Adv Mobile Learn Educ Res, 2022, 2(2): 464-474
DOI: 10.25082/AMLER.2022.02.015

RESEARCH ARTICLE

Augmented reality mobile application to improve the astronomy teaching-learning process

Saul Beltozar-Clemente[1] **Fernando Sierra-Liñan**[2] **Joselyn Zapata-Paulini**[3] **Michael Cabanillas-Carbonell**[4*]

[1] Universidad Científica del Sur, Lima, Perú
[2] Facultad de Ingeniería, Universidad Privada del Norte, Lima, Perú
[3] Universidad Continental, Lima, Perú
[4] Vicerrectorado de Investigación, Universidad Norbert Wiener, Lima, Perú

Correspondence to: Michael Cabanillas-Carbonell, Vicerrectorado de Investigación, Universidad Norbert Wiener, Lima, Perú; Email: mcabanillas@ieee.org

Received: July 12, 2022;
Accepted: September 2, 2022;
Published: September 6, 2022.

Citation: Beltozar-Clemente, S., Sierra-Liñan, F., Zapata-Paulini, J., & Cabanillas-Carbonell, M. (2022). Augmented reality mobile application to improve the astronomy teaching-learning process. *Advances in Mobile Learning Educational Research*, **2**(2), 464-474. https://doi.org/10.25082/AMLER.2022.02.015

Abstract: It is during the primary education stage that children begin to awaken their interest in science and, in turn, have new mathematical, geographical, and scientific knowledge, which are the basis for understanding astronomical aspects. This research focuses on developing an Augmented Reality Mobile Application based on the Mobile-D methodology for the teaching-learning process of astronomy in 4^{th} and 6^{th} grade students. The random selection design of an experimental group applied to a sample of 60 students was used, subdivided into groups of 30 students each. Finally, it can be concluded that the use of an Augmented Reality mobile application for the teaching-learning process significantly influences elementary school students in the subject of astronomy.

Keywords: education, astronomy, mobile–D, Augmented Reality

1 Introduction

Education can be defined as the process of socialization of people. By being educated, the person assimilates, understands, and obtains knowledge from babies to adults, transmitted from generation to generation (UNICEF, 2017).

Education in astronomy generates tremendous interest from an early age in some children, which with time, will generate more doubts about how the universe was created. Is there life beyond? Astronomy is a science that opens many doors to other sciences, such as mathematics, geography, biology, and physics, and l which, through the study of this science, it is possible to understand topics such as the dimensions of the stars, dimensions of the planets themselves, the gravity of each one and estimated time of rotation to complete a turn (Ezberci Çevik & Tanik Önal, 2021). Primary education is when students are trained who will build a foundation for understanding astronomical aspects and their relationship to mathematics or geography, making astronomy an interdisciplinary subject. However, despite the educational potential that astronomy suggests, several studies indicate that it is a complicated discipline to teach as much as learning it. This is due to the lack of teacher training in this aspect of science (Konstantopoulou et al., 2022; Domènech Casal, 2015).

For today, the XXI century, Peruvian school education has not made significant contributions to increasing the motivation of schoolchildren (United Nations Educational (UNESCO), 2022) since the state very rarely takes advantage of the potential of emerging technologies (Kapaniaris & Zampetoglou, 2021), although the pandemic accelerated the process of adaptation to the use of these technologies, it is still necessary to delve into the subject and leave behind education based on books, writings, and dictations, which is a form not very convincing for some students (Cabanillas-Carbonell et al., 2020) since it is estimated that more than half of students in a classroom do not pay attention to classes because they are topics that do not attract their attention or that they find very boring the repetitive, and that is that teachers usually use inferior didactic strategies (Javier Murilloa et al., 2016).

The educational system does not let primary and secondary students free their imagination in topics of more remarkable adaptation (Kikilias et al., 2009). On the contrary, when some study centres change their teaching methodology, this significantly influences students' academic performance. Since, when making the change, the student will feel freer to say what they think, in addition to having the advantage of obtaining learning not only face-to-face but also at a distance (Gamboa-Ramos et al., 2021). Some students claim that they prefer to learn through a concept of interactivity with objects, compared to just listening to what teachers expose on the subject.

The use of technologies in different fields is increasingly necessary, and in education, it has been revolutionized (Raja & Nagasubramani, 2018; Katsaris & Vidakis, 2021; Papadakis, 2020). Augmented Reality (A.R.) is a growing technology thanks to the expansion of mobile devices. A.R. tries to offer multimedia content in a didactic and enriching way to the user, increasing their perception of reality and providing many advantages in the field of education (Skaraki & Kolokotronis, 2022; Zapata-Paulini et al., 2020). This is how the implementation of emerging technologies in education, specifically Augmented Reality, is supposed to be a great potential that can be used for the teaching of topics belonging to astronomy.

Poor reading comprehension and lack of skill in mathematical calculations (Kalogiannakis, & Papadakis, 2017) are at the base of the problems that students have as they progress through the course, and these difficulties are forged in the first years of schooling, between the ages of three and twelve (Spencer & Wagner, 2018). So alternative teachings emphasize enhancing the independence and autonomy of students from the beginning because students must want to learn for education to be successful (Karakose et al., 2021), and they need to be provided with the most appropriate means to achieve it. In general, alternative education methods are based on offering the student the tools that allow him to become self-taught, although always under the direction of specialized teachers (Alirio Pérez et al., 2016; Papadakis, 2022).

Alternative teaching methods differ from the conventional educational system (Papadakis et al., 2020), although they are not a novelty since they have been operating for decades. Some schools base their pedagogical system on one of these methods that, in addition, can also be used for extracurricular activities, as is the case of the Kumon method. The Kumon method is divided into different levels, ranging from early childhood education to high school; the student is tested at the beginning to check at what level he should start, and it is structured so that until he masters the knowledge of one level, he cannot move on to the next (Orcos et al., 2019). This method is enough to practice the activity twice a week, for about half an hour, dedicating only a few minutes daily.

The present work is structured as follows. Section 2 describes the methodology used for this research, where the phases of the Mobile-D methodology are detailed, as well as the application development. Section 3 describes the Results and Discussions of the tests carried out on the application. Finally, section 4 details the conclusions derived from the study.

2 Methodology

The present research and the Mobile-D methodology allow us to assemble a project cycle based on five phases: exploration, initialization, production, stabilization, and testing of the system. In general, all phases (except the first exploratory phase) have three distinct development days: planning, work, and release (Alnanih et al., 2019).

2.1 Exploration

The exploration phase, being slightly different from the rest of the production process, is dedicated to establishing a project plan, and the basic concepts can be separated from the primary development cycle. This process is carried out in three stages, stakeholder establishment, scope definition, and project establishment.

The stakeholders of the project were the users of the application (The students of 4th and 6th grade of primary of the program “PROMINNATS” in the NGO IFEJANT), the Sponsor (Program “PROMINNATS” in the NGO IFEJANT), and finally the research development group. As a research sample, the 4th B and 6th A grades were chosen, each room represented by 30 students making a total of 60 students.

Therefore, the development and implementation of a mobile application of Augmented Reality for students in 4th and 6th grade of the primary school of the “PROMINNATS” program in the NGO IFEJANT was a scope so that students could use a Tablet or Mobile Phone to visualize the content regarding planets in a more didactic way and a project development based on the proposed methodology phases.

2.2 Initialization

Plans are prepared for the subsequent phases, and the technical environment, such as physical, technological, and communications resources, are established, including the training of the development team. To do this, we proceeded to carry out an analysis of the requirements and the establishment of the architecture of the project, where the mobile device captured a scene through its rear camera, the SDK of the software “Vuforia” (Unity, 2018), creates a frame of the same scene, converting the captured image into a different one with better resolution. The same SDK will look for matches in the database, which will be composed of the default targets made, proceeding to the application to verify the target with the logic programmed in Unity (Unity, 2016), which will proceed to render the image-making it a virtually interactive content with the end user, showing itself on the screen of the mobile device, observing itself as Augmented Reality.

In addition, we proceeded to the development of the prototyping and the application navigability scheme approach, where there is a start menu that contains the actions of "Start", "Exit", and "Credits". When starting the application, the camera will open automatically, which, when observing the target, will consult the database to which animation it belongs, showing the appropriate interactivity. The student, if he wishes, can make his doubts about the subject.

2.3 Product phase

The schedule (planning, work, release) is repeated until all functionalities are implemented using test-driven development to conduct the entire implementation.

Figure 1 shows the logo developed for the application with its respective name, "SolarSystemRA".

Figure 1 SolarSystemRA application Logo

On this 2-second screen, students are welcomed by showing the "Start" and "Exit" buttons, shown in Figure 2.

Figure 2 Menu of the SolarSystemRA application

Figure 3 shows the action to be performed after the application is launched. The camera is automatically opened and must be focused on the defined target.

Figure 3 SolarSystemRA application Startup option

After focusing on the target (Figure 3), the application will recognize the target loaded to the predefined database and activate the animation in Augmented Reality shown in Figure 4.

Figure 4 SolarSystemRA application "Show Theme" interface

2.4 Stabilization phase

This methodology phase consists of making the integrations to the software in development and determining a correct operation after pre-performance tests. Which consist of the software recognizing the targets predefined in the database.

In Figure 5 and 6, a student can see the code used and implemented in the Main Menu screen, which consists of the encoding of the "start" and "exit" buttons, each with a set method. In the "Start ()" method it was established that by pressing the "Start" button opens the way to the next screen where the camera opens automatically, to start with the recognition of the targets and the visualization of the animated objects.

```
Assembly-CSharp                                   menuPrincipal
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class menuPrincipal : MonoBehaviour {

    public void Comenzar()
    {
        SceneManager.LoadScene(SceneManager.GetActiveScene().buildIndex + 1);
    }

    public void Salir()
    {
        Application.Quit();
    }
}
```

Figure 5 Code for linking the main menu to "start"

```
RotateScenarie.cs   RotacionXTiempo.js   menuPrincipal.cs
#pragma strict
//declaramos una propiedad para la velocidad del angulo
var velocidadAngulo:float=5.0;
function Start(){

}

function Update(){
//aplicando la transformacion de Rotacion

transform.Rotate(0.0,velocidadAngulo*Time.deltaTime,0.0);
}
```

Figure 6 Rotation code by time

2.5 Testing phase

In this phase, the system is tested and repaired. A test phase is passed until a stable version is proposed above. This goal is to achieve the availability of a stable and fully functional version of the system. This phase aims to verify that the application follows the functional requirements coordinated above to fulfil the correct functioning towards the end user (The students), verifying components and performing the appropriate functional tests of each module developed (Figure 7).

Figure 7 Testing stage of the developed application

3 Results and discussions

Table 1 and 2 show the data obtained from the there-test and post-test indicators set up for the research.

Table 1 Pre-test and Post-test results (Indicators 1, 2, and 3)

Indicator 1 Note		Indicator 2 Note		Indicator 3 Note	
Average		Maximum		Minimum	
Con Group	Exp Group	Con Group	Exp Group	Con Group	Exp Group
12.9	12.8	15.3	16.8	5.2	8.8
12.7	13.4	16.3	16.7	5.1	7.7
12.9	12.7	15.5	16.7	7.4	9.2
12.4	14.0	15.8	15.7	7.5	7.9
13.4	12.1	15.3	16.2	9.0	8.5
12.4	13.4	16.6	15.5	7.0	9.2
13.3	13.5	15.5	16.0	8.9	8.7
13.6	13.5	16.0	16.0	6.4	7.1
12.5	13.2	15.2	16.3	6.6	8.2
13.1	13.2	15.2	16.9	5.3	9.8
13.6	12.9	16.6	16.1	6.2	8.0
12.3	13.4	15.7	16.1	8.6	8.3
14.0	13.6	15.3	16.2	7.2	9.5
12.0	13.2	15.5	15.1	6.2	7.7
13.1	12.3	15.2	15.9	6.3	9.7
13.9	12.2	15.8	15.7	5.9	9.4
13.4	13.4	15.1	16.3	6.8	8.5
14.0	13.1	15.8	15.8	5.2	9.5
14.0	12.8	15.0	16.4	6.8	7.7
13.9	12.3	16.2	15.1	8.6	9.0
13.5	13.5	17.0	15.8	7.9	7.6
12.6	12.8	16.2	17.0	8.7	9.7
13.0	13.4	16.7	15.2	7.3	8.6
13.5	13.7	15.0	15.4	5.6	9.1
13.7	13.9	16.6	16.8	6.5	9.0
12.3	13.3	16.0	16.7	8.5	9.9
12.5	13.9	15.4	16.5	5.7	8.8
13.2	13.7	16.8	15.9	5.7	7.9
12.4	13.7	16.3	16.8	6.7	7.2

Table 2 Pre-test and Post-test results (Indicators 4 and 5)

Indicator 4 Time of teaching (sec)		Indicator 5 Time to resolve a evaluation (sec)	
Group With	Group Exp	Con Group	Group Exp
5345	5547	1114	780
5288	5690	1150	959
5285	5614	1008	1001
5226	5672	927	825
5287	5449	1078	800
5379	5472	985	864
5321	5528	1060	898
5263	5418	1035	927
5265	5625	950	881
5246	5556	984	917
5221	5601	1008	803
5299	5532	1009	915
5323	5463	962	1019
5349	5497	1022	938
5355	5443	1191	976
5243	5579	996	847
5256	5440	1091	795
5299	5513	1085	860
5392	5442	966	794
5257	5540	1168	806
5328	5622	1063	939
5383	5580	1150	982
5312	5692	1095	983
5291	5555	985	1000
5316	5417	1200	855
5283	5405	1049	1014
5379	5538	1172	983
5225	5612	1139	797
5305	5533	940	918
5244	5644	1162	896

(1) **Average grade indicator**. It was found that 63.33% of the average grades in the PostTest were higher than their average. In addition, 33.33% of the average grades in the PostTest were higher than the goal set, which was established to be 13.5. Finally, it was obtained that 66.67% of the average grades in the Post-Test were higher than their average in the Pre-Test.

It is observed in Figure 8 a minimum difference between both results that is 0.1 points, indicating that if we increase the average grade after having put into action the mobile application of Augmented Reality. In addition, the median of the control group is 13.15 points, while the median of the experimental group is 13.31, which we can interpret as not having irregularity in the data obtained. On the other hand, the average grade is 13 out of 20 points, which can be considered an average grade for the students.

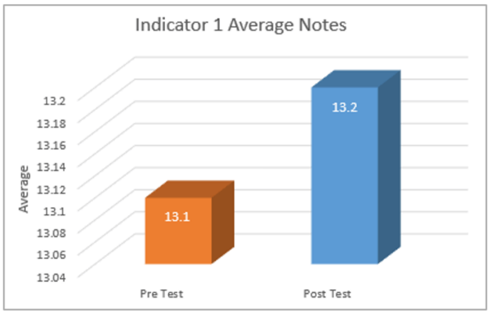

Figure 8 Comparison of Indicator 1 of the Pre-test and Post-test data

From Figure 9, it can be inferred that approximately95% of the grades obtained in the "Average Grade" indicator of the experimental group are within two standard deviations of the mean, between 12.97 and 13.36 scores. The first quartile (Q1) is equal to 12.78 points, which indicates that 25% of the grades obtained in the "Average Grade" indicator are less than or equal to this value. The third quartile (Q3) is equal to 13.53 points, which indicates that 75% of the grades obtained in the "Average Grade" indicator are less than or equal to this value.

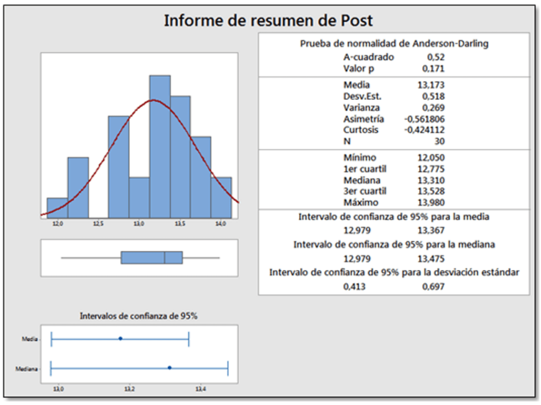

Figure 9 Summary report of Indicator 1 Post–test (Experimental Group)

(2) **Indicator maximum grades**. 53.33% of the maximum grades in the PostTest were higher than their average. In addition,l 30.00% of the maximum grades in the PostTest were higher than the goal set, which was established to be 16.5. Finally, it was obtained that el 73.33% of the maximum grades in the PostTest were higher than their average in the Pre-Test.

It is observed in Figure 10 a minimum difference between both results that is 0.3 points, indicating that if I increase the maximum grade after having put into action the mobile application of Augmented Reality. In addition, the median of the control group is 15.80 points, while the median of the experimental group is 16.12, which we can interpret as not having irregularity in the data obtained. On the other hand, the average grade is 16 out of 20 points, which can be considered high grades for the students.

From Figure 11, it can be inferred that approximately 95% of the grades obtained in the "Maximum Grade" indicator of the control group are within two standard deviations of the mean, which are between 15.89 and 16.30 scores. The first quartile (Q1) is equal to 15.72 points, which indicates that 25% of the grades obtained in the "Maximum Grade" indicator are less than or equal to this value. The third quartile (Q3) is equal to 16.68 points, which indicates that 75% of the grades obtained in the "Maximum Grade" indicator are less than or equal to this value.

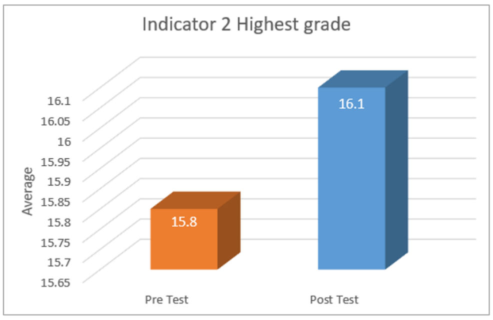

Figure 10 Comparison of Indicator 2 of the Pre-test and Post–test data

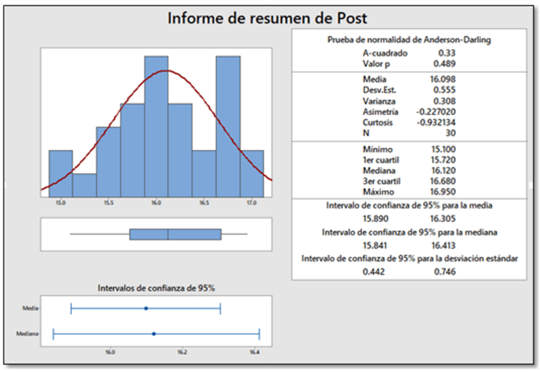

Figure 11 Summary report of Indicator 2 Post–test (Experimental Group)

(3) **Minimum grade indicator**. It was obtained that 46.67% of the minimum grades in the PostTest were lower than their average. In addition,60.00% of the minimum grades in the PostTest were lower than the goal set. Finally, 0% of the minimum grades in the PostTest were lower than their average in the Pre-Test.

It is observed in Figure 12 a difference between both results that is 1.8 points, indicating that if I increase the minimum grade after having put into action the mobile application of Augmented Reality. In addition, the median of the control group is 6.63 points, while the median of the experimental group is 8.65, which we can interpret as not having irregularity in the data obtained.

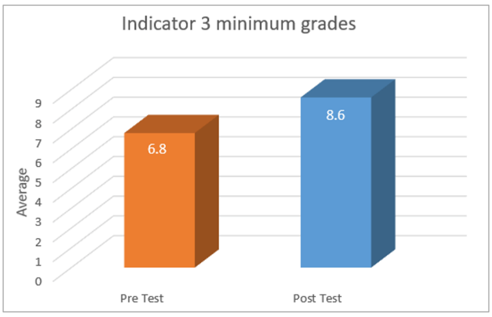

Figure 12 Comparison of Indicator 3 of pre-test and post-test data

From Figure 13, it can be inferred that approximately 95% of the grades obtained in the "Minimum Grade" indicator of the control group are within two standard deviations of the mean, which are between 8.26 and 8.89 scores. The first quartile (Q1) is equal to 7.83 points, which indicates that 25% of the grades obtained in the "Minimum Grade" indicator are less than or equal to this value. The third quartile (Q3) is equal to 9.26 points, which indicates that 75% of the grades obtained in the "Minimum Grade" indicator are less than or equal to this value.

(4) **Teaching time indicator**. It was obtained that 46.67% of the teaching time in the PostTest was more significant than their average. In addition,43.33% of the teaching time in the PostTest was more significant than the goal set. Finally,100% of the teaching time in the PostTest was more significant than your average in the PreTest.

It is observed in Figure 14 a difference between both results that are four additional minutes, indicating that if I increase the teaching time after having put into action the mobile application

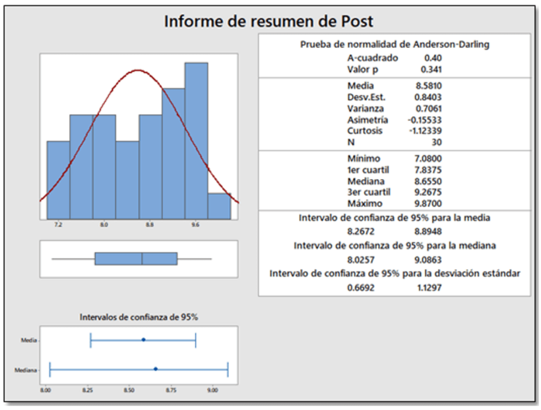

Figure 13 Summary report of Indicator 3 Post–test (Experimental Group)

of Augmented Reality. In addition, the median of the control group is 88.25 minutes, while the median of the experimental group is 92.31 minutes, which we can interpret as not having irregularity in the data obtained. On the other hand, we observe that the average teaching time is 1 hour and 30 minutes, which can be considered an optimal teaching time for students.

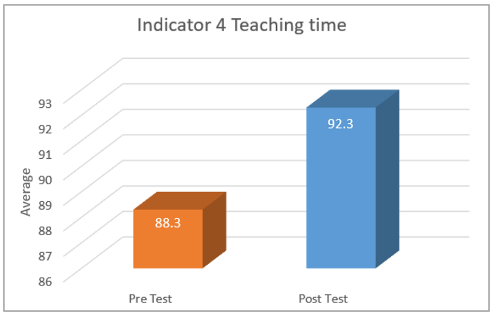

Figure 14 Comparison of Indicator 4 of pre-test and post-test data

From Figure 15, it can be inferred that approximate 95% of the time obtained in the "Teaching time" indicator of the control group is within two standard deviations of the mean, which are between 91,821 and 92,867 minutes. The first quartile (Q1) is equal to 90,992 minutes, which indicates that 25% of the time obtained in the indicator "Teaching time" is less than or equal to this value. The third quartile (Q3) is equal to 93,542 minutes, which indicates that 75% of the time obtained in the indicator "Teaching time" is less than or equal to this value.

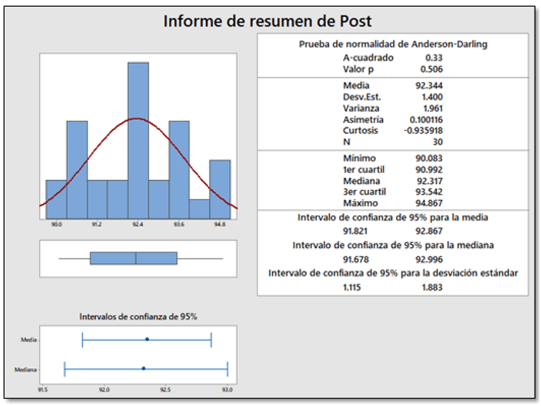

Figure 15 Summary report of Indicator 4 Post–test (Experimental Group)

(5) **Indicator time to resolve an evaluation**. It was obtained that 50.00% of the time in solving an evaluation in the PostTest was less than their average. In addition, 63.33% of the time, solving an evaluation in the PostTest was less than the goal. Finally, 100% of the time in solving an evaluation in the PostTest was less than their average in the PreTest.

It is observed in Figure 16 a difference between both results that is 2.65 additional minutes, indicating that if I decrease the time to solve an evaluation after having put into action the mobile application of Augmented Reality. In addition, the median of the control group is 17.56

minutes, while the median of the experimental group is 15.1 minutes, which we can interpret as not having irregularity in the data obtained. On the other hand, we observe that the average time to solve an evaluation is 20 minutes, which can be considered an optimal time for students.

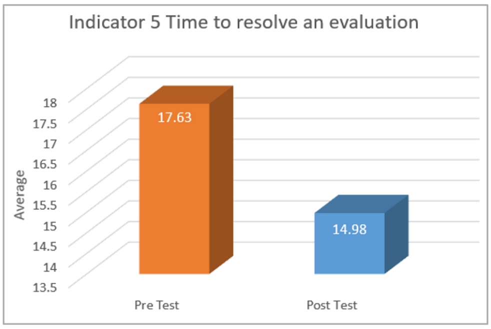

Figure 16 Comparison of Indicator 4 of the Pre–test and Post–test data

From Figure 17, it can be inferred that approximate 95% of the time obtained in the indicator of "Time to solve an evaluation" of the control group are within two standard deviations of the mean, which are between 14,507 and 15,462 minutes. The first quartile (Q1) is equal to 13,671 minutes, which indicates that 25% of the time obtained in the indicator "Time to solve an evaluation" is less than or equal to this value. The third quartile (Q3) is equal to 16,292 minutes, which indicates that 75% of the time obtained in the indicator "Time to solve an evaluation" is less than or equal to this value.

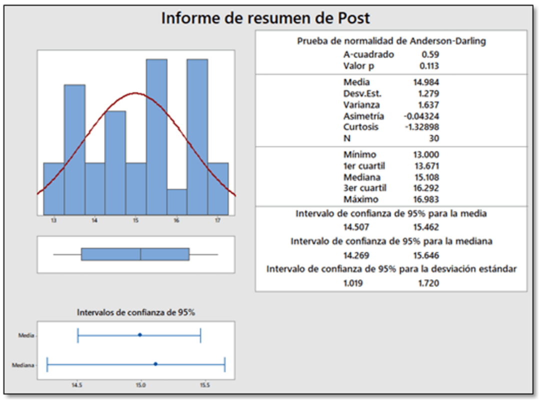

Figure 17 Summary report of Indicator 5 Post–test (Experimental Group)

4 Conclusions

Nowadays, mobile applications have taken on greater relevance worldwide since, from their use, you can perform several actions previously unique to computers (Kalogiannakis & Papadakis, 2020). This streamlines several processes and has interesting educational purposes (Tzagkaraki et al., 2021). This research aimed to implement a mobile application of Augmented Reality that contributes to the teaching-learning of astronomy and figure out its influence on students in 4th and 6th grade of primary school, allowing them to observe animations of the planets more interactive way and generate greater interest in this science.

After the results were obtained, it was found that having implemented the mobile application of Augmented Reality, using the Mobile – D methodology, improved the Teaching-Learning Process in the students of 4th and 6th grade of the primary school of the, I.E. San José Obrero in the program "PROMINNATS" in the NGO OFEJANT. It was also observed that after the application implementation, there was an increase in the number of maximum grades in students. There was a decrease in the number of minimum grades in students, as well as the number of average grades of students increased; there was also an increase in the number of minutes taught per class; finally, the time to resolve an evaluation was reduced. This confirms that the implementation of the mobile application of Augmented Reality increases the level of interest of students in learning new topics related to astronomy.

It is recommended that temporary work continues with the application's study and development, implementing new interactions between students and applications that make learning more striking for them.

Conflicts of interest

The authors declare that they have no conflict of interest.

References

Alirio Pérez, Á., Beatriz Africano Gelves, B., Alejandra Febres-Cordero Colmenárez, M., & Enrique Carrillo Ramírez, T. (2016). Una aproximación a las pedagogías alternativas An approach towards alternative pedagogies.

Alnanih, R., Bahatheg, N., Alamri, M., & Algizani, R. (2019). Mobile-d approach-based persona for designing user interface. International Journal of Advanced Trends in Computer Science and Engineering, 8(5), 2597-2607. https://doi.org/10.30534/IJATCSE/2019/111852019

Cabanillas-Carbonell, M., Canchaya-Ramos, A., & Gomez-Osorio, R. (2020). Mobile application with augmented Reality as a tool to reinforce learning in pre-Inca cultures. Proceedings of the 2020 IEEE Engineering International Research Conference, EIRCON 2020, 42, 3-6. https://doi.org/10.1109/EIRCON51178.2020.9254018

Domènech Casal, J. (2015). Eppur si muove: una secuencia contextualizada de indagación y comunicación científica sobre el sistema astronómico Sol-Tierra. Revista Eureka Sobre Enseñanza y Divulgación de Las Ciencias, 12(2), 328-340.

Ezberci Çevik, E., & Tanik Önal, N. (2021). Türkiye'de Okul Öncesi Astronomi Eğitimine İlişkin Yapılan Çalışmaların Tematik İncelenmesi. Kastamonu Eğitim Dergisi, 29(2), 362-377. https://doi.org/10.24106/kefdergi.770393

Gamboa-Ramos, M., Gómez-Noa, R., Iparraguirre-Villanueva, O., Cabanillas-Carbonell, M., & Salazar, J. L. H. (2021). Mobile Application with Augmented Reality to Improve Learning in Science and Technology. International Journal of Advanced Computer Science and Applications, 12(10), 487-492. https://doi.org/10.14569/IJACSA.2021.0121055

Javier Murilloa, F., Hernández-Castilla, R., & Martínez-Garrido, C. (2016). ¿Qué ocurre en las aulas donde los niños y niñas no aprenden? Estudio cualitativo de aulas ineficaces en Iberoamérica. Scielo, 38(151), 55-70. https://www.scielo.org.mx

Kalogiannakis, M., & Papadakis, S. (2017). Pre-service kindergarten teachers acceptance of "ScratchJr" as a tool for learning and teaching computational thinking and Science education. In Proceedings of the 12th Conference of the European Science Education Research Association (ESERA), Research, practice and collaboration in science education (pp. 21-25). Dublin: Dublin City University and the University of Limerick.

Kalogiannakis, M., & Papadakis, S. (2020). The use of developmentally mobile applications for preparing pre-service teachers to promote STEM activities in preschool classrooms. In Mobile Learning Applications in Early Childhood Education (pp. 82-100). IGI Global.

Kapaniaris, A. G., & Zampetoglou, G. (2021). Visual programming for the creation of digital shadow play performance using mobile devices in times of Covid-19. Advances in Mobile Learning Educational Research, 1(2), 162-170. https://doi.org/10.25082/AMLER.2021.02.010

Karakose, T., Polat, H., & Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the COVID-19 pandemic. Sustainability, 13(23), 13448.

Katsaris, I., & Vidakis, N. (2021). Adaptive e-learning systems through learning styles: A review of the literature. Advances in Mobile Learning Educational Research, 1(2), 124-145. https://doi.org/10.25082/AMLER.2021.02.007

Kikilias, P., Papachristos, D., Alafodimos, N., Kalogiannakis, M., & Papadakis, St. (2009). An Educational Model for Asynchronous E-Learning. A case study in a Higher Technology Education, In D. Guralnick (ed.) Proceedings of the International Conference on E-Learning in the Workplace (ICELW-09), 10-12 June 2009, New York: Kaleidoscope Learning (CD-Rom).

Konstantopoulou, G., Dimitra, V., Papakala, I., Styliani, R., Vasiliki, T., Ioakeimidi, M., Niros, A. D., Boutis, M., & Iliou, T. (2022). The mental resilience of employees in special education during the pandemic Covid-19. Advances in Mobile Learning Educational Research, 2(1), 246-250. https://doi.org/10.25082/AMLER.2022.01.008

Orcos, L., Hernández-Carrera, R. M., Espigares, M. J., & Magreñán, A. (2019). The Kumon method: Its importance in the improvement on the teaching and learning of mathematics from the first levels of Early Childhood and Primary Education. Mathematics, 7(1), 109. https://doi.org/10.3390/MATH7010109

Papadakis, S. (2020). Tools for evaluating educational apps for young children: a systematic review of the literature. Interactive Technology and Smart Education, 18(1), 18-49. https://doi.org/10.1108/ITSE-08-2020-0127

Papadakis, S. (2022). Apps to Promote Computational Thinking Concepts and Coding Skills in Children of Preschool and Pre-Primary School Age. Research Anthology on Computational Thinking, Programming, and Robotics in the Classroom, 2, 610-630. https://doi.org/10.4018/978-1-6684-2411-7.CH028

Papadakis, S., Trampas, A., Barianos, A., Kalogiannakis, M., & Vidakis, N. (2020). Evaluating the Learning Process: The "ThimelEdu" Educational Game Case Study. In Proceedings of the 12th International Conference on Computer Supported Education - Volume 2: CSEDU, ISBN 978-989-758-417-6, pages 290-298.
https://doi.org/10.5220/0009379902900298

Raja, R., & Nagasubramani, P. C. (2018). Impact of modern technology in education. Journal of Applied and Advanced Research, 3, 33-35.

Skaraki, E., & Kolokotronis, F. (2022). Preschool and early primary school age children learning of computational thinking through the use of asynchronous learning environments in the age of Covid-19. Advances in Mobile Learning Educational Research, 2(1), 180-186.
https://doi.org/10.25082/AMLER.2022.01.002

Spencer, M., & Wagner, R. K. (2018). The Comprehension Problems of Children With Poor Reading Comprehension Despite Adequate Decoding: A Meta-Analysis. Review of Educational Research, 88(3), 366-400.
https://doi.org/10.3102/0034654317749187

Tzagkaraki, E., Papadakis, S., & Kalogiannakis, M. (2021). Exploring the Use of Educational Robotics in primary school and its possible place in the curricula. In Educational Robotics International Conference (pp. 216-229). Springer, Cham.

UNESCO (United Nations Educational, S. and C. O. (2022). Leave No Child Behind, Boys' disengagement from education, Peru case study. Bulletin of the American Academy of Arts and Sciences, 47(2), 32.
https://doi.org/10.2307/3824397

UNICEF. (2017). Educación y aprendizaje.
https://www.unicef.org

Unity. (2016). Unity - Manual de Unity.
https://docs.unity3d.com/es/530/Manual/UnityManual.html

Unity. (2018). Vuforia – Unity Manual.
https://docs.unity3d.com

Zapata-Paulini, J. E., Soto-Cordova, M. M., & Lapa-Asto, U. (2020). A Mobile Application with Augmented Reality for the Learning of the Quechua Language in Pre-School Children. 2019 IEEE 39th Central America and Panama Convention (CONCAPAN XXXIX), 1-5.
https://doi.org/10.1109/concapanxxxix47272.2019.8976924