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# M-learning based on the problem solving method in the achievement of mathematical competence in alternative basic education students

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**Abstract**
The purpose of the study was to determine the effect of the problem-solving method on the achievement of mathematical competence in alternative basic education students. For this purpose, a quasi-experimetric design was used. The instrument applied is a 10-item questionnaire, which is an adaptation of the PISA tests that was validated by expert judgment, and its concordance was evaluated using Fleiss' Kappa with a coefficient of 0.688 and Cronbach's Alpha reliability yielded a coefficient of 0.820. It was concluded that the application of the problem-solving method had a significant effect on the achievement of mathematical competence of alternative basic education students, with $p=0.000<0.05$. Similarly, a significant effect was found in the achievement of mathematical competence in the dimensions numbers and relations, geometry and measurement, and statistics and probability in each of the cases with $p=0.00<0.05$.

**Keywords**: M-Learning, Method, problem solving, problem solving and mathematical competence.

## 1. Introduction

The Organization for Economic Cooperation and Development (OECD), conducts the PISA tests, which stands for Programme for International Student Assessment, which evaluates every 3 years the skills and abilities of 15 year old students in areas such as: Mathematics, Reading Comprehension and Natural Sciences. OECD member countries compete in this evaluation and those that voluntarily wish to participate in it, as is the case of Peru, which participated in 2000, 2009, 2012 and 2015. In 2000, Peru participated in the PISA test with 65 countries with the result of 292 points in mathematics being the OECD average of 499, that is, we are 207 points below the OECD average. In the PISA tests of 2003 and 2006 Peru did not participate; in 2009, 65 countries participated where Peru's score in Mathematics was 365 points being the OECD average 496, i.e., we are 131 points below the OECD average. In 2012, 65 countries participated with the following result in Mathematics 368 points being the OECD average 494, i.e. we are 126 points below the OECD average.

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In 2015 72 countries participated, but the results were published for 69 countries the score in Mathematics was 387 points being the OECD average 490 i.e. we are 103 points below the OECD average. It is recommended [1] the use of technologies that will benefit for learning and for this students must have the necessary tools for educational development.

## 2.Literature review

### 2.1 Sistema virtual

[1] We must understand that times and distances have changed in all aspects. It is simple, particularly in teaching, teachers can no longer be the only providers of information, students also have this responsibility, since it is a fact that new technologies provide us with it, even the mass media bombard us, in their own style, with information (Díaz, 2012).
Among those commonly used in virtual learning environments for university teaching are asynchronous telematic resources such as e-mail, newsletters, distribution lists, newsgroups and the World Wide Web, as well as FTP (File Transfer Protocol) services for the transfer of computer programs and files of all kinds

### 2.2 Los entornos virtuales de enseñanza – aprendizaje

Learning environments are not limited to the school space or to formal education, nor to a particular educational modality; they are those spaces where conditions are created for the individual to appropriate new knowledge, new experiences, new elements that generate processes of analysis, reflection and appropriation. They are called virtual in the sense that they do not take place in a predetermined place and that the element of distance is present [2].

## 3. Problem definition/formulation

Training in mathematics is of vital importance for the development of science and engineering and then for its application in the creation of technologies and it is precisely countries such as China, Singapore, Japan, South Korea who are in the top positions in the PISA test and these are the countries that develop state-of-the-art technologies. Therefore, the present study proposes: how to develop mathematical competence in students of Alternative Basic Education, knowing that these students have particular characteristics such as: they did not finish their high school studies for different reasons such as illness, travel, repetition, family reasons, etc. According to the experience in teaching in this modality, students have difficulty in understanding problems, this causes that they cannot advance with the other procedures for the solution of the mathematical problem. For this reason, the application of the problem solving method proposed by [3] is proposed to develop mathematical competence; because this method has 4 phases, where the first one is the understanding of the problem which is of vital importance to identify the data, the conditions of the problem, the unknown that you want to obtain, etc, followed by

planning where the strategy and the operations to be performed are elaborated, execution which is the application of the elaborated plan and finally verification, to corroborate if the calculations made are correct and it fits what the problem really asks for as a solution.
The following objectives were set.
To know the effect of the problem solving method in the achievement of mathematical competence in students of Alternative Basic Education of a Public Educational Institution of Metropolitan Lima. To determine the effect of the problem solving method in the achievement of the mathematical competence of Numbers and Relationships in students of Alternative Basic Education of a Public Educational Institution of Metropolitan Lima.
To establish the effect of the problem solving method in the achievement of the mathematical competence of Geometry and Measurement in students of Alternative Basic Education of a Public Educational Institution of Metropolitan Lima To determine the effect of the problem solving method in the achievement of the mathematical competence of Statistics and Probabilities in students of Alternative Basic Education of a Public Educational Institution of Metropolitan Lima. [3] in his research procedure to develop Mathematical Competence. He concludes that studentshave a low performance, due to the fact that they have not developed mathematical competence. [4] studies mathematical competence through research tasks in the classroom. He concludes that the use of the didactic method of problem solving significantly influences the learning of mathematics. [5] carried out a study on the influence of the didactic experimental method on students' academic performance. He concludes that after applying the didactic experimental method, students increase their academic performance considerably, compared to the use of other methods.
[2] stated that the solution of a problem, even a modest one, is developed by awakening curiosity through stimulating guidance from the teacher, where the student is the center of learning. When he is able to solve by his own means, only with the help of the teacher if necessary, it generates in him the satisfaction and the charm of discovery. The role of the teacher is to awaken the student's curiosity and creativity, avoiding routine tasks that will kill reflection and intellectual work; because a student, even if he has innate abilities towards mathematics, if he is not stimulated in a timely manner, he will be lost because he did not manage to reach the enjoyment and pleasure of mathematics. [6] states that mathematical competence is when the student puts more emphasis on solving problems with his own mathematical knowledge and skills than on theoretical and formal mastery. According to [7] mathematical competence is the ability of each person to understand the role that mathematics plays in the world and to know how to apply mathematics to their needs and interests in a constructive and reflective way; posing, arguing, representing, modeling and communicating not only through symbolic language but also through natural language. Achieving mathematical competence is a gradual process of building the foundations according to the student's age, giving mathematical concepts through an appropriate method and the use of concrete materials with their respective application in the student's daily life. It is important to give applicability to mathematics, it is not necessary to master theorems, postulates, axioms or propositions that often scare away and generate rejection in the student.

## 4.Method of analysis

The approach of the present research is quantitative because the procedure to carry out the hypothesis testing is based on statistical techniques, using numerical magnitudes. The type of research is applied because the type of research transforms 'pure' knowledge into useful knowledge. The research design is experimental because the independent variable problem solving method will be manipulated to then see

the effect on the dependent variable mathematical competence and the quasi-experimetric type because two groups were taken already formed, i.e. intact, according to [8].
The population is 50 students of the fourth grade of the advanced cycle of the Institution of metropolitan Lima, according to enrollment of the year 2021 distributed in two classrooms of 25 each.

Table 1: Population

| Group | Sex | | Subtotal | Total |
|---|---|---|---|---|
| | M | F | | |
| **GE** | 12 | 13 | 25 | 50 |
| **GC** | 14 | 11 | 25 | |

The sample is of the non-probabilistic type given that the study sample was not chosen randomly, because the groups for both the experimental and control groups are already formed; the inclusion criteria are to be a student enrolled in the fourth grade of the advanced cycle, to have permanent attendance, to be 16 years of age or older, and the exclusion criteria are to have non-permanent attendance, to be a repeating student.
After applying these criteria, a sample of 20 students was obtained.

Table 2: Sample

| Group | Sex | | Subtotal | Total |
|---|---|---|---|---|
| | M | F | | |
| **GE** | 11 | 9 | 20 | 40 |
| **GC** | 10 | 10 | 20 | |

The instrument was developed in accordance with the design and purposes of the research. The instrument applied is a 10-item questionnaire, which is an adaptation of the PISA tests that was validated by expert judgment, in addition, according to [8], its concordance was evaluated using Fleiss' Kappa with coefficient 0.688 and Cronbach's Alpha reliability yielded a coefficient of 0.820.
The statistical treatment was done with the following statistics: mean, median, standard deviation, range, and graphs (error bars). The Mann Whitney U test was used for hypothesis testing. All this was done with the support of SPSS version 25, STATA and Excel computer programs.
The procedure was to apply the problem-solving method using its 4 phases: understanding the problem, conceiving a plan, executing the plan and examining the solution obtained through a workshop for a period of 4 months and only in the experimental group; the control group continued with the method usually used; after this period the questionnaire was applied again to the experimental group and the control group. (Post-test). Based on these data, the statistical processing and analysis of the results were carried out. For hypothesis testing, the Shapiro Wilk test was used first to determine the normality of the data; it was found that the data did not have a normal distribution; therefore, the nonparametric Mann Whitney U-test was used.
The design of the present research was experimental because the independent variable problem solving method will be manipulated in order to see the effect on the dependent variable mathematical

competence, and quasi-experimental because two groups were taken already formed, that is, intact, according to [8] regarding quasi-experimental studies.
In this sense, the diagram of the design is.

Table 3: Research design

| Grupo | Pre-Test | Intervention | Post-Test |
|---|---|---|---|
| The experimental group (GE) | $O_1$ | X | $O_2$ |
| The control group (GC) | O3 | - | O4 |

## 5.Results and discussion

In the present research we will present the descriptive results of the pretest and posttest of the achievement of mathematical competence in students.

### 5.1 MathematicalCompetence

In this graph we are going to present a consolidation of the results of the mean of the mathematical competence in the CG (Control Group) and EG (Experimental Group) of the Pretest and Posttest.

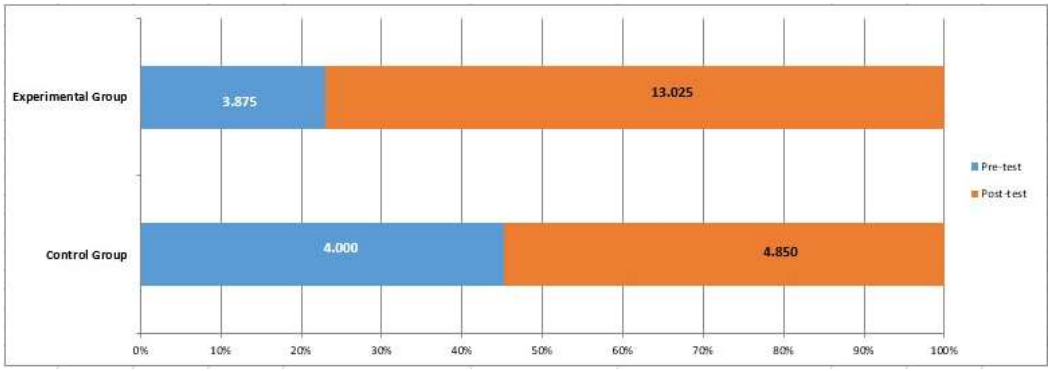


Figure 4. Mean mathematical proficiency scores (pretest-posttest).

In Figure 4, we observe that in the GE (experimental group), the mathematical competence of the pretest has a mean of 3.875 and goes to 13.025 in the posttest with a considerable percentage increase of 236.13%, this indicates that the increase was caused by the use of the method (problem solving). While the GE (control group) has a mean of 4.000 in the pretest and goes to 4.50 in the posttest, it has a percentage increase of 21.25%, this slight increase was due to the non-use of the method (problem solving).

### 5.2 Mathematical competence in numbers and ratios

In this graph we are going to present a consolidation of the results of the mean of the mathematical competence in numbers and relations in the CG (control group) and CG (experimental group) of the pretest and posttest.

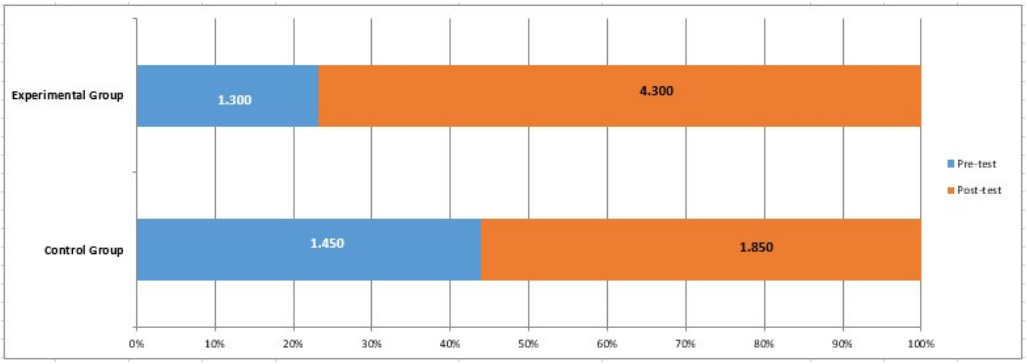


Figure 5. Mean results of mathematical competence in numbers and relations (pretest-posttest).

In Figure 5, we observe that in the GE (experimental group), the mathematical competence in number and relations in the pretest, has a mean of 1,300 and goes to 4,300 in the posttest with a considerable percentage increase of 230.77%, this indicates that who caused the increase is the use of the method (problem solving). While the GE (control group) has a mean of 1.450 in the pretest and goes to 1.850 in the posttest, it has a percentage increase of 27.59%, this slight increase was due to the non-use of the method (problem solving). Competenciamatemáticaengeometría y medida.

In this graph we are going to present a consolidation of the results of the mean of the mathematical competence in geometry and measurement in the CG (control group) and CG (experimental group) of the pretest and posttest.

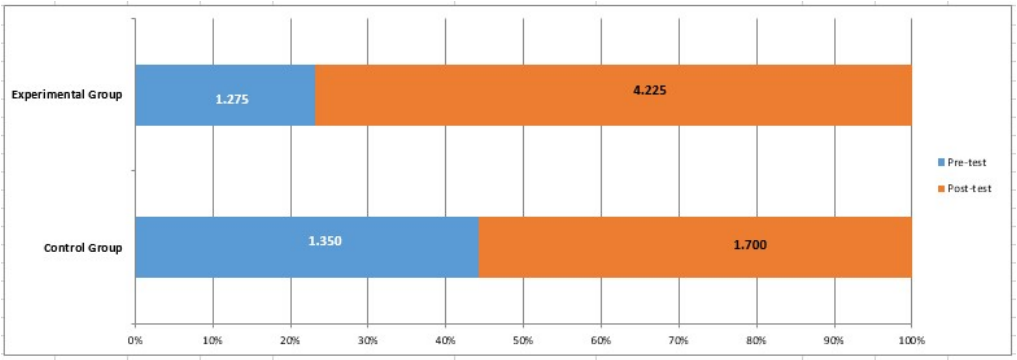


Figura 6. Mean results of mathematical proficiency in geometry and measurement (pretest-posttest).

In Figure 6, we observe that in the GE (experimental group), the mathematical competence in geometry and measurement in the pretest, has a mean of 1.275 and goes to 4.225 in the posttest with a considerable percentage increase of 231.37%, this indicates that who caused the increase is the use of the method (problem solving). While the GE (control group) has a mean of 1.350 in the pretest and goes to 1.700 in the posttest, it has a percentage increase of 25.93%, this slight increase was due to the non-use of the method (problem solving).

## 6. Conclusión

It is concluded that the significant effect of the problem-solving method on mathematical competence in students was achieved with a 5% probability of error and a 95% confidence level.
The significant effect of the problem-solving method on the achievement of mathematical competence was demonstrated, with a considerable increase of 236.13% in the output evaluation of the experimental group with a 5% probability of error and a 95% confidence level, due to the use of the 4 phases of the problem-solving method, which are: understanding the problem, conceiving a plan, executing the plan and examining the solution obtained.
The significant effect of the problem-solving method in the achievement of the mathematical competence of number and relations was demonstrated, with a considerable increase of 230.77% in the output evaluation of the experimental group with a 5% probability of error and a 95% confidence level, this was due to the use of the 4 phases of the problem-solving method, which are: understanding the problem, conceiving a plan, executing the plan and examining the solution obtained.

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