be used also for 6th grade. The author proposed to use her ideas in 6th grades and to use them in her lessons, she shared her experience how to modify the tasks for everyday work in mathematics lessons. In the methodological sessions of the X school the author shared her experience with her colleagues, conducted master classes, open lessons.

Stage 4 - observation, document analysis, task preparation and validation, diagnostic work 3.

In Stage 4 of the study, special attention was paid to the validation of the tasks in Year 6, the cooperation and exchange of experience between teachers, and the evaluation of the monthly tests. During the lessons, the author continued to observe the pupils and found that they became more organised, self-disciplined, willing to engage in discussions, happy to collaborate in groups, work on research projects, understand the meaning of the outcomes, and create small descriptions of the outcomes. The dynamics of pupils' achievements can best be inferred from the 3rd diagnostic work.

Comparing the results of all classes, there was a dynamic change in students' knowledge and skills.

Figure 1. Results of diagnostic work in grades 6 (percentage).



Comparing the dynamics of class achievement, we can see that the dynamics of class b is grade-low. In other classes, the results improved after the 2nd diagnostic work, when teachers also used more tasks requiring critical thinking in their work. The author interviewed both colleagues and verified that the exchange of experience and the use of tasks had produced obvious results. As one of the results of effective work, the colleagues highlighted the collaboration and development of a common methodology, the variety of tasks and the use of digital tools in distance learning.

Stage 5 - surveys, interviews, data collection.

After working for two years with class 6b, observing and analysing the tests, studying the tasks in the textbooks, the author came to the conclusion that the usual style of work in the classroom had to change, but first, the whole concept of assessment had to change.

The results of the diagnostic tests show that there is a dynamic change in pupils' achievements in all grades. Ideally, all these diagnostic exercises would be based on the same algorithm and prepared by the same team. Nevertheless, it is possible to conclude that the results of class 6b are more independent, as there is growth in the tasks that require evaluation, justification and explanation. In the other classes, the results in diagnostic work 2 are much lower. Teachers also admit that they have had little time to work on open-ended or higher-level tasks in lessons. The mathematics teachers at School X analysed each piece of work and teachers made adjustments to their work and chose more critical thinking tasks in lessons.

5. Basic principles of task design for promoting critical thinking and creativity in mathematics lessons for pupils in Years 5-6

When preparing the tasks for mathematics lessons, the author followed some basic rules on how to work with students on critical thinking tasks:

1. More time should be allowed for solving the problems, so that the pupil can think and look for solutions without anxiety.
2. Choose tasks that do not have a single solution so that there are more options and possibilities.
3. Not to give an algorithm for solving the problem, so that each pupil chooses his/her own strategy.
4. Schedule time for students' questions, discussions, exchanges of ideas.
5. Use diagrams, models to solve problems.
6. Use a variety of methods to solve the problems, create interest and try to keep it up until the problem is solved and even continue it in the next lesson or at home.
7. To provide reflection during the problem-solving process, the pupil must see his/her own mistakes and try to eliminate them.

It is very important to understand that when solving critical thinking tasks, everyone has the right to choose his/her own method of solving, based on the skills and knowledge of each student. But these skills and knowledge must grow and develop by doing, by exploring, by making mistakes, by seeking

answers to one's own questions. The teacher must have a special tolerance when dealing with such tasks and be able to motivate the pupil in order to strengthen his/her self-confidence and personal development.

After working for two years with class 6b, observing and analysing the tests, studying the tasks in the textbooks, the author came to the conclusion that the usual style of work in the classroom had to change, but first the whole concept of assessment had to change. There are high expectations for competence education, where the learner and his/her development are at the centre. It is important that the very idea - the teacher as counsellor and the pupil as a growing person, ready for life's challenges, able to solve problems and create new values - is not lost under the pretty words.

By observing the pupils, the author saw how the cooperation of the pupils in the classroom changes, how the pupils become more open. At the beginning of the study, pupils were reluctant to answer questions, afraid of making mistakes, unwilling to justify their answers, the shyest ones generally tried to keep quiet. After regular work, the classroom situation has changed dramatically. Pupils are eager to ask questions, express their opinions, even argue to prove they are right. This gives the teacher enormous satisfaction and the pupils' self-confidence and self-esteem grow.

6. Conclusions

1. Critical thinking tasks, which require students to find answers to questions, deal with unusual situations, reason, investigate, analyse and evaluate, have not been sufficiently explored in the context of mathematics learning in schools. Each teacher works within the limits of his/her enthusiasm and abilities. The author's research has shown that this type of tasks will contribute to the dynamics of pupils' achievement.

2. Critical thinking tasks should be included in the curriculum and regularly used in lessons to develop students' skills - to analyse, discuss, select information, use prior knowledge, express their opinions. These types of tasks help pupils to socialise, increase self-confidence and self-esteem.

3. Regular critical thinking tasks in mathematics lessons improve pupils' knowledge, skills and grades, and there is a clear dynamic.

4. For mathematics teachers in grades 5-6, there are few critical thinking tasks in the textbooks, but there are opportunities for teachers to modify and extend the tasks in the books to create higher-level tasks. The modification of tasks uses critical thinking questions and the basic principles of taxonomy or descriptions of levels of learning.

7. Recommendations

1. To include at least once a week critical thinking tasks in the planning of mathematics lessons for pupils in Years 5-6.

2. When assessing critical thinking in tests, it is recommended that pupils answer orally or record their answers using digital tools.

3. In the 5-6th grade group, use the 4th and 7th grade maths tasks developed by the Skola2030 project, or use the ideas and guidelines offered there.

4. Use the principles of taxonomy of learning objectives, descriptions of learning levels, critical thinking questions, own creativity and students' abilities when modifying tasks from textbooks.

5. In mathematics lessons, give students the opportunity to talk, discuss, ask questions and express their opinions. Teachers should encourage pupils to speak freely, to make mistakes and to correct them.

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