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RESEARCH ARTICLE

SYSTEMATIC REVIEW ON THE EFFECTS OF MOBILE TEACHING APPLICATIONS IN IMPROVING STUDENT'S PHYSICS PERFORMANCE

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ABSTRACT

Background: Anemerging and innovative method of applying technology in teaching is the use of mobile applications for learning. This meta-analysis aimed to provide evaluative data about several experiments that explore the effects of mobile applications in instilling knowledge, skills, and attitudes among students. **Methods:** In order to investigate these effects, this study scrutinized—using specific inclusion criteria—six full-text articles searched in academic databases. Effect sizes were computed for each research, and the mean effect size for all the studies was obtained. The review's findings reveal that the six research articles involved 1,483 study subjects, with6 effect sizes determined accordingly. **Results:** The mean effect size of 2.32 reveals that mobile teaching applications produce remarkable improvement in knowledge, skills, and attitude outcomes relevant to physics education. Android-based applications are observed to produce the largest effect size (9.95) while integrating mobile devices with learning management systems produced the lowest effect size (–1.84). **Conclusions:** Consistent with educational and learning theories, the results of this academic synthesis provide convincing and converging evidence as to the wisdom of incorporating mobile applications in the teaching-learning milieu of physics students, in particular, and the academic community, in general.

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INTRODUCTION

Educators and scholars have long argued that the development of students occurs when knowledge, skills, and attitudes are transferred correctly and adequately. This means that the teaching-learning process has to occur using relevant and responsive instruction delivered by expert academicians in a contemporary educational milieu. That is, proficient educators who will teach the students should be aware of the exigencies and vicissitudes of the contemporary world so they can always utilize the best methods to affect learning. In today's modern world, technology has become a tool for facilitating and catalyzing learning. Academicians in different learning institutions are capitalizing on these advancements and are developing quite a number of technologicallydriven methods to incite curiosity and spark motivation among learners. Several researches have explored the effects of integrating technology and instruction. The study of Gros in 2014 revealed that children learn most when teaching is combined with multimedia. Gros noted that game-based learning environments are needed to improve learning among children.

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Nugent and colleagues (2014) asserted that robotics and geospatial technology interventions effect greater learning among middle school students of science, technology, engineering, and mathematics. They found out that applying their type of educational intervention can encourage students about technology and seek out additional opportunities to explore subject topics in better detail. Effects of one-to-one technology policy in K-12 schools were also explored greatly, with Harper &Milman (2016) conducting a meta-analysis on it. They asserted that themes such as effects on student achievement, changes to the classroom environment, classroom uses, effects on learner motivation and engagement, and challenges to classroom integration were evident in the examined researches from 2004 to 2014. Implications such as classroom improvement were made for future research. In the Emirates, the effects of blended learning have been attracting attention and acceptance among graduate school faculty. Tamim (2017) postulated that Arabian graduate students have an overall positive perception on blended learning. This finding espoused that blended learning would become successful only if it is student-centered, collaborative, and student-led. The above-findings suggestthat the use of technology-based learning methods brings remarkable student outcomes.

Of all the methods in the arsenal of the technologically adept teacher, an emerging and innovative technique is the use of mobile applications to supplement and augment concepts taught through traditional lectures and teaching methods. This technological method has been utilized beyond the boundaries of culture and classes. The benefits of mobile applications in teaching can be observed scientifically, as different researches posited a number of good effects. Arain and colleagues (2018) found out that mobile learning applications enhance student outcomes in the higher education setting. It is believed that experimental mobile application motivates and influences the students to study better.Thesefindings are affirmed in the scientific discourse of Oyelere (2018), where positive learning attitudes are fostered by using mobile applications and technologies in the teaching environment. Technological advancements in nursing education also brings improved disposition in learning, as discovered by Buabeng-Andoh (2018). He observed the pedagogical impact of studentsusing mobile applications in their school work.The youth interacts more with visual content in speaking, notetaking, or thinking;engages them more when relating to the subject; and fuses better knowledge and memory. Viewing experimental data in real-time is one of the benefits of using smartphones in natural sciences education (Abidin & Tho, 2018). It was discovered that having information easily accessible enables students to perform experiential activities. Another interesting benefit of using mobile applications in learner development is its ability to invoke groupthink, as it encourages students to collaborate with one another, since communication avenues expand through the use of technology (Lee, 2018).

As evidence present the many positive effects of applying mobile applications in learning, there are confusing and contradicting outcomes in terms of physics education. Few studies have demonstrated the validity of application-based learningin supplementing and instilling scientific concepts in physics. Claims on the interactivity of mobile applications vis-à-vis summative learning is loosely grounded on a wide-array of experimental findings. The predictability of using mobile applications in teaching physics conceptshave not been succinctly explored, for there are still gray areas encountered empirically in the implementation of such learning activity. In this study, the effects of mobile applications on student performance in physics were systematically reviewed. Since these studies are done in the pretext of experimental research designs, the outcomes may talk of different, yet similar, parameters. More specifically, this research aims to answer the following questions:

- Do mobile teaching applications produce considerable effects on student performance relevant in physics in terms of knowledge, skills, and attitude?
- Which mobile teaching application is the most efficient mode in effecting student learning of physics concepts?

METHODOLOGY

This academic synthesis performed a review of different studies about the usage of mobile applications and its effect on student learning in terms of physics. The search period for the study to be included was set between 2008 and 2018. Electronic databases (Academic Search Complete, ERIC, Library Information Science & Technology Abstracts, MAS Ultra-School Edition, Military and Government Collection, and Primary Search) were searched for relevant references. Two criteria were used to initially screen the studies: (a) whether they use mobile applications in learning and (b) if the outcomes of the study relate to improving student outcomes in physics. Keywords such as*mobile, wireless, portable, handheld, iPad, mobile phones*,and *tablet computers* were used to search for related articles. The search results retrieved showed 511 articles relevant to student achievement in physics. The second stage of screening identified whetheror not a study employed an experimental research design. Out of 511 studies screened using the initial selection phase, 265 of the studies were identified to have utilized posttest-only control group design. These studies were deemed experimental researches. The third screening process examined whether the articles provide sufficient data to compute for effect sizes.Additionally, acriterionconsidered for this stage is that full text files should beaccessible. After the last phase of selection, there were 6relevant articles left for analysis.Variables that were analyzed in this paper are the independent variable (use of mobile applications), the learning outcomes (knowledge, skills, and attitude), and group size. Moreover, publication bias was investigated using Corwin's (1983) method and compared to Rosenthal's threshold value.

RESULTS AND DISCUSSION

Description of the Studies Reviewed: Table 1 presents the distribution of studies on mobile applications according to variables described in this systematic review. In total, there are 6 studies included, 6 effect sizes determined and 1,483 research participants.In terms of the control groups in the experimental researches, there are more articles that(n = 5) utilized traditional teaching methods in physics (i.e., face-to-face interaction, classroom instruction, and lectures). On the other hand, one study used desktop personal computers as the control group for the research. Group characteristics were determined to be mostly heterogenous (n = 3), while one research made use of a homogenous group (n = 1). Two studies did not mention the characteristics of the control and experimental groups.

The students involved in the different studies were mostly at the tertiary level (*n = 4)* while there were two studies that were conducted in middle school. As per the learning outcomes of the study, three studies utilized the knowledge component in assessing the outcomes on the use of mobile applications in teaching physics. Two studies focused their outcome assessment in terms of attitudes and perceptions on these technological advancements. Lastly, one study focused on the psychomotor learning aspect in measuring improved physics performance. The interventions that were utilized in the individual articles varied from the use of Android-based applications (n = 2), augmented reality or gaming (n = 1)*,* e-books (n = 1), learning management system (n = 1), and online playground (n = 1) to improve learning outcomes in physics among middle school and higher education students. Table 2 enumerates the elements of the experimental researches reviewed. Bogdanović, Barać, Popović, Jovanić, B., and Radenković (2014) evaluated the effects of integrating mobile phones in learning management systems in relation to physics activities. Their research utilized an experimental design that involved 20 respondents in the treatment group (mobile) and another 20 respondents in the control group

Table 1. Categories and Percentage of Researches Reviewed

Variable	Category	No. of Studies *(n)*	Percentage (%)
Control group	1.Used desktop PC	1	16.67
	2.Traditional	5	83.33
Student Stage	1.Middle School	2	33.33
	2.Tertiary/Higher Education	4	66.67
Group Characteristics	1.Not mentioned	2	33.33
	2.Homogenous	1	16.67
	3.Heterogenous	3	50.00
Learning outcomes	1.Knowledge	3	50.00
	2.Skills	1	16.67
	3.Attitudes	2	33.33
Type of Application Used	1.Android-Based	2	33.33
	2.Augmented Reality/Gaming	1	16.67
	3.E-Books	1	16.67
	4.Learning Management System	1	16.67
	5.Online Playground	1	16.67

Table 2. Effect Sizes Computed from Researches Reviewed

Author	Mobile Teaching Application	Outcome	Sample Size	Group* and group size	Posttest Score		Effect Size
					Mean	SD	
Bogdanovićet al. (2014)	Learning Management System	Knowledge	40	T (20)	7.80	0.07	–1.84
				C (20)	7.92	0.06	
Delcker et al. (2016)	E-Books	Attitude	122	T (61)	6.40	1.24	2.54
				C (61)	2.58	1.73	
Friedman et al. (2017)	Online Playground	Attitude	1166	T (744)	–0.21	0.90	0.38
				C (422)	–0.54	–0.84	
Liliarti et al. (2018)	Android-Based Application	Knowledge	60	T (30)	91.94	0.82	9.95
				C (30)	84.17	0.74	
Sulisworo et al. (2017)	Android-Based Application	Knowledge	61	T (34)	31.62	2.25	0.73
				C (27)	30.07	1.94	
Baran et al. (2017)	Augmented Reality and Gaming	Skill	34	T (21)	9.45	2.5	2.16
				C (13)	4.92	1.16	

Note:T stands for treatment group;*C* stands for control group.

Table 3. Failsafe *N*Computation for Publication Bias (Corwin, 1983)

Element	Value
Mean Effect Size of Meta-Analysis	2.32
Number of Observed Studies (*n*)	6
Smallest Effect Size Expected	0.20
Failsafe Lower Boundary	0
Failsafe Number of Studies	64
Comparison Limit*	43

*Based on Rosenthal's estimate (5n + 10)

(desktop PC). The second study, conducted by Delcker, Honal, and Ifenthaler (2016), explored the use of e-books in mobile devices to improve students' understanding of physics concepts. The research recruited 122 participants, equally divided into the treatment and control groups. Friedman and colleagues (2017), on the other hand, explored the effects of implementing online playgrounds to help in developing good perceptions and acceptance of physics concepts. Their stud recruited 744 students who engaged in online interactive games to reinforce physics lessons, while 422 students undertook the regular classroom sessions. Android-based applications were used in improving the physics knowledge of college students. In the experimental research of Liliarti (2018) and Sulisworo (2018), they discovered that these types of applications help in explaining and simplifying physics concepts through the use of special diagrams included in the programs. Lastly, Baran and colleagues (2017) found out that using augmented reality can improve physics skill acquisition amongmiddle school students. The highest effect size (9.95) was observed in the study Liliarti and Kuswanto (2018). Conversely, the lowest effect size (–1.84) was seen in the study of Bogdanović and associates (2014). The mean effect size obtained from all the articles reviewed is 2.32. According to Cohen (1992), this mean effect size suggests that the use of mobile teaching applications in physics has a large effect size. It can be understood that there isremarkable physics learning improvement among those who used mobile applications compared to those who did not. Investigating publication bias is also important in determining the significance of the computed effect size. Table 3 demonstrates a failsafe *N* value of 43, which is larger than the comparison value of 40, indicating that the mean effect size determined in this meta-analysis is not affected by data in unpublished studies.

The effects of using mobile applications in improving student outcomes have been observed in numerous researches in different fields. But the findings of this research provide converging and convincing evidence that utilizing mobile apps is a superior strategy in teaching and effecting learning among physics students. The effect size obtained in this study can be affected by several implementation factors, such as insufficient teacher training, lack of technological resources, inability to translate technological instruction, and incoherent in-service training for teachers (Barri, 2013; Kelani & Gado, 2018). Moreover, the effect size can be affected by learner-mentor/instructor interaction, learner-professional content interaction, and online and offline self-efficacy (Avsec, Rihtarsic, &Kocijancic, 2014).

Though effect sizes vary based on differing mobile teaching applications, the differences determined herein gives the teacher a reason to consider using mobile applications in teaching, most especially in physics. Results of this systematic review can be seen as beneficial in improving students' knowledge, skill, and attitude in physics. It is discerned that technology helps in augmenting the negative effects of large class sizes (Gleason, 2012; Daele, Frijns, &Lievens, 2017) and improves attitudes in learning and practicum (Arain&Tho, 2018; Oyelere, Suhonen, Wajiga, &Sutinen, 2018). The findings of this research also echo claims of other researches that technology can impact self-directed learning (Mentz & Van Zyl, 2018), fosters love for lifelong learning (Uslu, 2017), and increases the accessibility of educational materials as well as class participation (Maloney et al., 2010). However, mobile devices may become counterproductive in classroom activities, as they can distract students from focusing on their classroom tasks (Duncan, Hoekstra, & Wilcox, 2012).

Therefore, care must be exercised in utilizing technology to improve the teaching-learning milieu. Implementing Android-based applications can be observed as the most effective method of improving physics learning. This occurrence can be explained by the fact that physics are best taught with a combination of tactile and visual techniques. As mobile applications provide more avenues for exploring physics concepts, students will be able to connect textbook knowledge into practical and visual work. Surprisingly, the learning management system produced the lowest effect size. This effect size may have been moderated by several factorssuch as the knowledge, ability, and enthusiasm of learners (Islam, 2015); perceived usefulness, uselessness and, unease-of-use (AteşÇobanoğlu, 2018); institutional and infrastructural support (Khan, Hameed, Yu, & Khan, 2017); and even students' resistance to change (Strang &Vajjhala, 2017). Administrative decisions and organizational efforts have to address these challenges, so that learning management systems would be more receptive and perceptive to changing student requirements.

Conclusions and Recommendation

Consistent with educational researches and learning theories, it can be concluded that mobile teaching applications can produce remarkable effects in improving learning outcomes among students. An effect size of 2.32 is indicative that students who utilized mobile teaching application techniques outperformed students who did not. This means that learners benefit by employing such technological advancement. Even though Android-based applications demonstrated the greatest effect size, other modes of mobile teaching applications should be considered in designing instructional plans. Educational administrators, teachers, and stakeholders are, therefore, encouraged to incorporate technological advancements in curriculum planning, implementation, and evaluation.

Disclosure Statement

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