Research Article

Studying the Effect of Academic Status on the Results of Personalization of Mathematical Word Problems

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Abstract: This study aimed to investigate the effect of specializing of mathematical word problems on students' problem-solving performance in the schools of Izeh city. Participants in this study are 60 students, of which 20 are in the fifth grade of elementary school, 20 are in the third grade of middle school and 20 are in the second grade of high school. After collecting the average math scores of students in the three academic years, they were divided into groups of high, middle, and lower status. The content of the problems in each level was selected according to the contents of the textbooks of the previous years and what the students were familiar with.

The results showed that the scores of students in each group when the instructions for assigning the mathematical word problems were done; there was an increase in the performance of the students in comparison with the case where this was not done. The difference in performance between students with low academic status is higher than students with middle education status and this group is higher than students with high academic status. The research results suggest that specializing in mathematical word problems increases their motivation and understanding of problems by helping the learner to interpret problems and engage them in the information that is important to them. Furthermore, by personalizing math problems, students become more interested in math problems and can easily have a mental idea of the problem.

Keywords: Mathematics Education, Personalization, Academic Status, word problems solving

1. Introduction

Learning experts believe that mathematics is a way to develop thinking skills and strengthen creative and critical thinking. These beliefs lead us to understand mathematical concepts and relate them to our daily life experiences. This is how we can substitute conceptual understanding and mathematical reasoning for the preservation of rules and procedures. However, mathematics education is an issue that requires special methods considering the cultural and traditional context of each country. Therefore, for the correct education and generalizing mathematics in Iran, one should hope for the excellent efforts of mathematicians in this country. [1]

The main purpose of any educational system is to provide the necessary skills to individuals so that they can play an effective role in society as useful members. Given the characteristics of today's society, mathematics has a great role in providing these skills, because it deals with observation, measurement, calculation, inference, analogy, and prediction, and as a communication system helps the individual to gain an accurate understanding of information, patterns, and reasoning. [2]

Mathematics is one of the components of the curriculum, which affects all aspects of people's lives, including formal education, useful activities, employment, and daily life[1]. The idea of problem-solving is one of the most important components of mathematics and is a good factor for the daily development (professionalization) of environments.[2]

It is been a while that Iran is participating in these important and credible international educational exams. The result of the "TIMSS" test is so important that after the publication of its official results, some ministers of education and sometimes even the highest executive authorities of the participating countries suggest their assessment and analyze the educational performance of their country and if the performance is not desirable, Make new promises to improve the education system.

The result of the first TIMSS Test, in which Iran participated, was shocking. However, the final report was published in large numbers. The result of the second test, which was held a few years later, also showed that there has been no positive change in the educational system performance during this period. The 2003 test report was more or less in the same situation and was not reflected in the media. Interestingly, the result of the TIMSS test has a significant relationship with the development and performance of each country in this field. Southeast Asia, Japan, Korea, Singapore, Hong Kong, and China will take first place if they take the test. [3]

One of the special cases among students is the inability of students to understand the structures placed in the text (content) of the problems[3]. In some cases, the low score of students in the exam was due to the incompatibility

[1] Miller, Butler, & Lee, 1998; Rivera, Smith, Goodwin, & Bryant, 1998
[2] Jonassen, 2000; Williams, 2003
[3] Bernardo, 1999; Mayer, 1982; Rosen, 1984

of the structure of the exam questions with the mental structures of students. Although some cases have been used to clarify the process of solving mathematical problems, limited progress has been done in equipping students' learning with the necessary problem-solving skills. Personalization of education using student experiences and interests is one way to individualize education, which may be useful for math learning[4]. In particular, this method of education can increase interest and motivation in the student and this is one of the important factors in learning and teaching.

Many studies have investigated the effect of personalization of mathematical problems that most of these studies have examined the effect of personalization of problems on three factors in problem-solving. These three factors are motivation, comprehension, and performance. One of the methods that have changed education in advanced societies is to pay attention to individual education and use the talents of each individual. The instructional guide that has a positive effect on students in solving math problems is the personalization of problems. In this instruction, using habits, interests, daily phenomena, etc. in the context, helps students to understand problems and motivate them.

However, research on the personalization and use of individual characteristics and differences of students due to poor generalizability to other people and also the difficulty of research on the individual in society has received less attention. This research tries to answer this question: "Is it possible to improve the problem-solving performance of students in different educational situations in Izeh schools by personalization of mathematical word problems?"

2. Theoretical Foundations

Different Theories about the Personalization of Problems

Robert J. Sternber a cognitive psychologist. In his research on intelligence ability, he concluded that when we change (personalize) intelligence tests for elementary school students based on their interests and environmental characteristics, their scores improve significantly. This test is called the Sternberg Test of Mental Abilities (STOMA).[4]

Regarding personalization, Lynda R.Wiest (2003)[5] states, "Expressing the words of problems in another way creates a semantic connection to understand problems and the process of solving them. In his study, he stated, "personalization of math problems, which can include students' names or using speaking situations with students, has a positive effect on students". However, Davis Dorsey says that changing words in problem-solving may be helpful for younger students who have weaker problem patterns, while for people with problem-solving experience, this can be introduced as an unsuitable pattern. Awareness of students' prior personal information and processing skills of information is one of the primary factors that should be considered as an effective factor in understanding mathematical problems[6]. Students' performance can be improved by personalization of math problems as well as introducing personal advantages and making the content of the problems attractive[7].

The term refers to a developed program by Tom Synder. The program was established in 2004 after American students got lower scores on math tests than other industrialized countries. This program teaches students how to understand them before solving math problems. This program helps students to understand mathematical models, conditions, and arithmetic problems - with valid methods that provide better solutions to problems through providing appropriate solutions. In this program, one of the methods and instructions that are recommended in education is the method of personalizing mathematical problems, and in this case, it states that:

"Personalization is a valid research technique to increase motivation in students. Typically, the content of math problems does not have any relation with students. Issues are related to people and not related events are related to the learner."

"Research on the personalization of mathematical problems has shown that the personalization of mathematical problems improves students' motivation and comprehension. It also helps to identify students and create a mental model of each problem. This program leads students to personalize problems. This educational program may ask students to name a person or friend, family member, or legendary character, and sometimes asks about the place or something like the name of the sea and so on. Students should answer these questions quickly. According to the research, personalization increases students' involvement in problem-solving and the student's relationship with the model". [5]

Research Background

[4] Ensign, 1997
[5] University of Nevada, Reno ,October 2003
[6] Cummins, Kintsch, Reusser, & Weimer, 1988; Kinstch & Greeno, 1985
[7] Anand & Ross, 1987; Davis-Dorsey, Ross, & Morrison, 1991; Ku & Sullivan, 2002; Lopez & Sullivan, 1991, 1992

In 1993, Cordova used personalization instruction to increase intrinsic motivation and learning in 72 fourth- and fifth-grade elementary school students. The results of what students reported showed that "attributing problems to what they liked" involved a high score on math exams. Personalization and selection will be helpful on students' motivation and learning, but no interaction was seen between the two behaviors.

Cordova (1993) reported that both personalization and selection were effective in both posttest measurements. However, in expressing the results in a general way, it should be noted that what is obtained in the study of educational instructions has occurred in specific and fixed conditions, their generalization may be difficult, and they require more work and implementation in different conditions. The results of this study suggest that, in general, personalization instructions to mathematical problems increase students' interest and learning and may be an effective source of participants' mathematical efficiency.

Ku Heng-Yu et al. (2004) in a study examined the effects of personalizing education through computer instruction on the tendency to solve arithmetic problems among 104 high school students in the United Students. Students were divided into two groups with high and low ability according to a pre-test math entrance test. Then, the students of each group were randomly selected to participate in personalization and non-personalization educational programs in mathematics by computer instructions. In the end, it was found that when the overall performance of students in the personalized group is compared with the non-personalized group, there is a significant difference between the scores obtained between the performance of these two groups and it can be said that personalizing math problems is an effective factor in students' learning. [6]

Bates, Eric.T. (2002) conducted a study to investigate the effect of personalization of mathematical verbal problems with the help of students' interests and habits in their problem-solving performance. In the end, it was found that the personalization of mathematical verbal problems as one of the educational instructions did not affect the success of middle and upper-level students in an elementary class and only in low-level students did not cause a difference between their performance on personalized and non-personalized problems. The results of this study suggest that students do not perform better when confronted with personalized verbal problems that reflect their area of interest than other mathematical problems. Only in a subset of those with low reading levels, the performance is improved. [7]

Berri Hsiao (2004-2005) conducted a study on two different algebra classes (basic algebra and elementary algebra) over eight weeks to investigate the effect of personalizing mathematics education over a period. A class of 13 individuals and a class of 25 individuals were formed about four times a week for 50 minutes. Both classes have similar curriculum content written by Robert Blitzer. This project has shown that personalizing mathematical problems has not been helpful to the students' performance. According to research and initial findings, personalization in adolescents has less effect than in children. This is because adolescents are less effective in understanding issues based on the obtained information in their normal lives. After all, a teenager has found his role model compared to a child. One hypothesis is that more personalization affects children since they have less experience in modeling related to mathematics and the problems around themselves. [8]

Nicki Anzelmo-Skelton (2006) examined the effects of learning style, the strategy, and personalization of mathematical verbal problems on selecting appropriate functions and performing correct calculations of unable students in learning. The results of problem-solving were that people who used high-level math personalization scored higher on performing correct calculations than people who used math problem-solving at a lower level of personalization. The findings of this study show that the style of learning and personalizing mathematical problems has not been effective on the computational performance of unable students.

The present study was descriptive-applied. The statistical population included three levels of education (elementary, middle, and high school) in Izeh.

In this study, due to the limitations in the selection of random samples from students of each grade, the results of these two tests were collected from the quasi-experimental method with 9 experimental groups that were examined in two stages. The results of these two tests were collected and analyzed. The participating groups are as follows:

1. Elementary students in low academic status
2. Elementary students in middle academic status
3. Elementary students in high academic status
4. Middle school students in low academic status
5. Middle school students in middle academic status
6. Middle school students in high academic status
7. High school students in low educational status
8. High school students in middle academic status

9. High school students in high academic status

A multi-stage group method was used to select the statistical sample. In the first stage, three regions were randomly selected from different regions of Izeh city. In the second stage, for each region, a personalization study was considered for one grade, and in the third stage, one school was selected among the schools in each region. In the fourth stage, one class was randomly selected from the classes of each school. A total of 18 students with low educational status, 24 students with middle educational status, and 18 students with high educational status participated in this study.

The same test design method has been used for all three grades. The tests of this study can be examined in two parts:

Section 1: Survey test: This test is presented in the same way for all students in all three grades. In the survey test, this includes 20 innovative titles for use in personalizing problems in later tests.

Survey test questions were presented to students, such as the questions used in previous research in Eric T. Bates's research for fourth-grade elementary students and the questions used by Beri Hasioa research for high school students. The questions were about students' habits and interests: a favorite team, favorite job, favorite TV show, favorite books, and movies, etc.

Section 2: Personalized Tests: These tests include two exams for each grade. In each test, 10 problems are presented, of which 10 in the first test are with even numbers, i.e. problems of 2, 4, 6, 8, and 10 are personalized. Furthermore, in the second test, problems with odd numbers, i.e. problems 1, 3, 5, 7, and 9, are personalized. This test method has increased the internal validity of the tests by reducing the effect of transferring learning from the first test to the second test.

Not all questions were selected from textbooks, as there was a possibility that the questions were not standard because a score of 4 was given for each question to score the questions and simplify the analysis. Each question had a score of 4.

One of the problems in math exams is correcting and grading students to solve a problem because, in formal exams, the designer specifies a score for the question. In the correction method, for each part of the answer that has been specified, a special grade is considered and the corrector must give the student a grade based on it.

However, this method has many problems in solving a problem. First, giving a score of zero (instead of a score of one) means that the student should not get any points from it, and considering that the questions are selected from different sections, so there was no learning in this section.

Second, to solve a problem, there may be several ways to get at an answer and several computational methods, so specifying the answer may be incorrect.

Third, in solving a problem, a divergent thinking student gives a different answer to a problem than others, and the teacher's goal should be to guide the student in this direction, not to a fixed response or response method.

Scoring and grading in each problem were as the following order:

1. Score one for students who did not answer the question in any way.
2. Score two for students who gave the wrong answer to the problem and the wrong solution method.
3. Score three for students who gave the wrong answer to the problem but with the correct solution method.
4. Score four for students who answered the problem correctly with the correct solution method.

Finally, to analyze the data in the two tests, the first, Kolmogorov -Smirnov Z test, examined the normality of the obtained data. Then the t-test method was used to compare paired-samples t-test. Moreover, in a general study, a two-way analysis of variance was used to determine the effect of degree and educational status on the mean scores obtained from personalized problems.

3. Results

Table 1. Paired-Sample t-Test to Compare the Mean Scores of Elementary School Students in Three Educational Levels of High, Middle, and Low

Educational level	Tests	The mean of scores in one question	Standard deviation	Paired sample t-test	Significance level
High	Personalized	3.2333	1.0145	1.592	0.117

	Non-personalized	2.2950	1.1413		
Middle	Personalized	2.6375	1.1500	2.824	0.006
	Non-personalized	2.2000	1.2055		
Low	Personalized	2.1833	1.1860	2.256	0.028
	Non-personalized	1.800	1.0383		

In the above table, the mean differences are 0.2833, 0.4375, and 0.3833, respectively, and these differences are with significant degrees of 0.117, 0.006, and 0.028, respectively.

In the study of Table 1, according to the differences between the mean score and the significant levels of P <0.05, hypothesis 1 by personalization of mathematical word problems increase the students' performance in the middle status in solving problems. Hypothesis 2 by personalization of mathematical word problems, confirms the students' performance with low math status in problem-solving. Hypothesis 3 does not confirm the students' performance with high mathematical status in problem-solving by personalization of mathematical word problems.

That is, students with low and middle education in primary school scored better in the personalized problems, and it can be concluded that this practice increases the performance of students. However, the significance level of the paired sample t-test for students in high academic status is P> 0.05 and it indicates the insignificance of this hypothesis, which also increases performance among these students.

Table 2. Paired Sample t-Test to Compare the Mean Scores of Middle School Students in Three Educational Level of High, Middle, and Low

Educational level	Tests	The mean of scores in one question	Standard deviation	Paired sample t-test	Significance level
High	Personalized	3.3 333	1.0523	2.777	0.007
	Non-personalized	2.7833	1.0750		
Middle	Personalized	2.8625	1.1555	4.617	0.000
	Non-personalized	2.2250	0.9410		
Low	Personalized	2.63 33	1.1927	2.892	0.005
	Non-personalized	2.1167	0.9037		

In the above table, the mean differences are 0.55, 0.6375, and 0.5167, respectively, and these differences are with significant degrees of 0.007, 0.0001, and 0.005, respectively.

In the study of Table 2, due to the differences between the mean score and the significant levels of P <0.05, hypothesis 1, by personalization of mathematical word problems increase the students' performance with middle academic status in problem-solving. Hypothesis 2 increases the performance of students with low math status in problem-solving by personalizing word problems, and hypothesis 3 confirms the performance of students with high academic status in problem-solving by personalizing word problems.

That is, students in all three levels of education in low, middle, and high school got a better grade in the personalized problems than non-personalized problems, and it can be concluded that this action increases the performance of students.

Table 3. Paired Sample t-Test to Compare the Mean Scores of High School Students in Three Educational Levels of High, Middle, and Low

Educational level	Tests	The mean of scores in one question	Standard deviation	Paired sample t-test	Significance level
High	Personalized	3.1833	0.9476	2.944	0.005
	Non-personalized	2.2375	0.8604		
Middle	Personalized	2.4333	0.9806	4.131	0.000
	Non-personalized	2.2375	0.8604		
Low	Personalized	2.4333	0.9806	4.131	0.000
	Non-personalized	1.8500	0.5469		

In the above table, the differences between the means are 0.4667, 0.4625, and 0.5833, respectively, and these differences are with significant degrees of 0.005, 0.0001, and 0.0001, respectively.

In the study of Table 3, according to the differences between the mean score and the significant levels of P <0.05, hypothesis 1, by personalizing word problems, increases the students' performance with middle educational status. Hypothesis 2 approves the performance of students with low math academic status in problem-solving by personalizing word problems and hypothesis 3 confirms the performance of students with high mathematical academic status in problem-solving by personalizing problems.

That is, students in all three levels of the lower, middle, and higher in high school grade scored better on personalized problems than non-personalized problems, and it can be concluded that this practice increases students' performance.

Table 4. Paired Sample t-Test to Compare the Mean Scores of Students in all Levels of Education in Three Educational Status of High, Middle, and Low

Educational level	Tests	The mean of scores in one question	Standard deviation	Paired sample t-test	Significance level
High	Personalized	3.2500	1.0021	4.205	0.000
	Non-personalized	2.8167	1.0595		
Middle	Personalized	2.4333	0.9806	4.131	0.000
	Non-personalized	2.2208	1.0089		
Low	Personalized	2.4167	1.1329	5.239	0.000
	Non-personalized	1.9222	0.8617		

In the above table, the differences of the means are 0.4333, 0.5125, and 0.4444, respectively, and these differences are with significant degrees of 0.0001, 0.0001, and 0.0001, respectively.

In studying Table 4, due to the differences between the mean score and the significant levels of P <0.05, hypothesis 2, personalizing word problems, increases the performance of students with low math status in problem-solving. Hypothesis 3 increases the performance of students with middle academic status in problem-solving by personalization of problems. Hypothesis 4 confirms the performance of students with high academic status in problem-solving by personalization of mathematical problems.

That is, students in all three levels of education, low, middle, and high, at all levels obtained better scores on personalized problems than non-personalized problems, and it can be concluded that this action increases students' performance.

Table 5. Mean Scores of Total Students of Personalized Problems in all Sections and Situations with their Numbers in each Group for Use in Variance Analysis Test

Educational degree	Educational status	The mean of total score in the personalized questions	Number	Standard deviation
Primary school	High	3.2333	6	1.0145
	Middle	2.6375	8	1.1500
	Low	2.1833	6	1.1859
	Total	2.6847	20	1.1894
Middle school	High	3.3333	6	1.0523
	Middle	2.8625	8	1.1555
	Low	2.6333	6	1.1833
	Total	2.9430	20	1.1651
High school	High	3.1833	6	0.9476
	Middle	2.7	8	1.0720
	Low	2.4333	6	0.9806
	Total	2.7722	20	1.0465

Table 5 shows the mean scores of total students in personalized problems in different educational situations and levels. These data have been collected for use in two-way variance analysis. In Table 4.10, the output of the SPSS program is obtained after defining the grade and educational status with the numbers 1, 2, and 3.

Figure 1 shows a general comparison of the mean scores from the two tests in the specified and non-specified questions. In this diagram, in addition to drawing the average, scores are also given.

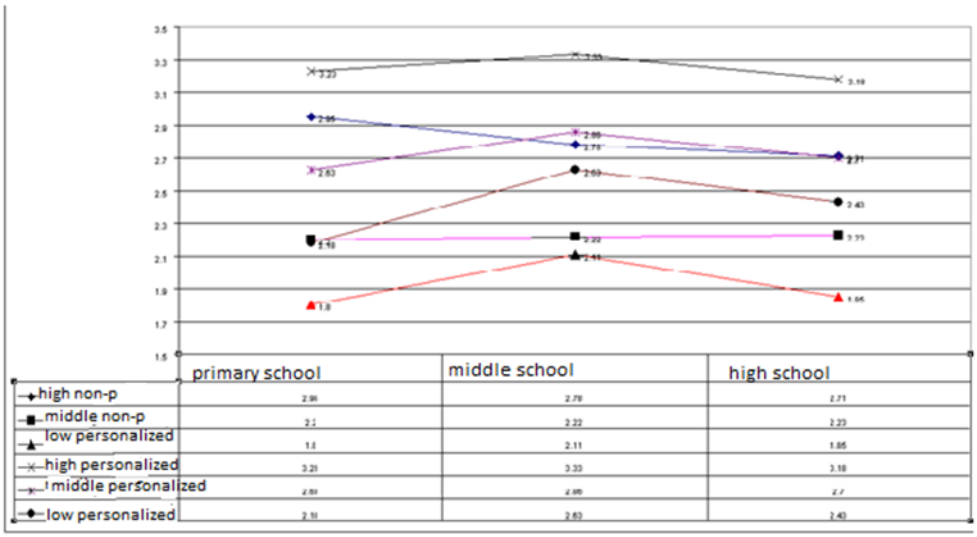

Figure 1. Related to Comparing the Obtained Mean Scores in Personalized and Non-personalized Problems in Different Situations

4. Conclusion

Examination of the obtained findings confirms the research hypotheses that it is clear that the personalization of mathematical word problems has improved the performance of students with low and middle academic status in primary school. Considering the difference between the obtained averages, it seems that the higher the educational status of the students, and the stronger the students in mathematics than the others, the lower the difference in their performance in the specified problems.

These results of Bates, Eric. T. (2002) research confirms the fourth-grade primary school students, with the difference that in his research, personalization of problems is a method that is effective only on low-status students.

In studying the obtained findings, the confirmation of the research hypotheses is determined. Personalizing the mathematical word problems has improved the performance of students with low, middle, and upper status in the middle. These results are similar to the results obtained for elementary students. It does not confirm the differences and the previous results, but by looking at the differences obtained among the students in the lower, middle, and high educational status in the middle school, the results in the primary school are weakly confirmed. The same results are repeated for high school students.

However, these results show that when we put all the students of a grade in a group, this instruction improves the students' performance in solving mathematical problems.

In general, this research was conducted among students of three grades with three different educational statuses, and the findings of the research in the fourth chapter indicate that in general, the personalization of mathematical word problems should be used as effective instruction.

So that this method is effective in the ability to solve problems in all students with different levels of education and the case of students with middle and lower educational status, this issue is completely clear.

The results of this research confirm the conducted research in the field of personalizing mathematical problems and never leave a reason to reject the obtained results because the achieved results have been done in different situations and conditions and to reject an article need to do that research in similar circumstances. Another consequence of student behavior was that students' motivation to respond to problems has increased.

References

1. Momtahen, Ehsan. (2001). Incredible Results in Mathematics, Chamran University Press, Ahvaz

2. Desmond Broms et al., Translated by Mohammad Reza Keramati. (2003). Mathematics Education for primary school Children, Tehran
3. Ku, Heng-yu ; Sullivan , Howard j (2001) . Effects of personalized instruction on mathematics word problem in Taiwan. Education Researches International Center
4. www.Iranian Futurist.com
5. www.Human Intelligence Robert J_ Sternberg.com
6. SNYDER, Tom (2005) GO Solve Word Problems: Research& Results Scholastic.2003
7. Ku Heng-Yu, Christi A. Hartera, Pei-Lin Liua, Ling Thompsona, and Yi-Chia Chenga. (2004) .The effects of individually
8. Bates, Eric .T. & Wiest, Lynda. R. (2004) Impact of Personalization of Mathematical Word Problems on Student performance. The Mathematics Educator.
9. Hsiao, Berri. (2004-2005). Impact of Instruction through Personalized Word Problems. Mathematics Department Lane Community College
10. Nicki Anzelmo-Skelton, (2006) Learning style, Strategy use, Personalization of mathematical word problems and responses of students with a learning disability, international journal of special education.