

# Making It Count: Strategies for Improving Problem-Solving Skills in Mathematics for Students and Teachers' Classroom Management

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## ABSTRACT

Understanding a problem is as important as solving it to understand the meaning of mathematics. It is a widespread view that problem-solving skills help individuals to overcome the problems easily in their daily lives. An individual with problem-solving skills is a self-confident, creative and independent thinker. It can be explicable that the societies formed by these individuals can easily solve the problems. In this vein, this study is aimed to determine the relationship between the acquisition of problem-solving skills that play an important role in mathematics alongside two dimensions of classroom management which are time management and plan-program management. It is thought that there is a close relationship between these two dimensions; problem-solving skills. The types of problems are divided into two; routine and non-routine. The aim is to get opinions about how these problems will be taught by mathematics teachers, at what level they will be used in class and what methods they will use for them. The study was conducted by doing a content analysis of qualitative research methods. The sample group which is randomly determined from five provinces of North Cyprus is composed of mathematics teachers who teach at the 9th grade level. The data was collected through semi-structured interview forms. Content analysis technique was used in the evaluation of the obtained data. As a result, it was found out that the mathematics teachers who work in the Ministry of National Education and teach at the 9th grade, have been given importance to problem-solving skills such as, problem-solving duration and problem-solving methods in their classes. In addition, the teachers pointed out that the time given is not sufficient at schools and they could not give enough importance to plan-program activities. They also pointed out that although the annual and monthly plans specified by the Ministry, the desired variety of questions could not be provided by different methods.

**Keywords:** problem-solving skills, non-routine problems, classroom management, time management, management of plan program activities

## INTRODUCTION

Problem-solving in mathematics is known to have an important place in classroom management. Having considered the problems that emerge in our daily lives are a kind of problem, and problem-solving skills enable individuals to overcome these kinds of problems. Therefore, problem-solving skills, which have an important place not only in mathematics but also in our real life, should be turned into one of the 21st century teaching methods (Ocak & Eğmir, 2014).

As a result of the literature review, the problem types used in mathematics are divided into two groups as routine and non-routine problems. The routine problems are those that are found in textbooks, the four operations are sufficient in order to be solved and that are solved in the same way by using the previously known formulas (Polya, 2014; Van de Walle, Karp, & Bay-Williams, 2013). Non-routine problems are those that are encountered

#### Contribution of this paper to the literature

- Gaining the ability to solve problems is closely associated with the effective management of time.
- Plan-program activities have a great importance at the usage of activities which will be implemented for gaining the ability to solve problems.
- Teachers' views for problem types which are not routine and have a great role at gaining the ability to solve problems.

mostly in real life, which do not have specific formulas that can be solved by using different strategies and categorization requiring creative thinking skills (Memnun, 2015).

An individual with problem-solving skills grows up as a self-confident individual who can think creatively and independently (Güneri Yöyen, Azaklı, Üney, & Demirci, 2017). Therefore, it can be said that individuals are able to overcome any problems easily that will arise against a society formed by individuals who have grown up in this way. Particularly in the mathematics education and teaching that will be implemented by adopting the constructivist learning approach, the aim should be raising individuals who develop problem-solving, creative and reasoning skills instead of a memorizing system. In this context, it will be possible to improve the independent thinking and creativity of individuals by paying attention to the fact that the non-routine problems, that is, the kind of problems that come to our minds in our daily life, are provided more.

In fact, non-routine problems allow individuals to think, perform reasoning, and use a mathematical language (Altun, 2005). Unfortunately, in the conducted literature review, it was concluded that the teachers did not include non-routine problems which allowed the students to analyze the problems in the classroom, to make judgements and to produce alternative ways (Işık & Kar, 2011). On the other hand, it is also important for individuals to have high-level thinking skills in order to solve non-routine problems. This is not only a case of non-routine problems, but also the expected level of metacognition that students have as one of the important factors in the teaching of problem-solving skills. The level of metacognition that individuals possess plays an important role in helping the individual to cope with problems, to think flexibly, and to assist individuals in the selection of strategies (Ormrod, 2003).

Oğuz (2008) stated that high-level thinking skills can be encouraged in the educational settings by the constructivist approach which is knowledge and learning theory (Çandar & Şahin, 2013). It was observed that the high-level thinking skills, which have not yet been described, were mentioned by Zoller (1995) and an arrangement should have been made that would draw attention to the necessity of these skills can be built on the old information that could ask questions, create, analyze and make evaluations.

The acquisition of high-level thinking skills is possible only through the development of mental skills. In the context of high-level thinking skills, the steps of analysis, synthesis and evaluation that are determined in Bloom Taxonomy are closely related to thinking, questioning, analyzing and evaluating. They can be achieved through critical thinking, questioning, analyzing and creative thinking and therefore mental operations and effective use of information (Krathworld, 2002). Similarly, in Lester (2013), attention was drawn to the need for high-level thinking skills to be linked to students' reasoning before the implementation of strategies to solve non-routine problems. In this context, teachers need to prepare a course content that will provide the thinking process in order to acquire high-level thinking skills. While preparing a lesson content, they should also be careful to use the clusters that students will meet for the first time to make them think from an easy level to a difficult level. Even the problems in the exam questions that will be prepared using such clusters will give students the opportunity to think creatively and critically while analyzing them (Demirel & Yağmur, 2017). Mogari and Chirove (2017), addressed the need for students to be exposed to questions in order to develop their ability to solve non-routine problems in their work. They also pointed out that with these kinds of questions students will be aware of the level of their strategies to solve problems and help them understand.

Identifying the types of questions, which are mostly challenged by the students and have been supporting them to come from above, will show their positive attitude towards mathematics and provide them with confidence in the field of mathematics by the teachers' addressing to the different problems of the individual's lives as much as possible (Aydoğdu & Ayaz, 2008).

For this reason, teachers also have great responsibilities. In this regard, Polya (1973) has contributed the field in order to help teachers and revealed the 5 steps that should be followed while solving problems. Attention has been first drawn to the necessity of collecting the data, getting to the root of the problem and planning while following these steps. In the implementation of this, the teachers should emphasize that it is necessary to progress in the steps of understanding path-way, modelling, verifying and expanding respectively.

Having considered the solution of problems, it is seen that there is no single rule to be applied for each problem (Altun, 2005). In particular, Polya (1973) stated that, four stages of problem-solving process, which are

understanding the problem, making a strategic choice about the solution, applying the selected strategy and evaluating the solution, are necessary. On the other hand, only the individuals who can do this process can gain problem-solving skills.

One of the most important factors of solving a problem, as Polya mentioned, is to determine the appropriate strategy. Having reviewed the studies in the literature, it has been seen that among the most problematic problem-solving strategies are controlled by estimation, systematic list, finding correlations, drawing diagrams, writing equations or inequalities, making use of solutions of similar problems easily with retrospecting and judging by making tables (Ersoy & Güner, 2014).

In this respect, it is seen that dealing with cognitive, emotional and mental skills in problem-solving is emphasized in order to determine the most appropriate strategy and gathering the information about the problems are necessary (Tüysüz, 2013; Stevens, 1998).

In addition, cognitive domain theoreticians emphasize the importance of concept and meaning in order to solve the problem and demonstrate that a permanent learning can be possible by using the conceptual knowledge together with the operational knowledge (Baki, 1998).

However, studies have revealed that the teachers can only perform knowledge, comprehension and application in the first three steps of the cognitive domain by using traditional methods of analysis, synthesis and evaluation, which require high-level thinking skills, have not been carried out (Aydin & Yılmaz, 2010).

Basic methods determined in a standard format are used in problem-solving at schools. However, individuals, who are raised in order to make right decisions quick for the adaptation to the changing age, should be taught to find solutions not only with an ordinary way but also with different ways. At this point, the students will be able to establish problems and put effort in order to solve these problems, which will help them to improve their relevant skills (Korkmaz, Gür, & Ersoy, 2004).

Since it is not possible to learn knowledge rapidly in today's world, it will be adequate for the teachers to assume a guiding role for learning at this point. On the other hand, teachers must have a profession of the classroom management skills for permanent and effective mathematics education in acquiring problem-solving skills (Karaman, 2016). In the process of achieving the goal by determining the positive and productive learning boundaries in classroom management, attention should be paid to the continuous motivation in the classroom, establishment of a trustworthy environment, improvement of the students' responsibilities and regulation of their behaviours. With that included, an effective classroom management will be provided by enabling the students to control their behaviours by creating their own learning environment (Karip, 2017).

It should also be remembered that class management is shaped by the dimensions that are categorized underneath. These dimensions consist of five subheadings: the physical environment of the class, the planning activities, the time, classroom relationship and behaviour management (Karaman, 2016). The program effectiveness and time management dimensions is considered to be related to problem-solving skills which has been discussed in this study.

Instructional planning can be defined as a complex process in which teachers have to present different information for instruction according to the plan (Leinhardt & Greeno, 1986).

It can be said that the dimension of managing the program effectiveness is taken either in the form of management or in the form of instructional planning in different research. The dimension of program management discusses annual, monthly, weekly and daily course timetables. The levels of readiness, development and student levels are taken into account while preparing these timetables. In this dimension of classroom management, attention is drawn particularly to the participation of the students in the classroom, to the well-planned teaching and to the profession of the teachers in terms of relevant skills. Classroom management is crucial for the teachers as good leaders in designing the necessary information to be taught in a way that it will not be used only in class but also outside the classroom (Çelik, 2012).

One can assume that the main problems emerging in the class are the lack of time management and well-planned instruction. Nevertheless, it should be paid attention to ensure that the teachers establish a common goal, determine assessment and evaluation levels in the planning and programming of teaching, and provide feedback about the students' level of readiness. During the detailed arrangement of the plans, the students' requests and concerns should also be taken into account (Dinçer & Yeşilpınar-Uyar, 2015).

In mathematical planning, it can be said that the teachers have to develop different solutions for each problem by researching the problems related to the subject in the course of the lesson, and designing the answers they will give as well as providing the necessary materials in response to the answers given by the students. It can also be thought that, it will help to rearrange the teaching plan by taking back the planning during the implementation phase and by eliminating the deficiencies and mistakes.

Furthermore, it is believed that mathematical planning is important in the analysis of problems that students need to learn and achieve, which gives the main theme of study. In this context, it is expected to continue the lesson by starting the lesson with the information to be given about the targeted achievements of the lesson, specifying the relevant concepts to be learned for these goals, giving the possible suggestions considering the difficulties of the students and the misconceptions before starting the lesson (Güner & Akyüz, 2017).

Time can be regarded as an important process in the realization of the goals of the education and training process. Time management as another dimensions of classroom management is described as three phases: pre-class, in-class and post-class (Livatyalı, 2005). In this context, it is aimed that the pre-teaching phase of the course allows a teacher to prepare and investigate the course, to implement the preparation of the course progress and the development of different strategies, to use the post-course phase in order to use the acquired gains of individuals in the non-teaching environments and to spend this period effectively.

Since it is not enough to develop a plan on how to implement time management in the implementation phase, it is expected that the teachers will be prepared for any possible problems during the implementation of the plan and master the skills in order to solve the problems. In this context, time management, which is an effective one for problem-solving, allows the students to make effective and fast decisions, at the same time, effort should be put in order to use efficiently (Gözel, 2013).

In short, it is expected that from a teacher is to design the best way for starting and finishing the lesson, which methods to apply, which materials to choose, and how long the activities should take place. Having considered the individual differences, diversity should be achieved as a basic target (Gürkan et al., 2004).

Teachers are expected to develop the thinking approaches to help students for developing rules and strategies that can be expressed in formulas while teaching problem-solving (Soylu & Soylu, 2006). Thus, the students can learn how to integrate the conceptual and operational knowledge with new strategies in order to create new kinds of problems (Olkun & Toluk, 2004).

Therefore, when the individual is solving a problem, it is necessary to pay attention to presenting the alternative suggestions by understanding the problem cluster, choosing the data needed for the solution, making the appropriate plan, responding to the problem and controlling the correctness of this problem (Karataş & Güven 2003). In case students make mistakes, it is very important to explain and demonstrate students encourage to be voiced by the teacher that there is not a single method for every question, and to make them check their answers by offending them.

The development of the problem-solving process will enable individuals to gain both problem-solving skills and to have problem-solving approaches to the events surrounding individuals who have acquired problem-solving skills (Aydoğdu & Ayaz, 2008).

## METHOD

The study was conducted through a content analysis as a qualitative research method. Qualitative research is described by Creswell (2013) as the process which people in the social environment are asked to question by using special methods from their daily life.

### Research Group

The research group of the study consists of mathematics teachers teaching 9th grade high school students, who were randomly selected from five provinces. Taking into account the 9th grade high school level, which develops high level thinking skills necessary to solve problem as indicated by TIMSS' (2003), this study deals with the mathematics teachers who teach at 9th grade high school education. One of these teachers holds a PhD, one holds a postgraduate degree and three have undergraduate degrees.

### Data Collection Tool

The data were collected by using semi-structured interview forms. It is aimed with the meeting form to put forth how the process of solving problems should be, which methods are used by teachers at the point of gaining the ability to solve problems and what are the things which are given attention while using these methods. In this content, the purpose is to determine how the management is provided by teachers inside the classroom by taking the management of time and management of plan-program activities which is one of the class management and also a thought to be closely associated with abilities of problem-solving, into consideration at the process of implementation process.

## Data Analysis

Content analysis technique was used in the analysis of the obtained data. Content analysis is used in order to classify the collected data according to the meaning of the words and to transfer the desired message by creating themes (Martin, McCormack, Fitzsimons, & Spirig, 2014: 4).

In ensuring the reliability of content analysis, encoding has been carried out also by another colleague and two expert views have been compared. A compliance percentage between two coders used in content analysis which is more than 70%, is deemed as reliable for that study (Miles & Huberman, 1994). As a result of the compliance obtained, the percentage of intercoder reliability has been calculated as 80.4%.

## FINDINGS AND INTERPRETATIONS

The data obtained from the research were arranged in tables in the context of content analysis. Codes were determined and the themes were created with this table in order to provide a better understanding of the views of mathematics teachers teaching 9th grade high school students. While the themes represent the conceptualization of the general meaning of the questions in the semi-structured interview form, the themes were divided into 2 groups in the form of the *applications* in line with the opinions of the teachers and *suggestions* for the opinions of the teachers who did not give sufficient information about what they do to the class. The codes were discussed in the sense of conceptualization of the most repetitive opinions and the most representative of the given opinions.

As shown in **Table 1**, the views of the teachers on the applicability of non-routine problems, which are one of the problem types and which are not generally included in the curriculum, were addressed in the classroom. In terms of the obtained views, it was observed that only two teachers questioned why they could not include these types of questions although they wanted, and the other three teachers gave their suggestions regarding this issue. The teachers who wanted to include non-routine problems in the classroom indicated that they could not include them due to the curriculum density determined by the education system and to the crowded classrooms. Similarly, it was found out that their strategies for the applicability of non-routine problems were by drawing shapes, reasoning and simplifying the problem and the teachers, who constituted the study group of this study, did not adequately address the non-routine problems by putting forwards the excuses of the curriculum density or the crowded classrooms, and they only used the strategy of giving one example from the daily life for the simplification of problems. Durmaz and Altun (2014) emphasized that students have to be concerned about non-routine problems that require mathematical thinking, and that they are inadequate in skills such as flexible thinking and reasoning.

Similarly, Ulu, Tertemiz, and Peker (2016) revealed that the problems can be determined, the relationships can be recognized, and they can be adapted to real life by allowing the solution of non-routine problems. Two teachers stated that they could use routine problems in order to associate the solution with non-routine problems and the last teacher stated that applicability of non-routine problems can only be discussed by including examples that could encourage students to be productive.

In terms of the issues that need to be considered in problem-solving and the methods used, it is seen that the teachers stated the method they applied, but the other teachers did not give any opinion on this issue. One of the teachers who had given an opinion on which method she used, brought attention to the method used by the student with the question-answer method. It was seen that the teacher who used the method of discussion preferred to lead the students by using concrete examples. The situation that, two teachers who did not give views about the method which is used by them, help to teach steps for solving problems at understanding mathematical language and determination of the formula which will be implemented. It is seen that; one teacher has mentioned to the situation that a student should not only lead to usage of the mathematical language however student should also lead to find the shortest and the most sensible way with the purpose of providing the situation that students are careful at the process of solving problems.

In this regard, it has been seen that, in the study of Öksüz and Uca (2011), they discussed that a large amount of information on the problems was collected during problem-solving and it is possible to reach the results faster. In this study, which emphasizes the importance of the problem-solving process, it has been shown that students have different solutions for problems that do not have only a single solution and that attention is paid to the importance of collaborative learning and grouping in order to develop different strategies. Likewise, Gök and Erdoğan (2017) pointed out in their study that providing suitable environments with the formation of small groups of students and the ability to develop the skills needed to solve problems along with the necessary materials are required.

**Table 1.** Teacher views

Themes		Codes	f	%
Q1: Applicability of non-routine problems	Classroom applications	Inability to include these types of problems due to the curriculum intensity determined by the education system implemented in schools	1	20.0
		Inability to include these types of questions due to the crowdedness of the classrooms	1	20.0
	Suggestions	Using routine problems and associating them with non-routine problems may render solution finding more significant	2	40.0
		It can be said that non-routine problems can only be applied by giving examples that can encourage students to be productive	1	20.0
Q2: Issues to be considered in problem-solving	Classroom applications	Drawing attention to the method used by students while using the question-and-answer method implemented in the classroom	1	20.0
		Leading students by using discussion method and concrete examples	1	20.0
	Suggestions	Helping students to understand the mathematical language and then determine the formula to be applied may help student learn the steps of problem-solving	2	40.0
		Leading not only in the use of mathematical language but also in the shortest and logical way at the same time can be effective in the carefulness of the student in the problem-solving process	1	20.0
Q3: Leading individuals who make mistakes	Classroom applications	Leading and directing students to question in the classroom	2	40.0
		Supporting students to find their own mistakes themselves by asking questions	1	20.0
		Indicating mistakes clearly	1	20.0
		Helping students to understand questions again by using the mathematical language	1	20.0
Q4: The relationship between problem-solving skills and time management	Classroom applications	Effective and efficient use of time with the use of practical solutions to increase diversity	2	40.0
		Determining appropriate questions and solutions for the purpose of the problem in order to provide reinforcement	1	20.0
	Suggestions	Using time effectively and efficiently may contribute to completing the curriculum on time	1	20.0
		Teaching how to use the time effectively may increase the student success in terms of problem-solving skills.	1	20.0
Q5: The relationship between program management and problem-solving skills	Classroom applications	Using weekly plans by rearranging the previously prepared plans according to the follow-up and necessity	1	20.0
		Paying attention to the subject matter integrity while preparing the subject-based plans	1	20.0
	Suggestions	Preparing the plan can determine the right strategy and ensure that the curriculum is implemented effectively	2	40.0
		Plans can be prepared taking into account the level of student readiness for an efficient course process	1	20.0

It was seen that five of the teachers commented on the way how they behave in the classroom regarding the item on leading individuals who make mistakes in problem-solving. In terms of leading the students who make mistakes in the classroom, it was observed that two of the teachers pointed out that the students were directed to questioning and that they supported the mistakes made by the students with the help of the directed questions and they aimed that students find their own mistakes themselves. It was observed that both of the remaining teachers explained the solution by intervening immediately without giving students the time to find their own mistakes rather than directing the students. It was stated that one of the teachers intended to clearly indicate mistakes while the other helped students to understand questions again by using the mathematical language.

At this point, as Demir (2016) pointed out in leading individuals, who make mistakes while solving problems, is accepted as an important factor in finding out the correct solution that students become aware of their strengths and weaknesses while solving the problems and being encouraged in finding their own mistakes.

Three teachers commented on the relationship between time management and problem-solving skills by taking into account the application in the classroom, it was seen that the other teachers stated their opinions in the form of a generalization again. After mentioning the importance of time in the classroom, the teachers indicated that they pay attention to determine the appropriate questions and solutions in line with the purpose of the problem in order to increase the diversity of the effective and efficient use of the time with the use of practical solutions. One of the teachers stated that using time effectively and efficiently will contribute to the teaching of the curriculum on time while others reported that teaching how to use the time efficiently will contribute to improve student achievement in problem-solving skills.

In parallel to this, Bal-Incebacak & Ersoy (2016) stated that, the types of problems that students are more likely to encounter will improve their problem-solving skills; therefore, the development of thinking skills should be adopted as the main objective by including problems to help developing reasoning skills in the classroom. Similarly, the study of Şahin and Gümüş (2016) suggests that the purpose of time management is to increase the instruction in the suggested time. It is therefore necessary not only to prevent the time loss, but also to do time planning for both teachers themselves and their students to be successful.

In terms of the relationship between program activities management and problem-solving skills, it was seen that two of the teachers indicated the way they applied in their class and the remaining three teachers made generalizations about the importance of program management. One of the teachers commented that she used the weekly plans to redesign the plan according to her needs during the period and that the other person used the planning usually on a subject basis and also took actions according to the subject matter when preparing the plans. On the other hand, it has been seen that both of the teachers, who made generalizations by recommendation, drew attention to the preparation of the plan by determining the right strategy for effective implementation of the curriculum and for the preparation of the plan by taking into account the student readiness levels for an efficient course process.

Güner and Akyüz (2017) emphasize that the course plan design gives an insightful effect on the course related activities in order to be able to have an idea about how students think mathematically. In terms of problem-solving skills, Gök and Erdoğan (2017) propose an environment in which mathematical culture can be mentioned, where different solutions can be used at the same time, different strategies can be defined and discussions can be made on the problem that will demonstrate the importance of solving problems with the use of samples taken from student life.

## CONCLUSION AND RECOMMENDATIONS

Teacher opinions were collected about problem-solving skills in line with the basis of the study. Along with the obtained views, it has been observed that the teachers refused to give their opinions about their applicability, especially because they did not have sufficient knowledge about non-routine problems, and therefore they preferred giving more general answers and making recommendations. It has been seen that only two teachers, who are thought to be partly informed about non-routine problem-solving skills, indicated their practices for these problem types. However, it was observed that they did not provide enough information about what kind of practice and activities they included in the classroom. Problem-solving skills consist of the steps of understanding the problem, determining the appropriate strategy for the solution, applying the chosen strategy and evaluation. In line with the answers given by some of the teachers, it has been determined that they only used the question-answer method while guiding the students throughout class management. Moreover, some teachers stated that they draw attention to the use of mathematical language in understanding the problem, encourage students to find the shortest and logical solution while trying to give concrete and real life examples. In case of a mistake during solution, some of the teachers stated that they directed students to question, analyze and evaluate while the other teachers indicated that they intervened in the solution of the problem even without allowing students to think. While it is known that it is necessary to use procedural and conceptual information together in the implementation of permanent learning, it was seen that teachers did not give any information about problem-solving strategies. At this point, good time management plays an important role in the well design of the plan. Spending the time devoted to the lesson most effectively and efficiently, allowing the enhancement of education, solving problems in a short amount of time and acquiring different strategies in a short time will vary in accordance with the way how the plan is designed in the most appropriate way. It has also been shown that success can be achieved by helping individuals develop reasoning skills by enabling practical activities such as the use of practical solutions for the teachers' effective and efficient use of time, diversification, provision of reinforcement and training of curricula. However, consequently, it has been revealed that some teachers cannot include the activities in line with the opinions they provided. Taking into consideration the annual, weekly, monthly and daily plans prepared for the lesson, the teachers will find a few possible solution ways especially in problem-solving skills and transfer them to the students and they will be able to guide them to predict what they will be able to produce after a short time. In the Turkish Republic of Northern Cyprus, it is aimed to raise self-confident, critical, reasoning and creative individuals in the mathematics education determined by the Ministry of National Education Therefore, it is aimed to prepare the plan and program for the most effective and efficient use of the time left for the problem-solving skills, and to educate individuals who can solve problems by applying this program in the most effective way. In line with this goal, the teachers should teach the students problem-solving skills in a short time in the most effective way in order to achieve success in mathematics.

In line with the obtained data, it can be suggested to provide in-service trainings in order for the teachers to use the time related management to improve success in mathematics effectively. As well as to solve the non-routine problems that were highlighted in the research. In the effective and efficient use of time management, conferences

can be arranged by the school community in order to manage the program activities that will constitute the road map. Moreover, a similar study can be conducted on a larger sample group since the study is limited to the views of five teachers in five provinces. Similarly, different types of questions may be included in order to gather data on non-routine problems so that this study can cover a larger scope. The questions can be prepared as open-ended questions and views of the teachers on this issue can be obtained.

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