THE IMPACT OF A MULTIMEDIA MOBILE APPLICATION

Dinu MIHAIL-VĂDUVA

Bucharest University of Economic Studies, Romania

dinu.mihailvaduva@stud.ase.ro

Abstract. *The objective of this paper work is to emphasize the impact of a multimedia mobile application on the academic performance toward the interface where learning and final evaluation are separated by a thin just-in-time approach. A well-know acronym adopted in computer science says that what you see is what you get. We proposed a paraphrase to the previous acronym with the statement that in educational social field, regardless if you are a learner or a teacher, what you get is not always what you expect, because academic performance is gauged according to the tight formal requirements of the stakeholders. This research handles the self-evaluation academic performance, symbolized here with acronym PE as a new quality metric, in a new way defined by our experimental observations connected with the time coverage, measured in seconds, implemented into a dedicated mobile multimedia application. An experimental laboratory activity was deployed across a sample population of students using a dedicated multimedia mobile application, specially created for this research, with a unique theme and four different versions that emulates a decreasing percent of multimedia components. The primary goal of this research was to observe the impact of the mobile multimedia application proposed and to calculate an analysis with multiple correlation regression between a dependent variable, represented by the self-evaluation academic performance PE, and those independent variables covered by the time coverage of different stages occurred during the running process of our dedicated multimedia mobile solution.*

Keywords: mobile applications, mobile learning, Android, impact on academic performance

JEL Classification: I25, C88, L86

DOI: 10.24818/ie2020.01.06

1 Introduction

Numerous studies have revealed that between academic performance of learners and mobile applications could be positive or negative effects. A study accomplished by the Wang [1] reveals the importance of visual cognitive traits versus verbal ones when he studied impact of those traits toward academic performance. Irregular behavior of learners during classroom activities was remarked by many researchers like Bakon [2] and Shahibi [3] who emphasized consequences like nomophobia or cyberloafing observed by other researchers like Mendoza [4] and Gokçearslan [5]. A literature review was completed by this research to reveal the mathematical tools used to explain the impact between academic performance and different quality metrics regarding mobile applications with multimedia support. From this activity of reviewing different scientific works regarding our objective we emphasize methods like survey or questionnaire used to gauge experimental values of different quality metrics allocated to the mobile apps. This paper is constructed as we declare in the following rows. The first chapter is a mandatory introduction to our objective and offers an explanation toward the objective of this article. The second chapter is a large review of scientific articles that underlines interconnections between other paper works concerning our target, especially those regarding academic performance and the impact of mobile applications. The third section presents the methodology that we created for our target. The next section explains a case study that involves

a mobile application with multimedia support to calculate the quality metric defined by self-evaluation of academic performance as a measurement of the impact of mobile application on the learners. The paper ends with conclusions and details about other intentions that we hope to study in future.

2 Literature review

The impact of mobile applications usage on those people who are seeking formal or informal education is a highly scientific domain for many researchers. The variables used for this objective are gathered keeping account of the actual possibilities of mobile devices, and on the other hand, looking at the final expectation of any learner, which is his score evaluation or, in other words, school performance. Both sides of this educational process are concerned to achieve a high level of final evaluation applied toward knowledge transferred with the help of modern tools like mobile device. The problem raised by this method of delivering knowledge is what effectiveness we could hope to obtain. The researcher Salvation [6] reveals the impact of the amount of time spent by the respondents with different activities regarding mobile application inside a target population involving undergraduate college students. Multimedia environment based on messaging service, entertainment apps or electronic word of mouth that emulates the oldest form of communication between different people were studied by Ahmed [7] using a conceptual separation of variables based on their domain covered. His findings should be considered a practical guide for any decision-makers that are involved above formal or informal educational activities. Excessive usage of social networking apps or sites, with mobile devices, applied over the overall academic evaluation was a primary objective of the researcher Khan [8] who collects data from a group of students involved in Bachelors degree activities. The multiple linear regression was used to discover a negative impact of mobile addiction when he analyze overall academic results. The impact of daily activities of learning with mobile devices was targeted by a researcher Foen [9] who emphasized a negative correlation between a large utilization of mobile devices and the indicator of academic performance named cumulative grade point average. The similar findings should be observed at the researcher Winskel [10] who covered experiments done on groups of students geographically separated which could be lead to the conclusion that results aim toward a widespread behavior. A literature review was completed by Amez [11] about the impact of mobile devices on the general teaching activities that reveal empirical negative results of association between students' proneness to overuse mobile apps and their learning performance. A correlation between browsing frequencies and gathering new knowledge from the Internet and the academic performance was studied by the researcher Sumathi [12] and found that there is no significant link. Financial and academic implications, due to a large usage of mobile devices among the students, with a quantitative study was realized by the researcher Chukwuere [13] and the conclusion says that a positive and negative relevance toward students was found regarding of all actions to keep up to date a lot of software and hardware resources needed to the process of education. The phenomenon of self-efficacy, self-regulation or cyberloafing was studied by the researcher Gokçearsan [5] when he focused the addiction proneness inside the learning environment. He concluded that both cyberloafing and the total time allocated to use mobile devices will be principal factors to increase addiction related to smartphones. The researcher Sunyoung [14] studied the hypothesis of a correlation between self-efficacy and perceived academic performance and he found that there is a positive impact toward academic performance. A real help toward the community of educators is located inside the paper work written by the researcher Jesse [15] who investigates the connections between students dedicated by the a mobile operating system, the most and least applications or social media usage. He found that the most of the students are not fully awareness about the total

functionalities of their own mobile device. The researcher Alfawareh [16] has a scientific article about the effects of mobile devices usage concerning academic staffs in which he unveils a method to create a survey study using questionnaires. He found that a phenomenon of checking habits or creating an artificial relationship between coworkers affect basic performance of academic staffs and the feeling of incompleteness is stronger than ever. Another way of doing scientific research in the field of complex implications of smartphone usage toward academic performance is represented by the author Bakon [2] who created a paper work that reveals a strong and positive correlation between student irregular behavior and perceived social value of the mobile devices. A new direction of what effect could we obtain when we are using mobile devices may be found in the paper work written by the author Mendoza [4]. He search the effects related to the general attention and the learning process when we are considering the factors like time, distraction or nomophobia. He studies using laboratory experiments the conditions needed to be accomplished by a mobile device that could impair the general attention and learning into classrooms. He found that there is a negative impact about academic performance for those students who kept their mobile devices opened during teaching activities. The researcher Giunchiglia [17] is involved into a paper work who studies the mobile social usage and the possible effects toward academic performance. He concluded that a negative correlation could be found between new patterns scattered across the social media and the general academic activities and, by consequence, toward academic performance. He underlines a need to control the mobile device usage in academic environments. The author Kibona [18] introduces a study about proneness of overuse mobile devices especially with social mobile apps and the effect of such behavior related with academic performance. A survey was deployed and the final conclusion reveals that a negative impact toward academic performance could be obtained if an actual trend of wasting 5-7 hours to communicate using social mobile apps will be maintained. An article written by the author Shahibi [3] is orientated toward a new point of view concerning addiction that occurs when we use mobile devices and apps. He emphasizes the need of touch as a new phenomenon regarding mobile devices and he experiments the locus of control behavior as psychological traits correlated with an irregular attitude in front of a new type of technostress. He concluded that an excessive usage could be seen as a source of negative impact regarding academic performance. The researcher Boahene [19] reveals that social media apps deployed on mobile apps with educational learning purpose may have a positive impact related to academic performance of learners. He said that the practical effects of his study should influence the stakeholders to design proper policy and a general guidance to support usage of mobile apps with educational reasons like social mobile apps. An exploratory research completed by Hossain [20] underlines the importance of variety-seeking intention using mobile device related to the academic performance. He concluded that the indicator of variety – seeking may have a positive impact toward academic performance. The author Wei [21] realized a research paper about the effects of instructional multimedia as a positive solution to increase the achievement of new learning discipline. He emphasizes the important role of film watching as a primary objective into an educational project who desires to deliver instructional multimedia learning materials. A paper work completed by the author Wang [1] shows that a visual cognitive learner against a verbal cognitive learner could be a better approach to understand the effects of multimedia mobile solution related to the academic performance. He concluded that no relevant differences were found when he considered the verbal cognitive abilities but greater values of correlations were found when he considered searching visual cognitive traits.

3 Methodology

We started our research with building four mobile applications, named APP_i, where letter *i* is an indicator from one to four, with a decreasing multimedia factor from the first application to the last one. Our research question is the following: *What is the correlation between the time spent for learning, remembering and evaluating knowledge acquired, at one moment of time, and a personal degree of a self-intrinsic evaluation of academic performance for previous just happened educational event?* The second research question is the following: *What is the correlation between quality characteristics of a mobile application and a personal degree of a self-evaluation of academic performance?* Like other researchers Wang [1], Hossain [20] and Foen [9] our aim is to establish the impact of a multimedia mobile application in a variety – seeking situations. Our particular experimental situation gauges our own capacity to conceive a more accurate self-evaluation of personal academic performance. The consequence of this point of view is very important because the feeling of awareness about personal educational knowledge, at one moment, is crucial when we make decisions in life. The multimedia factor was characterized by the presence of the video and sound components emphasized with the embedded virtual instructor participation. The LMS profile chosen to implement these mobile applications packages was established to SCORM 1.2. The software format used to run these mobile applications was HTML5 because in this case we obtained a software compatibility with Android, iOS and desktop environment. The same educational content was allocated to every mobile application. This laboratory experiment took place in November 2019 at the Bucharest University of Economic Studies involving 170 students scattered in different working groups allocated to a discipline connected with programming mobile application. From this sample population we obtain 116 valid individual results from our free Moodle website. The general planning experiment was limited by free Moodle website to a number of 50 users with simultaneously access. In table 1 we are illustrating decreasing the multimedia components from first mobile application to the last one. We introduce, in table 1, the convention Yes for dynamic content, specific for multimedia effect, and No for static content, well known when we read electronic document without any multimedia accessories.

Table 1. The multimedia components policy allocation from APP1 to APP4

Order	Virtual instructor	Sound	Callout Text	Static presentation	Simulator for recap	Questionnaire for final evaluation	Evaluation survey	I ₁ (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
APP1	Yes	Yes	Yes	No	Yes	No	No	57
APP2	No	Yes	Yes	No	Yes	No	No	42
APP3	No	No	Yes	No	Yes	No	No	28
APP4	No	No	No	Yes	No	No	No	14

From table 1 we introduce indicator I₁, calculated in column 9 that investigates the percent of the mobile multimedia impact (MMI) with the formula 1.

$$I_1 = \frac{C_{yes(i)}}{C_{yes(i)} + C_{no(i)}} \quad (1)$$

where:

C_{yes(i)} = the total items with Yes value for mobile application i

C_{no(i)} = the total items with No value for mobile application i

i = the number of mobile application from 1 to 4.

The quality of being new for our experimental idea research was demonstrated by the fact that both stages, learning and the evaluation process, took place into an integrated event. The educational subject chosen was a new one for almost students involved now of running those

mobile applications. In figure 1, we depicted the general framework of sequences chosen to deploy the laboratory experiment.

Figure 1. The flow sequence requested laboratory research of multimedia mobile educational impact

Every link between two steps connected with an arrow, shown in figure 1, is meaning a time, in seconds, measured by the mobile application and reported with the support of the Moodle website using an email transfer. The method used in our research to evaluate the individual degree of self-evaluation performance obtained in phase S, displayed in figure 1, is shown by formula 2 for those users that produced an overestimation regarding their personal academic performance:

$$PE_{ji} = \frac{(\max_j \{(IE - FE)_i\}_{j=1}^N + 1) - (IE_{ji} - FE_{ji})}{(\max_j \{(IE - FE)_i\}_{j=1}^N + 1)} \times 100 \quad (2)$$

For those users that produce an underestimation regarding their personal academic performance formula 2 will be translated into formula 3.

$$PE_{ji} = \frac{|\min_j \{(IE - FE)_i\}_{j=1}^N - 1| - (FE_{ji} - IE_{ji})}{|\min_j \{(IE - FE)_i\}_{j=1}^N - 1|} \times 100 \quad (3)$$

where:

j = the indicator of a user with mobile application i from 1 to total number N of users (APP_i)

i = the indicator of a mobile application from 1 to 4

PE = personal evaluation of individual degree of awareness about self academic performance.

FE = formal evaluation based on the internal questionnaire (EQ) true or false answers

IE = informal evaluation at the end of the internal survey questionnaire (S) meaning a self-evaluation expected by the user before knowing his formal evaluation FE (position 17, table 2)

In case of an overestimation from the side of a particular user the value of IE_{ji} is greater than FE_{ji}. In case of an underestimation from the side of a particular user the value of IE_{ji} is lower than FE_{ji}. In case of a correct evaluation from the side of a particular user the value of PE_{ji} will be 100 percent. The indicator PE will be the dependent variable into a multiple regression analysis.

To correlate the quality characteristic of every mobile application developed we build a survey (S) with 26 questions that cover different aspects of hardware, software discovered by the user involved into this laboratory experiment regarding personal opinions. The values obtained from the survey were totalized for every mobile package and checked for reliability, or internal consistency, with Cronbach's Alpha test. The same procedure was fulfilled by the researcher Ahmed [7] who showed that his Cronbach's Alpha factor was greater than the threshold value of 0.60 that is an argument for the convergent validities of considered factors. The method used for Cronbach's Alpha test is shown by formula 3.

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum_{i=1}^K \sigma_{Y_i}^2}{\sigma_X^2} \right) \quad (3)$$

where:

K = number of items

σ_X^2 = variance of the total test scores

$\sigma_{Y_i}^2$ = variance of the component i for the current sample

The survey (S) contains 16 questions that offer the possibility to build a system of indicators used to answer to the second question research. These indicators were centralized into table 2 presented below. The 17-th indicator (question) is related to the dependent variable PE.

Table 2. The system of quality indicators Ind_{xy} inserted into final survey questionnaire (S)

Ind-X	Ind-Explanation	Ind-Y	Ind-X	Ind-Explanation	Ind-Y
1	Preexistent knowledge about educational subject	2	10	Speed browsing necessity	3
2	Type of mobile network	2	11	The temperature of mobile device during application	3
3	Type of operating mobile system	3	12	Landscape or portrait view	3
4	Display size	4	13	Discharging mobile's battery	4
5	Sequentially operating mode	2	14	Gaps over the video sequence	3
6	The importance of audio content	5	15	Logical presentation of the educational content	3
7	Calibration of font size	2	16	Correlation between learning objectives and evaluation questionnaire	3
8	Utility of animation	5	17	<i>Self evaluation of academic performance concerning previous questionnaire</i>	<i>Used to calculate personal evaluation (PE)</i>
9	Virtual instructor evaluation	5		Total options from 1 to 16	52

Every indicator was separated into a number of parts equal with the number of options shown in table 2. For every indicator we proceed to count the answers distributed to every mobile package developed. Every indicator was treated like an independent variable to apply a multiple correlation with the dependent variable represented by the personal evaluation for academic performance. The index x , IND_{xy} , represents the category of the indicator and the index y represent the total number of the options inside the category.

4 The proposed solution

For our research we develop a strategy to gauge automatically the time allocated to every phase of our laboratory experiment. Every mobile application deployed was equipped with internal capabilities to acquire the user name for the entire process depicted in figure 1. The activity SR1 ended with an email report that include a reference to the time consumed. The time difference between SR1 and SMA represents the total time allocated to phase LT1. The same calculation was realized to determine the time for the phase LT2 and LT3. The activity SR1 and SR2 was inserted to emulate a dialog between a virtual instructor and the student to recap something that was previous already explained. This activity, to recap in classroom, is usually done by every teacher to maintain the attention of the learners, to offer a pause in delivering new information and to remember together few important concepts. The phase EQ has a

different transfer process by email for results obtained during a questionnaire to evaluate the level of educational acquisition. The phase S represents the final stage that completes gauging the time consumed during the mobile application package. In figure 2 we depicted the framework of collecting data about time consumed with every phase. Every email received as we represent in figure 2 was send *automatically* to a unique collector email with detailed information about the action executed. The starting point, named Start in figure 1, was represented by a row inserted automatically into a log file, with the help of the Moodle website, generated by the login activity launch through a user intervention. The log file was exported to Excel format to be managed for needed calculation.

Figure 2. The time coverage of every mobile application package APP(i)

The table 3 offers a centralized view of results obtained to discover correlation required by the first question of our research.

Table 3. The total time in seconds calculated for every phase from LT1 to EQ+S, from column 2 to 7

Order	LT1	SR1	LT2	SR2	LT3	EQ+S	PE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
APP1	3695	1773	4328	1190	13924	7637	1298
APP2	6738	1920	7368	1733	21372	10953	2088
APP3	10439	1559	8732	1333	31833	17369	2885
APP4	4998	3313	5963	708	15230	13915	1492

We search with multiple correlation regression the nature of interconnection between independent variable represented by LT1, SR1, LT2, SR2, EQ+S and the dependent variable represented by the PE, personal evaluation of academic performance. The values from column 8 were calculated with the formula 2 and 3 previous already explained. To solve multiple correlation regression and simple correlation regression we used option regression from add-ins Analysis ToolPak from the application named Excel. In table 4 we are illustrating that between dependent variable, Y represented by the variable PE from column 8 shown in table 3, and the independent variables represented by the phases SR1 and SR2, reveal a *weak correlation that could not explained the scores obtained, related to personal evaluation PE*, at every mobile application package studied, from APP1 to APP4.

Table 4. The parameters obtained for multiple and single correlation statistics with SR1 and SR2

Multiple R	R Square	Significance F	SR1	SR2	Intercept
0.529023635	0.279866007	0.84860709	-0.319243522	0.3463105	2194.559
0.511975889	0.262119311	0.488024111	-0.459512428		2924.681
0.476051073	0.226624624	0.523948927		0.80280631	944.4674

In table 5 we represent that between learning time from every phase as independent variables and the dependent variable exposed by the personal self-evaluation, PE, may be a strong correlation in every model of combining those phases allocated to the learning process.

Table 5. The parameters obtained for multiple and single correlation statistics with LT1, LT2 and LT3

Multiple R	R Square	Significance F	LT1	LT2	LT3	EQ+S	Intercept
0.996196815	0.992408094	0.087131545			0.086272388	0.001927755	140.3869
0.999460017	0.998920325	0.032858414		0.08431997	0.068859896		-33.3801
0.994678104	0.989384531	0.103031397	0.232669716	0.01593904			330.7968

For the system of indicators, that refer to the survey questionnaire, shown in table2, we obtain a value of 0.945814 for Cronbach's Alpha test, with the formula 3 previously explained, which is much greater than the threshold value of 0.60. In this case we consider the model reliable to proceed for an investigation concerning multiple regression correlation between those independent indicators, X_i , and the dependent variable, Y_i , represented by the variable PE. In table 6 we selected only relevant values calculated with Analysis ToolPak – correlation – between variables represented as indicators inserted in survey questionnaire.

Table 6. The relevant correlation between PE and the indicators of quality regarding mobile applications

Order	Option	Correlation	Explanation
Ind1	2	0.983368	No previous knowledge about the educational subject experimented
Ind2	1	0.993079	Mobile data (3G/4G)
Ind3	2	0.909884	iOS
Ind4	2	0.997801	Between 14 and 17 cm (between 5.5 and 7 inch)
Ind4	4	0.882112	Below 9 cm (<3 inch)
Ind5	1	0.85513	YES sequential exploring access
Ind5	2	0.996922	NO sequential exploring access
ind6	3	0.87298	Sound - Very little important
Ind7	1	0.992404	YES – font size OK
Ind8	1	0.964736	Very important animation
Ind9	1	0.995137	Very important virtual instructor
Ind9	2	0.983091	Relative important virtual instructor
Ind10	1	0.939247	YES speed OK for next page
Ind11	3	0.957119	Normal temperature
Ind12	2	0.986649	Only Portrait
Ind13	3	0.988167	Below 10% battery discharge

Ind15	1	0.95895	YES logical educational presentation
Ind16	1	0.940234	YES correlation between education content and the evaluation questionnaire

In table 6, the column named - Option - represents the choice selected by the user when he solves the survey questionnaire. When we applied multiple regressions, correlation we find only that three indicators have a significant connection that explains the values recorded for personal self-academic performance. In table 7 we represent those indicators that have a significant multiple correlations with PE, personal self-evaluation of academic performance.

Table 7. The significant multiple correlations between PE and the indicators of quality regarding mobile applications studied

Multiple R	R Square	Significance F	Ind1-2	Ind3-2	Ind10-1	Intercept
0.999712162	0.999424407	0.023991522	54.02453	29.60757		252.2451
0.939720356	0.883074348	0.341943931		9.985517	64.83874	360.8208
0.994244552	0.98852223	0.107134357	52.41219		24.49104	47.0681

5 Conclusions and future work

From table 3 we discover that APP1 and APP4 produced lowest values of indicator PE. A low value of PE is meaning that the users have a weak awareness of what they are capable to understand or not and, by consequence, they fail to transmit an accurate self-evaluation of their academic performance. A high value of PE is meaning that the users have a good representation of what they learn and understand because the difference between formal evaluation, FE, and informal evaluation, IE that is meaning self-evaluation, is very low. The lowest value was obtained for mobile application APP1 with the maximum content of multimedia components. In this case the impact of the multimedia application, represented by the value of PE, has a minimum and negative influence toward their capacity to create a proper self-academic performance evaluation. The multiple regression correlation between time learning, represented by LT1-LT2-LT3 table 5, and the values of PE against the same action involving dialog simulation for recap with a virtual instructor, represented by the SR1-SR2 table 4, shows that the students are willing to have a proneness for a quick learning memorize action to the detriment of a steady assimilation of new knowledge by doing a recap simulation. The multiple correlation between quality indicators, embedded into survey questionnaire, reveals that the dependent variable PE could be explained by a mix of factors consisting of the fact that they do not have previous knowledge about the educational subject experimented with APP1-APP4, they used mobile devices with iOS and they considered a good browsing action from one phase to another during the usage of the mobile application experimented – table 7. The maximum value for PE – table 3 - was encountered to APP3, where the value of multimedia percent support is 28 % that produce a high level of awareness regarding self-evaluation of academic performance. The conclusion is that the impact of multimedia mobile application on educational process is maximized at a medium percent of multimedia components that could be explained by a low level of possibilities to distract the attention or to generate irregular addiction like social sites. In this case the mobile application with multimedia support could be the guidance needed for a user that prefers to learn with mobile application. *The consequence of our study is very important, on educational process, because for a teacher is much easier to work with a group of learners that have a good awareness of what they learn and understand, with a high level of metric named PE. More rational learning is meaning a better self-evaluation of academic performance and a high value of PE. An indicator metric of self-*

evaluation academic performance should be a formal standard toward any educational field anywhere and anytime. The following actions will be considered to more quantitative and qualitative explorations of this subject:

- Studying a new approach for developing mobile application that covers more hardware functions of the mobile devices.
- Considering a new model to emulate time coverage at the interface between learning and evaluation or an accurate remembering of previous knowledge acquired.

References

- [1] J. Wang and T. Mendori, "Strategies for Multimedia Learning Object Recommendation in a Language Learning Support System: Verbal Learners Vs. Visual Learners," *International Journal of Human-Computer Interaction*, vol. 35, p. 345–355, 2019.
- [2] A. Bakon and Z. Hassan, "Perceived value of Smartphone and its impact on deviant behaviour: An investigation on Higher Education Students in Malaysia," *International Journal of Information System and Engineering (IJISE)*, vol. 1, no. 1, 2013.
- [3] S. Shahibi, "The Effect of Smartphone that Influence the Compulsive Usage among Students," *International Journal of Academic Research in Business and Social Sciences*, vol. 7, no. 8, 2017.
- [4] J. Mendoza, B. Pody, S. Lee and M. Kim, "The effect of cellphones on attention and learning: The influences of time, distraction, and nomophobia," *Computers in Human Behavior*, vol. 86, 2018.
- [5] S. Gokçearslan, K. Mumcu and T. Hasslaman, "Modelling smartphone addiction: The role of smartphone usage, selfregulation, general self-efficacy and cyberloafing in university students," *Computers in Human Behavior*, vol. 63, pp. 639 - 649, 2016.
- [6] M. D. Salvation, "The relationship between smartphone applications usage and students' academic performance," *Computational Methods in Social Sciences*, vol. 5, no. 2, pp. 26-39, 2017.
- [7] R. R. Ahmed, "Smartphone Use and Academic Performance of University Students: A Mediation and Moderation Analysis," *Sustainability*, p. 439, 2020.
- [8] A. A. Khan, "Revealing the Relationship between Smartphone Addiction and Academic Performance of Students: Evidences from Higher Educational Institutes of Pakistan," *Pakistan Administrative Review*, vol. 3, no. 2, 2019.
- [9] S. N. Foen, "The Relationship Between Smartphone Use and Academic Performance A Case of Students in a Malaysian Tertiary Institution," *Malaysian Online Journal of Educational Technology*, vol. 5, pp. 58-70, 2017.
- [10] H. Winskel, "Smartphone use and study behavior: A Korean and Australian comparison," *Heliyon*, vol. 5, no. 7, 2019 July.
- [11] S. Amez and B. Stijn, "Smartphone Use and Academic Performance: A Literature Review," *IZA – Institute of Labor Economics*, no. 12723, 2019 Oct..
- [12] K. Sumathi, S. Lakshmi and S. Kundhavai, "Reviewing the Impact of Smartphone Usage on Academic Performance Among Students of Higher Learning," *International Journal of Pure and Applied Mathematics*, vol. 118, no. 8, 2018.
- [13] E. Chukwuere, "The Financial and Academic Implications of Using Smartphones Among Students: A Quantitative Study," *Journal of Economics and Economic Education Research*, vol. 18, no. 1, 2017.

- [14] H. Sunyoung, "How does the smartphone usage of college students affect performance," *J Comput Assist Learn*, vol. 35, pp. 13-22, 2019.
- [15] G. Jesse, "Smartphone and App Usage Among College Students: Using Smartphones Effectively for Social and Educational Needs," *Issues in Information Systems*, no. IV, pp. 8-20, 2016.
- [16] M. Alfawareh, "The Use and Effects of Smartphones in Higher Education," *ijim*, vol. 11, no. 6, 2017.
- [17] F. Giunchiglia and M. Zeni, "Mobile social media usage and academic performance," *Computers in Human Behavior*, 2018.
- [18] L. Kibona and G. Mgya, "Smartphones' Effects on Academic Performance of Higher Learning Students," *Journal of Multidisciplinary Engineering Science and Technology (JMEST)*, vol. 2, no. 4, 2015.
- [19] O. Boahene, J. Fang and F. Sampong, "Social Media Usage and Tertiary Students' Academic Performance: Examining the Influences of Academic Self-Efficacy and Innovation Characteristics," *Sustainability*, vol. 11, p. 2431, 2019.
- [20] A. Hossain, M. Nurunnabi and K. Hussain, "Effects of variety-seeking intention by mobile phone usage on university students' academic performance," *Cogent Education*, vol. 6, 2019.
- [21] C. Wei, F. He and S. Huang, "Effects of Instructional Multimedia Integrated Situational Approach on Students' Learning Achievement," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 14, no. 7, pp. 3321-3327, 2018.