Study of the impact of ICT on the active pedagogy

Said Etterach[1] and Moulay Youssef Hadi[1] and Fatima-Zahra Guerss[3]

[1] Faculty of Science, Ibn Tofail University, Kenitra, Morocco,
[1] Faculty of Science, Ibn Tofail University, Kenitra, Morocco,
[2]Ibn tofail University, Kenitra,Morocco

Abstract. The aim of this study introduced in this article is to examine the effect of creative use of Geogebra software in the context of active pedagogy. The research sample consisted of 36 students divided into two groups. The first experimental group was taught with Geogebra software and cooperative pedagogy .On the other hand, the second witness group was taught to focus on the active pedagogy only. The target population is thirty six students of scientific first year of High school of provincial direction of Tantan –Guelmim Ouednoun region-Morocco.
A diagnostic test is organized before the experiment and it was used to distribute the students and check their prerequisites. Quantitative data was collected using test and evaluation organized respectively during and after the experiment, and the qualitative data was collected using a focus group. The ANNOVA analysis and Tukey's test show that the integration of the Geogebra software teaching and the mobilization of active teaching methods (collaborative) with the commitment of learners in the process of using Geogebra creatively to improve the students' achievement compared to the other group and the analysis NVIVO has shown that creative use of Geogebra can improve other student skills (autonomy, self-esteem, active learning, etc.)…

Keywords: Geogebra, Creative use of ICT, Homothety, 1st year of High school, cooperative pedagogy.

1. Introduction:

In the last decades, Morocco, like several developing countries, has invested a lot of efforts in order to integrate Information Communication and Technology (ICT) in education and update their educational system with technological emergence that affects all areas and therefore make this progress in the service of education, but this integration is limited in most of the time in the physical side concerning computers, tablets, data shows….

In this context, our article deals with the active use of technology, more precisely, the dynamic geometry software Geogebra in the teaching of usual transformations in the plan and particularly the discovery of homothety; one of the usual transformations studied in the Moroccan mathematics syllabus for students of 1st year Science in High school, i.e. we study the impact of the use of ICT on the active pedagogy.

M. Khaldi et al. (eds.), *Proceedings of the E-Learning and Smart Engineering Systems (ELSES 2023)*, Atlantis Highlights in Social Sciences, Education and Humanities 14,
https://doi.org/10.2991/978-94-6463-360-3_52

So, we have settled the following hypotheses to be tested:

- **The integration of learning dynamic environments of mathematics can ameliorate the results of students in the subject of mathematics.**
- **The combination between technology and active pedagogy could improve the qualitative skills of learners.**

This study has two goals. First, to evaluate the impact of the integration of Geogebra software in the students learning. Second, to determine the influence of the cooperative pedagogy on this integration for students of 1st year scientific stream.

In fact, our problem generates the following questions:

- **What is the impact of the pedagogic integration of the ICT on the results of the learners in mathematics?**
- **What are the perceptions of the learners about the benefits of the use of Geogebra software in mathematics?**
- **What are the developed qualitative competences of the learners when technology is combined with the cooperative pedagogy?**

The results of our study show that the active use of ICT helps learners to improve their level in mathematics and that the software of the dynamic geometry Geogebra is an effective solution to present and facilitate mathematical concepts which are difficult to understand by the classical method. Also, the impact of the creative use is not limited to the quantitative side, but far from that as it improves other qualities and other skills in students such as: autonomy, anti-stress ….

All these results can help us to solve other problems of educational systems such as dropping out of school, school failure and violence in schools. That is to say that the effective use of ICT and their coupling with innovative pedagogies has indirect advantages on the success of any educational reform.

2. Review of literature:

Today, the world has undergone an inevitable evolution thanks to the progress of ICT which affects all fields in which the field of teaching and learning must benefit from it because « ICT provides an opportunity to rethink and relocate, in space and time, exchanges between teachers and students, thus fostering new avenues for learning or training activities » (Depover, Karsenti and Komis, 2007, p. 179, quoted in Oudrhiri, 2016a). In other words, "The introduction of digital technologies in education appears as an opportunity to develop new pedagogical approaches aimed at improving the quality of the teacher in the field and student learning" (Nouhou, 2019).

«The integration of ICT in the field of education brings so many benefits such as flexibility, accessibility, increasing exchanges and interactions among the various actors in educational system. » (Karsenti, 2003 cited by Nafidi, 2019).

In addition, the use of ICT for personal purpose does neither allow for the achievement of the educational objectives nor the development of learners' competences, because when learners are « put in a learning environment which allows them only to view the digital resources or to interact with certain elements of the environment without any productive realization, they will be in a position of consumers ». (Romero, Lille, Patiño 2017)

Therefore, it is necessary to mix a pertinent use of ICT and the appropriate teaching modes would ameliorate the process of teaching mathematics. Yorganci (2015),That's to say, « The use of technologies can promote more active, even socio-constructivist pedagogical approaches, that would motivate teachers to shift their practices in this direction […] enable learners to be more active, productive and creative… Likewise, certain competences are linked to cooperation, communication, methodology and re-flexibility would be reinforced through these practices ». (Bullat- Koelliker and Staf 2003)

As a result, the teaching of Mathematics in general and geometry in particular, is increasingly marked by the integration of dynamic learning environments. This type of learning environment is considered to be an environment in which learners can imagine, construct, and use mathematical concepts. Dynamic learning environments allow learners to perform mathematical operations and study relationships between objects, which would not be as intuitive in a paper-pencil environment as emphasized by many authors (Charles-organ and Gladys Ibibo; Hohenwarter and Jones, 2007; Güyer, 2008)."

Depover and Al. (2007) reported that dynamic geometry software provides improved cognitive learning environments. These programs allow students to explore and solve problems in meaningful ways. Several studies have analysed the effect of the use of dynamic geometry software on the learning process of students' mathematics and their overall success. Several studies have shown that students who use Geogebra software generally have higher math scores and a better understanding than students who do not use the software (Dogan, 2010; Tay and Mensah –Wonkyi 2018; Williams, Charles-Ogan and Adesope 2017; Arbain, and Shukor, 2015; Mehanovic 2011). However, other studies have shown that the use of Geogebra software does not allow learners to significantly improve the learning process (Ogbonnaya and Alfred 2017; Ljajko 2017; Masri and all 2016; Vasquez 2015).

In view of the various studies, it seems that the passive use of the Geogebra software does not always allow to improve the mathematical skills of the learners. For this, we will see how the results will be when we combine the use of this software with an innovative pedagogy (cooperative) and how effective that combination will be.

3. Research Methodology:

As a reminder, our study has two goals. First, to evaluate the impact of the integration of Geogebra software in students' learning. Second, to determine the

influence of the cooperative pedagogy on this integration. To do so, we adopted a quasi-experimental methodological approach. This research model is designed in accordance with the pre-and post-experiment control group model. We applied this to recognise the rules of homothety; one of the usual transformations studied in the Moroccan mathematics syllabus for students of 1st year science in high school.

The study was carried out with 36 students belonging to one class of 1st year of high school and took place in the engineering room at Al-Quds high school in Tan-Tan during the 2021-2022 school year and was carried out over a two-hour-session.

Our sample consists of 36 students belonging to two classes. We have divided them into two groups of 18 students for each we will note: GE and GT. The experimental group GE followed this experiment with Geogebra and the cooperative pedagogy. Whereas, the GT witness group focused only on the cooperative pedagogy.

The content taught to the two groups is the same and it is related to the transformation of homothety. This lesson contains the properties of homothety transformation concerning the lengths, angle measurements, parallelism, orthogonality, areas of geometric figures, and the image construction of a given figure.

The students of the group GE have benefited from a session of two hours of familiarization with Geogebra software. However, the students of the second group GT have worked on expository method that consists of collective visualizations of activities already created with PowerPoint and Geogebra software's.

Before beginning this experience, all students have had a diagnostic test in order to divide them into groups in this study, and check students' basic learning's so as to tackle the new notion (homothety). This diagnostic test includes the properties of similar triangles, areas, and properties of the central symmetry and axial. The diagnostic test is made up of ten multiple-choice questions (MCQs), the students are invited to tick the correct answer.

Then, we used a control test after the experimentation session and an evaluation test one week after the experience and a focus group after the last experience session.

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.

group	Control test average	Evaluation test average
GE	12.861	17.431
GT	10.139	12.056

Table1: Distribution the averages of control test and evaluation test for the two groups.

Table 2 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=25.535, p<0.0001, ddl=3) or the evaluation test (F=417.594,p< 0.0001, ddl=3), the hypothesis H0, 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 2: analysis of variance

	DDL	F	Pr > F
Control	3	25.535	< 0.0001
Evaluation	3	417.594	< 0.0001

To determine the extent to which experimental group GE differed

significant compared to the witness group GT, we used the Tukey test which allows them to compare each pair of averages. For the control test, the multiple comparison control test given in Table 3 shows that GE presents the significant differences in regard to the second group is very significant (p<0,0001 between GE and GT) with differences in the obtained in the control test (+2.722 in comparison to GT).

Table 3: Comparison multiple of diagnostic tests' results, assessment test and evaluation test for two groups.

	Contrast	difference	Standardized difference	Critical value	Pr > Diff	significant
Diagnostic	Group GE vs Group GT	0.639	1.030	2.032	0.310	No
Assessment	Group GE vs Group GT	2.722	5.053	2.032	<0.0001	Yes
Evaluation	Group GE vs Group GT	5.375	20.435	2.032	<0.0001	Yes

For the evaluation test, the multiple comparison given in table 5 shows that the difference between the experimental group with a control group is very significant (p<0,0001 between GE and GT) with differences in the obtained in the control test (+5.375 in comparison to GT).

To see the impact of our experiment on the qualitative side, we utilized a focus group of 8 students who were selected randomly. The choice of this method is justified because the focus group is flexible and allows us to question many students at the same time. In addition, it gives students more courage to give their opinion because they often find the group discussions amusing and interesting. The focus group lasted for 8 minutes and aimed at asking students about their opinions on this new experience. We recorded the discussion in form of audio, after reviewing the records, we proceeded to the transcription phase and eventually we used software of qualitative data analysis called NVIVO.

The results obtained with the help of NVIVO show that the use of Geogebra with the cooperative method does not only improve the students in terms of mathematical abilities, but also improves other qualities and other competences in students like:

Anti-stress: The use of Geogebra software has created an anti-stress atmosphere for the students, as the use of the software as an intermediary in the learning process decreases the students' stress. As RD states, "This method has allowed me to reduce the stress level of the classroom where I work with paper and pencil. The increase in self-esteem is a direct consequence of the decrease in stress as confirmed by YS "teaching mathematics with the computer is more relevant and easier than teaching with the traditional method", in the same sense Pelgrum and Law (2004) consider that ICT has the potential to improve certain skills, including motivation, enjoyment of learning and self-esteem.

Autonomy: The use of software makes students independent and capable of learning individually or in groups. Therefore, the student can learn alone through the use of software as KT states, "this experience allowed me to conclude that the teacher is not the only the one who has knowledge", or the student can learn alone or with others independently of the teacher, as YS states, "I propose this method so that students can work on mathematics alone". In the same vein, Deaudelin, C., & Nault, T. (Eds.). (2003) affirm that « today, technology allows students to work even more autonomously than before, alone or in small groups » (p.31).

5. Discussion:

Our results suggest that the use of cooperative pedaogy in the absence of ICT can improve students' performance compared to traditional teaching. The method of combining the creative use of Geogebra with cooperative pedagogy, in which students produce, is always preferred. This was the case with the GE group in our experiment, which obtained the highest averages compared to the other groups. Therefore, we can conclude that the use of ICT with cooperative pedagogy enables students to improve their mathematical competences.

In the same way, according to Ouellet, Delisle, Coutute and Gauthier (2000), ICT can stimulate the development of certain intellectual skills. The authors note that information and communication technologies make it possible to accumulate knowledge, but also to develop and encourage the spirit of research, facilitate teamwork and develop metacognition.

The effectiveness and success of the pedagogical integration of ICT really depends on the degree of "new technologies with new pedagogies and create a

socially active classroom, simulating cooperative interaction, collaborative learning and group work." (UNESCO, 2011).

6. Conclusions and Perspectives:

Our results show that it is necessary to mix technology and pedagogy to put the learner in the center of the learning-teaching process.This combination has pertinent advantages like the improvement of the mathematical competences, autonomy, cooperation, and self-esteem…

This research gives us motivating results about the use of ICT in teaching of mathematics with the cooperative pedagogy. So, we suggest adding distance teaching to our method in the coming research and see to which extent this method (the use of ICT, cooperative pedagogy and distance teaching) will be beneficial and how it will be different from our method.

References

1. Nouhou, A. M. Impact de l'utilisation de GeoGebra sur l'apprentissage des élèves: Cas de la compréhension du concept de fonctions numériques au lycée (Doctoral dissertation, Cergy-Pontoise). (2019).

2. Arbain, N. & Shukor, N. A. The effects of Geogebra on student's achievement. Procedia –Social and Behavioral Sciences, 172, 208-214. (2015).

3. Bullat-Koelliker, C., & Gina, S. (2003). Les apports des TIC à l'apprentissage. Ce qu'en pensent les enseignants qui utilisent les ateliers d'informatique avec leurs élèves (Mémoire de DESS). Faculté de Psychologie et des Sciences de l'Education, Université de Genève. Récupéré du site : http://tecfaetu.unige.ch/perso/staf/bullat/doc/Bullat-Koelliker_DESS-TECFA.pdf 32.

4. Charles-Ogan, G., & Ibibo, G. (2018). GeoGebra: technological software for teaching and learning of calculus in Nigerian schools. American Journal of Applied Mathematics and Statistics, 6(3), 115-120.

5. Depover, C., Karsenti, T. & Komis, V. (2007). Enseigner avec les technologies : favoriser les apprentissages. Presses Universitaire du Québec, Québec, 2007.

6. Deaudelin, C., & Nault, T. (2003). Collaborer pour apprendre et faire apprendre: la place des outils technologiques (Vol. 8). PUQ.

7. Dogan, M. (2010). The role of dynamic geometry software in the process of learning: Geogebra example about triangles. Journal of Human Sciences, vol 8, 1.

8. Güyer, T. (2008). Computer algebra systems as the mathematics teaching tool. World Applied Sciences Journal, 3(1), 132-139.

9. Hohenwarter, M., & Jones, K. (2007). Ways of linking geometry and algebra, the case of Geogebra. Proceedings of the British Society for Research into Learning Mathematics, 27(3), 126-131.

10. Karsenti, T. (2006). Comment favoriser la réussite des étudiants d'Afrique dans les formations ouvertes et à distance (foad): principes pédagogiques. TICE et développement, 2(9), 9-23.

11. Ljajko, E. (2017). Does the problem complexity impact students' achievement in a computer aider mathematics instruction? Teaching of Mathematics, 19(1).

12. Masri and all (2016). The effects of using Geogebra teaching strategy in Malaysian secondary schools: A case study from Sibu, Sarawak. Malaysian Journal of Society and Space, 12-7).

13. Mehanovic, S (2011). The Potential and Challenges of the Use of Dynamic Software in Upper Secondary Mathematics Students' and Teachers' Work with Integrals in Geogebra Based Environments(mémoire, Linkoping University).

14. Ogbonnaya, I. O. and Alfred. (2017). The impact of using Geogebra to teach circle geometry on grade 11 student's achievement.

15. Oudrhiri, M. (2016a). De l'usage pédagogique du numérique dans l'enseignement des mathématiques au Maroc. Revue EPI, 185,

16. Ouellet, J., Delisle, D., Couture, J., & Gauthier, G. (2000). Les TIC et la réussite éducative au collégial. Collège de Chicoutimi.

17. Pelgrum, W. J., & Law, N. (2004). Les TIC et l'éducation dans le monde: tendances, enjeux et perspectives. UNESCO, Institut international de planification de l'éducation.

18. Romero, M., & Belhassein, D. (2019). Interdisciplinarité et usages Co-créatifs du numérique en éducation.

19. Romero, M., Lille, B., & Patiño, A. (2017). Usages créatifs du numérique pour l'apprentissage au XXIe siècle. PUQ.

20. Tay, M. K and Mensah-Wonkyi, T. (2018). Effect of using Geogebra on senior high school students' performance in circle theorems. African Journal of Educational Studies in Mathematics and Sciences, vol.14, 2018.

21. Youssef,Nafidi. (2016). Intégration pédagogique des TIC dans l'enseignement du secondaire: Impact et évaluation des enseignements et des apprentissages.

22. YORGANCI, S. (2015). Web Tabanli Uzaktan Eğitim Yönteminin Öğrencilerin Matematik Başarilarina Etkileri. Kastamonu Eğitim Dergisi, 23(3), 1401-1420.

23. UNESCO (2011). Les défis de l'enseignement des mathématiques dans l'éducation de base. Paris, France: UNESCO.

24. Vasquez, E. D., (2015). Enhancing student achievement using Geogebra in a technology rich environment (Master's thesis, Califirnia State Polytecnic University, Pomona).

25. Williams, C., Charles-Ogan, G. and Adesope, R.Y. (2017). The Geogebra interactive software and senior secondary school tree (SSS3) student's interests' and achievement in mathematics. International Journal of Mathematics and Statistics Studies. 5(1), -8.