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Area Calculation using Measure (iPad and iPhone App)

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Abstract

Mobile applications are rapidly growing in importance and can be used for various purposes. They are now widely used in education. One of the educational purposes for which mobile applications can be used is to calculate the exact result of surface area. This research aims to study the relationships between behavioral factors and the perceived usefulness of using the Measure mobile application in calculating polygonal surfaces. Also, the purpose of the research is to investigate the performance, satisfaction, and perceived behavior of the students while using this application. The methodology of the study is the observation method. The sample of the study includes 50 students from the primary and lower secondary school "Heronjtë e Lumës" Vërmica /Prizren, and from the primary and lower secondary school "Zef Lush Marku" Velezha/Prizren from the Republic of Kosovo. For data collection, the observation list with three sections of 10 indicators is the main instrument. The results of this study show that the use of the Measure mobile application in learning mathematics for students using the application helped to increase student achievement and success. Also, the application was considered satisfactory and promoted a significant increase in students' knowledge, being appropriate for its intended use.

Keywords*— *Area, Learning, Math, Measure, Mobile Apps, and Students

I. INTRODUCTION

Traditionally, education is provided in classrooms where students can interact directly with their teachers, making the physical presence of students very important. However, the widespread distribution of computers and communication technologies has made the learning process easier. Since the advent of mobile phones in the 1980s, they have been widely used by people of all ages around the world. It can be said that the whole world is becoming mobile, where mobile phones are not only communication devices but also mobile and private devices of technological equipment [1].

Nowadays, mobile technologies are becoming more and more widespread and networked. Such technologies can be creatively used in various fields. The use of mobile technologies in education is a clear example of such innovation. Mobile devices equipped with Internet connections have created the need for a new form of e-learning, called mobile learning. Internet-enabled mobile devices can help learners access learning resources and online courses anywhere, anytime. The mobile application industry is growing rapidly [2].

Students will learn how to calculate the area of various shapes during their time in elementary and junior high school. They will start by calculating the area of squares and rectangles. The area is the term used to define the amount of surface area occupied by a 2D shape or surface. We measure the area in square units: cm^2 or m^2. The area of a rectangle is calculated by multiplying the length of a shape by its width. Whereas, to calculate the area of the square, we simply multiply two of the sides together. Learning about the surface area of different surfaces helps students estimate and quantify the size and space they take up. These learning units also pave the way for more complex concepts later in their learning journey. In their everyday lives, students will also need to recognize and apply their understanding of calculating surface area.

Technology in the classroom is about more than just pleasing students who want to see you realize value from their investment. New digital tools can help you engage students at all levels, activate multiple learning styles, and provide exciting and memorable activities for them. So, technology, and especially various mobile applications are promoting the love of mathematics which is one of the biggest obstacles to getting students interested in science, technology, engineering, and mathematics careers [3].

Measuring apps, on the other hand, are apps designed to help you quickly measure real-world objects without relying on a conventional tape measure. Powered by AR

(augmented reality) and on-device sensors, these apps are pretty reliable as long as you're not going to use them for professional use cases. If you are someone who wants to measure length, width, or area, you can use one of the apps available on the iPad and iPhone [4].

1.1. Purpose of Study

This research aims to study the relationships between behavioral factors and the perceived usefulness of using the Measure mobile application in calculating polygonal surfaces. Also, the purpose of the research is to investigate the performance, satisfaction, and perceived behavior of the students while using this application. Also, to compare the area of the polygonal surfaces calculated with the relevant formulas with the one calculated by the application.

II. MATERIALS AND METHODS

Technology is a tool and how teachers use that tool greatly affects how well students learn math. Good use of technology, like making other instructional decisions about mathematics, requires teachers to have a solid knowledge of mathematics and a working knowledge of available technologies. There is nothing wrong with students knowing more than their teachers about how to use certain features of a calculator or an application [5].

Being able to accurately estimate area is important for certain areas of mathematics, and calculating the area of a shape is not always an easy task. Technology is providing dynamic opportunities for learning in math and STEM classrooms. We can enhance the learning process and make concepts come alive through engaging and interactive media. We can also provide additional support to address the needs of all learners and create personalized learning experiences [6]. Here are some important ways students can benefit when we incorporate apps into our geometry lessons.

Therefore, we will elaborate on one of the benefits that mobile applications offer to serve the subject of mathematics. The app in question is the Measure app installed on iPhone and iPad mobile devices.

Measure app uses augmented reality (AR) technology to turn your device into a measuring instrument. You can measure the size of objects, automatically detect the dimensions of rectangular objects and save a picture of the measurement. And with the iPad Pro 12.9-inch (4th generation), iPad Pro 11-inch (2nd generation), iPhone 12 Pro, and iPhone 12 Pro Max, you can measure objects more easily with visible guides, measure the length of a person and see a history of your measurements. However, the measurements are approximate [7].

Fig.1. Measure (iPhone App) [7]

2.1. How to make a single measurement

Open the Measure app, then follow any onscreen instructions that ask you to move the device. This gives your device a frame of reference for the object you're measuring and the surface it's on. Keep moving your device until a circle with a dot in the center appears. Move your device so that the point is over the starting point of your measurement, then tap the Add button. Slowly move your device until the point is over the end point of your measurement, then click the Add button again. After taking a measurement, you can adjust its start and end points. Touch and hold one of the points, then drag it where you want it to go. The measurement changes as you move the point [7].

2.2. Measuring an area

If your device detects that the object you are measuring is square or rectangular, it automatically places a measurement box around the object. Tap the Add button and measurements are displayed for the width and length of the object. Move your device slightly and the calculated image area is displayed. While the measurement is displayed, you can tap the calculated area number to see the length of the diagonal, as well as the area in square inches or square meters [7].

III. METHODOLOGY

3.1. Design of Study

Based on the literature review and previous studies that have focused on factors affecting mobile learning applications and their impact on users, the research model for this study consists of three dependent variables: learner performance, learner satisfaction, and student behavior. In addition to these dependent variables, there are four independent variables: learning outcomes, perceived usefulness, ease of use of the application, and content quality. However, for this research, the method of observational research was chosen. Observational research is a research technique where you observe participants and phenomena in their most natural settings. This allows researchers to see their subjects make choices and react to situations in their natural environment, as opposed to

structured settings such as research labs or focus groups. The choice of this method was specifically for the live situation in the environment where the students are performing surface measurements using the application. During the observation of the students, the teachers also took an active part in the study itself. In addition to observing the students' behaviors, the teachers took notes while the students performed the tasks.

3.2. Participation

The study group of this research consisted of 50 students from the primary and lower secondary school "Heronjtë e Lumës" - Vërmica /Prizren, and from the primary and lower secondary school "Zef Lush Marku" Velezha/Prizren from the Republic of Kosovo. The students were from classes VI-IX and voluntarily participated in this research.

3.3. Research Objectives

The objectives of the research are identified as follows:

1. Are there any significant gains in student learning outcomes while using the Measure mobile app?
2. Is there any significant difference between calculating surface area with a pencil versus calculating with the Measure mobile app?
3. Are there any significant differences between students' attitudes and views when using the Measure mobile application?
4. Are there any significant benefits and usefulness of using the Measure mobile app when calculating the area of polygonal surfaces?
5. Is there any significant relationship between the use of the Measure mobile application and students' motivation and satisfaction when calculating surface area?

3.4. Data Collection and Analysis

To test our model and understand the factors that influence the performance, satisfaction, and behavior of students in using the Measure application, an observation of students using this application was conducted. To achieve our research objectives for data collection, we used a control list, which contained three sections of 10 indicators each, describing indicators such as student performance, student satisfaction, student motivation, student behavior learners, perceived usefulness, quality of content, and ease of use of the application. The indicators were divided on a three-point scale, that of meeting the objectives a high, moderate, and low. These data were then coded and systematically organized to find themes and patterns around the study.

IV. RESULTS

In our observational study, we examined how research students behave when using the Measure mobile application in calculating polygonal surfaces and comparing them when solving problems manually. The following figure shows the use of the Measure mobile application by students:

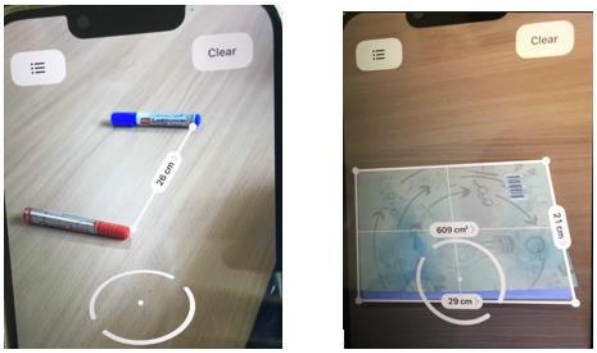

Fig.2. Calculation of distance and surface area using the Measure application

Therefore, during the observation, we used a control list and our results from this study show that our study objectives were met.

The results from the first section of the control list for students' performance when calculating surface area and their comparison with the Measure application are presented as follows:

Table 1. Results from student performance

I. Student performance							
No.	Indicators	High	Percentage	Moderate	Percentage	Low	Percentage
1.1	Success in learning outcomes	38	76.0	10	20.0	2	4.0
1.2	Precision in measuring the lengths and dimensions of polygons	45	90.0	5	10.0	0	0.0
1.3	Impact on error correction when calculating	34	68.0	15	30.0	1	2.0

	the surface area of polygonal surfaces						
1.4	Applying the concept of polygonal surfaces to real-life problem solving	35	70.0	13	26.0	2	4.0
1.5	Self-evaluation of results	39	78.0	10	20.0	1	2.0
1.6	Conceptual learning	34	68.0	15	30.0	1	2.0
1.7	Supports math domain results	35	70.0	13	26.0	2	4.0
1.8	It achieves the learning objectives	35	70.0	11	22.0	4	8.0
1.9	Learning strategies about the learning topic	36	72.0	13	26.0	1	2.0
1.10	Understanding mathematical concepts	32	64.0	16	32.0	2	4.0

From table 1 and the analysis of the control list from the first section, the results of the study show that students were successful in learning outcomes with a mean of 2.72 and a standard deviation of .536. They were accurate in measuring the lengths and dimensions of polygons with a mean of 2.90 and a standard deviation of .303. However, the impact on the correction of errors during the calculation of the surface area of polygonal surfaces was an average of 2.66 and a standard deviation of .519. The application of the surface of polygonal surfaces to real-life problem solving had a mean of 2.66 and a standard deviation of .557. On the other hand, the results from the students' performance show that the self-assessment of the results was with an average of 2.76 and a standard deviation of .476. Conceptual learning had a mean of 2.66 and a standard deviation of .519. The observation with the control list for the support indicator of the results of the field of mathematics had a mean of 2.66 and a standard deviation of .557. Students achieved learning objectives with a mean of 2.62 and a standard deviation of .635, and they had a learning strategy around the learning topic with a mean of 2.70 and a standard deviation of .505. And finally, the results from the first section show a mean of 2.60 and a standard deviation of .571 for the understanding of mathematical concepts.

The results from the second section of the control list for students' motivation and satisfaction during the calculation of surface area and their comparison with the Measure application are presented as follows:

Table 2. Results from motivation and satisfaction of students

I. Motivation and satisfaction of students							
No.	Indicators	High	Percentage	Moderate	Percentage	Low	Percentage
2.1	Motivated to learn	44	88.0	6	12.0	0	0.0
2.2	They enjoy doing the tasks	43	86.0	7	14.0	0	0.0
2.3	Active during class discussions	33	66.0	15	30.0	2	4.0
2.4	Concentration during task solutions	21	42.0	22	44.0	7	14.0
2.5	Effective classroom debates (critical thinking)	28	56.0	22	44.0	0	0.0
2.6	Encourage cooperation	34	68.0	15	30.0	1	2.0
2.7	Stimulation of creativity	27	54.0	18	36.0	5	10.0
2.8	Active participation in forms of learning	34	68.0	14	28.0	2	4.0
2.9	Providing immediate feedback	25	50.0	20	40.0	5	10.0
2.10	Positive attitude toward mathematics	30	60.0	18	36.0	2	4.0

From table 2 and the analysis of the control list from the second section for indicators of student motivation and satisfaction, these results emerge. The results show that they were highly motivated to learn with a percentage of

88%. Likewise, 86% are very satisfied while performing tasks, while only 12% on average are satisfied with performing tasks with the Mesasure application. About 66% of students were more active during class discussions, about 14% on average and only 4% of them were not active during class discussions. They had a higher concentration of 42% during task solutions, while the rest was on average concentrated as in other lessons. Classroom debates were more productive with 56% effective (critical thinking) and 44% average. The results of the control list show that about 68% more encourage application collaboration, 30% on average, and only 2% do not encourage collaboration. The application stimulates creativity more by 54%, on average by 36%, and in 10% of students, it did not affect the development of creativity. Students had active participation in most forms of learning at 68%, on average at 28%, and no active participation at 4%. The results from the indicators in the second section show that the Measure app provides half of the students with immediate feedback. And about 60% of students changed their attitudes to positive ones about mathematics after applying the application while measuring surface area.

The results from the third section of the control list for the benefits and usefulness of students when calculating surface areas and their comparison with the Measure application are presented as follows:

Table 3. Results from benefits and usefulness of students

I. Benefits and usefulness of students							
No.	Indicators	High	Percentage	Moderate	Percentage	Low	Percentage
3.1	Supporting the learning process	35	70.0	13	26.0	2	4.0
3.2	Optimizing available time	37	74.0	10	20.0	3	6.0
3.3	Didactic tool	25	50.0	24	48.0	1	2.0
3.4	Visualization of geometric figures	35	70.0	12	24.0	3	6.0
3.5	Interest in geometric figures	36	72.0	13	26.0	1	2.0
3.6	Acquiring the necessary digital skills	38	76.0	11	22.0	1	2.0
3.7	The more engaging learning environment	33	66.0	16	32.0	1	2.0
3.8	Applies measurement processes by selecting appropriate techniques	31	62.0	15	30.0	4	8.0
3.9	Development of computational skills	46	92.0	3	6.0	1	2.0
3.10	Classifies and promotes relationships between geometric figures	12	24.0	27	54.0	11	22.0

From table 3 and the analysis of the control list from the third section for indicators about students' benefits and usefulness from using the Measure application, these results emerge. The results show that the Measure app influenced 70% to support the learning process as much as possible, 26% on average and only 4% had no support. The application with a mean of 2.86 and a standard deviation of .587 optimized the available time and with a mean of 2.48 and standard deviation of .544 was used as a didactic tool during the calculation and comparison of surface area. The results show that about 70% of students helped them visualize geometric figures, 24% on average, while only 6% of students did not help them visualize plane geometric figures. The application with a mean of 2.70 and standard deviation of .505 created students' interest more in geometric figures, and it helped by about 76% in acquiring the necessary digital skills students. The results of the control list show that 66% of the application created a more engaged learning environment, 32% average and only 2% did not create a more engaged learning environment. The results show that with a mean of 2.54 and a standard deviation of .646, the application implements measurement processes by selecting appropriate techniques and formulas to perform measurements of the dimensions of polygons. Also, with a high percentage of 92%, the application had benefits in the development of calculation skills in students. However, the Measure application was not useful in classifying and promoting relationships between geometric figures, with the results showing that only 24% indicated usefulness, 54% indicated it had a moderate impact, and the rest indicated the opposite.

T-tests were performed to test the objective of whether there is a significant difference between the pencil surface area calculation versus that calculated with the Measure mobile app. The following table is a summary of the t-test analysis for the research objectives:

Table 4. One-Sample Test results from the control list

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Student performance	46,977	49	,000	2,780	2.66	2.90
Motivations of students	41,243	49	,000	2,700	2.57	2.83
Benefits of student	36,962	49	,000	2,680	2.53	2.83

From table 4 we notice that the p-value is equal to .000. In other words, this means that the probability that the sample has a mean difference of 2.78, 2.70, and 2.53, respectively, will indicate that there is a statistically significant difference. Also, the lower and upper bounds do not tend to zero, and that indicates that there are significant differences. Our results from Table 4 show that the lowest values are 2.66, 2.57, and 2.53, respectively. And the upper values are 2.90, 2.83, and 2.83, respectively. Since the bottom and top values do not touch zero, there is a significant difference between calculating surface area with a pencil versus calculating with the Measure mobile app.

Correlation tests were conducted to test the objectives, to understand the relationship between the variables, and to determine the strength of the relationships. The following table is a summary of the Pearson correlation analysis of the research objectives:

Table 5. Correlations results from the control list

		Student performance	Motivation of students	Benefits of student
Student performance	Pearson Correlation	1	,601 **	,331 *
	Sig. (2-tailed)		,000	,019
	N	50	50	50
Motivation of students	Pearson Correlation	,601 **	1	,533 **
	Sig. (2-tailed)	,000		,000
	N	50	50	50
Benefits of student	Pearson Correlation	,331 *	,533 **	1
	Sig. (2-tailed)	,019	,000	
	N	50	50	50
**. Correlation is significant at the 0.01 level (2-tailed).				
*. Correlation is significant at the 0.05 level (2-tailed).				

Pearson correlation coefficient is .601 which describes the mathematical relationship between each variable of student performance, motivation, and benefits the Measure application has high coefficient values indicating that these relationships are statistically significant.

V. DISCUSSIONS

Technology in the educational process is not new and mobile learning applications have now become more widespread. Therefore, it is necessary to understand the impact of mobile applications used in teaching and learning options. This research aimed to investigate the Measure application on the iPhone and conduct observations to verify its impact on students when

calculating surface areas. Control list results during observation overall, the Measure app was found to be more effective for learning than repeated exposure to the learning material in all learning conditions.

Math apps and mobile technologies in general offer improved communication, collaboration, creativity, and problem-solving in classrooms [8]. In addition, pedagogical features in math apps support theoretical components of meaningful learning, including personalized feedback, self-regulation, and customization [9]. Mathematics applications are used effectively in problem-based settings [8]. So, our results confirm similar findings as the performance of students as shown in table 1 presents an average of 2.78, which indicates that the objective of the study was achieved and shows that there is significant success among the learning outcomes of students while using the Measure mobile application.

Importantly, there is growing evidence that educational applications should include high-quality activities that rely on research-based principles to improve learning in general. In particular, educational apps promote (a) active, engaged, and meaningful learning, supporting high-quality social interactions and clear learning goals, and (b) intentional practice that is focused, active, and includes feedback. regular and combines different activities in different contexts [10]. Our results parallel the findings of the above study, as the Measure mobile app stimulated not only the desire to learn but also systematic learning.

It is an accepted fact that students nowadays are very comfortable with mobile applications and the need to use these applications in learning is very evident. The results of the study show that students learn quickly through the Measure mobile app for iPhone and iPad which is the best way these days. Therefore, even to support our study objective, we can say that the Measure mobile application during the calculation of the area of polygonal surfaces had significant benefits and utility. From the results of table 3 from the observation through the control list, we can mention the benefits and uses of the application, where it supported the learning process, optimized the available time, was used as a didactic tool, visualized geometric figures, added interest to students for geometric figures, acquire the necessary digital skills, create a more engaged learning environment, students apply measurement processes by selecting appropriate techniques and formulas to measure the dimensions of polygons, and develop students' calculation skills.

The results of our study show that the t-test value is .000, which is less than the .05 level of significance. Since the bottom and top values do not touch zero, there is a significant difference between calculating surface area with a pencil versus calculating with the Measure mobile app. From this, the other objective of the study was also achieved. So, it is an accepted fact that students nowadays are very comfortable with mobile applications, and the need to use these applications in learning is very evident. The results of the study show that students learn quickly through the Measure mobile app for iPhone and iPad which is the best way these days.

The more motivated students are to learn something new, the more likely the student will learn the material. Research shows that in the ever-increasing world of technology, incorporating technology helps motivate students to learn [11]. The use of applications in the educational field increases the motivation of students during school activities [12]. Also, the results from the study show that the Measure mobile application motivated participating students for mathematics lessons. Our results are presented with an average of 2.70 in favor of students' motivation and satisfaction to use the Measure mobile application. Applications positively affect student participation during the educational process and encourage new ways to achieve learning [13]. The results of our study from the control list show that the other objective of the study was achieved, as a significant difference between the attitudes and views of the students when using the Measure mobile application is proven. The Measure mobile app helps students who are looking for new things in the learning universe. Apart from the sense of novelty, the app adds an element of fun and involvement to the learning process.

A positive Pearson correlation coefficient of .601 shows that with the increase in the value of the student motivation variables and the benefits that the Measure application has the average of the student performance variable tends to increase. From this, we can fulfill the objective of our study that there is a significant relationship between the use of the Measure mobile application and the motivation and satisfaction of students during the calculation of surface area. Also, the impact of mobile applications on student performance is currently related to the use of digital media, computers, and the Internet to facilitate learning. This means that the direct relationship between the Measure mobile app and student performance depends on student motivation and the benefits has this app.

VI. CONCLUSION

Mobile applications open a new way for teaching and learning mathematics in 21st-century classrooms. This study determined the effects of using a Measure mobile application in teaching mathematics when calculating the area of polygonal surfaces.

The study concluded that the use of the Measure mobile app in learning mathematics for students using the app helped to increase student achievement and learning. Also, it was found that the Measure mobile app not only improves learning outcomes but also increases student engagement when calculating surface area. Students had a relatively high level of motivation to perform and learn more, and relatively high perceived satisfaction with the app. Likewise, the use of the Measure mobile application had a significant relationship with student's motivation and satisfaction when calculating surface area. The results also show that students' attitudes and views when using the Measure mobile application are not seen as positive. Additionally, we found that students perceived the Measure app as engaging, interesting, and fun and that they spent some time calculating polygon surface areas in the classroom environment. Overall, our results underline that the application was a useful and effective tool that can support the acquisition and retention of semantic knowledge in different learning environments. Against this background, our results emphasize that the application supports effective learning through integration in different environments and that even its core features can provide students with an enjoyable and motivating experience. In conclusion, the application was considered satisfactory and promoted a significant increase in student knowledge, being suitable for its intended use.

VII. LIMITATIONS OF STUDY

However, our research had some limitations, one of the limitations of the research was that not all students had iPhone or iPad mobile devices available to calculate surface area. However, we have tried to overcome this limitation by distributing the mobile device to other students after completing the task with a classmate.

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AUTHOR CONTRIBUTIONS

All authors have sufficiently contributed to the study and agreed with the results and conclusions.

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DECLARATION OF INTEREST

No conflict of interest is declared by the authors.

REFERENCES

[1] Huet, JM, & Tcheng, H. (2010). What if telecoms were the key to the third industrial revolution? Global edition
[2] Fu, FL, Su, RC, & Yu, SC (2009). EGameFlow: A scale to measure learners' enjoyment of e-learning games. Computers & Education, 52 ed., vol. 1. pp.101-112.
[3] Roland, J. (2023). How to Make Technology in Classrooms Effective and Exciting. Retrieved from hey Teach!: https://bit.ly/3XDIClr
[4] Subin, B. (2023). 10 Best Measurement Apps for Android and iPhone. Retrieved from Beebom: https://beebom.com/best-measurement-apps-android-iphone/
[5] Seeley, CL (2006). Technology Is a Tool. Retrieved from NCTM: https://bit.ly/3IJy409
[6] Scharaldi, K. (2020). What are the benefits of teaching math using technology? Retrieved from Texthep: https://bit.ly/3YJ51z7
[7] Apple. (2023). Use the Measure app on your iPhone, iPad, or iPod touch. (Apple) Retrieved 02 02, 2023, https://apple.co/3Z3XLgS
[8] Aaronson, D., & Barrow, L. (2007). Teachers and Student Achievement in the Chicago Public High Schools. Journal of Labor Economics, pp.95-135.
[9] Railean, E. (2012). Google Apps for Education – A Powerful Solution for Global Scientific Classrooms with Learner-Centered Environments. International Journal of Computer Science Research and Application, pp.19-27.
[10] Bjork, RA (1994). Institutional impediments to effective training. In Druckman D., Bjork RA (Eds.), Learning, remembering, believing: Enhancing human performance. National Academies Press, pp.295–306.
[11] Shaen, RJ, Hayden, G., & Zydney, JM (2016). "Now" We Have an App for That. Teaching Children Mathematics. 22 ed., vol. 8, pp.506-509.
[12] Zeivots, S., & Schuck, S. (2018). Needs and expectations of a new learning space: Research students' perspectives. Australasian Journal of Educational Technology. 34 ed., vol. 6, pp.27-40.
[13] Blaine, AM (2019). Interaction and presence in the virtual classroom: An analysis of the perceptions of students and teachers in online and blended Advanced Placement courses. Computers & Education, 132, 31-43.