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Mobile App: A Boost in Math Learning Motivation

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Abstract

This paper presents a study analyzing the impact of the mobile application Aplic Triang to help high school students learn the topic "Application of Right Triangles." This work eliminated the impact of the teacher's experience to present evidence that the didactic strategy using the mobile app made a difference in student performance. Students used the application to solve exercises, working in pairs in only one class session. Then, 11 days after the practice session, an exam was applied whose results were analyzed. We conducted a one-way Anova test comparing students' average time solving two exam exercises, analyzing the experimental and two control groups, and finding a significant statistical difference between their means. The experimental group and the first control group were taught by the same teacher, while another taught the second control group. The statistical test results suggest that using the strategy that included the mobile app helped students consolidate their knowledge of the topic, regardless of the teacher.

Key Words: Trigonometry Learning, Application of Right Triangles, Mobile Apps for Learning, Educational Innovation, Higher Education.

Introduction

Several studies state that mobile applications positively impact student performance, motivation, and learning attitudes [1], [2], [3]. In the spring term of 2021, the Aplic Triang mobile application [4] was used for the first time in an experimental group and compared with a control group, finding a significant difference in the time a student takes to solve one exercise [5]. Then, in the spring of 2022, the Aplic Triang mobile application was used to demonstrate that the significant difference in the time reduction was not related to the teacher's expertise but to the didactic strategy that included the mobile app. This paper presents the didactic strategy in class to use the app, some of the mobile app characteristics, the result of the test applied, and, finally, the conclusions of the work.

Literature review

Several authors state that the positive correlation between learning results and motivation is a precondition for learning success [1], [6]. According to Duarte [7], increasing the motivation of young people in academic activities requires incorporating technology and improving performance and productivity in the classroom. Jimenez, Mora, and Cuadros [8] suggest that with technology, students increase their motivation, a fundamental element in the educational process. Bartolomé-Pina, Garcìa-Ruiz, and Aguaded [9] suggest that new ways of teaching and learning must be adapted to the new media and learning contexts. As noted by Samper, the students' needs, context, and time for learning should be a priority of every teacher when planning their classes [10]. According to Moreira, when students enjoy working with technology, the result can be a better understanding of the subject and the ability to use and apply it [11].

A Survey conducted by Poçan, S., Altay, B. & Yaşaroğlu, C [1] showed the effects of using apps on the success and motivation of 73 students in a high school algebra class. The findings revealed that mobile technology applications positively impact the learning process. Fabian, Topping, and Barron [2] explored the effects of mobile technology on the attitudes and achievements of 52 elementary school students. They found that mobile technology results in positive student responses, improving their performance. Yussop, Annamalai, and Salam [3] investigated to find out the effectiveness of a particular mobile application. They found that by using the app, students learned math more easily. According to Bryers [12], to get the student more actively involved in trigonometry learning, teachers must find the best tools to make learning efficient and effective and find attractive and diverse educational options to present content differently.

The use of mobile applications facilitates teaching and learning, personalizing the learning and adapting it to the specific needs of each student, favoring self-directed learning. However, relevant and appropriate apps sometimes cannot be found [13]. Also, it is strongly recommended that the apps be fundamental to avoid distractions for young learners [14]. Using apps and other technologies offers immediate feedback, making it easier for students to test their ideas and revise their concepts [15]. The apps allow more interaction and more effective learning in which the students are active participants in their learning process, in contrast with the experience of traditional teaching and learning. Mobile devices can significantly transform and improve formal and informal mathematics education [16]. Incorporating technological tools in education provides benefits that facilitate knowledge and interaction with the students, as well as efficiency and productivity in the classroom.

Method

1. Context

In the spring term of 2021, the Aplic Triang mobile application was used for the first time in an experimental group consisting of three classes taught by the same teacher and compared with a control group consisting of three classes taught by other teachers, finding a statistical significant difference in the time a student takes to solve one exercise [5]. But the question arose: Can this difference be due to the teacher's expertise? So, in the spring of 2022, the Aplic Triang mobile application was used again to demonstrate that the significant difference in the reduction of time was not related to the teacher's expertise but to the didactic strategy, which included the mobile app. The research was carried out during the spring semester of 2022 in a private high school in Mexico; the students were between 16 and 17 years old. The population included all the students of three out of six groups taking the subject Trigonometry; the two groups of one of the authors of this paper were chosen, and also another group of another professor.

2. The Application

The authors of this work designed and developed the mobile application Aplic Triang [4], which allows users to practice "Application of Right Triangles" exercises. This application is available in the App Store for iOS OS (iPhone, iPad).

The application has 25 types of exercises, each with variables randomly calculated, so the application always provides different exercises. Figure 1 displays some screen captures of the app.

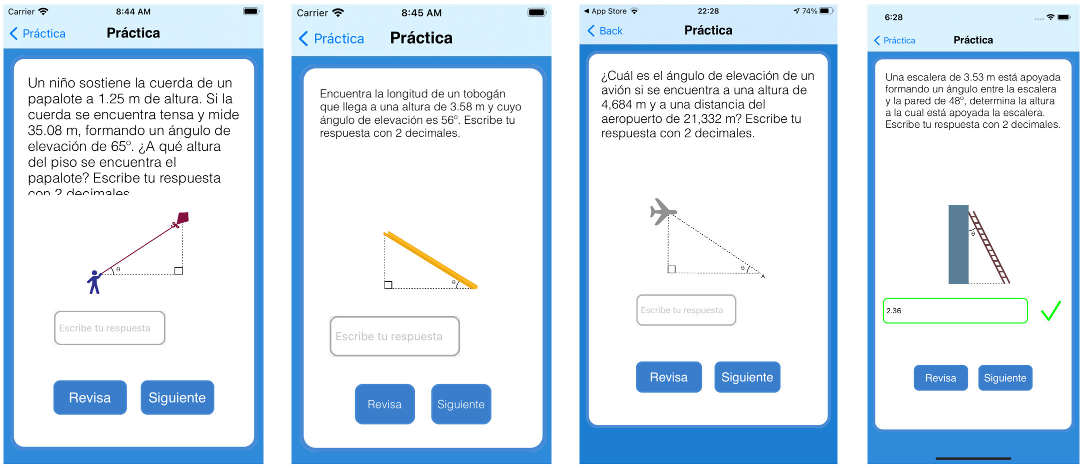

Figure 1. Screen captures of the practice section of the Aplic Triang mobile App, where several types of exercises can be seen.

The application has three main sections; the first is for practice, where students can solve as many exercises as they want. The second one is a quiz with 5 questions that the students must answer within 10 minutes. The third one tracks all the activities in the app. In both practice and quiz sections, the tool gives students immediate feedback about the correctness of their answers; when the answer is wrong, the app presents the option to display the correct answer, allowing the students to check why their answers were incorrect.

3. The strategy

The topic "Application of Right Triangles" was covered in two one-hour sessions in the three groups. The professors explained the concept in the first session and solved several problems to show the students the solution strategies.

The second session was different for the control (CGs) and experimental groups (EG). In the CGs, the professor gave the students a list containing about 15 exercises, and each pair of students finished between 6 and 10 in the 1-hour class session. In the CGs all the students have the same exercises and it is easy for them to share information between the pairs, thus limiting their learning.

In the experimental group using the mobile app, each pair of students was first required to solve at least 5 practice exercises correctly. They usually try to solve more than 5 in order to obtain the 5 correct exercises, which allows them to discover and take ownership of the solution strategy. Then they are asked to solve one quiz in 10 minutes with all the five exercises correct. The app's timer helps them manage their time and forces them to solve problems quickly.

Figure 2 contains screen captures of two teams of students. The dark blue squares indicate practice exercises, while the light blue squares correspond to quiz exercises. The activity of this class session was evaluated the same way as any class activity for experimental and control groups.

The module exam was applied approximately 11 days after using the mobile app in the class session. Two out of 10 exercises of the exam were on the topic "Application of Right Triangles." Every Trigonometry class was evaluated using the standardized test of the Aleks tool [17].

Figure 2. Screen captures of two teams of students. The images show the number of correct exercises and the number of intended exercises.

4. The experiment

The research design was quasi-experimental with a quantitative approach, where an experimental group (EG) and two control groups (CGs) carried out a post-test.

Group	Teacher	Number of students	Question	Average grade per exercise	Average grade for the two exercises	Time consumed to solve each exercise
EG	A	25	exercise 1	100	100	1'08"
			exercise 2	100		1'47"
CG_1	A	22	exercise 1	95	88.5	1'43"
			exercise 2	82		2'12"
CG_2	B	26	exercise 1	96	92.5	1'20"
			exercise 2	89		4'18"

Table I. Descriptive statistics of the three groups.

Table I shows that the EG had 25 students taught by teacher A, the first control group CG_1 had 22 students taught by teacher A, and the second control group CG_2 with 26 students was taught by teacher B. The time each student took to solve each one of the exercises in the CGs and EG was obtained from the Aleks tool, which also showed if the answer was correct or incorrect.

The null hypothesis (H_0) stated that the time used by the students to solve an exercise would be the same in the three groups, while the alternative hypothesis (H_A) stated that the time spent by the EG students to solve an exercise would be less than the time of the students in the two control groups (CG_1 and CG_2).

Results

To show that the three compared groups were similar, we also compared their final average grades and found they all have similar conditions (see Appendix A).

Each student's time to solve two exercises in the module exam was compared in the three groups. The one-way ANOVA with the Tukey test was applied, using a significance level of 0.05 (5%) and standard deviation known.

The null hypothesis was rejected when comparing groups EG and CG_1 (p-value = 0.0043) and EG and CG_2 (p-value = 0.020). The null hypothesis was accepted when comparing CG_1 and CG_2 (p-value = 0.75). In other words, there was no significant difference between the CGs, and there was a significant difference between the EG and the CGs. These results are shown in Table II.

Compared Groups	p-value	Result
EG, CG_1	0.004331	Rejected
EG, CG_2	0.020899	Rejected
CG_1, CG_2	0.752166	Failed to Reject

Table II. Results of the one-way ANOVA test with Tukey applied to compare the time students took to solve two exercises in the experimental and control groups.

The results of the statistical tests suggest a significant difference in the time the students spend solving a problem on the topic "Application of Right Triangles" with and without the didactic strategy that uses the Aplic Triang mobile application regardless of the teacher. So the teacher was not the differentiator, but the technology-based strategy was.

Discussion

When applying the strategy described, the professor observed that the students were more enthusiastic about solving the exercises in the app than before under traditional teaching methods. With the app, at least 80% of the students completed the exercises in less time than available. In a traditional class, students have the same exercises and can help each other, but with this mobile application, they were forced to solve the problems by themselves since different exercises were generated each time.

The professor of the EG and CG_1, who has been teaching math for 30 years, affirms that in a traditional class session, the students generally solve no more than 10 exercises, even though they have more available exercises to solve. On the other hand, the students in the EG not only solved at least 10 exercises required for the class activity correctly but also worked on more problems, practicing, obtaining wrong answers and finding an effective way to solve this kind of problems. According to Hernandez [18], the experience of solving problems becomes an opportunity to learn.

Hadijah, Isnarto, and Walid [19] reported a positive correlation between immediate feedback and math learning results. With this app, the students receive immediate feedback, which does not happen when solving the exercises using traditional methods. This helps students be confident about their skills, and keeps them motivated to continue practicing, minimizing repeated mistakes and correcting them. Flores [20] mentioned that one way to measure a student's learning is the time he takes to solve the exercises. The results obtained by our research suggest that the didactic strategy where the mobile app was used, besides helping students take less time to solve the exercises, also helped them learn the concepts better; this can be observed because all the students of the EG solved the two exercises correctly (see Table I), while in the CGs, not all the students had a correct answer.

Conclusions

As conclusions of this work, it can be said that:

- Thanks to the didactic strategy, including the Aplic Triang mobile app, the students could solve and practice more exercises in class than usual.
- The students worked more engaged and motivated with this topic, which can be attributed to using the mobile app.
- There is a significant difference in the time used to solve exercises by students who used the didactic strategy based on the mobile application, less than those who did not.
- This work highlights the need for teachers to adapt their classes to new learning methods, including technology, to increase students' motivation and engagement.

- It is essential to consider that the results of this implementation cannot be generalized but can be considered a step for further implementations that would analyze the effects of mobile apps on the learning process of high school students.

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Appendix A

We compared students' final average grades in the Trigonometry course to show that the three groups were similar. In this case, they were compared using the one-way ANOVA with the Tukey test. The null hypothesis (H_0) was that the final average grade would be the same in the three groups, while the alternative hypothesis (H_A) would be that they would not be the same. The null hypothesis failed to be rejected for the three comparisons (with p values 0.77, 0.98, and 0.85, respectively). Consequently, there was no significant statistical difference between the final average grades of the three groups. These results show that the three groups were in the same basic conditions. Table III displays the results.

Compared Groups	**p-value**	**Result**
EG, CG_1	0.767765	Failed to Reject
EG, CG_2	0.982741	Failed to Reject
CG_1, CG_2	0.853648	Failed to Reject

Table III. Results of the one-way ANOVA test with Tukey applied to compare the average grade of the experimental and control groups.