International Journal on
"Technical and Physical Problems of Engineering"
(IJTPE)
Published by International Organization of IOTPE

ISSN 2077-3528
IJTPE Journal
www.iotpe.com
ijtpe@iotpe.com

March 2024 | Issue 58 | Volume 16 | Number 1 | Pages 408-413

IMPACT OF CREATIVE USE OF ICT ON THE SUCCESS IN MATHEMATICS

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Abstract- The study presented in this research aims to study the impact of the implementation of GeoGebra software and the cooperative pedagogy on the performances of 1st year of high school scientific students. Our sample for this study is conducted on thirty-six learners, divided into two groups. GeoGebra software and cooperative pedagogy were assigned to be adopted by the experimental group. Whereas, the second group followed a focused learning on the collective visualization of animated productions via PowerPoint. We have conducted a pre-experimentation diagnostic test which served to the repartition of learners and to verify their uptake. Thanks to the tests of control and evaluation, respectively organized within and after this experience, we have collected the quantitative data. the use of ANNOVA analysis and Tukey test displayed that the implementation of the GeoGebra software teaching and the integration of cooperative teaching promoted the 1st group's acquisition success in comparison to second group. The outcome showed that using GeoGebra software in a transmissive teaching environment is still limited in the competence's development and the students' knowledge.

Keywords: GeoGebra, Creative Use of ICT, Homothety, Cooperative Pedagogy.

1. INTRODUCTION

Morocco has invested many resources so as to integrate Information Communication and Technology (ICT) in teaching. However, this integration tackled mostly the material aspect like data shows, computers, tablets. No doubt that this kind of integration is primordial but still not enough because the learner in this case will be just a watcher, and his function will not exceed being a consumer, who doesn't participate effectively in his uptake. Thus, the pros of such integration remain restrained in regard to the efforts made. For this reason, it is mandatory to blend technology with the innovative pedagogy which is able to make the learners active in their teaching-learning process.

In this regard, our research tackles the active implementation of ICT; GeoGebra software use in teaching homothety in mathematics for 1st year Moroccan scientific students. In other words, we study the effect of Co-creative implementing of GeoGebra in the teaching-learning of mathematics and we compare this type of use with the passive use of GeoGebra. We have put a hypothesis that the pedagogical integration of dynamic environment of learning mathematics will foster the result of students in mathematics. precisely, it seems to us that carrying out a study about the importance of GeoGebra software in the learning of mathematics to see to which extent the use of this software can improve the skills of 1st year high school scientific students in mathematics and what is the impact of the combination between the technology and the active pedagogy on the competences of students in mathematics.

In fact, our problematic generates the following questions:

• What is the effect of the pedagogical integration of ICT on the level of students in mathematics?
• What are the views of learners toward the use of GeoGebra software in mathematics?
• What are the developed mathematical competences in learners after combining the technology and the cooperative pedagogy?

Our research has the specific objectives:

• To study the impact of the integration of the GeoGebra software in students' learning process.
• To investigate the impact of cooperative pedagogy on the integration of this software within the context of scientific education in the first year of high school.

To get into these results, we have carried out an experiment in which 36 students of 1st year high school scientific students participated who they were divided into two groups: the experimental group and the witness group. The results of our study demonstrate that using ICT effectively helps students to ameliorate their levels in mathematics. In addition, the GeoGebra software is an effective solution for presenting and facilitating the difficult concepts of mathematics that are, on the other hand, not easy to grasp through the traditional approach.

Registered: 230827 Article Info: 1759 Accepted: 240223
Reserved: 231116 Available: 240331

2. LITERATURE REVIEW

Mathematics remains a difficult subject to understand due to its abstract nature, as according to [1], mathematics becomes difficult when it concerns a domain for which there are no simple visual or physical representations. In the same vein, [2] considers that "visualizations are an important aid in making abstract thinking more concrete", also the author in [3] consider "Visualization plays an essential role in learning, an active process centered on the learner in which the students themselves construct meaningful learning", that is why the integration of new tools has become a necessity, especially with the advent of free mathematics software that can be downloaded on the internet, notably due to their adaptability to mobile devices such as tablets and smartphones, and therefore technology has become indispensable in mathematics education. Among the most important fields of mathematics is the field of geometry, which is necessary to improve the level of reasoning in mathematics according to [4] believe that geometry is a field of mathematics that allows students to improve their level of understanding in the other fields of mathematics.

However, the traditional teaching of geometry using a paper and pencil environment does not allow students to participate in the construction of their learning, which is why it is preferable to diversify the modes of teaching, especially with the positive contributions of computer environments to the learning of geometry. The use of appropriate and relevant mathematical software can help students to develop the abstract reasoning skills necessary for high-level mathematical thinking such as that required for the comprehension of geometric concepts. The teaching of mathematics in general, and geometry in particular, is increasingly marked by the integration of dynamic learning environments, as they allow for the manipulation and exploration of mathematical objects through visual and dynamic means. Such learning environments are considered to be ones in which learners can imagine, construct and use mathematical concepts. Dynamic learning environments enable learners to perform mathematical operations and examine the connections between objects. which would not be as intuitive in a pen-and-paper environment. As emphasized by many authors [5-7].

Depover, et al. [8] indicated that dynamic geometry software provides improved cognitive learning environments. These software programs allow students to explore and solve problems in a meaningful way. Several studies have analyzed the impact of using dynamic geometry software on students' mathematics learning processes and overall success. Several studies have shown that students who use GeoGebra software generally have higher math scores and better understanding than students who do not use the software [9-13]. However, other studies have shown that the use of GeoGebra software is not a significant improvement in the learning process for learners [14-17].

In view of the different studies, it appears that the passive use of the GeoGebra software does not always allow improving the mathematical skills of the learners, so we will see what the results will be when we combine the use of this software with an innovative pedagogy (cooperative) and to what extent this combination will be effective. At their core, active pedagogies aim to emphasize the activities of the learner rather than those of the teacher [17]. What these approaches have in common is that they put students at the heart of the learning process, allowing them to engage in cognitive activities beyond reading a text or listening to a lecture. This active engagement is the backbone of learning and promotes curiosity and autonomy. It also helps increase learners' motivation to the tasks presented to them [18].

3. RESEARCH METHODOLOGY

The objectives of this study were, on the one hand, to evaluate the impact of integrating the dynamic geometry software GeoGebra on student learning, and on the other hand, to determine the influence of cooperative pedagogy on this integration, with the example of discovering the properties of homothety, one of the common transformations studied in the chapter on common transformations in the plan by students in the 1st year of High School. Our sample for this study is conducted on thirty-six learners, divided into two groups. GeoGebra software and cooperative pedagogy were assigned to be adopted by the experimental group (G1). Whereas, the second group (G2) followed a focused learning on the collective visualization of animated productions via PowerPoint. This experiment was done with 36 students from a scientific 1st year class of high school in the multimedia room called 'the engineering room' at Al Quds High School in Tan-Tan, Morocco, during the 2021-2022 academic year.

For the students of the experimental group G1, the cooperative pedagogy, as a learner centered active teaching method, it was adopted. The students of this group were put in small and heterogeneous groups of three. For the teaching session conducted for this group, the pedagogical scenario of integrating ICT is prepared. By the way, the session's structure revolves around hands-on computer tasks that involve the well-known dynamic geometry software, GeoGebra. The students of each small group work together on a computer which has the GeoGebra software pre-installed. The practical work guides (TP) to be completed were handed out in printed format. In this type of approaches, learners are responsible for and active in their own learning, while the teacher's role is that of a guide and facilitator, intervening whenever necessary to assist their students. The students in this group were tasked, for each TP, with creating the corresponding animation and answering questions that paved the way for the study of the resulting properties.

The students of the witness group G2 were taught using an expositive method. In fact, the students in this group did not work on a computer, and the teacher used his own computer to project animations and dynamic simulations to enrich his lesson, reinforce his explanation and illustrate the concepts he was covering. It should be noted that the cognitive content taught to the two groups is the same, which is the course on common transformations in space, specifically the common transformation of homothety. The choice of this common transformation is justified because the other common transformations (translation, central symmetry, and axial symmetry) have already been covered in the middle school mathematics curriculum, and homothety is the new common transformation. This course covers the properties of homothety regarding lengths, angle measures, parallelism, orthogonality, areas, constructing an image of a given figure, and discovering the concept of enlargement and reduction of a figure. The four activities of this study are presented in Table 1.

Table 1. The four activities of the study

Activity1: 1. Place two points A and O. 2.Construct the image du point A by the homothety of center O and factor 1.5 3. Read the values the lengths of segments: OA and OA'. 4. Place, in the plan, three points A, B and C then construct the triangle ABC. 5. Construct the image of the triangle ABC by the homothety of center O and the factor 1.5. What do you notice?
Activity2: 1. Place, in the plan, three points A, B et C then construct the triangle ABC. 2. Construct the image of the triangle ABC by the homothety in center O and the factor 1.5. 3.Calculate the lengths of segments of the triangle ABC, and of their image by the homothety of center O and factor 1.5 A'B'C'. 4.Compare, (using the symbols<, > or =) the lengths of segments making up the figure. A'B' _ _ _ _ _ AB A'C' _ _ _ _ _ AC B'C'_ _ _ _ _ BC 5. In Conclusion, I conclude that (tick the right answer or answers). • The homothety does not preserve lengths • The homothety preserves the lengths • The homothety doubles the lengths
Activity3: 1. Place in the plan three points A, B et C then construct the triangle ABC. 2. Construct the image of the triangle ABC by the homothety of center O and factor 1.5. 3. Calculate the values of the areas of the triangle ABC, and of its symmetrical by the homothety of center O and fact 1.5 A'B'C'. 4. Compare, (using the symbols<, > or =) the values of the areas of the triangles ABC and A'B'C'. area (A'B'C') _ _ _ _ _ area (ABC) 5. In Conclusion, I conclude that (tick the right answer or answers). • The homothety doubles the areas. • The homothety does not preserve the areas. • The homothety preserves the areas.
Activity 4: 1. Place in the plan three points A, B and C then construct the triangle ABC. 2. Construct the image of the triangle ABC by the homothety of center O and factor 1.5. 3. Mesure the values of the angles of the triangle ABC, and of its symmetrical by the homothety of center O and factor 1.5 A'B'C'. 4. Compare, (using the symbols<, > or =) the values of the angles that constitute the figure. mes B' A'C'_ _ _ _ _ mes BAC mes A'C'B' _ _ _ _ _ mes ACB mes C'B'A'_ _ _ _ _mes CBA 5. In Conclusion, I conclude that (tick the right answer or answers). • The homothety preserves the measures of angles. • The homothety does not preserve the measures of angles. • The homothety doubles the measures of angles.

4. RESULTS

To achieve our objectives, we are interested in the comparison of the averages obtained by the two groups of this experiment. As the two groups are the same samples (18 students) and the analysis aims to verify the impact of a qualitative variable (teaching method) on a dependent variable quantitative (the averages of the control and evaluation tests). For all these reasons, we have chosen to use the ANOVA test. The descriptive statistics of results of the test and evaluation given in Table 2. The table describes, for each group, the average score of the two tests. The principal finding from the table show that the best scores (12.861 and 17.431 out of 20 points) are obtained by students who belong to the experimental group G1 who had been taught using a cooperative pedagogy incorporating creative use of ICT.

Table 2. Distribution the averages of control test and evaluation test for the two groups

Group	Control test average	Evaluation test average
G1	12.861	17.431
G2	10.875	14.014

Table 3 gives the analysis of variance by ANOVA. According to the very high significance of the *F* statistic and of p-value which is below the significance level (alpha: 0.05), that either for the control test (F=12.185, p<0.001, *ddl*=3) or the evaluation test (F=167.826, p<0.0001, *ddl*=3), the hypothesis H_0, according to which the averages of the tests of the two groups are similar, will be rejected. So, the difference between the groups is highly significant. We can conclude that the teaching method adopted has a very significant impact on the students' learning.

Table 3. Analysis of variance

Test	*DDL*	*F*	$P_r > F$
Control	3	12.185	< 0.001
Evaluation	3	167.826	< 0.0001

To determine the extent to which experimental group (G1) differed significantly compared to the witness group (G2), we used the Tukey test which allows them to compare each pair of averages. For the diagnostic test: the p-value is p=0.295, which is not significant, we can assume that there was no significant difference between the groups tested. For the control test, the multiple comparison control test given in Table 4 shows that G1 presents the significant differences in regard to the second group is very significant (p<0.001 between G1 and G2) with differences in the obtained in the control test (+1.986 in comparison to G2).

Table 4. Comparison multiple of diagnostic tests' results, assessment test and evaluation test for two groups

Test	Contrast	Difference	Standardized difference	Critical value	$P_r >$ Diff	significant
Diagnostic	G1 vs G2	0.667	1.063	2.032	0.295	No
Assessment	G1 vs G2	1.986	3.491	2.032	<0.001	Yes
Evaluation	G1 vs G2	3.417	12.955	2.032	<0.0001	Yes

This result confirms that the students in the experimental group G1 gained quite significantly in performance compared to those in the control group G2. For the evaluation test, the multiple comparison given in Table 4 shows that the difference between the experimental group and the control group is very significant. (p<0.0001 between G1 and G2) with differences in the obtained in the control test (+3.417 in comparison to G2). This result confirms that the students in the experimental group G1 gained quite significantly in performance compared to those in the control group G2. The results obtained confirm the importance of using ICT in general and the GeoGebra software in particular in the context of learning applied to the experimental group G1.

5. DISCUSSION

Our results suggest that the passive use of GeoGebra without learners participating in the production of content does not achieve educational goals. The method of combining the creative use of GeoGebra with cooperative pedagogy in which students produce is always preferred and this is the case of the G1 in our experiment which obtained the best averages compared to the other groups in the experiment. Also, by aligning with Lebrun [20], we can ensure that the use of ICT promotes success and facilitates the adoption of active teaching methods and offers them a variety of possibilities to enrich them. Conversely, the active methods promote the success of the integration of ICT. In view of the findings of this study, it seems that using collaboration among learners is necessary for an innovative approach to teaching with ICT. and the creation content by learners themselves. These results come to reinforce the conclusions of numerous studies synthesized in the literature review on the impact of ICT in European schools [21, 22] that emphasize that the use of ICT must be approached pedagogically, considering differentiation and supporting a project-based approach to enhance learning.

In another sense, technology in schools will become "new" if the pedagogy using it is innovative, as emphasized by Bibeau [23] in a conference discussing the difficulties of integrating computers in schools. I this context, the results of the study support those of numerous studies that show that the use of GeoGebra contribute positively to the process of students' learning [24]. Based on these results, we can say that the GeoGebra software alone cannot promote effective learning, but its use in a cooperative pedagogical context where learners are engaged in the process of a creative use of dynamic digital resources related to the learning objectives allows them to construct their knowledge through its construction protocol, visualization functions, and concretization.

The effectiveness and success of the pedagogical integration of ICT really depends on the degree to which "new technologies with new pedagogies and create a socially active classroom, simulating cooperative interaction, collaborative learning and group work [25], in the same vein, the author in [26] consider "positive evolution was not only due to individual reflective work but also to collective work organized and supervised by the research team". Our results also show that the use of GeoGebra software allowed students to progress significantly in terms of learning the homothetic transformation. These results reinforce the conclusions of numerous studies on the impact of the use of GeoGebra [10-12]. But this use still remains limited because according to Romero and all in [27] "even if the technological uses related to passive or interactive consumption could have an initial motivating effect, their added value is very limited". Therefore, it is necessary to combine this use with innovative pedagogy to achieve the educational goals.

6. CONCLUSIONS

The present study aimed to investigate the impact of integrating the GeoGebra software on student learning, using the discovery of the usual transformation of homothety as an example. It also sought to determine the influence of cooperative pedagogy on such integration, in other words, to search for the appropriate formula for a relevant combination of technology and pedagogy to make the learner more active, productive, and responsible in their learning. To this end, an experiment was conducted with 36 students in the scientific 1st year highschoolers divided into two groups (one experimental group and one control group).

It is true that updating the school curriculum requires a higher teaching-learning workload than before, but we can take advantage of distance learning, which has become one of the pillars of successful educational systems. We believe that hybrid teaching and learning, and subsequently dividing classes into two modes: face-to-face and distance, can help us generalize this teaching and learning method and also motivate other mathematics and other subject teachers to work with such a method and consequently experiment with it in new ways, and then have new ideas to improve our teaching and learning. The present research gives us motivating results regarding the use of ICT in mathematics education with cooperative pedagogy. We intend to add distance learning to our approach in the next research and see to what extent the method (use of ICT, cooperative pedagogy, and distance learning) will be useful and what their differences will be compared to our method.

ACKNOWLEDGEMENTS

- Provincial Directorate of National Education Tantan, Morocco.
- The high school director qualifying al Quods Tantan, Morocco.
- Students of the 1st year of high school scientific in qualifying al Quods Tantan, Morocco.

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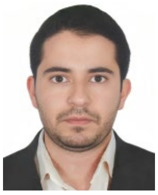

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