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Android-Based Interactive Media to Raise Student Learning Outcomes in Social Science

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Abstract—Learning media is a part of the important components in the procedures of implementing learning, especially during the current pandemic. But there are still few teachers who use media in the learning process, causing student learning outcomes to decline. Interactive media, which can attract students' attention by combining systems ranging from text, images, videos, and audio/sound, can provide new experiences for students in learning. This study aims to determine learning outcomes of the students after applying android-based interactive learning media in social science subjects. The population group consisted of 70 students from several Cluster 2, Cipinang Muara Village. Then samples were taken using the Slovin formula to get 60 samples of fourth-grade students. The data analysis performed in this investigation was a Boolean analysis utilizing a t-test. The collected data were analyzed through a t-test. The results showed that android-based interactive media positively affected student learning outcomes. Students experienced a significant increase in learning outcomes by using this media. In addition, students experienced more fascinated and untroubled to understand the material by using this application. The results showed that android-based interactive media positively affected student academic achievements. Students experienced a significant increase in learning outcomes by using this media. In addition, students perceived more curious and simpler to understand the material by using this application. The results showed that android-based interactive media positively affected student learning outcomes. Students experienced a significant increase in learning outcomes by using this media. In addition, students undergo more attentive and uncomplicated to understand the content by using this application.

Keywords—Interactive media, Android, learning outcomes

1 Introduction

Entering the revolution of industry 4.0 era, which emphasizes the figure of the cyber economy requires the world of education to be more proactive in innovating to create progress [1]. Cloud-based online learning helps teachers keep a close eye on the entire

curriculum, meeting the learning needs of students. Teachers can use cloud platforms to teach students following the identical processes. In institutions of tertiary education, exams are done digitally through these programs. This inquiry shows that most of students operate smartphones to get entrance through online courses. The remarkable development of smartphones has led to alter the education landscape. As mobile technology reaches every corner of the world, it permits more students to retrieve the cyberspace on the internet. Mobile addiction isn't just about convenience.

Optimization of forthcoming educational chances, the educational pattern requires to proceed to productive capability in solving today's educational problems [2]. This study aligns with the current world of education, which is being affected by the Covid-19 pandemic, where all students must study from home. On the other hand, social science lessons are often boring for some students. The low student achievement and student responses during learning can be seen in this situation. Furthermore, both teachers and students have difficulty in conducting online learning. Teachers find it difficult to convey the material, and students find it difficult to understand it. Understanding these conditions, innovation is currently something that must be done in education as it is by digitizing all existing learning systems, including learning media.

The importance of learning media today is indeed inseparable from the role of technology. Technology in the classroom can positively impact students' encouragement, participation, and interest in studying while inspiring the progress of energetic, exploratory, and inquiring learning styles [3]. The development of today's era allows us to get used to living in a technology that is also constantly evolving. Life will always coexist with technology, including in the classroom. Currently, various schools have implemented technology-friendly learning. With technology, students are taught to develop their abilities and knowledge through themselves with the help of technology. Combining diagnostic mechanisms based on learning games can reduce students' anxiety levels and increase attentiveness in education and problem-solving competence, improving learning achievement [4]. Technology that can stimulate student involvement will cause students' curiosity in the learning process.

In another survey, teachers' point of view toward educational modernization and the fortrights application of modern teaching methods to education were investigated [5]. Strong ICT-based tutoring motivates students to apply positive attitudes to topics. Advantages of implementing ICT to guide learning include increased connection to teaching and learning, visualization of abstract concept, and easier comprehending of the lesson under study. This state can cause studying the substances more attractive and provide interaction. This is under investigation. Focusing on the preference of practicing ICT will inevitably lead to ICT use in education and schools. Schools must always generate significant accomplishments to meet the requirement of these ICT tools.

One of the formidable results of the epidemic is that many students are pushed to pursue homeschooling online, following school termination and face-to-face classes [6–8]. Because of pandemic, the transformation from full-time education to online education has revealed the problematic unfairness of economically handicapped students. This shift in learning methods coerces several groups to join the trackway taken so that learning can occur, and the choice is to implement technology as an online learning means. Automation is like two blades, each of which has the same role, namely the positive and negative sides that influence changes in human civilization. All aspects

of life today cannot be separated from technology. Therefore, technological literacy is especially important for society. The use of technology is beneficial without harm and has a negative impact about life. Especially in education, this technological literacy needs to be learned by all education stakeholders, especially in its application as an online learning form which is presently being done.

In developing multimedia projects, the utilization of mobile applications appealed to the awareness of students and guarantee constructive communication [9–11]. The advantage of multimedia is that it has an important role in getting learning objectives, especially in difficult subjects. This shows that multimedia is interesting and innovative. Multimedia can be accessed through gadgets that are needed by students so that they can use all of their learning adventures in answering problems and motivate students to study independently without feeling burdened. Therefore, the purpose of author is to develop valid, practical, and effective android-based interactive media that students can access personally using smartphones.

From several earlier studies that have investigated interactive learning media, it creates to offer a positive reply. Researchers developed Android-based interactive learning media in subjects such as social sciences in elementary schools to improve student learning outcomes. Considering in previous studies, there are still few researchers who have developed interactive learning media based on Android. Hence, researchers need to build these media to acquire quality assurance in education in the digital era. Consequently, the objective of this research is to respond some questions, including:

a) How to develop android-based interactive media to enhance social sciences academic achievement in the forth grade students at elementary school?
b) How to use android-based interactive media to improve social sciences learning outcomes for elementary school students grade four?
c) Can android-based interactive media raise learning results in social sciences for fourth-grade elementary school students?

1.1 Information and communication technology in education

Technology is turning into one of the important aspects of education that assists students apprehend the larger deskription of the world and is not only limited to the content taught by schools and teachers [10]. Of course, advanced technology can replace traditional methods. Some teachers in Europe apply ICT to arrange their material.

Learning has become a powerful component of learning and teaching [12]. In most countries, it is evident that ICT has an essential role in teaching and learning. Educational reforms are being implemented towards the application of technology in the classroom. It is believed that technology can increase the effectiveness of education by providing access to educational content from around the world and enhancing interaction between people who cannot easily communicate face-to-face. In addition, the application of technology allows extended training individually.

Educational technology is a combination of computer hardware, software, and educational theory [13]. Educational technology applies high-quality information reinforcement for students, teachers, parents, and the society. Educational technology is

also utilized to assist learning. In addition to experience in education, educational technology is also on the basis of theoretical skill from variety of disciplines.

Educational technology is an exclusive word for tools and conceptual foundations used to aid learning in teaching. Educational technology is not restricted to multimedia but is included in everything that increase learning in the classroom [14]. As a consequence, condition of learning can alter flexibly and be arrange freely. Studying no longer only depends on educators in the classroom. Still, the process of learning can keep on to be done with variety of technologies in education.

With the increasing demands of society in the utilization of ICT in education, ICT competencies need to be mastered by teachers both in making media and operating existing media. This has led to an ideal shift in education system of education with the teaching concept application with better quality. In this case, technology asks students to be more autonomous in learning and changes the curriculum to be more progressive. By utilizing various advantages of information technology, it is expected that students will find it easier to understand the material provided. The presence and advancement of information technology in the current era of global communication has provided opportunities and enlargement of learning resources occuring anytime and anywhere without any limitation by area and era [15–19]. With the help of ICT, presenting the material becomes more fascinating and amusing. On the other hand, the existence of ICT claims teachers to professionally manage information to utilize ICT media productively and proficiently in the learning process. This is in line with the requirement of the 2013 curriculum, where the field of probing becomes the target to boost teachers to adopt ICT as an instrument or media in assisting students comprehend the material.

1.2 Interactive media

Professional teachers must select variety learning media types to facilitate the transmission of teaching materials and assist students in understanding the material [20]. Media are graphic, photographic, electronic, or mechanical devices for presenting, processing, and explaining information orally or visually. Media can also be said to create conditions that allow learners to receive know-how, expertise, and belief. There are many types of learning media consisting of audio, visual, and audio-visual. Learning media that combines these three types of learning media is interactive multimedia [21]. From some of the explanations above, interactive media are tools, materials, or teaching materials intended for students to learn with or without teacher guidance using a combination of two or more media. Interactive learning media is media developed with a program or software that complements each other to be interactive. The use of interactive learning media offers tremendous educational opportunities. With the introduction of interactive learning media, the focus has shifted to practical teaching methods that provide hands-on experience.

Interactive multimedia that can combine images, text, video, and audio on a screen has several advantages to attract students' attention. Students can learn in a fun learning atmosphere. In addition, utilizing interactive multimedia as a complement in learning can increase student activities and learning outcomes [22]. An important feature of

the modern pedagogical curriculum is innovativeness, which implies the development of new achievements of students of professional and cultural experiences in teaching project activities based on creative and critical thinking, multimedia, and cognitive activities. The extensive use of media provided through student-prepared multimedia helps to advance to higher levels of academic achievement rapidly. In the project work, students use multimedia materials generated by them to stimulate students' independence and motivate learning. Appropriately structured project activities contribute to the successful shaping of a student's educational outcomes.

1.3 Learning outcomes

A key aspect of effective educational practice – high-quality educational substances; thematic and ad hoc organizing the curriculum; cognitive load dissemination during training; establishments of tools to engage students; effective attendance of students in the educational system; synergies of ability collection and transfer in the studying surrounding; Thematic general interactions of study group participants [23]. Learning outcomes can be interpreted as a change in students in the form of cognitive, affective, and psychomotor aspects resulting from learning activities that students have carried out. The cognitive dimension is the primary components in the educational curriculum and becomes a criterion for evaluating children's growth. Cognitive is an aspect related to reasoning or thought processes, particularly the competences and productivity of the brain to enhance rational skills. Affective aspects are dimension related to appreciation, feelings, enthusiasm, interests, and attitudes towards something. The psychomotor aspect is a territory that includes progress action and visible regulation, motor abilities, and a person's physical competences.

Learning outcomes can also be interpreted as a change in overall behavior, not just one aspect of human potential [24]. This means that learning outcomes categorized by education experts, as mentioned above, are not seen as fragmentary but comprehensive. For the learning to be of high quality and students have achievements, schools must focus on students' happiness and learning outcomes. Student fulfillment has an essential role in developing knowledge and skills to enhance academic achievements [25]. This happens because when students feel happy and motivated in learning activities, students' emotions will affect the quality of mastering the material provided. It can reach an agreement that learning outcomes are changes that occur in students not only from one aspect but comprehensively which includes aspects namely cognitive, affective, and psychomotor obtained by students after participating in the learning process by the learning objectives that have been set previously by still paying attention to student satisfaction in participating in learning.

The intent of this research is to determine the power of using Android-based interactive media in learning social science material on cultural diversity on the learning outcomes of fourth-grade elementary school students. Through this test, it is expected that elementary school teachers, mainly grade IV, can have an idea about the use of this interactive media in social science learning to raise students' performance in this era of globalization.

2 Method

2.1 Research design

This research applied research design of experiments examining the causal relationship between variables. Through experimental studies, researchers can observe the influence of one independent variable on one or more dependent variables. This evaluation finds a use for a single group pre-test – post-test. This pattern includes one group given a pre-test (O), treatment (X), and a post-test. In single group pre-test post-test research, the first step is to decide about the sample utilized and break it down into one-class research. The next step is to pre-test to measure academic achievement before being assigned treatment using interactive media. In the next stage, the sample was treated utilizing interactive media. Then, the sample was given a post-test at the last stage to measure the outcome afterward. The difference between the average values of the pre-test post-test shows the influence of the independent variable on the dependent variable.

Table 1. Android-based interactive media use research design

Pre-Test	Treatment	Post-Test
O_1	X	O_2

Notes: O_1 = Pre-test given treatment; O_2 = Post-test given treatment; X = treatment in the form drawing on metaverse applications.

2.2 Population and research sample

The population extracted is grade IV elementary school students in Cluster 2, Cipinang Muara sub-district for 2020/2021, as many as 70 students. Then the sampling was carried out using the Slovin formula to get the number of 60 students. The research was done in 2020/2021 academic year.

2.3 Research instruments

The instrument utilized is a cognitive learning outcome test for students' social science subjects using android-based interactive media. Data collection techniques using pre-test and post-test techniques are used to find out the effectiveness of android-based interactive media on the content of social science class IV Elementary School in Cipinang Muara Village. The collected data will be analyzed using descriptive statistical calculations. The final data analysis in a t-test was used to determine the average difference in social science academic achievements before and after applying learning media.

2.4 Data analysis

The test of normality was finalized on the scores of pre-test and post-test with Kolmogorov Smirnov formula using Monte Carlo approach. Sig or p-value is at 5% level of alpha significance. If $p > 0.05$, then the data is normally distributed. Calculation of normality using SPSS version 26.1.0 After the normality test, the homogeneity test was done. To test the homogeneity of the statistical test of variance (test of variance) in the distribution of the group concerned. The homogeneity of the pre-test and post-test scores was done with the rules if the significance value was greater than the significance level of 0.05 (5%). The homogeneity test with the paired sample t-test was used to decide about the difference of the mean of the paired two samples.

The technique of data technique utilized to test the hypothesis in this research is the t-test. The t-test is attempted to test the average value between the scores of pre-tests, and the post-test having a significant difference. SPSS 26.1.0. was used to analyze data.

3 Results

3.1 Analysis stage

Stages of analysis are carried out in an outline analysis of the media program. The analysis includes two steps, namely: (1) curriculum material analysis and (2) learning aspiration. The curriculum materials are analyzed to designate and rearrange the material for Indonesian cultural diversity to suit the 2013 Indonesian curriculum. Furthermore, confirmation and preference of evidence relevant to interactive multimedia are carried out so that the essential competencies of the curriculum can be executed. The review resulted in the formulation of learning intentions. To comprehend the styles of plane and solid numerical symbols, the material boundaries of interactive multimedia are decided at this stage. This stage also determines what materials can be made of geometry, both in animation and simulation.

3.2 Design stage

We frame a flowchart to settle the research trace at the design stage. The flowchart is a flow of program produced from the beginning, subjects to leave the program; the scenario is distinctly described in the flowchart. The creation of a flowchart involves the following steps.

- **Create storyboards**
  Before making a storyboard, the researcher carried out a paper-based stage. This stage contains a delineation that starts from sketching an image on paper. After plotting in a paper-based form, begin with making storyboards. The storyboard is a version that contains visual and audio commentary of each plot in the flowchart. One column on the storyboard represents one view on the screen. This stage aims to get an idea of the shape and display on PowerPoint. The design consists of several menus. The menu consists of learning objectives, materials, and quizzes.

- **Application design**
  It is splitted into two stages: (1) Gathering the materials desired to discharge an interactive multimedia disposition. This stage includes making ideas from storyboards to computers. Materials that wanted to get ready include video, sound, animation, and pictures, (2) joining all the existing material. Interactive media is one of the media that can introduce learning material expressed systematically and concretely to make it manageable for students to apprehend. This stage is carried out on Microsoft PowerPoint by adding a hyperlink to each button that will be enabled and not forgetting to add images and audio.

3.3 Development stage

In the interactive media development stage, the material on Indonesian cultural diversity was carried out using the iSpring Suite 9 software and the Web2Apk builder software. After opening the media design in Microsoft PowerPoint, proceed with publishing the design into the iSpring Suite 9 software. The media design, originally in a PowerPoint file, is converted into flash or HTML form with this software. After the file is in HTML, we must convert it into an android application using the Web2Apk builder. Thus, the design of learning media that is made apart from interactive can also be accessed through students' smartphones in the form of an android application.

3.4 System interface

The following are some descriptions related to the display of interactive PowerPoint media based on Android that researchers have developed. The interactive PowerPoint developed will be converted to form an android application. The application will later be shared via a WhatsApp group. Then students can install the application on their respective devices. After installing the application, students are directly directed to the login page. Here is how the application login page looks like in Figure 1.

Fig. 1. Login page

After students press the play button on the login page, then students are directed to the menu page, which contains several features such as objectives, materials, and quizzes. Students can directly choose where they will start the application. Here's what the menu page looks like in Figure 2.

Fig. 2. Menu page

If students select the material button, students will be explained the nature of cultural diversity and knowledge about traditional clothes and houses from several regions in Indonesia. Here's how it looks in Figure 3.

Fig. 3. Material page

This page shown in Figure 4 contains questions that can be done as a form of evaluation practice questions for their understanding of the material that has been studied.

Fig. 4. Quiz page

3.5 Effect of android-based interactive media on learning outcomes

Based on the test results, the analysis spefification of the examined data were used to determine the level of normality and homogeneity of the research data of pre-test and post-test scores achieved by students before and after using the metaverse application. The Kolmogorov-Smirnov normality test applies the Monte Carlo approach with the Sig 5% rule. If $p > 0.05$, then the data is normally distributed. The calculation of normality with the help of SPSS version 26.1.0 can be seen as follows:

Table 2. One-sample Kolmogorov-Smirnov test

			Unstandardized Residual
N			60
Normal Parameters	Mean		.000
	Std. Deviation		7.138
Most Extreme Differences	Absolute		.143
	Positive		.143
	Negative		−.077
Test Statistic			.143
Asymp. Sig. (2-tailed)			.004
Monte Carlo Sig. (2-tailed)	Sig.		.153
	99% Confidence Interval	Lower Bound	.144
		Upper Bound	.162

Based on the normality test results using the Kolmogorov-Smirnov, the p-value of significance was $0.153 > 0.05$. The decision-making of the pre-test and post-test data of significance obtained a value bigger than 0.05 so that H1 was accepted. So it can be dissolved that the pre-test and post-test data are normally distributed.

Table 3. Test of homogeneity of variances

Levene Statistic	**df1**	**df2**	**Sig.**
.022	1	118	0.882

The homogeneity test was doneon the pre-test and post-test scores with the rules with a calculated significance value greater than the 0.05 level. The homogeneity calculation was carried out with SPSS version 26.1.0 computer program. The hypotheses are as follows:

H0: All variants are the same or homogeneous
H1: All variants are not the same or not homogeneous
p value > 0.05 (5%), H0 is accepted; H1 rejected
p value < 0.05 (5%), H0 is rejected; H1 accepted

On the basis of SPSS output, it is sensed that the significance value is 0.882, which represents it is larger than 0.05, so it can be ceased that H0 is accepted. Then to test the product's effectiveness using rametik statistics through t-test using the Paired Samples Test formula. The data tested shows the same variance (homogeneous) for the reacon

that the data from the calculation of normality and homogeneity tests proclaim normal and homogeneous.

Table 4. Paired sample t-test

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
−21,423	59	.000	−24.667	1.151	−26,970	−22,362

Based on the SPSS output, it is informed that the value of Sig. (2-tailed) of 0.000 > 0.05 since the value of Sig. (2-tailed) is equal to 0.000, smaller than 0.05, so it can be culminated that the value of android-based interactive learning media has a positive effect. Overall, these results indicate that android-based interactive learning media can augment learning development in social science subjects material on Indonesian Cultural Diversity.

4 Discussion

This interpretation was designed to determine the effect of implementing Android-based interactive media on the learning outcomes of fourth-grade elementary school students in social science subjects on cultural diversity in cluster 2, Cipinang Muara Village, Indonesia.

The results of this study signal that the use of android-based interactive media has succeeded in improving student learning outcomes. Several other researchers have previously shown that interactive media has a affirmative effect on student learning outcomes. It is proven that android-based interactive media is needed during this pandemic. This media has the advantage of having a more attractive design and easy to use, easy for students to understand [26–29]. This is what underlies researchers to develop android-based learning media, given the positive impact it provides and its suitability with the current conditions of the world of education. In addition, the development of interactive media has also been carried out in various subjects in schools which also have a promising impact on learning effect. The use of digital media has been proven to significantly improve students' skills compared to traditional learning [30].

This is because students can dig up their information about the material provided through digital media to increase students' curiosity about the material. Due to the pleasant learning experience, student achievement also experienced a significant increase. It is contemplated an beneficial way to revamp student versality, such as optimistic thinking, collaboration, and dissemination. It is regarded as a crucial part of significant innovation. The ability to respond to the increasing demand for education according to the needs of the 21st century has developed, which has brought about a paradigm shift from the existing teaching method to a new teaching method. It also shows some significant results in integrating technology into learning, including a positive student experience. This includes improving student focus, flexible access to learning materials, and using mobile technology for e-learning.

Technologies can simplify and enhance information communication while teaching and learning [31]. Various sources of educational information and how to receive and transmit it are currently available. This should be ordered to codify. This trend calls for the dynamic requirement of visualization methods for learning and retaining in modern educational processes. In addition, state-of-the-art technology and methods achieve high-level visualization of educational materials, saving time for both students and teachers. Technology positively impacts student learning outcomes, especially on the human framework material. The students find it easier to learn the lessons. Due to using technology, the students are presented with boring writing. The material is shown in a mind map equipped with interesting pictures and audio. The use of technology can increase student motivation in learning so that it affects student learning outcomes.

Other empirical results also state that technology can be exerted to advance the independent learning process [32]. With an independent learning process, students can actively improve their cognitive abilities in solving problems and determining the right attitude in dealing with a problem. Technology gives students access to numerous resources on the subject they want to study. If students can use this skill, they will become independent learners. Technology makes it easy for students to learn and acquire hands-on knowledge. Technology provides students with instant information on the topics that are searched. Technology is available, so students don't have to go straight to the person they want to learn. Interactive lessons that use technology can be more effective and provide students with more independent learning. Technology allows students to explore other people's work and provides valuable feedback. This would make student learning ideal. Using advanced technology, students can come along the condition of their learning. Learning things with the help of various technologies is much better and of better quality than traditional classroom instruction.

In the development of education, technology plays an important role in it. The existing technology brings so many positive impacts for the progress of education [33]. The positive impacts include facilitating rationality, abstract reasoning, problem-solving, and experimentation and can increase children's involvement and learning curve. This is supported by a study that says that android-based learning media can tweak motivation and learning success of students who suffer from attention difficulty, hyperactivity, and impulsiveness. Students will find it difficult to concentrate and focus their attention during learning. However, students are more focused on following the lesson when using interactive media.

Interactive media can motivate and reward students for improving their skills [34]. By using the media, students feel more valued because they listen and do the teacher's tasks. Still, they are also involved in the learning process. Schools are increasingly using digital learning environments for learners. Technology has enabled students to critically select, analyze and review data found on the Internet. Interactive media use in the field of education has paid off. This is used appropriately and appropriately. Students are now Deployed in almost all schools and educational institutions in the training process because of its usefulness and efficiency.

Students desperately need better content and learning perspectives not available in the curriculum [35]. Because the students are very easily bored and are not interested in monotonous lessons, teachers must be creative in developing content that can attract their attention by providing a different perspective than before. Interactive learning

media has succeeded in overcoming the disturbances in social-cognitive students needed in learning and knowledge construction [36]. With interactive media, students can increase their knowledge through simple things that are close to their daily activities. From some of the studies that have been mentioned, it can be concluded that the potential of social media is conditioned by the level of participant involvement in interactions that are strengthened by the right community [37]. Researchers realize that there are still many shortcomings and limitations in this study. As for some of these limitations, including the media that was made could not display the number of scores, the pre-test, and post-test assessments were still done manually by means of the help of google forms. This is due to feature limitations in the iSpring Suite application. However, this does not mean that these limitations make interactive media development less than optimal. It is still the primary purpose of the media itself. They motivated and stimulated students' interest in exploring their abilities independently and being fun. So that the expected results are appropriate, namely by increasing their learning achievement at school. Other limitations are: the number of samples taken is only 60 people, which is still very lacking in describing the real situation. The research was conducted online due to the ongoing Covid-19 pandemic situation. In other words, researchers take data through the help of the google form application. The learning outcomes data provided by respondents through the google form sometimes do not show actual results because we do not know the honesty factor of each respondent in answering the pre-test and post-test questions.

Other researchers are also expected to continue the enlargement of this android-based interactive media; it is hoped that other researchers can develop interactive media which includes all subjects. Given the positive impact of interactive media on student learning outcomes in subject social Sciences, it is not impossible if interactive media can positively influence student learning outcomes in other subjects.

5 Conclusion

Overall, this study shows that the use of Android-based interactive media positively influences student learning outcomes in social science subjects on Indonesian cultural diversity. Students can learn the diversity of traditional clothes, traditional clothes, and greetings from various regions in Indonesia just by using their smartphones. Interactive media is equipped with animated images of Indonesian children from various regions, provided with interesting audio. By using interactive media, students have a new experience in learning. Students can see and listen for real about this diversity. Therefore, this study shows the appropriate changes in the tests carried out before using the media with the tests after using the media on the material of Indonesian cultural diversity. This study focuses on the effectiveness of using Android-based interactive media on student learning outgrowth. Increased knowledge about the application of various technology-based learning media is used to make teaching materials easier to understand by students. Besides, that learning materials can be conveyed more attractively and well-organized and support renewable learning models in the era of globalization.

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Developing a Virtual Nature Laboratory of Faculty Social Science (LAV-FIS) to Assists Field-Based Learning during Pandemic: A Need Analysis Review

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Abstract—The Covid-19 outbreak has affected several aspects of field-based learning. The best way to ensure the survival and safety of everyone involved in field-based learning is to adapt and integrate technology. In response to this problem, numerous innovations in learning technology that lead to the virtualization of the learning environment have begun to emerge. However, the various application products developed have fallen short of the expectations of students. As a result, in order to design the optimal virtual application for use in field-based learning, a needs analysis must be done. This study offers an understanding of student needs for virtual field-based learning applications. An online survey of 140 active university students was carried out to do so. The results showed that students require applications with sophisticated features that resemble the real world for the implementation of online field-based learning. They expect the incorporation of online meeting features, 360 Virtual Reality Panorama, access to learning videos, augmented reality, learning materials, chatbox, and multimedia into the software that will be developed.

Keywords—LAV-FIS, field-based learning, virtual, learning, Covid-19

1 Introduction

The ongoing Covid-19 pandemic is threatening many aspects of life, including education. These difficulties are addressed by modifying the educational system, which employs technology as a platform In the United Kingdom, for example, health information technology (HIT) has been integrated into the health learning system [1]. In Pakistan, the Flipped Class Room (FCR) is utilized to supports both synchronous and asynchronous online learning [2]. Meanwhile, during this pandemic, e-learning is widely employed as a platform for learning at all levels of education [3]–[6]. Not only technologies specifically designed for education, even social media is also used to support the teaching and learning process during this pandemic. Whatsapp, for instance, is one of the social media that are widely used for the learning process in Indonesia [7]. In this setting, the Indonesian government implemented a learn-at-home strategy.

Various kinds of online learning applications are used to assist the implementation of distance learning, for example Google Classroom [8], Moodle [9]–[12], MOOCs [13], [14], SPADA Brightspace [15] and others. However, these technologies are intended more for theoretical learning. When in normal circumstances, learning activities are not limited to theory but also field-based. Field-based learning, on the other hand, is almost impossible to accomplish due to government mobility restrictions [16] which impede the execution of field trips. This circumstance undoubtedly requires the development of alternate solutions to the problem, as the endpoint of the epidemic cannot be foreseen with confidence.

Although health risks must be taken into account, proper education during a pandemic must also be pursued. Learning must continue, as must the curriculum, which includes field-based learning. Incorporating technology into the classroom is, without a doubt, the best answer at this time. The development of learning technology innovation is currently leaning toward online virtual platforms. Several prior studies have attempted to address the challenge of field-based learning during a pandemic in a variety of ways, including Jiang et al. [17] who used smart learning, flipped learning, and interdisciplinary education to overcome field-based learning issues. Additionally, Larsen et al. [18] also recommend using the notion of Hybrid Environments for field-based learning, where virtual field trips are the best alternative. However, every new idea has its own set of advantages and disadvantages. This weakness could be in the incomplete features of the apps. In this context, it is necessary to design a field-based learning application based on an analysis of student needs. Unfortunately, there are very few studies on needs analysis, especially in the field of field-based learning. In turn, this condition raises questions about virtual learning applications that will be developed, such as: how do students feel if field-based learning is eliminated? What kind of field-based learning are they expecting? What kind of field-based learning platform do they think will be available online? What kind of field-based learning applications do students expect if it's done online? What are the characteristics that students expect to see in a field-based learning program that is conducted entirely online? Therefore, we believe that having the proper answers to these concerns is critical before designing a virtual application that supports field-based learning during this epidemic.

2 Literature review

2.1 The urgency of developing virtual applications in field-based learning

The use of technology in the field of learning is currently growing rapidly due to the ongoing Covid-19 pandemic. Progress in mobile learning education research is also moving at an incredible rate [19]. In this new situation, leaders in schools have a very important role to set an example in mastering digital technology [20]. Since there are basic challenges that still need to be addressed by many parties, such as instructors' abilities to use technology for learning [21]. Other than that, the government also need to pay particular attention to the psychological effects of the pandemic [22].

A number of initiatives have been undertaken by the Indonesian government to keep the learning process alive is the implementation of online learning [23]–[25]. It may

solve some problems, but not all, since there are lecture activities in universities that require students to go out into the field (field study) to test their knowledge empirically. Due to the outbreak, the college administration was obliged to postpone this session [26]. Meanwhile, several universities made steps to ensure the application of learning, which included field lectures that were conducted both offline and online under specific conditions, as well as online field lectures [27]. However, this still provides a different learning experience when it comes to putting lectures into action in the field, which is especially beneficial for students of social sciences. Examples include geography, which allows students to gain hands-on experience exploring physical geography when implemented in the field [28], [29], history, which involves studying historical heritage sites scattered throughout various regions [30], social studies [31], culture [32], and community economics [33]. These potentials must be preserved and utilized in lecture activities. However, due to the outbreaks, field-based learning has become more risky, and virtual laboratories may be one answer to this problem.

When it comes to virtual laboratories, significant advancements are now being made in the domains of natural science and engineering. Several researchers [34]–[36] have developed virtual laboratories for Physics learning, which allow students to experiment with the rules of physics and learn more about them. Furthermore, virtual laboratories are used as learning media in the fields of chemistry [37]–[39], Biology [40], [41], as well as courses related to Engineering [42], [43]. Virtual laboratories for social research, on the other hand, are still few. Based on earlier study, the developed application is still in the form of web-based information management [44], [45] and it is also in the form of a virtual tour application for field trip activities [46]–[48].

2.2 Theoretical framework

This study supports Larsen et al. [18] contention that the paradigm of field-based learning can be transformed into an online hybrid form. This is a learning adaption to a specific situation. Larsen believes that the onset of a pandemic, for example, is an opportunity for new inventions rather than the end of field-based learning. Based on this logic, the researchers translated the natural environment into a virtual environment to facilitate learning processes. To make the virtual space as lifelike as possible, a virtual tour with a 360-degree panorama capability was implemented. This virtual tour is supplied with various information in accordance with the curriculum to enable student independent study activity. Students can obtain material in the form of multimedia that resembles a learning environment in the field and enjoy activity that allow them to assess how far they have learned after taking this virtual tour. This aspect of evaluation is in the form of a quiz that students must complete.

3 Method

3.1 Research design

The objective of this study is to find the right formula for an online platform that students can use as a replacement for field-based lectures during the pandemic.

Therefore, this study used a survey as data gathering method to explore student's preferences. This research used Krosnick's [49] survey research approach with some adjustments to fit the objectives of the study.

3.2 Participants

Researchers distributed research instruments to 140 students at the Faculty of Social Science Universitas Negeri Malang, who frequently performed field lectures. These respondents included 107 female and 33 male students from a variety of majors (see Table 1). The students were classified according to their year of enrollment into college, as follows: 2016 (0.71%), 2017 (5%), 2018 (63.57%), 2019 (25%), and 2020 (25%) (5.72%).

Table 1. Respondent's distribution

Departement/Study Program	n
Social Studies Education Study Program	62
Department of History	49
Department of Geography	20
Department of Sociology	8
Department of Law and Citizenship	1

3.3 Data collection

The information for this study was obtained from 140 students who completed an electronic survey. The data gathered included: 1) student opinions if field-based learning is abolished during the pandemic; 2) the preferred form of field-based learning during the pandemic; 3) an online field-based learning platform needed by students during a pandemic; 4) applications that students want when field-based learning is carried out online; and 5) features that students want in applications for online field-based learning.

3.4 Data analysis

Once downloaded, the data on our Google Form is tabulated for each item. To analyze the research data, we used descriptive statistical data analysis techniques to reveal its meaning [50].

4 Findings

4.1 Student opinions if field-based learning is abolished during pandemic

Table 2. Student's perception

No	Elimination of Field Based Learning	Total	Reason
1	Agree	41.42%	86.20% health reasons
			10.34% did not give a reason
			1.72% ineffective
			1.72% adaptation to other learning methods
2	Disagree	57.14%	61.25% interfere with competency achievement
			20% did not give a reason reason
			7.5% of learning methods can be adapted according to conditions
			6.25% learning atmosphere is not conducive
			1.25 can't interact with fellow students
			1.25 can't enjoy entertainment
			1.25 interferes with physical health
			1.25 interferes with mental health
3	No Answer	1.42%	did not give a reason reason

Based on the data in Table 2, it can be concluded that 57.14% of students do not agree if field studies during the pandemic are abolished. They are afraid that it will interfere with the achievement of student competencies. On the other hand, a significant number of students (41.42%) agree that field studies should be omitted due to the health risks.

4.2 The desired form of field-based learning during the pandemic

Based on these findings (see Figure 1), it can be inferred that, notwithstanding pandemic conditions, 75% (105 people) of students choose offline field-based learning, whereas 20% (28 people) prefer to do it online. Other findings indicated that among the 20% (28 students) who chose online, 14 people (50%) suggested using VR Apps (Virtual Reality Apps), 8 people (29%) suggested using other applications, and two persons (7%) suggested using DC Apps (data collector Apps); OM Apps (online meeting); and LS Apps) (live streaming Apps).

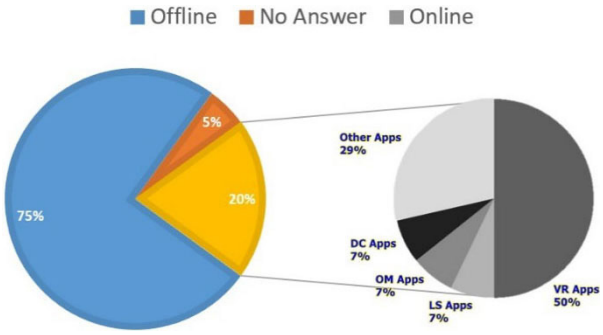

Fig. 1. FBL need analysis

4.3 Field-based learning platform preferred by the students during the pandemic

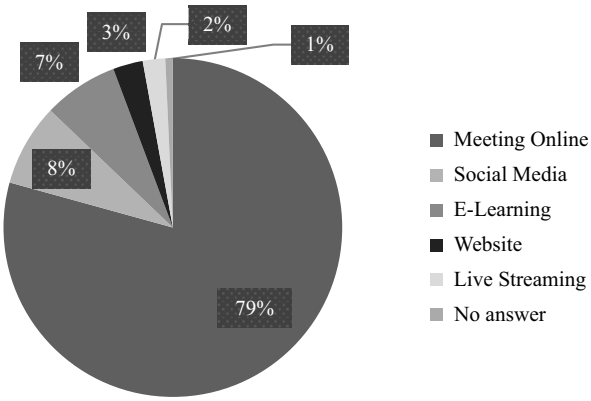

Fig. 2. The need analysis of online FBL

According to the data collected (see Figure 2), the most popular field lecture platform among students if it is conducted online is online meetings (79%), with live streaming being the least popular platform choice (amounted only 3%).

4.4 The desired online application for field-based learning study by students

Student preference for the 360 VR Panoramic a learning medium that may assist them in conducting online field-based learning is demonstrated very clearly in Figure 3. Meanwhile, other applications that were also chosen by students were multimedia apps (32%), video conferencing (27%), and live streaming (22%).

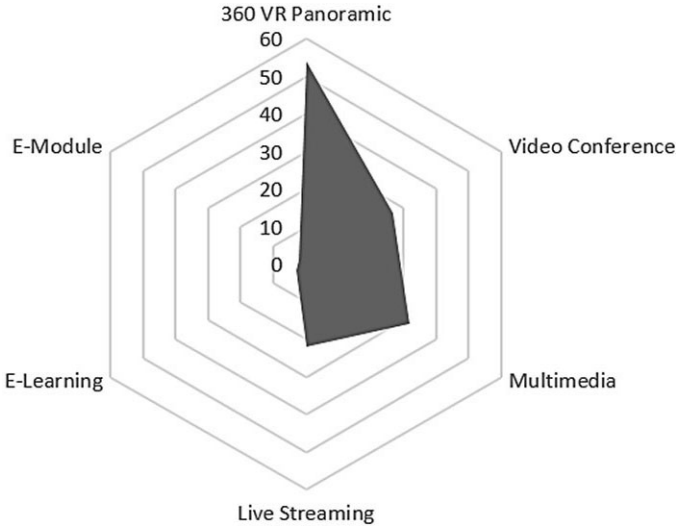

Fig. 3. The tendency of online FBL application that students required

4.5 The desired features of online field-based learning application by students

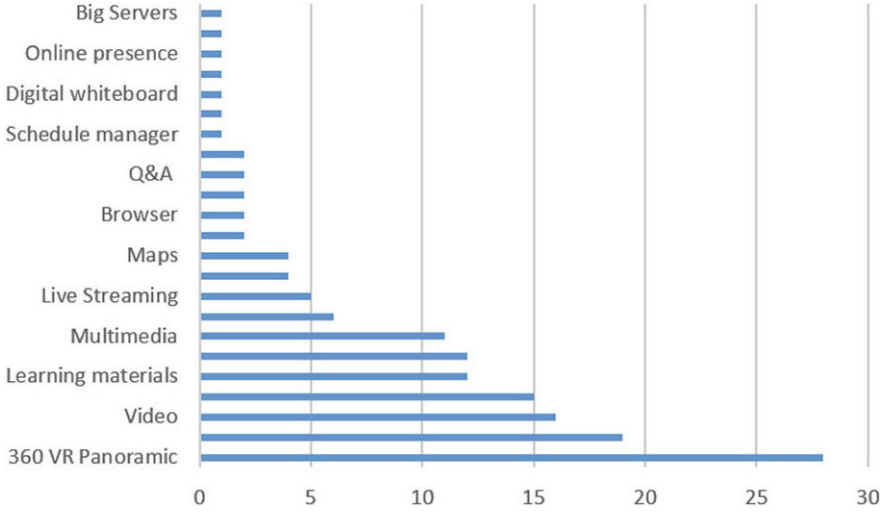

Fig. 4. Online FBL features required

Each application should have features that are not only attractive but also help the learning process. Likewise, what students expect from applications that will be developed for online field lecture activities. Figure 4 demonstrates that the 360 VR

Panoramic feature (28) is frequently referenced by students, indicating that it should be included in the developed program, along with online meeting capabilities (19), video connections (16), and Augmented Reality (15).

5 Discussion

According to the statistics, the majority of students still want field lectures to take place throughout the pandemic. Field lectures are still expected to be held offline rather than online, according to them. They objected to the field lectures being eliminated since they are afraid of not acquiring the expected competency. This finding is backed up by prior research, which found that students still prefer face-to-face instruction [51]–[55]. This could be related to the difficulties that must be overcome when putting online learning into practice. Online learning, for example, has technological infrastructure restrictions [56], [57]. In addition to technological barriers, there are also individual (student learning styles, physical and mental health), domestic (financial difficulties), institutional (administrative, curriculum, school resources, and educator skills), and community (lockdown restrictions, infrastructure challenges, and socio-political issues) barriers [58]. Bozkurt et al. [59] study finds that students do not get adequate support psychologically, socially and academically. This may be related to the perception of parents regarding the implementation of online learning during the pandemic. Dong et al. [60] reported that parents generally have negative opinions about the value and benefits of online learning. They tend to refuse for reasons related to the lack of online learning, student discipline, lack of time, and professional knowledge of students. Referring to the framework of field-based education, Larsen et al. [18] claimed in their article that "the field has not ended," but is undergoing adaption to online and hybrid environments. In fact, long before this pandemic appeared, students were already familiar with various virtual applications, the internet, handheld devices, social media and others [61]. These technologies help students to learn about things in the field more easily and lead them to the cyborg generation [62], [63].

This study find that students want online meetings that are integrated with the 360-degree panoramic application, multimedia, Augmented Reality (AR), learning materials, and chat boxes. This crisis certainly gave rise to new innovations in the field of learning [64]–[66]. Learning in this time of crisis makes us more in touch with technology [65], [67]–[69]. Features that are useful in learning are also increasingly diverse, for example online meetings [70]–[72]. Learning management system [8], [73], [74], multimedia [75], [76] and features for learning evaluation [77]–[80]. Existing technological developments are increasingly sophisticated with the incorporation of the real world into virtual elements such as in Virtual reality (VR) [81]–[84] Augmented Reality (AR) [85]–[87]. And the newest, Mix reality (MR) feature [88], [89] take it one step further by enabling online learning experience that feels closer to the actual world. But more than visual experiences, the developed program also requires interactive capabilities where users can leave comments, bookmarks, and annotations, all of which can help to increase student learning qualities [90], [91]. Although it has been able to meet the needs of teaching and learning, technology is frequently thought to be inadequate to enable lecturers' supervision of students' integrity. Occasionally,

questions emerge as to whether students are genuinely enrolled in distance courses that are delivered through an LMS. However, with the feature to detect student attendance in the LMS, however, there is no need to be concerned [92]. The Neural Turing Machine function can also be used to detect student interest in learning [93]. All those things strengthen the notion that engaging and complex features are critical to the long-term success of online learning. As a result, the more comprehensive and helpful the features provided by an application, the more likely it is to aid learning during this crisis. Its development path is fairly obvious, towards future education [94], [95].

6 Conclusion

Due to a lack of studies that analyze the demands of the product to be developed, this research contributes to the initial study of development research. This study provides a fundamental viewpoint that learning practitioners should consider when developing various learning technology developments, particularly in virtual-based field-based learning. The results of the study indicate that there is an openness to paradigm shifts in field-based learning which begins to integrate technology in it. However, when field-based learning is translated to an online format, it is important to consider the application/platform that will be used as a learning tool. Applications/platforms that are developed need to pay attention to the completeness and sophistication of the features offered. In this context, students need applications that have features such as Virtual Reality Panorama 360o, video, Augmented Reality, learning materials, chat boxes, and multimedia. This research is limited to application development in the context of learning only. However, we believe that future researchers can further refine these findings so that they can be used as a basis for them for the future. We recommend the next researcher create a more current needs analysis model that may be applied in a variety of fields.

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A Comparision of Node Detection Algorithms Over Wireless Sensor Network

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Abstract—MANET is standing for Network as Mobile Ad-hoc which is a self-directed mobile handlers group that communicates over relative bandwidth-constrained wireless channels. Many services with different classes of Quality of Services (QoS) could be provided through the MANET such as data, voice, and video streaming. Thus, efficient packets routing is an essential issue especially over this kind of burst channel. To settle this issue, many scheduling techniques are proposed to reduce the packets dropping and channel collision when a huge demand of data is transferred from a sender to a receiver. In this paper, four MANET scheduling algorithms are selected and investigated in mobile ad hoc networks which are Strict Preference (SP), Round Robin (RR), Weighted Round Robin (WRR), and Weighted Fair (WF). The network simulator EXata 2.0.1 is used to build the scenario which is consist of 50 nodes and performed the simulation. The results showed the performance metrics difference of the network such as the throughput and the end-end delay as well as queuing metrics like peak queue size, average queue length, in queue average time, and dropped of whole packets. Regrading throughput, the SP algorithm has a greater throughput than WF, RR, and WRR by 4.5%, 2.4%, and 1.42%, but WRR has outperformed others regarding the end-end delay. Moreover, WRR represents the best scheduling algorithm regarding both peak queue size since its greater than RP, WF, and WRR by 10.13%, 9.6%, and 5.32%, in order, and average output queue length, in contrast, WRR worsts more time in queuing but it is the best in preventing the packets from dropping.

Keywords—secure detection, MANET, Ad-hoc network, strict preference, round robin, weighted round robin (WRR), weighted fair

1 Introduction

A network as wireless ad hoc is a wireless stations congregation that is capable of configuring itself to establish a network with no whatever infrastructure assistance as shown in Figure 1. It is needed that in a wireless network (WN), the stations that are

sharing channels of communication as the same must be offered a reasonable chance as a fair one for accessing the medium. Fairness is considered as the main issue where the whole wireless network ad hoc should tackle [1]. Unfairness takes place if few stations are grabbing the channel's bandwidth mostly whereas others are starving [2].

The channels in wireless ad hoc networks are characterized by bursts and location-dependent errors. Such subjects are handled via scheduling algorithm as fair packets. Many packet scheduling algorithms for WNs could be found in [3]. It's worth mentioning that optimum packets scheduling will lead to fewer packets collisions in networks especially when a single channel is shared among the wireless nodes. Ad hoc networks and mobile of single-channel are suffering from the sender being hidden, the receiver as hidden, sender as exposed, and receiver as exposed difficulties and thus need operative mechanisms for packet scheduling to avoid collision and let all packets fairly transfer through the channel [4].

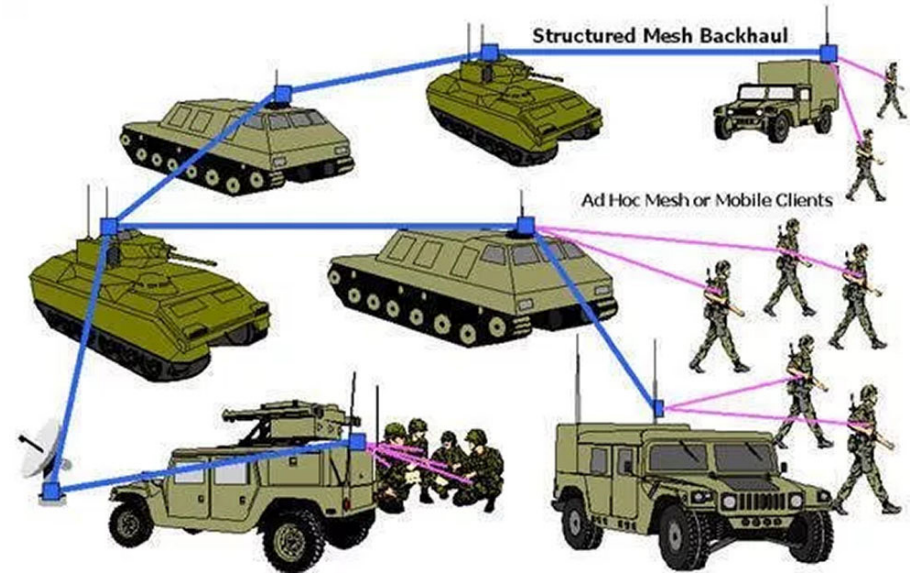

Fig. 1. Mobile ad hoc in military application [5]

Designing optimum packet scheduling algorithms is a challenge for mobile ad hoc networks (MANET). Since weak scheduling algorithm led to severe packets collision over the channel which is the reason for wasting a considerable amount of radio resources and dropping packets especially when the frame size is big [6]. The source nodes looking to transmit the packet completely whatever the channel conditions which is the main cause of performance degradation if no scheduling is implemented. Moreover, the packet priorities do not have meaning when the channel push out the first in without considering which one is more important than others. In some MANET applications, safety data have the privilege to send before any other data since it carries critical information [7]. Thus, designing and developing scheduling algorithms with low complexity offering significant fairness and potential differentiation among the data flow is important in MANET.

This study mainly aims to investigate and make a comprehensive overview of four, RR (WRR). These algorithms are examined in mobile ad hoc networks in terms of average throughput, delay as End-End, queue size peak, queue length as average, average queue time, and total packet dropped. Other factors that are affecting the wireless network such as security and battery life have not been examined in this paper and set as fixed parameters. This paper focuses only on the accuracy and ease of packet transmission without losing any information. The QualNet is the simulation from which all simulation figures are turned up.

1.1 Scheduling algorithms

Selecting the proper packet to transfer over a channel among all sored packets in a specific buffer is called the scheduling technique. It is mainly looking to serve and optimize the quality of service of the network in which a variety of services are existing [8]. The following section briefly describes some scheduling algorithms.

SP. SP queuing adopts that traffic types capable of differentiation and preferentially treated. Queues as separate FIFO are formed for every definite level of preference and the traffic that arrives is arranged into its appropriate queue as it reaches. Therefore, the 1st configuring task as SP queuing is for determining the traffic organizations. Extra queues signify further complexity in algorithm running [9].

At the queue service side, the rule of processing is easy: greater FIFO queues as preference are processed always to end before queues of lower preference are processed; i.e., in the system as 3-queue, when the 2 maximum queues as the preference of no buffered packets, so the lowermost queue of preference would be repaired. The moment where a greater preference packet arrived in its queue as FIFO; nevertheless, servicing the lesser preference packets would be hindered in greater preference queue favour. SP queuing is standard as gold for high preference traffic.

The greatest detriment links to the approach SP queuing treating queues. High-preference packets are processed always before such of less preference. When the high-preference amount of traffic is excessive, other queues may never be unfilled, causing a worse accomplishment for the low and medium-preference traffic in comparison to the case where a queue as a single FIFO were utilized [10].

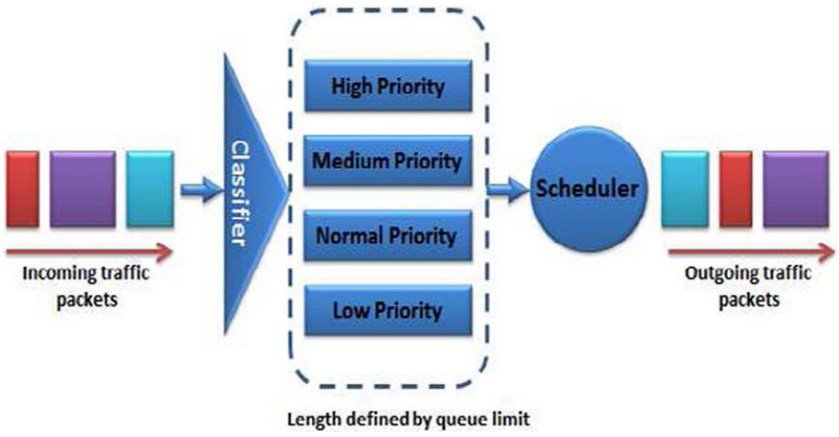

Fig. 2. SP scheduler [11]

Scheduling of RR. The scheduler algorithm of the RR packet is the simplest one which is distributing the turns of scheduling similarly among all utilizers of active MANET, irrespective of the condition of the radio channel and the QoS application running requirements. The system resource fairness in time-sharing is forming unfairness to such UEs that are of conditions of good radio and is starving for throughput [12].

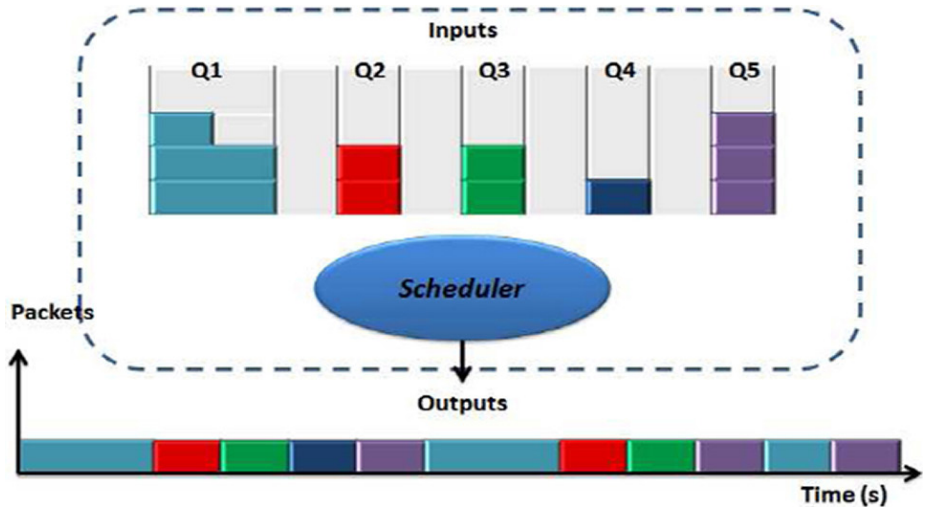

Fig. 3. Round-robin scheduler [11]

WF. WF Queuing (WFQ) is a technique of packet scheduling permitting services as guaranteed bandwidth [13]. The WFQ purpose is to allow numerous sessions sharing links to be the same. Generalized Processor Sharing (GPS) is approximated by WFQ. It relies on a model of fluid; thus, it adopts that the traffic input is markedly separable and all sessions capable of being served at the time being the same. As long as every session has its queue, a session that is ill-behaved (that is conveying numerous data) will just 'punish' itself and not another session [14]. Such is a server of work-conserving, and it assures that every session obtains the rate of service as a minimum in which r is the rate of server and θi is the weight for the ith session. The scheduler takes a minor piece of information from every session and conveys it to the link of output. From the stand point of implementation, the slow methods of scheduling are of a lower complexity degree compared to fast ones of schedule, due to that the latter needs the data of support rate from the measurements of UE channel quality for whole utilizers in the cell, and later compute their [15].

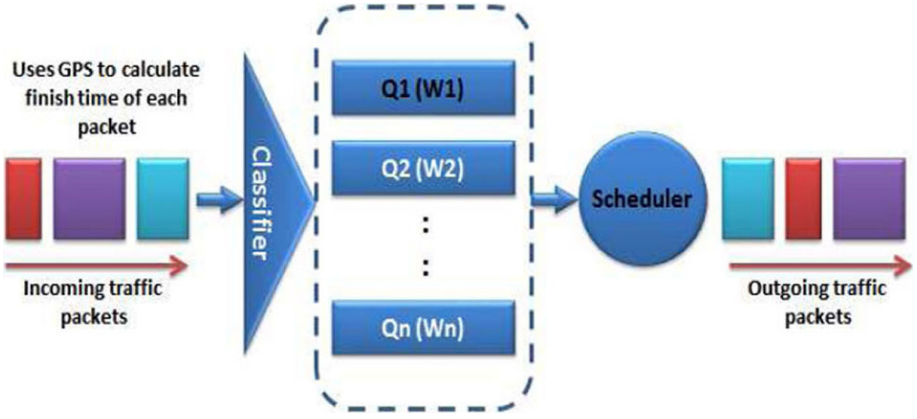

Fig. 4. WF queuing scheduler [11]

WRR. In the procedure of WRR, packets are classified into diverse service groups and then assigned to a queue which capable of assigning various bandwidth and served according to RR order as illustrated in Figure 5. The algorithm works by giving priority to the packet with lower bandwidth. Such an algorithm tackles the starvation issue by assuring that all service groups can access a minimum few configured network bandwidth amounts.

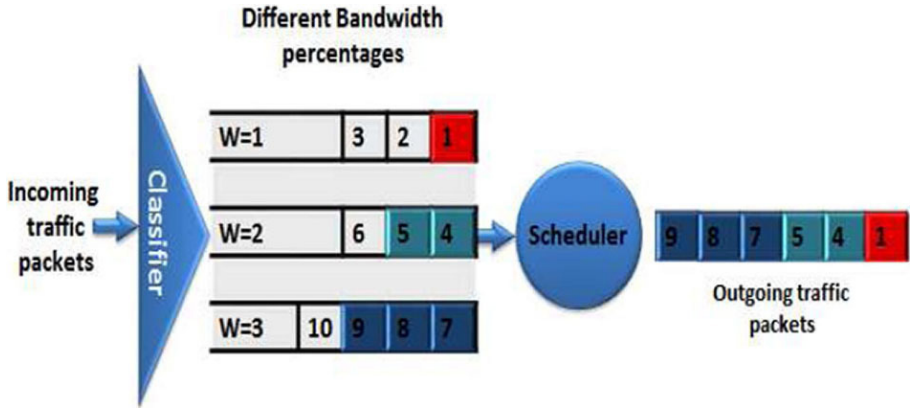

Fig. 5. The scheduler of weighted RR [11]

1.2 Problem statement

Selecting the scheduling algorithm in MANET is essential to mitigate packet losing and dropping [16]. Since the Scheduling algorithms are accountable for sharing in distributing manner network properties among all nodes in the MANET and offer them a greater QoS guarantee [17].

Many scheduling algorithms are proposed and developed. Research has been done on joint routing and link scheduling where they found increasing in the throughput regardless of the power consumption [18]. Other research was done based on a time division multiple access allocation scheme which increases the performance of the MAC protocol [19]. A model that simplifies packet routing and scheduling by allowing nodes to arrive and leave arbitrarily has been proposed [20]. Nevertheless, performance evaluation to select some of them still lack and need more investigation. In this research, four scheduling algorithms are selected and investigated in the mobile ad hoc network [21]. Two of them are classified as slow scheduling algorithms which are RR and SP scheduling algorithms [22]. Then, fast scheduling algorithms are examined also which are WF queuing and weighted scheduling algorithms. The selection of four scheduling algorithms comes from they are famous and reliable scheduling in MANET [23].

2 System model

The main idea of this paper is to compare four selected scheduling algorithms in ad hoc networks and mobile in which 50 nodes are randomly distributed. Firstly, an extensive literature review is conducted in terms of the definition of mobile ad hoc networks, their advantages, their applications, and their issues. Next, designing the proposed scenario using EXata V. 2.0.1 which is a network emulator. Then, implementing the four selected scheduling algorithms (RP, WF, RR, WRR) consequently [24, 25]. Finally, run the simulation and extract the results to analyze them in terms of many performance metrics either for the overall network performance such as the average throughput and end-end delay or for the queuing performance metrics i.e., size of peak queue, queue length as average, in queue average time, and whole dropped packets. Figure 6 depicts the overall methodology of this paper.

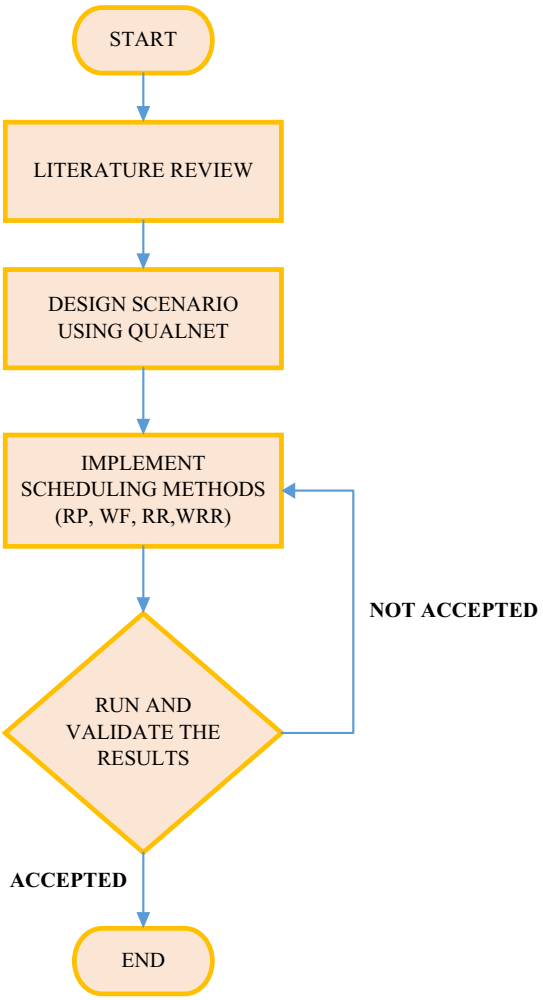

Fig. 6. Overall methodology

3 Simulation and validation

There are many simulation parameters related to the proposed scenario that need to be adjusted before running the simulation. Table 1 represents simulation parameters that must be adapted and checked for proper simulation results.

Table 1. Parameters of simulation

Parameters	Value
Network kind	Ad hoc WN
Nodes #	50
Terrain:	1500–1500
Time of simulation	100 sec
Application of traffic	CBR
CBR #	20
Sended items	100
Size of packet	512 B
Interval	1 sec
Start-end of CBR	1–25 sec
Protocol of Network	IPv4
Protocol of MAC	IEEE 802.11
Model of mobility	Random Waypoint
Speed (Min-Max)	(0–3) m/s
Time of pause	10 sec
Model of physical layer	PHY 802.11b
data rate	1,2,6,11 Mbps
Transmission power	25 dBm
Noise factor	10.0
Received sensitivity	83.0
Channels #	1
Wireless frequency of channel	2.4 GHz
Protocols of routing	AODV
Scheduling	RP, WF, RR, WRR

Followed by the simulation scenario which is consist of 50 nodes and is built by EXata software: as shown in Figure 7.

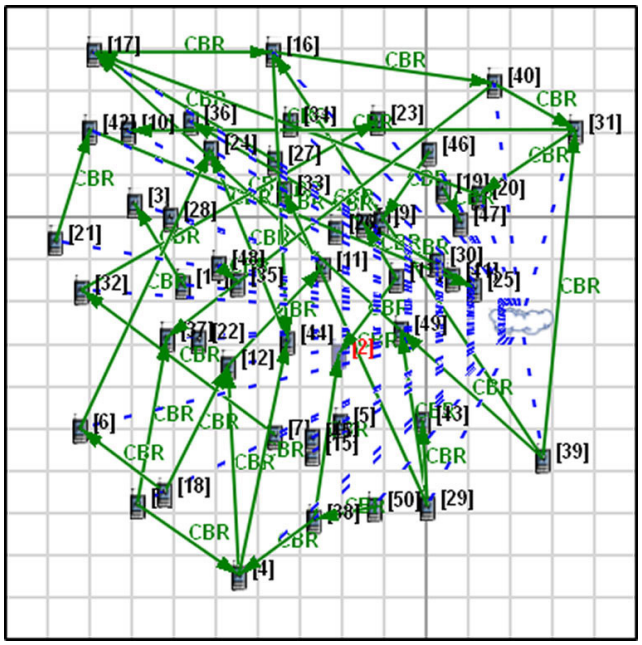

Fig. 7. Simulation scenario

For each parameter, its values are changed by selecting the related tab at the output view in the EXata view. Next, the elements in the respective tab are selected, right clicked and the properties area is opened [26].

After all the parameters have been set up, the simulation is running through action button clicking and then the play button. Figure 8 shows the menu from which we can select the scheduling algorithms [27].

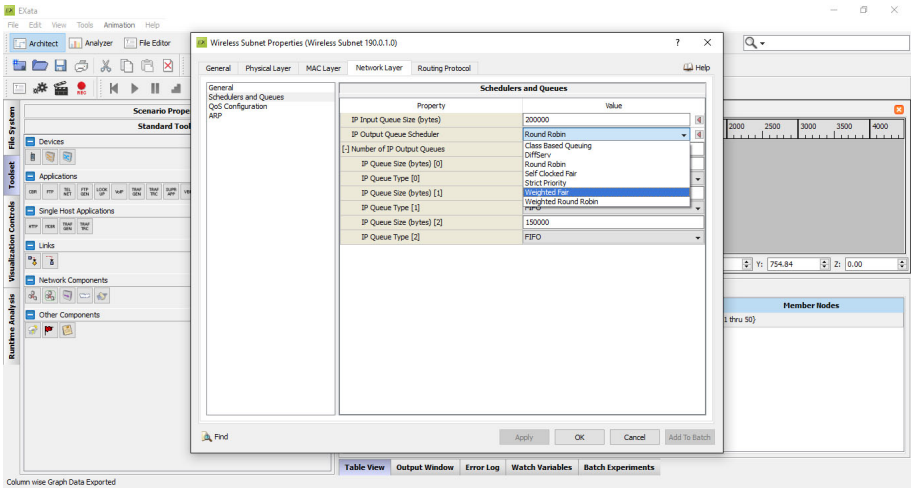

Fig. 8. Selecting scheduling algorithms menu

Then, after finishing the simulation, the button of the analyzer is clicked for viewing the graphs of the simulation. As shown in Figure 9. By exporting the results to a text file, plotting the results figures could be achieved by Microsoft Excel.

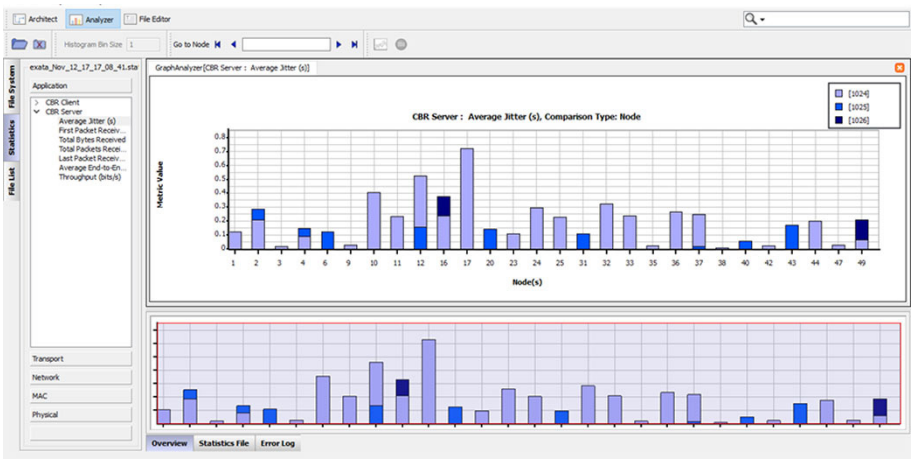

Fig. 9. Analyzer screen to extract the results

4 Results and discussions

This section presents the results and their analysis when different scheduling algorithms are implemented in the mobile ad hoc network. These algorithms are analyzed in terms of average throughput, jitter as average, delay of End-End, size of peak queue, queue length as average, the average time in queue, and whole dropped packets forcibly.

4.1 Throughput as average

The total average packets received through network simulation in kilobit per second is an important metric. Figure 10 depicts the average throughput for the SP, WF, RR, and WRR scheduling algorithms which are 3870.2 Kb/s, 3693.42 Kb/s, 3775.89 Kb/s, and 3815.2 Kb/s, respectively. SR algorithm has a greater throughput than WF, RR, and WRR by 4.5%, 2.4%, and 1.42%, respectively. The restricted mechanism of the RP regarding assigning in order the priorities for the sending packets are the main reason behind that. The lowest throughput is for WF algorithms.

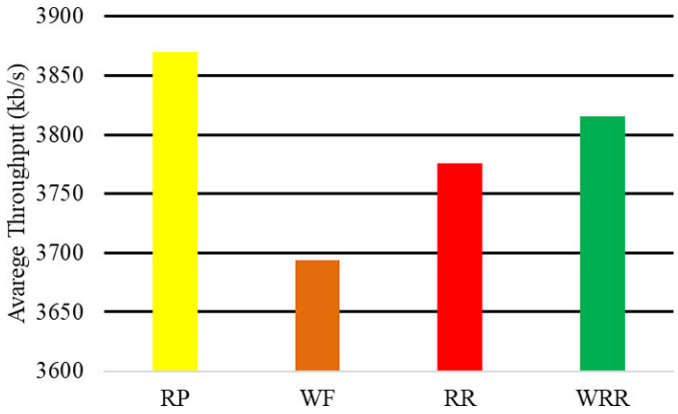

Fig. 10. Average throughput for the selected scheduling algorithms

4.2 End-end delay

The scheduling process is one of the most processes that could make significant delays in the network according to packets arrangements and queuing. The end-end delay or the latency which is the summation of processing delay, queuing delay, transferring delay, and propagation delay need to be investigated. Figure 11 depicts the end-end delay over the selected four scheduling algorithms. WRR has the highest latency comparing to other scheduling algorithms based on its mechanism regarding the categorization and assigning processes as mentioned in the literature, but still shows better performance as will be presented later. The end-end delay is 0.192 s, 0.269 s, 0.284 s, and 0.293 s for the reSP (SP), WF (WF), RR (RR), and Weighted RR (WRR), correspondingly. The lowest delay is shown in SP and it is lower than WF, RR, WRR by 28.4%, 32.18%, and 34.34%, respectively.

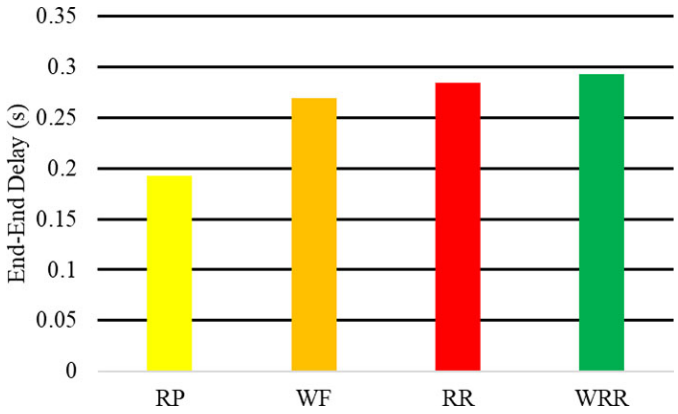

Fig. 11. End-end delay for the selected scheduling algorithms

4.3 Size of peak queue

Figure 12 illustrates the size of the peek queue at the wireless router which is 799.2 bytes, 803.76 bytes, 841.92 bytes, and 889.3 bytes for SP, WF, RR, and WRR, respectively. From the previous values, the most horrible scheduling algorithm at the size of queue 150 KB is SP. WRR represents the best scheduling algorithm since its greater than SP, WF, and WRR by 10.13%, 9.6%, and 5.32%, in order.

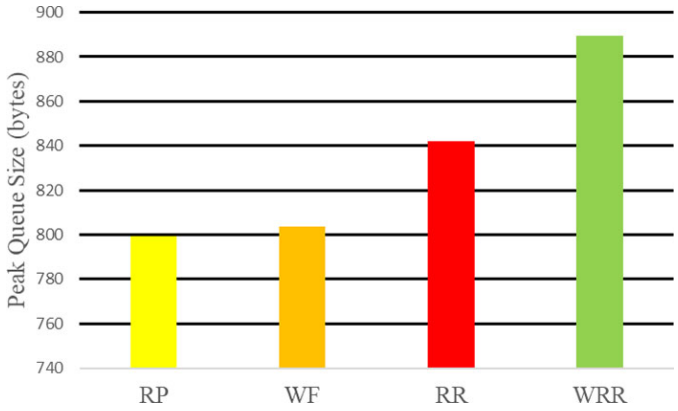

Fig. 12. Peak queue size for the selected scheduling algorithms

From the results, the weighted RR scheduling algorithm can provide a significant queue size at the wireless gateway.

4.4 Average queue length

Average output queue size results for the four selected scheduling algorithms are presented in Figure 13. The measurements are taken placed over all the nodes and calculate on average. The Average output queue size is 10.89 bytes, 11.10 bytes, 11.72 bytes, and 13.73 bytes for the SP, WF, RR, and WRR, in order. The Weighted RR scheduling algorithm shows the highest average output queue size at 13.73 bytes, but the lowest queue size is appeared by the SP scheduling algorithm (11.10 bytes). The WRR is proceeded by 14.64%, 19.09%, and 20.68% compared to RP, WF, and RR, respectively.

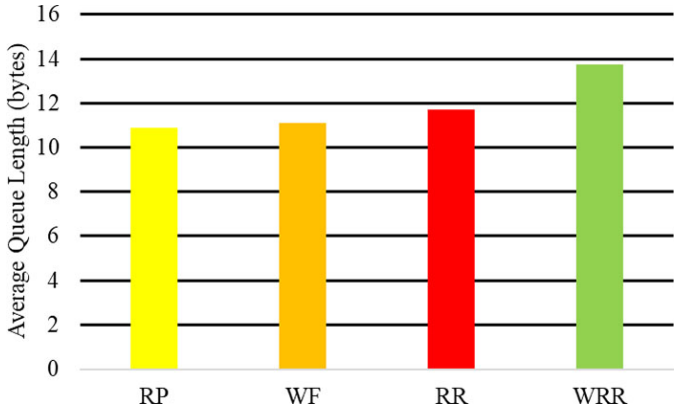

Fig. 13. Average queue length for the selected scheduling algorithms

4.5 Average time queue

Figure 14 depicts the average time in queueing process at the wireless getaway for the reSP (SP), WF (WF), RR (RR), and weighted RR (WRR) scheduling algorithms which are 0.013 s, 0.0125 s, 0.0107 s, 0.0087 s, respectively. The SP waste is more time in queuing comparing to others. Moreover, WRR shows the lowest average time in queuing which mean is the fastest one. By 53.81%, 43.87%, and 23.06%, WRR is reserve more time comparing to SP, WF, and RR, in orders.

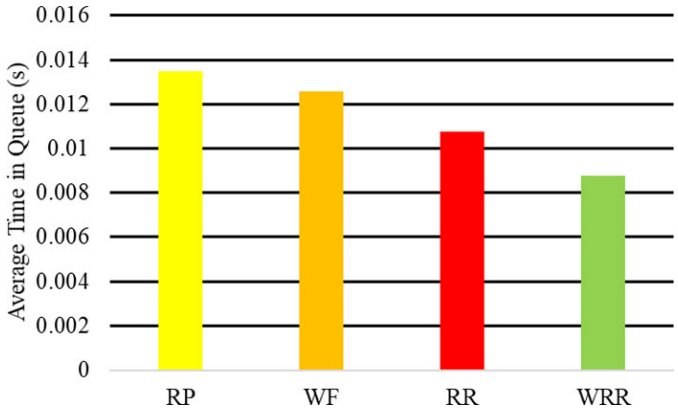

Fig. 14. Average time in queue for the selected scheduling algorithms

4.6 Total package drop

Figure 15 depicts how many packets are dropped by force when memory buffered is full which are 23 packets, 19 packets, 18 packets, and 15 packets for the SP, WF, RR, and WRR scheduling algorithms. From the figure, it is clear that WRR has dropped the least packets when the node buffer becomes full. The highest dropped is achieved by the RP scheduling algorithm since it dropped 23 packets at the same condition of buffering.

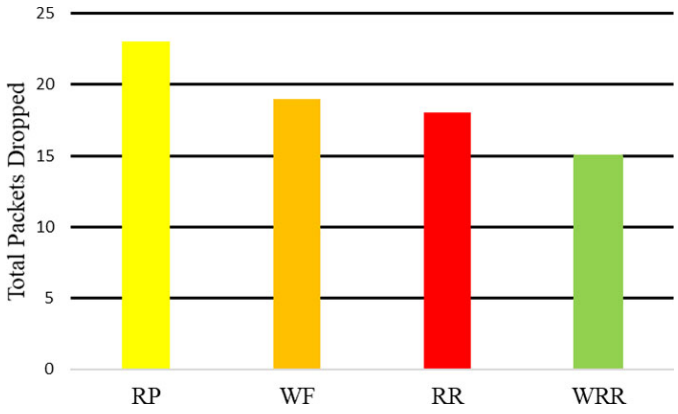

Fig. 15. Total packets dropped for the selected scheduling algorithms

5 Conclusion

Mobile ad hoc networks are emerging recently to ease the communication between distributed nodes without any infrastructure. The goal of this kind of network is to provide telematics services i.e., voice, data, and video with various qualities of service requirements. For this reason, the growing demand for scheduling algorithms that are capable of considering different QoS requirements is imposed to develop a new scheduling algorithm. Moreover, evaluating the performance of existing ones in different scenarios is essential. In this paper, the performance of SP, RR, Weighted RR, WF scheduling algorithms is investigated mainly in terms of network metrics and queue management metrics in ad hoc networks and mobile. The scenario consists of fifty randomly mobile nodes and is built using the network simulator EXata. The results showed that the SP outperformed the others regarding throughput. In contrast, WRR has outperformed the others regarding the reminding metrics end-end delay, size of peak queue, queue length as average, in queue average time, and dropped packets.

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The Impact of Social Media on the Use of Code Mixing by Generation Z

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Abstract—Generally, generation Z mixes English and Indonesia when communicating with each other. This sociolinguistic phenomenon called code-mixing impacts social media as part of the development of Information Communication Technology (ICT). Therefore, this study investigated the impact of social media on code-mixing by generation Z. This study was carried out at Serang Raya University, Indonesia, where English is the only foreign language used to teach students. Three hundred thirty-six students participated in this study (N=110, F=226). The qualitative data were collected through self-completed questionnaires and interviews. The research aims to highlight the contribution of social media in code-mixing and determine why this generation uses English and Indonesian in social media. The present study revealed that nine utterances with a high frequency were used. The causing factors and reasons behind this phenomenon were varied. In addition, the findings showed that individual factors were for the very high percentages (75%). Among them were social factors (15%) and cultural factors (10%). The results showed that the use of social media had an impact on code-mixing between Indonesian and English for Generation Z.

Keywords—code-mixing, generation Z, social media, sociolinguistic phenomenon

1 Introduction

There is a rapid growth in technology which has a significant impact on people all over the world, especially those born from 1995 to 2014, commonly known as Gen Z. This group of people are characterized as those born in the digital era, and they are unable to live without digital technology [1]. Generation Z (Gen Z) enjoys using social media to communicate and various activities because they are the first truly digital generation to grow up with technology and smartphones. According to a survey by Business Insider, this generation generally uses three platforms, and the most is Facebook. Furthermore, they are extensively influenced by technology because they have access to mobile devices, digital equipment, and the internet [2]. They prefer social media to communicate with each other rather than conventional means of communication, such

as short message service (SMS) with a change in the learning paradigm [3]. Although various social media platforms, Gen Z prefers Instagram, Snapchat, Facebook, and Twitter [4].

Currently, there is a yearly increase in the use of social media, which has significantly affected language [5]. Children and students of all ages are caught up in a massive, unexpected experiment, surrounded by digital devices that were not available even five years ago [6], and mobile learning is an educational reform [7].

Based on the study [8], social media has added a new dimension to language evolution, increasing the mixing of language and cultures, thereby leading to the fading of society. Schools administrators develop many social media platforms in the English language [9]–[11]. Furthermore, social media users always mix code when tagging on YouTube, Facebook, Instagram, and tweeter [12]. There are many familiar terms in social media, such as share, follow, unfollow, follower, like, unlike, wall, posting, online, offline, highlight, bio, activity feed, caption, mention, comment, follow back, endorse, give away, tag, hashtag, late post, repost, swipe up, tweet, retweet, trending topic, etc.

Code-mixing is a sociolinguistic phenomenon aimed to understand the relationship between language and culture better to better understand the structure [13]. The goal of sociology is to understand the social structure better through the study of language. The advancement in Information and Communication Technology (ICT) affects communication due to many code languages. Therefore, the doer becomes bilingual or multilingual, the most popular sociolinguistic phenomenon involving intermingling codes from various languages to facilitate communication and convey a message as the English language becomes more integrated into people's lives, its use in formal and informal settings increases. People have started using English code, such as hex or hexadecimal, to express themselves, thereby leading to a rise in the popularity of foreign languages. Aside from the mother tongue, English is one of the most commonly used foreign languages; hence it is a lingua franca due to the influence of globalization. In addition to their mother tongue, many Indonesian teenagers now use English to communicate. It has been observed that in today's social-communicative environment, these young people tend to code-mix English and their native tongues. This phenomenon is seen in their use of language on social media or real life, a standard mode of communication among Gen Z. Nowadays, people use social media to share their feelings, gather knowledge, and make new friends.

Data collected through observation showed that many public figures and teenagers use English language codes when interacting on Instagram and WhatsApp [14]. Many of these words were obtained from online media with motivations when someone mixes code with another language. There are many reasons youngers participate in mixing code while communicating [15]. These reasons show that English is a global language, effective communication, a better social position, or prestige. This research emphasizes the use of Indonesia in English classrooms.

Several preliminary studies on code-mixing investigated its function and reason based on users' conversations on several social media. stated that Facebook users mix code when communicating on the platforms for various reasons such as to express politeness and respect, convey clear meaning and feelings, and present their identities or group membership [16]. Facebook users use the mixed code for several reasons,

such as to make communication easier, to correct language, and to help understand the context [17].

Unlike previous research, this study focuses on some words used to carry out instruction in social media, such as like, friend, follow, follower, etc. This research aims to reveal various aspects of sociolinguistics phenomenon such as followers using social media, their preferred friendships, and their preferences. Accordingly, the current study investigates this phenomenon by identifying the most frequent types and factors that motive code-mixing. The study's findings will inform the research to understand how social media impacts code-mixing students' learning in Indonesia. Hence, the differences among the participants' responses that can be attributed to age, gender, flatform, and hours spent online are also investigated.

Gen Z always uses these instructions in their daily conversation. Due to the daily use of social media, some terms impact language, and social media contributes to code-mixing by Gen Z.

2 Literature review

2.1 Code-mixing

Code mixing has been discussed by a significant number of authors in literature. For example, research has provided evidence for language studies, society, and phenomena. This tendency can also be observed in a university or other academic setting [18], [19]. The study between language and society is sociolinguistic, and code-mixing is one of its phenomena. Sociolinguistics is the study of language in use [21]. In more detail, sociolinguistics is the study of the interactions between language and culture to understand the structure of language and how it works during communication [20].

Furthermore, it is concerned with the relationship between language and culture. The main focus is on linguistic diversity through social classes and the variety of communicative contexts in which women and men use their verbal repertoires. When people communicate, they use language as a tool to send messages, thereby making it a sociolinguistic phenomenon. There are many types of sociolinguistic phenomena, such as code-mixing.

Several scholars have studied code-mixing. Code-mixing is defined as "any situation in which lexical item and the statement has elements of grammar from two different languages" [22]. It denoted that the speakers or writers freely combines one or two spoken interaction. Code-mixing occurs when a speaker uses two languages in a single utterance simultaneously [23]. Code-mixing, also known as "Intra sentential code," refers to "all cases in which lexical objects and in one sentence, grammatical elements from two languages are mixed" [24]. They stated that the process of mixing two or more languages in word form in a sentence is a part of the utterance.

Furthermore, Code-mixing is divided into three types: insertion, alternation, and congruent lexicalization [22]. He said different ways constrain these three types in specific bilingual settings. This study highlighted code-mixing as the process of mixing two or more words, phenomenon, expression, reduplication, and idiom from [22].

The form of code-mixing occurs in social media, used by many people [25]. These forms of code-mixing are used to demonstrate products on social media through text, which has opened up a slew of new possibilities for information access and language technology. The mixing code phenomenon has many functions for each language user, including social media. There are many reasons for someone to mix code: bridge gaps, make effective communication, explain points, affirm social status, and emphasize something [26]. The reasons why people mix language in social interaction have been found [27].

Furthermore, the factors are speaker or writer, intercalators, the setting of the conversation, the purpose, and the topic of the conversation. In this study, the writers apply code-mixing introduced [28]. He stated three factors of using code-mixing, social, cultural, and individual factors.

In summary, the writers will investigate the type of code-mixing used by students at university through their Facebook group, the most absorption words used by students on Facebook, and factors influencing code-mixing.

2.2 Generation Z

A generation is defined as a group of people with varying characters and born within a specific period [29], [30]. Generation Z is the individuals born after the millennial [31]. Several scholars have described, generation Z refers to people born in the 1990s and raised in the 2000s through the most significant developments in the century. This category of people now lives in a world with the internet, cellphones, laptops, available networks, and digital media [32]. In this generation, students are more likely to use code-mixing on social media, such as Facebook, because of technological advancements. Generation Z is born in 2001 or later and the first generation to be "born digital." [33]

One of the most significant characteristics of this generation is that they were born "natives" in the modern digital world [34]. This generation has many names such as Digital Natives [35], post-millennials [36], Net Generation [37], The Centennials [38], etc. This era transformed the world towards digitalization, thereby creating challenges to the traditional ways of carrying out activities and increasing the use of technology [39].

Based on the concept above, generation Z is familiar with ICT. According to [40], they are comfortable with technologies that are relatively recent for older generations, with familiarity with the ubiquitous of mobile communications. In this generation, students. As a result, this generation is also affected and interconnected to the web. Globally known music, movies, and celebrities are connected to this generation, rather than numerous trends, fashion, food places, and several events are interconnected to social media through technology and globalization [41]. In brief, this generation usually communicates using the mixed code comprising of English and Indonesian. The participants in this study are natives of Indonesia and use both languages offline and online.

2.3 Social media

Social media enables people to connect, communicate, discuss, and interact [42]. The channels broadcast news and information to viewers of all genders. Another opinion, according to [43] people use social media to connect with others who have similar

interests, activities, backgrounds, or real-world connections. Research shows that half of all people get news from social media daily, which directly impacts today's world events [44], [45].

In addition, social media comes in various shapes and sizes, dependent on usage. Some of the most common ones are social networking sites (Facebook, LinkedIn), blogs (WordPress, Medium), microblogs (Tumblr, Twitter), media-sharing sites (Vimeo, YouTube, Instagram, review and recommendation sites (TripAdvisor, Yelp, and others), numerous discussion forums [46], [47], Slack, Trello, and other collaboration sites.

All social media networks can be divided into four distinct regions [48]. They are as follows: (1) a social group, (2) Publication on social media, (3) Amusement for the whole family, and (4) Social business. Each zone is characterized by functions that explain and unite the social media platforms.

Social community. All social media channels in this zone allow individuals to connect and communicate with various communities. Therefore, the primary goal is to facilitate interaction and collaboration. Social networks, message boards, forums, and wikis are part of the social culture [48].

Social publishing. The development, publication, and distribution of material, are the core characteristics of the social publishing region. The social media sites available in this region make it possible for anyone to create content regardless of their professional context [49]. The democratization of content creation was made possible by social publishing consisting of individual users, independent 44 practitioners, professional contributors, and brands [48]. The social publishing zone includes blogs, microblogs, media-sharing sites, bookmarking services, and news sites [50].

Social entertainment. Social entertainment zone refers to social media that provide entertainment, enjoyment, and fun-related content. Social media platforms enable users to play games, listen to music, and watch videos [51]. However, it is also important to note that the social networking sites that fall under this category include individuals interacting by sharing different content and posting personal updates. YouTube, Spotify, Reddit, and various online interactive games such as Trivia Crave and Candy Crush are good examples of social entertainment channels [48].

Social commerce. The social commerce zone encompasses all digital services that affect purchasing decisions, and it applies to all social media channels that consumers use in the decision-making process.

Several studies on social media are associated with Gen Z, with the result dependent on the associated area. One of such studies acts as a reference to analyze the specific social media platforms that are popular among them. According to statistics, Facebook, YouTube, WhatsApp, and Instagram are among the most popular social networks worldwide as of October 2021, ranked by the number of active users [52].

In conclusion, social media is a critical and convenient communication network nowadays. It can be used to meet new people, keep in touch with old friends from all over the world, and quickly share ideas and improve things. By sharing their content, users can learn new things and reduce their reliance on advertisements.

Numerous activities are carried out on social media with instructions based on the developers' rules. Several popular terms or instructions are used on social media in Indonesia, among Gen Z. These instructions are initially from the English language and

are obeyed while using the social media platform. Table 1 shows a popular list of terms used in social media.

Table 1. Popular list of term (vocabularies) in social media

Download	Like	Caption
Upload	Share	Private
Wall	Subscribe	Posting/post
Follow	Comment	Streaming
Follower	Mention	Friend
Unfollow	Tag	Unfriend
Followback (Follback)	Hashtag	password

To sum up, social media is a web-based communication tool that allows people to interact and share and seek information via web-based communication channels.

3 Methods

3.1 Respondents

This study is descriptive research patterned in the relational survey and interviewing model [53], [54]. The writers collect the data in the field of data site where the participants experience the issue or the problem under the study. The qualitative method is a procedure that yields results such as words of those who were observed and data from the research such as descriptive data.

The opportunity sampling method was used to obtain data from undergraduates of the Serang Raya University born from 1999 to 2001. The participants were accessible and met the requirements when the research was conducted.

3.2 Instruments

Three instruments were used to achieve the research goal. Namely, a questionnaire was created using Google forms, in-depth interviews, and code-mixing utterances popularly used by generation Z. However, before data collection, a set of questionnaires and interview protocols were prepared. The questionnaire was divided into 2; the first section contains vital information such as name, age, and gender. Conversely, the second section comprises of questions related to social media usages such as (1) which online platforms were used, (2) the number of times they were used per week, (3) which is the popular platform for Gen Z, (4) the use of some standard terms or instructions in their daily conversation (5) the impact of social media usage on code-mixing.

Irrespective of the data extensively collected from the questionnaire, this research mainly focuses on social media contribution on code-mixing usually uttered by Gen Z. Furthermore, it was developed using an interview protocol adapted from [55]. The goal was to confirm the items on the questionnaire, which was similar to the contents of the interview protocols. In the first stage, 10 participants filled the questionnaire. The result

was used as a preliminary study to ensure this phenomenon is re-investigated. In addition, the number of participants was increased to obtain valid and reliable results.

3.3 Procedures

The first stage identified some utterances mixed with English words; specific terms or instructions were also used on social media. Furthermore, an already prepared questionnaire was shared with the participants. This is because there were some instructions and linguistic terms that they were unable to understand, particularly the instructions or terms used on some social media platforms. The individual was given a prepared list of technical terms and instructed to fill out the questionnaire until they fully comprehended the word.

After its completion, all the participants were interviewed personally, and the duration depended on their responses to the questions. The process was recorded and digitally controlled by using the prepared interview protocol. As earlier mentioned, those personally interviewed were selected as the sample for further analysis.

3.4 Data analysis

This is descriptive qualitative research because it explains the linguistic form of code-mixing and its usage. Qualitative data was generally collected from Gen Z's daily utterances, while an in-depth interview was also conducted. The data obtained was represented quantitatively in percent using Google form summarization, analyzed to obtain descriptive statistics. Furthermore, the data realized from the in-depth interview was qualitatively scrutinized for confirmation. The research objects are some familiar English codes specifically used on social online. This study investigates the influence of online media regarding English code-mixing on generation Z. It focused on the undergraduate program. The data source includes questionnaires and interviews briefly carried out to acquire information concerning code-mixing, etc.

4 Results and discussion

4.1 Demographics of students respondents

As in Table 2 shown, the total number of respondents in this study was 336 (M=110 and F=226). All the respondents that responded to the survey were randomly selected from a university located in Serang, the capital city of Banten province. Among them, 67.3% of participants were female, and 110 (32.7%) were males, aged between 18 until 23 years. Active respondents were average age 18–23 years (49%). Participants came from different parts of the country, including the city where their university is located, after completing their Higher Secondary level of education under Indonesia's national curriculum.

Survey data indicated that the number of respondents having access to the social media platforms and Facebook for the very high percentages (43.15%). Among them were YouTube (31.25%), What's App (17.85%), and Instagram (7.75%). Moreover,

respondents could spend less than 5 hours online using social media (49.40%), at 6–10 hours (34.23%), and above 10 hours (16.37%).

Table 2. Demographic characteristics of respondents

Demographic	Characteristics	Frequencies	All Participants (N=336)
Gender	Male	110	32.7%
	Female	226	67.3%
Age	18–19	165	49.10%
	20–21	91	27.10%
	22–23	80	23.80%
Platforms	Facebook	145	43.15%
	Instagram	26	7.75%
	What's App	60	17.85%
	You Tube	105	31.25%
Hours spent online	Less than 5 hours	166	49.40%
	6–10 hours	115	34.23%
	Above 10 hours	55	16.37%

4.2 The type of code-mixing and most popular utterances

Among several kinds of utterances on social media, here is the list of the nine most popular. Table 3 proved that "share" was the highest (10.42%) used in code-mixing since it has become the common word. The participant used "download" (10.12%) and Subscribe (8.93%) on YouTube. "Hashtag" and "Caption" were most popular used on Instagram (8.93%).

Table 3. Most popular utterances on social media

Utterances	Frequency	Percentage (%) All Participants (N=336)	Platforms
Download	34	10.12%	YouTube
Follow	32	9.52%	Instagram
Follower	28	8.33	Instagram
Follow back (*Follback*)	20	5.95	Instagram
Share	35	10.42	What's app
Subscribe	30	8.93	You Tube
Hashtag	30	8.93	Instagram
Caption	30	8.93	Instagram
Unfriend	28	8.33	Facebook

When the survey using Google form was completed, The interviewees were chosen from among the participants because of their availability and willingness to participate,

and the researchers interviewed 10 of them. The most prominent themes that emerged from the interview were (1) the participants' language use; and (2) their attitude and effect towards mixed language. Results from participants' interviews have been presented in Table 4.

Table 4. Types of code-mixing

Participants	Sentences	Type of Code-Mixing
P1	[1] "*Jangan lupa* subscribe and like *ya video nya*." {Don't forget to subscribe and like to yeah}	Alternation
P2	[2] "*eh,, berapa* follower *kamu*" *dan* "*waaww…* follower *nya udah banyak banget ya…*" {"eh.. how many your follower" and "wow.. your follower so many.."}	Alternation
P3	[3] "*hai,,, jangan lupa di* follow *ya instagramnya.*" *Atau* "follow *Instagram aku ya…*" {"hey.. don't forget to follow its Instagram," or "follow my Instagram please.."}	Alternation
P4	[4] "*iihh,,, males deh, masa gw udah* follow, *dia nya gak follback.*" {"*iihh*.. it make me mad, I followed her, but she didn't *follback* me"}	Alternation
P5	[5] "*loh kenapa di* unfriend?" {"*loh* why unfriend"}	Insertion
P6	[6] "*nanti* share *ya di facebook jangan lupa tag gw*" {"please share it in Facebook and don't forget to tag me"}	Alternation
P7	[7] "*bagus tuh infonya dishare dong ke* WhatsApp." {"it's nice info, share it please to WhatsApp"}	Insertion
P8	[8] "ko *caption* nya ga nyambung ya sama fotonya…" {"why the caption is different with the pic.."}	Congruent lexicalization
P9	[9] "*banyak banget sih* hashtag *nya*" {"there are so many hashtags"}	Insertion
P10	[10] "*di facebook banyak foto dia, kamu bisa download mana yang lo mau*" {"there are many of her pictures on Facebook, you can download it, which one you like"}	Alternation

As in Table 4 shown above, several mixed code utterances comprise the Indonesian language and English. These are generally uttered by generation Z regularly; some are reported as follow:

[1] "*Jangan lupa* subscribe and like *ya video nya*."
{Don't forget to subscribe and like to yeah}

Subscribe and like their popular posts on YouTube. These are one of the features of this platform. It is a known fact that they are usually used to increase the number of subscribers. Furthermore, they tend to click on the subscribe icon button under any YouTube video or on any channel to view their content. Consequently, users get notified when a channel they subscribe to publishes new content. Gen Z is familiar with those

words because it is used daily. This impacts their language, particularly when they talk about YouTube content. The word 'subscribe' has similar meanings to '*berlangganan*'. Most utterances always involve 'subscribe' rather than '*berlangganan*'. This is based on the fact that they felt nice whenever their messages were delivered. Based on the questionnaire, this response was mostly gotten from social media. Also, the word 'like' has a similar explanation.

[2] "*eh,, berapa* follower *kamu*" *dan* "*waaww…* follower *nya udah banyak banget ya…*"
{"eh.. how many your follower" and "wow.. your follower so many.."}

[3] "*hai,,, jangan lupa di* follow *ya instagramnya.*" *Atau* "*follow Instagram aku ya…*"
{"hey.. don't forget to follow its Instagram," or "follow my Instagram please.."}

[4] "*iihh,,, males deh, masa gw udah* follow, *dia nya gak follback.*"
{"*iihh*.. it make me mad, I followed her, but she didn't *follback* me"}

The words 'follow, follower, unfollow' are from the features on the Instagram application. Sequentially, these are similar to these Indonesian words 'mengikuti, pengikut, tidak mengikuti'. A follower on Instagram is the user that follows a page, and the follower views the post on both the handlers' profile and feed. Meanwhile, those following are the users on Instagram; their profiles and posts are accessible [56]. This is only possible when the account is not set on private. Initially, these words are some sort of instructions. However, Gen Z uses these terms particularly when they want someone to follow them on Instagram. They prefer to use English rather than Indonesia when they have a conversation regarding this topic. Based on the interview result, it was reported that whenever they use the Indonesian language, the meaning tends to be biased and does not fit appropriately in the context. However, it was further stated that the use of English during conversation makes it easier for them to express themselves and opinions without worrying about grammatical restrictions and meaning [57]–[59].

[5] "*loh kenapa di* unfriend*?*"
{"*loh* why unfriend"}

Many words serve as instructions on the Facebook platform, such as unfriend, friend, wall, share, etc. Users are familiar with these words because they are used daily, which causes Gen Z to automatically use these terms during their conversations. For example, according to data [5], the speaker uses 'unfriend' to express that they have decided not to be friends anymore with some uses on their Facebook account. Although it was combined with English, this word was uttered in the speaker's native language because they are affected by social media.

[6] "*nanti share ya di facebook jangan lupa tag gw*"
{"please share it in Facebook and don't forget to tag me"}

[7] "*bagus tuh infonya dishare dong ke* Whattshapp."
{"it's nice info, share it please to WhatsApp"}

Also, for these words on data [6], when the word 'share' is clicked on, it simply implies that they intend to spread some relevant information with their friends. 'Tag' is used when they intend to attach their postings to their friend's wall and for it to be seen. Automatically, it was used in their daily conversation. Although their native language was not English, they combined both to make it easier to understand.

[8] "*ko* caption *nya ga nyambung ya sama fotonya*…"
{"why the caption is different with the pic.."}

[9] "*banyak banget sih hashtag nya*"
{"there are so many hashtags"}

Hashtag and captions are mainly used on social media. These are familiar on Facebook, Instagram, and tweeter. The hashtag is a label for sharing content [60], and a relevant topic is shared by adding a hashtag. Conversely, photos are described by the caption, which emphasizes the happenings of the post. These words are familiar to gen Z and are frequently used in their conversations.

[10] "*di* facebook *banyak foto dia, kamu bisa* download *mana yang lo mau*"
{"there are many of her pictures on Facebook, you can download which one you like"}

'Download' and 'upload' are also familiar terms. Even though it is preferably used in the English version than their native language, Indonesia, it is used in all situations, both written and orally. These instructions are used when some pictures, documents are either extracted or uploaded on online applications. Based on the questionnaire and interview result, almost 100% of Gen Z use these words in their conversation orally and written.

4.3 The code-mixing factors on social media

Table 5. The factors of code-mixing

No.	Factors	Frequencies (N=336)	Percentage
1	Social	50	15%
2	Cultural	36	10%
3	Individual	250	75%

Based on Table 5 above, there are three factors of code-mixing on social media refer to [28] The generation Z does the code-mixing in their utterance 15 percent because of social factor, there are five aspects in the social factor that influences the use of languages such as situation, topic, participant, place, and setting. The highest aspect in this research is the participant. That participant is a member of society; the participant did it due to habit when using social media.

Next, 10 percent were influenced by the cultural factor; participants did the code-mixing to show their millennial generation. The last, 75 percent due to individual

factor, the individual factor has the highest percentage in this research, individual factor was done by two aspects due to lack or limited vocabulary and showing up the skill to others. Most of them did the code-mixing because they did not find the appropriate word to convey their expression; even though they did not know the meaning textually in their first language (L1), they understood what it meant whole.

5 Conclusion

Indonesia is a bilingual country where English is a foreign language; generation Z may mix English and Indonesian in certain situations. Some reasons led to mixing English with the Indonesian language. This study included the code-mixing phenomenon among undergraduate program students enrolling for the BA degree. The finding of this study proved social media has a significant impact on the use of code-mixing by generation Z. This is because many oral and written languages seen on the screens of computers, tablets, smartphones, and other gadgets tend to impact the Indonesian language.

The findings showed that they were interested in responding to those who used code-mixing, conforming to the raised topic, increasing the understanding of the people they were talking to, or talking about western societies and culture. The frequent factors that motivated students code-mixing to make up for lack of words, showing their knowledge of technology and culture have changed, showing that they were educated and could speak English, showing that they had a linguistic background, or showing that they were happy and excited.

Additionally, code-mixing occurs when students combine one structural sentence with another language pattern. The incorporation of two different language systems within a sentence or the process of equally blending two distinct grammatical sentences. In summary, the process of alternation code-mixing does not have a dominant language [22].

Information technology has taken complete control of the world. Technology plays an essential role in developing social media for generation Z, which contributes to the evolution of language and code-mixing in their daily conversation. This might be attributed to how aged persons feel more confident while code-mixing both languages without embarrassment. In recent years, there has been a growth in the number of apps and social media that provide students with numerous programming lessons and challenges to study code-mixing [61]. It can be concluded that code-mixing through social media arouses the student's motivation to practice their English.

6 Limitation of the study

On limitations, firstly, this study was qualitative with survey design and interview. Although impact associations were detected, this study was limited in explaining friendships with students. Furthermore, due to the qualitative approach, extraneous factors such as individual differences (students' personality, cultural values) and social community might also impact the code-mixing [62].

In addition, mixed-method studies are needed to separate various factors. Therefore, future studies should collect more significant expansion that influences students' code-mixing and determine the causal factors influencing students' intention to use social media.

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The Effectiveness of Using Interactive Simulation in Kindergarten Children's Acquisition of Physics Concepts

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Abstract—The study aimed to investigate the effectiveness of using interactive simulation in developing some physics concepts in a sample of kindergarten children. To achieve the study objective, a semi-experimental method was used. The study sample consisted of the (45) kindergarten children of 'The Pink Bird' Kindergarten in Petra. They were randomly divided into two groups: an experimental group of (22) children who were taught using interactive simulation, and a control group of (23) children who were taught by the traditional way. Contrary to the traditional method of education. An achievement test was used to measure the Kindergarten Children acquisition of physics, where its validity and reliability were confirmed. The study results proved the effectiveness of interactive simulation in the acquisition of physics concepts among kindergarten children. It was also found that around 61% of the change in the dependent variable (physical concepts) is due to the use of interactive simulation in teaching. Eventually, the study included a set of recommendations in the light of its results.

Keywords—interactive simulation, physics concepts, kindergarten children

1 Introduction

Physics is considered as one of the essential sciences that include many abstract concepts that are quite difficult for students to fully understand what they mean. It is also concerned with the study of behavior and relationships among a wide range of concepts and physics phenomena. Thus, through learning physics, students acquire conceptual knowledge [1].

Forming and developing scientific concepts is one of the main objectives of teaching science for kindergarten children. It is also considered crucial to construct the scientific knowledge, where types of concepts differ according to their nature, levels, sources, and the way they are formed.

Computer simulation technology is one of the technological innovations that have influenced education. In fact, it has proved its effectiveness in students' understanding of abstract concepts and facilitating their teaching [2]. Therefore, computerized

education is an important advanced teaching method that increases the effectiveness of learning and provides the learner with activities and skills that are appropriate to their abilities considering the individual differences between students. This type of education promotes the student's self-reliance, awareness-building, autonomy, and the development of induction, deduction and inference strategies as he interacts with educational activities especially those programs are not the same parents' native language, which is very short in some of countries as Arabic for instance [3].

Since physics particularly, contains abstract concepts, using computers in teaching scientific subjects contributes to illustrate concepts tangibly. It has been proven that simulation is one of the most important computer programs used in active and effective education, because it transmits reality to the learner virtually, and allows him to experiment and interact safely which increases his motivation to achieve results. Interactive simulation allows the designer to intervene and add new variables or change the values of existing variables [4]. Also, interactive video can present information in different formats. It provides information using video footage, still frames, text, graphics, and sounds. The educational theory says that the greatest value of learning is achieved when information is presented in different formats [5].

The simulation software on the PhET website was designed by science specialists and was tested with students before using it. It was also developed by a team at the University of Colorado in the United States, so that users can download it from any device without having to connect to the Internet. Each simulation is designed to represent an independent learning tool that can be used in a variety of educational contexts to give the teacher the opportunity to choose what is appropriate to his lesson [6]. Moreover, the website provides these experiences in many languages, including Arabic, which saves the Arab teacher's effort to find a teaching tool that is effective for scientific topics in one site.

2 Problem statement

Upon investigating the interactive national curriculum of kindergartens in Jordan, one cannot find any focus on the different scientific concepts (physics, chemistry, biology) and that there are deficiencies in science programs particularly as there isn't a science book dedicated to this specific stage. Moreover, the modern educational programs applied in kindergartens in Jordan focus on stuffing children's minds with facts and knowledge, without providing the child with scientific skills and the different skills of research and thinking through various educational activities and games in a way that provokes their thinking.

Also, some kindergarten teachers are not convinced with the significance of using the appropriate means in the appropriate educational situation because of their ignorance about the psychological dimensions of the child's capabilities growth. This fact contributed to the process of introducing many concepts in a traditional way focusing only on stuffing the learner's mind with information and this is contrary to what has been proven by experiments and studies that children can deal with the computer as an educational tool and system in a creative and exciting way. However, what is seen

so far is that the computer is limited to being a curriculum taught and not used as an educational tool or means, especially in kindergarten stage.

Al-Debsi in [7] pointed out that the reasons for pupils' low ability to absorb scientific concepts are attributed to several factors; some are related to teachers and how they are not trained or qualified enough to use effective teaching methods or are unwilling to develop themselves. Other factors are related to pupils who lack proper thinking methods to deal with the scientific material and curriculum.

In order to correct learners' misconceptions about many scientific concepts and help them acquire these concepts in a functional way, science education at the elementary stage must be done using enquiring-based learning methods that adopt a sensible approach as the basis for teaching learning activities [8].

2.1 The study questions

1. What is the effectiveness of using interactive simulation in kindergarten children's acquisition of physics concepts?
2. What is the effect size of using interactive simulation on kindergarten children's acquisition of physics concepts?

2.2 The study purposes

1. Preparing a list of physics concepts that should be included in the interactive national curriculum for kindergartens.
2. Using computerized software based on interactive simulation that helps in kindergarten child's acquisition of physics concepts.
3. Identifying the effectiveness of using interactive simulation software in kindergarten children's acquisition of physics concepts.

2.3 The study significance

With its theoretical framework, this study draws the attention of those in charge of the educational process to the child's comprehension of physics concepts that help him to understand and interpret many of the things that are related to the environment, respond to them, and increase his ability to use scientific information in problem-solving situations. The child's comprehension of these concepts and relationships is associated with the formation of facts and practices carried out by the child, and then little by little he corrects them to acquire generalizations and rules associated with the concept absorbed by the child at a later stage.

It also serves to draw the attention of those who design the interactive national curriculum for kindergartens in Jordan to develop it by adding a variety of scientific concepts (physics, chemistry, biology, geology). Thus, providing kindergarten teachers with strategies and computerized program based on interactive simulation, which hopefully intends to make a qualitative change in teaching concepts for children.

On the practical level, the study is helpful to educational supervisors when holding educational meetings and training courses to train teachers on educational programs that support technology and methods appropriate to teach kindergarten children scientific concepts. The study results may also pave the way for graduate students and researchers of kindergartens teaching methods to conduct similar research and studies.

3 Literature review

3.1 Interactive simulation

Computer simulation programs are among the most used modes of learning. Students find it difficult to deal with some subjects that require a great deal of imagination, or facts that are difficult for the student to be in their real environment such as nuclear interactions, celestial bodies, deep seas, or others [9]. It is an integrated system that offers a variety of interactive teaching materials, media and learning styles that help in implementing education and modifying it through different methods to fulfill the needs of every learner and thus achieve the principle of individual differences [10].

Bellinger in [11] explained that it is processing a model or taking it in a way that makes it work overtime and place so that the learner can recognize interactions that might seem ambiguous.

AlGareeb in [12] defined it as dynamic and interactive computer software, designed as a model for information and educational experiments, which students can study through sharing and discovery.

Thus, it is a method in which events are presented artificially, taking into account the simplification and ease, and gives the learner the opportunity to control these events in terms of the possibility of recurrence or time of occurrence. Hence, the learner can indulge in the educational situation through the multiplicity and diversity of computer means, in addition to the multiplicity of the learner's interaction interfaces with the program. In so doing, simulation programs can be defined as a virtual system of reality.

The importance of interactive computer simulation in education can be illustrated by considering the studies that have tackled this issue such as Holzinger et al. [13] and Wieman et al. [14] which confirmed that computer simulation makes it easier for the student to easily save and retrieve information. It also encourages thinking and application processes, since thinking or meditating without practice leads to misguidance, as well as practicing without meditating is unlikely to succeed in the application. It also helps to learn new concepts through accurate reformulation of misconceptions and allows learners to control and process system variables and get immediate feedback on these changes, which further improves their conceptual comprehension and thus develops their attitudes towards learning. Furthermore, it provides the teacher and the learner with the opportunity to save time especially that there may be experiences that take the teacher only one minute to conduct and allows the learner to learn how events occur by placing them under observation and study.

Interactive simulation has many advantages among of which are control and interactive behavior. Control is defined as the students' ability to determine the speed of shots succession, while interactive behavior involves educational activities where content

is determined in successive shots through students' procedures [15]. It also allows the learner to make mistakes that do not cause negative consequences and exercise some freedom in the learning process. Through interactive simulation, processes and procedures can be explored and studies easily if the traditional method is helpless in this case. Moreover, it reduces the learning time, simulates interactive learning, increases motivation towards the learning process, and helps to achieve discovery learning in a way that leads to developing learners' concepts, mastering skills, and saving large expenses spent for training through actual reality [16], [4]. Alfar in [17] listed four types of simulation: physical, procedural, situational, and process. The following is a brief explanation of these types:

Physical simulation. Typically, a group of objects appear to the learner reflecting a virtual context and represent the elements of a realistic system that the learner can interact with to achieve the system output. For example, the learner learns to operate a machine, where the machine parts appear to be active. Thus, if the learner presses the power switch, the simulation software shows that the machine is in a working state. It also includes learning to operate and use laboratory equipment so that the learner can practice using the device and understand its mechanism in a virtual environment [18] before he starts using the actual device.

Procedural simulation. Procedural simulation relates to the content of the simulated in terms of action steps or following a correct sequence of steps that constitute a procedure or the best procedure that can be followed to achieve a specific goal, which helps to uncover the students' talents and abilities in creating easy and fast methods of diagnosis and treatment.

Situational simulation. It is also called simulation of situations in which the individuals' behavior in certain situations is revealed and their attitudes towards different situations are identified. It is different from procedural simulation in that it focuses on the learner's discovery of the impact of a method or strategy followed or present in the simulated and not following specific procedures to reach the results of the simulated system. What distinguishes it from other types of simulation programs is that it makes the learner one of the elements of the simulated to play an active role that might be in the form of a function or one of the system organisms, such as an animal and ways followed by this organism in trying to survive.

Process simulation. In the three simulation programs, the learner has an active and interactive role. For instance, in physical simulation, he acts as a learner and discoverer of the elements' roles of the simulated. In the procedural simulation, he plays the role of following a series of procedures, whereas in the situational simulation, he acts as one of the simulated program elements. However, Process simulation programs makes the learner an experimenter scientist who changes and modifies the elements and functions of the simulated system to discover laws and rules by linking the components relationships of the simulated elements.

3.2 Physics concepts

Among the objectives of teaching science for children is forming and developing scientific concepts. This goal requires a teaching method that includes the integrity

of scientific concepts, as well as forming and acquiring them. Therefore, developing scientific concepts for kindergarten children according to a studied scientific program that is consistent with the child's nature and the requirements of this age has become a significant and crucial issue that is worthy of attention [19].

Piaget in [20] believes that the concepts of children at this stage are distinctly different from the concepts of adults not only in terms of size, but in terms of composition, quality, and characteristics. In other words, the child cannot reach the levels of knowledge appropriate to his age and level of maturity only by himself. Thus, he believes that appropriate education can accelerate the child's mental development within his or her potential by organizing the environment and experiences in a way that helps to develop his concepts of knowledge, classification, sequencing, time, space, and other concepts related to the child [21].

Contemporary trends of pre-school children education have emphasized the importance of exposing the child to various stimuli and endowing him with the appropriate concepts that pave the way for the child to catch up with this huge technological development of science so that time is not wasted nor his energies and mental abilities, and not to deprive him of many experiences before school age [22].

Science education experts argue that the acquisition of scientific concepts enhances children's interest in the vocabulary of science, and increases their motivation to learn them, because it boosts their abilities to interpret, control and predict which form the main functions of science. Science curriculum documents of all school levels focus on common objectives, like the need to teach scientific concepts functionally [23].

Allam in [24] emphasized the need for teaching kindergarten children the physics concepts which help them understand and interpret many of the things that might interest them in their environment, things that children can learn and respond to through playing. Such a method is perceived as an active behavior through which children discover their surroundings.

The recommendations of some previous studies, such as Moore in [25] and Harrington in [26], stressed the significance of developing scientific concepts for kindergarten children since they allow them to understand the properties of things which strengthens the bond between the child and his environment, and helps him cope with and adapt to it and thus avoid risks.

The issue of the three states of matter (solid, liquid, and gas) is among the topics addressed by the child in science subjects at various stages, from kindergarten to university. So, if a student has misconceptions about certain concepts regarding the three states of matter, this will affect his university study. Therefore, it must be said that it is important for the student to learn correct scientific concepts accepted in the elementary education stage.

4 Related studies

The results of several studies conducted in the educational field showed the importance of interactive simulation in developing different scientific and mathematical concepts among children of elementary and advanced school stages. The study findings of

Eiydat and Aldwairi in [27] stressed the impact of using interactive simulation on tenth grade students' achievement physics and their attitudes towards them. The study in [6] by Almasoudi and Almazroui concluded that computer simulation is effective in developing conceptual assimilation in physics among third secondary science grade students. Whereas Gonen study in [28] showed that there are statistically significant differences regarding the levels of knowledge and understanding in favor of computer simulation teaching and structural learning on the achievement of secondary school students and their attitudes towards physics. Also, the study in [29] by Sheehy and Wylie proved the effectiveness of using computer simulation in developing children's abilities to solve environmental problems in science course.

The study of Alebadi in [30] showed the importance of developing physics concepts among kindergarten children through the using of different strategies such as an educational program based on scientific inventions. Usgs study in [31] showed the difference among children at the age of 4 and 5 years with regard to the level of their understanding of physics concepts according to the level of scientific thinking, the educational attainment of parents, IQ, and observation and questioning skills.

In China, Ding and Fang in [32] conducted a study aimed at using simulation to improve physics learning. To achieve the study objectives, a C++ physics laboratory was designed for students to identify the experiment quantities and discover the Diffraction of Law Grating. The study was conducted on 64 university students. The results showed that students accomplished high scores in research assignments, which encourages the use of simulation in physics.

Aldahmash et al. study in [8] showed that primary level students have alternative misconceptions about concepts related to the three states of matter and its features. The results also showed that interactive simulation experiments have a direct and positive impact on students' understanding of scientific concepts and on modifying their alternative misconceptions about scientific concepts.

5 Methodology

The study population consisted of all the (45) kindergarten students at Pink Bird Kindergarten in Petra city. They were distributed into two groups: an experimental group consisting of (22) children who were taught using the interactive simulation software and a control group consisting of (23) children who were taught the traditional way, according to the following statistical methodology design:

G1: O1 X O1
G2: O1 - O1

Where: G1: the experimental group of (22) kindergarten students
O1: Achievement test in physics concepts.
X: Experimental group members are taught using interactive simulation software.
G2: The control group of (23) male and female kindergarten students.
- The control group members are taught the traditional way.

Measurement Tools:

1. The study used interactive simulation software from Colorado website [33]. Figure 1 shows a screenshot of the simulation software. The validity of the educational software has been extracted through content analysis and then presented to six arbitrators of university professors to determine its suitability to achieve the objectives that include the physics concepts of kindergartens. Around 85% of the test items have been modified in the light of the arbitrators' notes.
2. The achievement test of physics concepts: The study used the illustrated achievement test of physics concepts constructed by the researchers. It consisted of (15) items to measure the physics concepts. The reliability of the achievement test was calculated using Pearson's correlation (test/retest) which reached (0.75); the suitable value for the study purposes.

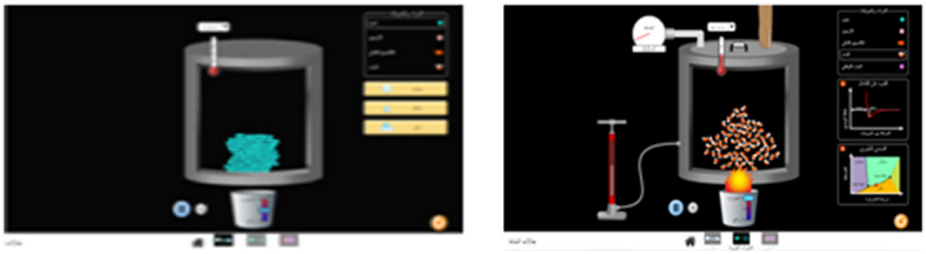

Fig. 1. Screenshot of the simulations [33]

6 Findings and discussion

6.1 Results related to the first question: what is the effectiveness of using interactive simulation in kindergarten children's acquisition of physics concepts?

To answer the first study question, mean and standard deviation of the study of two groups' responses to the test of physics concepts were extracted. And ANCOVA analysis test was conducted to examine the significance of the apparent differences between the pretest and posttest means of the two-study group, Table 1 show mean and standard deviation of the study.

Table 1. Means and standard deviations on the test of physics concepts

Group	N	Pretest		Posttest	
		Mean	S.D	Mean	S.D
Experimental	22	4.32	1.32	10.41	0.91
Control	23	1.78	0.74	6.13	1.10

Based on the Table 1, there are apparent differences between the means of the experimental and control groups in the pre/posttests of physics concepts. To examine the

significance of these differences, ANCOVA analysis was used. Table 2 shows the covariance analysis results.

Table 2. ANCOVA results

V.S	SS	df	M.S	F	P
Pre-test	1.246	1	1.246	1	0.274
Teaching Method	67.879	1	67.879	66.796	0.000
Error	42.681	42	1.016		
Total	131.806	44			

The results of the ANCOVA analysis show that F = 66.796 is a statistically significant at the level ($\alpha \leq 0.05$) and thus the null hypothesis is rejected, and the alternative hypothesis is accepted. As a result of using interactive simulation, it appears that there is a statistically significant difference at the level ($\alpha \leq 0.05$) between the means of the children's degrees in the pre/post- applications of testing physics concepts. In other words, it is quite effective to use interactive simulation to enhance kindergarten children's acquisition of physics concepts. This result can be explained by the fact that interactive simulation is characterized by its ability to stimulate learners' motivation towards learning through providing audio-visual media, which helps the child to involve more than one sense to perceive physics concepts. This serves different categories of learners, including people with special needs [34]. The human brain processes, stores, and manipulates the picture in a more effective way than dealing with oral linguistic description. The result can also be attributed to what Eiyadat and Aldwairi emphasized in [27]; that the interactive video provides learners with the opportunity to interact with and control the content presented to them and learn according to their own pace and method that suits them, which helped them to correctly acquire scientific concepts in terms of exchanging and discussing information with the teacher. Also, the video playback feature provided by the interactive video is helpful in retaining information in long-term memory, which has helped children maintain scientific concepts for a long time.

Moreover, the educational material was presented in an interesting and engaging way where images, sound effects and movement overlap, making the child active and interactive. The supremacy of interactive simulation is also attributed to the immediate feedback provided by the interactive video at every response the child generates, which creates a sense of challenge with himself, encouraging him to continue to achieve the desired goal. This finding was consistent with the findings in the studies of Eiydat and Aldwairi in [27]; Almasoudi and Almazroui in [6]; Sheehy et al. in [29]; and Aldahmash et al. in [8].

6.2 Results related to the second question: what is the effect size of using interactive simulation on kindergarten children's acquisition of physics concepts?

To determine the effect size of the interactive simulation software, Eta squared ($\eta 2$) was calculated to determine the effect size of using interactive simulation on the acquisition of physics concepts. It reached (61.4%), or approximately (61%) of the

dependent variable (physics concepts) as a result of using interactive simulation in teaching. The reason for this is that the use of interactive simulation allows children to convert microscopic images into macroscopic images and thus see phenomena that cannot be seen with the naked eye, which leads to introducing information into the child's mind correctly. This in turn leads to forming correct mental models, as well as correct physics concepts. The repetition of training by reusing an e-learning environment based on computer simulation has helped learners find meaning, connect ideas, use evidence that demonstrates the depth of what they have learned, and indulge in ideas related to physics concepts and how to use them.

7 Recommendations

In light of the study findings, the researchers recommend: activate using of interactive simulation as a teaching method in kindergarten stage, conduct studies on the impact of interactive simulation in developing other concepts among children at different school stages, train teachers in general and kindergarten teachers in particular to design and produce interactive video through different training workshops due to its effectiveness in the educational process, and conduct research studies on physics and chemical misconceptions among kindergarten primary stage children.

8 Conclusion

The study revealed the importance of using interactive simulations, even for kindergarten children in such a field of Physics. It is very essential for country like Jordan to establish a repository for data mining by schoolteachers and children alike, contains the necessary software and programs in Arabic language.

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Enhancement of Students' Learning Outcomes through Interactive Multimedia

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Abstract—The goal of this research was to find out the effect of implementing animated video media on student learning outcomes in Solar System science subjects and to decide the improvement in the sixth-grade student learning achievement at Padurenan Jaya elementary school. The research design used is a quantitative technique using a quasi-experimental method in a Non-Equivalent Control Group Design. The subjects of this study were the sixth-grade students at Padurenan Jaya elementary school, totaling 52 students. The sample was established by purposive sampling, namely, 28 students as the experimental group and 26 students as the control group. Techniques of data collection in this study used multiple-choice tests in pre-test and post-test. The t-test was utilized to measure differences in student learning result. Based on the study results, the average score for the pre-test control class was 46.54, and the average post-test was 64.04; while in the experimental class, the average value of the pre-test was 48.39, and the average value of the post-test was 74.82. The increase in learning outcomes for the control class was 17.50, and the experimental class was 26.43. Analysis using all results post-test and tested by t-test with the value of t count > t table (4.775 > 2.021), displaying that Ho is rejected and Ha is accepted. From these determination, it can be stated that student learning consequence using animated video media are greater than the results. Student learning using conventional methods.

Keywords—animation media, solar system, learning outcomes

1 Introduction

Information and communication technology development is very rapid in this modern era, especially in the multimedia field. Multimedia is currently being used as a means and medium of learning because of multimedia. Students are expected to understand better the lessons given. A person will remember more than what he saw, heard, and did based on research. This makes the world of education compete to use multimedia as a means and medium of learning for students. For example, in learning about the

solar system at school, if every school had to buy teaching aids so students could see what an imitation of the solar system looked like, now schools no longer need to buy props. Because with the development of multimedia technology, schools only need to display videos that describe what the solar system looks like.

Based on previous research, the application of Information Communication and Technology (ICT) is believed to significantly improve the quality of education [1]. Technology has an extraordinarily vital task. One of the considerations of using technology is that it can train students' concentration and focus on the presented material. Digital and telecommunication systems transform every aspect of 21st-century society, including schools. ICT is a good resource for school education. The outcomes will be encouraging when ICT is fully integrated into the education system. Students no longer have difficulty adapting to the ICT environment infiltrated by the education system. Readiness for ICT-based Education is linked to exposure to technology, computer use goals, college or academic experience, types of devices commonly used, levels of ICT use, and factors that may promote ICT use in schools. Showing a video as an example, besides attracting students' attention, students' attention will be focused second by second, and the students will never be willing to pass it [2]. ICT usage in education can incorporate real-world situations into teaching and learning processes learning for students learning atmosphere and motivate the students to participate in the curriculum actively and readily acquire new knowledge and skills. ICT encourages the teachers to be facilitators. The availability of ICTs in Education is vital to bring about transformational change for an effective teaching and learning process in a constructivist environment. When used in the classroom, ICT has many implications for teachers regarding the ICT-focused knowledge they need to identify, the appropriate ICT resources to use, and the pedagogical approaches to adopt to learn. Meaningful ICT learning occurs. This suggests that a specific ICT resource, ICT-oriented knowledge, and ICT-based pedagogy are necessary ingredients for the adoption of ICT by teachers. Therefore, as found in the literature, these elements could serve as possible characteristics to consider for designing ICT-based interventions that promote interactive teaching.

ICT is very important in facilitating and clarifying learning material delivery [3]. By incorporating ICT into the teaching of physics and science in general, a typical teacher-centered classroom environment could be transformed into an interactive learning environment that situates learning as a process involving the active construction of knowledge and not knowledge transfer. This suggests that the roles of teachers in such a revolution of ICT in Education are crucial to realize and appreciate the opportunities and impact of ICT as a teaching tool in education, especially teaching and learning. Therefore, it can be said that ICT can improve the quality of education. However, the impact of ICTs on teaching to achieve good results inevitably depends on their use in the classroom. Therefore, it is necessary to establish a relationship between the type of ICT and the pedagogy a teacher chooses to adopt to integrate ICT into his teaching practices. This suggests that examining pedagogy in the light of ICT requires considering what a selected ICT learning resource offers the student and teacher when used in education.

The distribution of messages or information can be done through learning media to minimize obstacles from learning resources [4]. The application of learning media in elementary schools is very important because they have limited ability to understand

abstract material at the elementary school level. One of the intended learning materials is the solar system. This material requires learning media to explain or teach students to concrete the material. In implementing learning on solar system material in general, teachers use still images available in textbooks so that students are apt to be passive and less interested because the image media cannot provide a reciprocal response, less visible and slighter appealing students. So, we need media that can simplify the material in order that the students understand the material of the solar system, get involved directly, and are interested through using learning media in the shape of multimedia.

The use of interactive animation as a learning medium is quite popular today. This is because the material delivery is more interesting and interactive and has high creativity in delivering the material. The material about the solar system is included in one of the materials of Natural Science subjects. It has a significant influence on students' level of understanding and memory. The solar system is taught for high school, junior high, and elementary school students. Hence, it is important to develop multimedia-based learning media to improve understanding of solar system concepts for 6th-grade elementary school students. Based on this, the following questions can be formulated:

a. What are the steps in developing interactive-based multimedia media learning in science learning?
b. How are the results of using interactive-based learning multimedia media on students' comprehending of solar system knowledge in science learning for the sixth-grade students at Elementary School?

1.1 Multimedia-based learning media learning

Media are media used in learning, including teaching aids for teachers and carrying messages from learning sources to recipients of learning messages (students) as presenters and distributors of messages. Learning media, in some instances, can represent teachers in presenting learning information to students.

Media is one factor that determines teaching success because it helps students and teachers deliver the subject matter in connection with teaching objectives [5]. Of the many functions of media, one of the main functions of learning media is as an intermediary capable of conveying messages or information so that they can support and affect the quality of learning provided by educators, such as motivation to learn for students, encouragement to learn, and a sense of belonging. The use of mobile applications in developing multimedia projects has attracted students' attention and ensured effective communication.

Practical research-based evidence has shown a positive association with the use of multimedia and improving children's learning skills [6]. Teaching skills through multimedia presentations can improve students' learning skills over traditional teaching methods. Better multimedia content can significantly benefit teachers and students in the classroom. Multimedia is an enhanced learning resource for teaching skills and teaching materials. Multimedia in education is a useful strategy that enables teachers to think differently and aid young children's learning process. The development of students' self-potential will run more effectively if a teacher utilizes the suitable learning media [7–9]. Teachers must have the ability to productively shape the learning media,

whether using technology or not. One of the learning media that utilizes technology is interactive multimedia. An interactive multimedia is an intermediary tool that conveys messages with collaboration from various elements that can create active learning so that messages from the information obtained can be well received. People are essential for the successful application of technology. Education can guide to adopt new technologies. The Information Technology system is essential for any data collection, storage, and analysis infrastructure.

Multimedia can create active learning for students to affect students' thinking power and provide input for the media [10–14]. Conceptually, multimedia presents two elements: text (oral or printed) and images (illustrations, photos, animations, or videos). Interactive multimedia can be created in various ways, one of which is animation with video. Interactive multimedia has a role in its use, one of which is using a computer. An innovative learning model based on the multimedia project offers students a chance to improve their language competences. Implementing multimedia in teaching helps train and develop students to express themselves orally without preparation.

Information and communication technologies are components of modern education. Mobile technologies greatly expand learning opportunities, needs, and goals and profoundly affect many learning styles and activities. With the computer, learning becomes interesting where the user does not have face-to-face with the teacher in the classroom but interacts with the media [15–19]. The concepts provided from adopting new technologies also enhance other personal skills, promoting integration into life in society.

Interactive multimedia can also increase learning motivation because, individually, students can master the subject matter as a whole. Students can also develop their abilities independently with interactive multimedia, successful learning, and efficiency in the form of more significant time savings than conventional learning [20–23]. Multimedia is a media that combines visual and audio aspects to be understood by students who have different learning styles more easily to use multimedia-based learning media as they wish. This multimedia has images, tests, animations, sounds, and videos. Multimedia transmits information using text, audio, graphics, and interactivity elements. Interactivity is defined as a navigation component. Previous research stated that multimedia could improve students' creative thinking and make it easier to absorb information. It can be concluded that multimedia is the unification of two or more communication media to convey or create something delivered via a computer or manipulated digitally to be controlled interactively to produce an attractive presentation.

1.2 Animation

Animation never develops without discovering the basic principles of human character, namely persistence of vision [24–25]. Through the optical equipment they invented, this study succeeded in proving that the human eye tends to perceive a sequence of images at a specific time as a pattern. Judging from the technique of making today's animations can be categorized into 3: Stop Motion, Traditional Animation, and Computer Animation. The development of animation at this time runs so fast in various fields. Animation is well known in cinema, especially films aimed at children.

However, now animation is used in entertainment and other areas such as advertising, web design, game marketing, and educational media. The path promotes the coaching–studying method withinside the schoolroom environment, in which everyday lectures and interactive multimedia are used. The path became stronger with numerous assisting gear and factors to guarantee the best stage of knowledge and deployment. There have been numerous gear (all designed regionally and primarily based on the neighborhood practice) to fulfill the predicted studying outgrowth. This gear is a specialized textbook primarily based totally on global best-exercise and neighborhood case studies, multimedia courseware to sell the coaching environment, commitment of stakeholders, and non-stop cycles of assessment and reinforcement primarily based totally on feed-backs and evaluation mark.

In terms of developing educational media, the animation is one of the media innovations in the form of moving visuals that can clarify the subject matter that is difficult to convey conventionally [26]. Learning animation media is a media that contains a collection of images that are processed in such a way as to move and are equipped with audio so that they are memorable and store learning messages. Learning animation media can be used as teaching tools that are ready to be used at any time to keep learning materials. By being integrated into multimedia, which contains components such as audio, video, animation, text, graphics, and images, this educational media can create dynamic and interactive presentations that make it easier for the subject matter or stages of the process of a job that cannot be presented directly.

Given the quality of animation needed, sometimes in its manufacture, it still requires sources other to be processed so that the animation looks more beautiful and maximal [27–30]. The increase in software and hardware support developments has the impact of a significant change in the current trend of teaching methods with multimedia. Because of its convenience and efficiency in all aspects, multimedia can increase interest in learning and understanding for students. Of course, this is what makes this method so attractive to teachers who want to make changes in delivering subject matter. There are several advantages of multimedia animation, including the ability to display objects that do not exist physically or termed imagery, having the ability to combine all media elements, having the ability to accommodate students according to their learning modalities, principally for those who have sight, auditive, kinesthetic, or alternative skills, being able to initiate learning components, mainly reading and listening skillfully. To design and produce animation or multimedia programs, it is required to be aware of the following factors: ease of navigation, cognitive content criteria, media integration criteria, an artistic appearance, and the overall function. The program developed must provide the learning that students want as a whole. So that when they finish running a program, students will feel they have learned something.

2 Method

The research method used aims to study the development of-based interactive multimedia media using animated videos for learning science content about the solar system, including the following steps:

2.1 Research design

This research was utilized using a quasi-experimental method from the research objectives mentioned above. The quasi-experimental research method utilized is Quasi-Experimental Design in the form of a Nonequivalent Control Group Design, namely placing the research participants into two class groups: the experimental group and the control group, which were not selected at random were pre-tested and then subjected to treatment. After being treated, the subject was handed a post-test to measure the effect of treatment on the group. The given instrument contains the same weight. The difference between the pre-test and post-test results shows the results of the treatment that has been given. The objective of quasi-experimental research is to get information that is an approximation to the information got by actual experimentation under conditions where it is unreasonable to govern and/or manipulate all relevant variables. The scheme Nonequivalent Control Group Design can be described in Table 1.

Table 1. Research design Nonequivalent Control Group Design

Group	Pre-test	Treatment	Post-test
Experiment	O1	X1	O2
Control	O3	X2	O4

Notes: O1 = Pretest for experiment group; O2 = Posttest for experiment group; O3 = Pretest for control group; O4 = Posttest for control group; X1 = Treatment of learning with animation media; X2 = No treatment of learning with animation media.

On the basis of the design above, this inquiry was run in two classes: the experimental class, which learns to use the animation media learning method, and the control class, which knows to use conventional learning methods in the science subjects of the Solar System material. The difference in the value of the experimental class learning outcomes with the control class can be interpreted as the effect of using animation media on student learning outcomes in the Solar System science subject, which is formulated as follows:

$$(O1 – O2) – (O3 – O4)$$

2.2 Population and sample

The Population of this study was sixth-grade students. The sample in this study was withdrawn from two classes at SDN Padurenan Jaya using the sampling technique using purposive sampling technique, namely to determine whether someone is a sample based on specific objectives with the considerations possessed by researchers to obtain information relevant to the research objectives. The selection of this sample was based on two considerations that the same teacher carried out the science subjects given to the two classes. So from the coordination results with the teacher concerned, the sample in this study was determined, 28 students were used as an experimental group taught with animation media, and 26 students as a control group taught using conventional

methods. The treatment given would show a clear difference in using animated media on student learning outcomes.

2.3 Research instrument

There are two sorts of data collection instruments applied in this work involving test and non-test instruments. The test instrument implemented is a test sheet for understanding elementary science concepts for solar system material, which refers to indicators (a) translation, (b) providing examples, (c) explaining. While the non-test instrument used is a questionnaire. The indicators were used to obtain an overview of students' attitudes and responses to interactive multimedia in science learning. The instrument validation used is the validity test and the reliability test.

2.4 Data analysis

Analysis used consists of initial and final data analysis. The initial data utilized is the daily test scores of students in the solar system science subject in the odd semester of the 2020/2021 academic year. Data analysis used an inferential statistical test. Before the inferential statistical test (parametric and non-parametric), the data must meet the normality requirements to display whether the data is normally distributed or not. Analyzing data applied to check the hypothesis in this research is the t-test. The data analysis technique was led using SPSS 17.0.

3 Results

3.1 System interface

Development of Multimedia-based IPA interactive learning media using Adobe Premiere Pro application program. In its development, audio-visual and animation are applied to storyboards by utilizing the Adobe Premiere Pro application facilities, which link and combine sound, video, and animation with the click of a button created. This is used to attract students' attention in learning the science of solar system material.

The design of this learning media is designed according to the material to be delivered by referring to an attractive, efficient, effective, and interactive display. In addition, the design pays attention to the ease of programmers in translating into the form of a programming language or on the animation that will be made when it is developed again. The media design is made in the form of a storyboard to facilitate the implementation of the design during the implementation of learning and simplify the students to understand the material that has been arranged according to the flow or sequence of the material on the syllabus.

The cover page display consists of the media title and a button that moves to the home slide. At this stage, what needs to be considered is students' focus before starting this interactive media. The opening page is designed in such a way with sound effects and animations to attract students' attention.

Fig. 1. Display of interactive media home page material

The cover page display consists of the media title and a button that moves to the home slide. At this stage, what needs to be considered is students' focus before starting this interactive media. The opening page is designed in such a way with sound effects and animations to attract students' attention. The content menu page display consists of instructions for use, learning objectives, and learning materials. After clicking the start button on the slide home page, you will go to the menu page. Students can follow the instructions for using this interactive learning media. The design is made simple to make it easier for students.

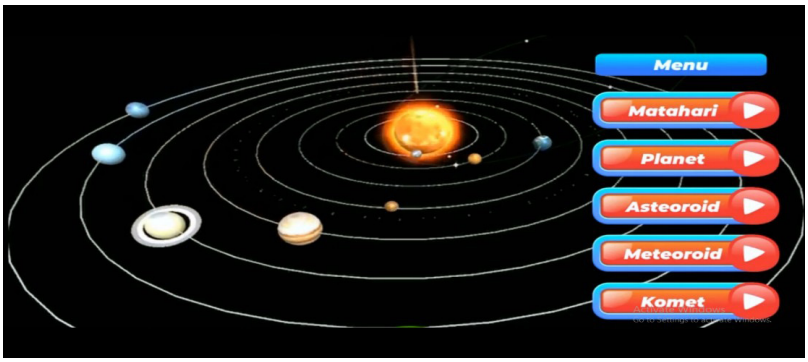

Fig. 2. Interactive media menu page display of solar system simple fractions

3.2 The effect of interactive multimedia in solar system materials to improve students' learning outcomes

Data analysis was to test the difference in initial ability between the control group and the experimental group. The test is using a t-test. Expected results show no significant

difference between the initial ability between the control and experimental groups. The second analysis is to test the proposed hypothesis. In this case, the proposed hypothesis consists of Ho and Ha. Ho is the value of student learning outcomes using interactive multimedia video animation smaller than the learning outcomes of students using blackboard media in the Solar System science subject. Ha is the value of student learning outcomes using interactive multimedia video animation greater than the learning outcomes of students using blackboard media in science subjects for the Solar System.

The analytical technique used is a t-test to test the comparative hypothesis of two independent samples if the data are in intervals or ratios. However, to use the t-test, there are analytical requirements; namely, the data must be homogeneous and normally distributed. Then the homogeneity test and normality test were managed. The homogeneity test designs to dictate whether or not the sample taken from a population is homogeneous. If the two groups have the same variance, the group is said to be homogeneous. The homogeneity test was carried out handling the F test. The normality test seeks to decide whether the data distribution is normal or not. The parametric statistical analysis technique can be used if the distribution is normal. The data normality test technique uses the value of Chi-squared.

The criteria for acceptance or rejection of Ho at a significance level of 5% can be seen through the t-count value in the table (for the one-sided test), if the t-count value is larger than the specified error level (t-count value > t table) then Ho is rejected, and Ha is accepted, whereas if the value of t count < t table, Ho is accepted and Ha is rejected.

Hypothesis testing in this study was done with t-test (Independent Sample Test). This test will be assisted by using the SPSS 17 program to facilitate the analysis process. The null hypothesis (Ho) reads, "The value of student learning outcomes using interactive multimedia based on animated videos is smaller than the learning outcomes of students using blackboard media in the Solar System science subject". While the alternative hypothesis (Ha) reads, "The value of student learning outcomes using interactive multimedia based on animated videos is greater than the learning outcomes of students using blackboard media in the Solar System science subject".

From the results of the research conducted, a description of the data that has been obtained from the initial test (will be presented pre-test) which is a description of the initial condition of students before the experiment is overseen and the final test (post-test) is the result after being given treatment. The learning given to the two groups used different treatments, learning with animated video media in the experimental class and for the control class using traditional learning or with lectures and whiteboards in science lessons on the Solar system material. This treatment was used to determine the difference in the influence of the media used.

This research was conducted using the t-test (*independent sample test*) to test the hypothesis. To perform the t-test, the requirement is that the data for each variable must be normally distributed. The data analyzed were from the *pre-test* and *post-test* in the experimental and control groups. To determine whether the data from the research *pre-test* and *post-test* above are normally distributed or not, these data need to be processed with the data normality test. If the distribution is normal, then parametric statistical techniques can be used. The normality test analysis technique uses the Chi-squared value with the provision that the calculated Chi-squared price is compared with the table's Chi-squared price at a significant level of 5%. Normality test results

pre-test and *post-test* the two groups can be viewed in Tables 2 and 3. Table 2 offers that the initial test scores of the experimental and control groups showed a value of x^2 counted $<x^2$ table, which means that the initial test scores of the experimental group and the control group the two groups are normally distributed.

Table 2. Results of the analysis of normality test pre-test

Class	x^2 count	x^2 table	Description
Experiment	9.69	11.07	Normal distribution
Control	5.85	11.07	Normal distribution

Table 3. The results of the analysis of normality test post-test

Class	x^2 count	x^2 table	Description
Experiment	6.45	11.07	Normal distribution
Control	8.70	11.07	Normal distribution

Based on the Table 3, it can be displayed that the two groups, namely the experimental group that was allowed learning treatment with animation media and the control group with conventional learning (whiteboard), showed a value x^2 count $<x^2$ table, this means that the initial test scores of the two groups are normally distributed. After the values of the two research groups were declared to be normally distributed, the homogeneity value was sought. The homogeneity test used data *pre-test* from the experimental and control classes. The test criteria for the two sample groups are said to be homogeneous if F count < F table, at = 0.05. According to Sudjana (2002: 249), if F count < F table, it means that the sample class data has a homogeneous variance. On the other hand, if F count > F table, the sample class data is not homogeneous. The results of the homogeneity test can be arrayed in Table 4.

Table 4. The results of the analysis of the homogeneity test

Data	F_h	F_t	Description
Pre-test	1.61	1.83	Homogeneous variance

It can be presented in Table 4 that the price *F* calculated is smaller than the *F* table value for error level 5%. It can be ended that the data variance *pre-test* is homogeneous. For the complete calculation, see the attachment of the homogeneity test *pre-test*. Testing is undertaken by using the t-test, which is based on the contrast of *t-count* with *t-table*, as a basis for decision making: If the statistical counted (*t-counted*) > table statistics (*t- table*), then Ho is rejected and Ha is accepted. If the statistical count (*t-count*) < table statistics (*t-table*), then Ho is accepted and Ha is rejected. Before testing the hypothesis, first, the average similarity test of the two groups was performed to determine the initial potentiality of the control group and the experimental group. A statistical hypothesis, Ho: there is no significant difference between the results of the *pre-test* students in the control class and the experimental class. Ha: there is a significant difference between the results *pre-test* of the control class students and the experimental class. The following data shows the results of the t-test with the help of SPSS 17.0.

Table 5. Independent samples test

F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
.947	.335	.417	52	.678	1.854	4.443	10.771	7.062

Based on Table 5, the result of the analysis that the value p-value Sig. = 0.678 > 0.05 then Ho is accepted and Ha is rejected. Then if we compare the t-count and t-table (0.417 < 2.021) with df (degree of freedom) = n1 + n2 = 54, it shows that Ho is accepted and Ha is rejected. So it can be drawn to a close that there is no significant difference between the results of the pre-test students in the control class and the experimental class. After testing the average similarity, then proceed with hypothesis testing. Table 6 reveals the findings of hypothesis testing with the help of SPSS 17.0.

Table 6. Independent samples test

F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
1.61	.252	4.775	52	.000	–10.783	2.258	–15.315	–6.252

Table 6 exhibits that in column F test, if its significance > 0.05, then the assumption is that the variance is the same; otherwise, if Sig. < 0.05, then the variance is not the same. From the results of the hypothesis test for the Levene Sig. 0.252 > 0.05 indicates that the variance is homogeneous. With = 0.05. The t-test column shows that the P-value = 0.0001 for the 2-sided test. P-Value Sig. = 0.0001 < 0.05, then Ho is rejected, and Ha is accepted. And when compared between t-count and t-table (4.775 > 2.021) with df (degree of freedom) = n1 + n2 – 2 = 52, it shows that Ho is rejected and Ha is accepted, meaning the value of student learning outcomes which uses animation media is greater than the learning outcomes of students who use conventional media. So from the statements and calculations above, it can be concluded that animation media positively influences its use.

4 Discussion

This analysis was to find out about the culmination of using multimedia-based learning media with animated videos on student learning outcomes through the ability to understand the concept of the solar system in science subjects for sixth grade at Padurenan Jaya elementary school. The results show that the use of interactive multimedia-based learning media has an effect on increasing students' understanding of concepts through pre-test and post-test. This happens because the manipulation of interactive learning media utilizing multimedia with animation gets students' attention so that messages conveyed through the media can increase student understanding. This aligns with the study showing that interactive multimedia positively impact teaching primary education. Using interactive methods can improve students' knowledge and

skills compared to traditional methods [31–32]. Using interactive multimedia learning media, students can control learning activities and determine the learning speed and the sequence of learning activities according to their needs.

Interactive multimedia can develop unlimited creativity [33–35]. Interactive media can provide guidance and learn a lot of fun things. Data analysis shows that the increase in students' conceptual understanding can be launched from the value and student learning outcomes that increase after the learning process with multimedia-based interactive learning media in complex Solar System science subjects can be explained using animation with analogies that are closely related to students' daily activities. So that students can visualize abstract concepts to be more concrete. This is in line with the study that stated that interactive media helped students' understanding process through concrete visualization. Students worked individually by repeating the media as much time as needed to process the learning material.

This research is also strengthened by research stating that the learning process with multimedia is important by utilizing technology. Students are given direct reinforcement by being projected by everyday life to increase their understanding of concepts [36–37]. One of the objectives of learning science is understanding the concept that can be achieved. Therefore, technology-based media helps students in developing their cognitive skills. Technology helps visualize abstract concepts more concretely. This is in accordance with the level of thinking of elementary school students at the concrete operational stage.

The hypothesis test results showed that there was a significant difference between the experimental class students' learning outcomes and the control class students' learning outcomes. The results of the pre-test group were used as data analysis to determine the level of difference between the two groups. The average pre-test result for the control class was 46.54, and the average result for the pre-test of the experimental class was 48.39.

The technique used in data analysis uses the normality test as a prerequisite test to measure the level of data normality, and the t-test is used as hypothesis testing. From the results of the research data analysis, it can be revealed that there are differences in learning achievement in science subjects using animation media. The t count > t table evidence this, then Ho is rejected, and Ha is accepted with a significance level of 0.05. This study also compared the results of the pre-test and post-test of the control class and the experimental class. These results obtained pre-test the control class an average value of 46.54, while the results pre-test experimental class obtained an average value of 48.39. Then from the post-test results, the control class's average value of 64.04 was obtained, while for the experimental class, the average value was 74.82. From these scores, after the experiment, there was an increase of 17.50 for the control class and 26.43 for the experimental class.

Given that science lessons have a higher level of understanding because concepts are based on shapes, they require visualization in their explanations. More importantly, with the ease of explanation and the attractiveness of learning with animated media, as well as from the research results and theories that have been stated above, it can be terminated that the provision of animated video media for learning science subjects in the Solar System material can improve student learning outcomes.

In practice, animation media classes are more focused and conducive to the subject matter presented. The level of student interaction is increased in conveying their

ideas and ideas. This can be seen from students' enthusiasm in participating in science lessons using animated video media. With learning activities, not only recording information from the teacher, but learning using interesting and interactive animations, learning activities feel fun and contribute to students be more motivated in the learning system.

Based on the statement above, a teacher must have the ability to choose, determine, develop various learning methods and media to achieve the expected learning objectives. These include selecting the right method and approach for presenting a concept.

5 Conclusion

Overall, based on the research results above, it shows a positive influence from the application of animation media in the teaching and learning process on student learning outcomes. The practicing of animated video media can help and fill a complementary role in explaining lessons that require visualization and field experience. By using animated media, students become focused on following the learning process, collaboration and interaction between students and teachers can be improved in a conducive classroom environment. The teacher's active role will be helped by the presence of animated media so that learning will be more accessible. Animated video media can still be developed into more interesting and interactive media. The operation of animation media in the teaching and learning process will not be limited to innovation and utilization, along with the development of technology and science.

This animated video support can be confirmed for future surveys to build on student's academic acquirement end in elementary school science classes in all districts of Jakarta. This study points to provide the most interesting and interactive material with great creativity so that it has a significant influence on the level of comprehension and memory of students. The extension of the limitations of this study includes the fact that it only covers pupils of Padurenan Jaya Primary School. Further research should be conducted in all regions of Jakarta and other Indonesian provinces to apprehend better the consequences of video animation on student learning outcomes.

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Mobile Augmented Reality Learning Media with Metaverse to Improve Student Learning Outcomes in Science Class

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Abstract—Information and communication technology development affects the learning methods and media used. Augmented Reality technology allows students to experience learning with objects seen in person. This study aimed to decide the efficaciousness of mobile augmented reality learning media with metaverse on improving student learning outcomes in Science classes. The population consists of 92 students from elementary schools in Cluster I, Depok Subdistrict. Then the sample was taken using the slovin formula until it obtained 75 samples of fifth-grade students. This study employed experimental research techniques and a single group pretest and post-test. In this study, the data analysis performed was an inferential analysis with a t-test. According to the findings, using that metaverse application positively impacts students' learning outcomes. Students can use the Metaverse app to see better learning outcomes. Students are also more interested in learning and can easily understand and discover new knowledge. In addition, students find it more fun to learn using the Metaverse app, which is a mobile augmented reality.

Keywords—mobile augmented reality, learning outcome, metaverse

1 Introduction

In a new global era, technological advances in education are a central issue aligned with learning materials assuming that incorporating technology into learning can usher in a new age in education [1]. The new period in question is the technological progress that supports the learning process. One of the most prominent characteristics in this era is the broader and easier access to science. The development of diverse applications that can be utilized as a learning medium offset the rapid development of technology.

In today's world, digital media is used for learning as they allow students to learn through educational games and interactive simulations. This digital learning experience

can be accessed through a smartphone or tablet, making learning easy, especially with Augmented Reality (AR), where students can interact with virtual content through mobile devices. AR systems are used to integrate virtual information into an actual environment so that students can see the information as it is in their state [2]. This technology is an update in education that will give rise to different learning styles and is expected to promote the teaching and learning process [3]. Students feel the object is accurate and get a new picture. Studies outline teachers' way of thinking towards teaching modernization and using these current teaching techniques in education to gain capability of the action [4]. Strong ICT-based coaching vitalizes college students to bring their attitudes close to the subject. The excellent point of behaving toward ICT to brace learning delivery is improving the superiority of learning, increasing entry to education and learning, visualizing abstract ideas, and facilitating mastery of the material under study. It can make the learning material more exciting and allow it to interact. Schools must always make great efforts to achieve the demand of these ICT provisions.

Educators have to adjust to online coaching programs at all levels of education and adapt and disseminate these materials and resources to help scholars preserve their knowledge during the pandemic [5]. Additionally, all faculty and college students had to find a way to use the various online distance learning programs. One of the frightening consequences of the pandemic is that many students are forced to continue their online learning at homeschooling after schools' physical closures and face-to-face classes [6]. Due to the pandemic, the shift from face-to-face learning to online learning has highlighted the hypothetical imbalance of economically disadvantaged students. Adopting innovative teaching methods with mobile learning environments will affect student learning outcomes [7–9]. Smart mobile devices with mobile apps can help students recognize numbers. Technology can provide easy-to-find information in a variety of formats, and this will undoubtedly make it easier for students to get various information.

A new foundation is needed to build consensus and trust in technology [10]. For this reason, educators must now be able to use technology in all training courses. Hopefully, the participation of this technology in the learning process can be more exciting, which can strengthen students' inspiration to participate in the learning process in the future. The new generation of learners is closely connected with the digital age and always uses information and communication technology (ICT) in their daily lives [11]. The advantages of applying ICT to back up the execution of learning can revamp the mastery of learning, fatten admittance to education and learning, aid to predict conjectural ideas, simplify recognizing the material being studied, unveil learning materials to be more entrancing, and permit interaction between the learning process and material being studied. Schools must always aspire to fulfil the necessity of these ICT facilities as a learning medium.

As the application of Augmented Reality in learning can describe something abstract into something, 3-dimensional objects projected through technology, it can also make it easier for students to receive, manage, and understand learning materials. Jean Piaget said that elementary school students are at a concrete operational thinking stage where all learning materials must be described clearly and clearly to be easier to understand. One of the mobile AR used is the metaverse projected to make learning materials easier for students and improve student learning outcomes, particularly in science, through

mobile learning media. A learning result is a person's capacity gained from learning activities. Studying science is a skill gained by someone who has completed learning activities such as explaining the type of digestive tract tools, functions, and processes of food digestion.

Previous research explains that Augmented Reality is an effective tool if used in learning [12]. Students become motivated and help improve learning outcomes and increase information knowledge [13]. This medium's cognitive abilities can provide a different experience and explain a suitable concept. Many studies have integrated Augmented Reality in education, but few have noticed the generalization of concepts and the accuracy of information. Therefore, this study developed a mobile-based AR learning media through a metaverse application for students to study the human digestive system.

This study further examined the students' knowledge value focused on real-life experiences using Mobile Augmented Reality in science learning to increase student learning outcomes. This study aimed to construct a metaverse-based augmented reality medium and investigate how it influenced grade 5 fundamental science learning results. "Does the use of metaverse-based augmented reality mobile media have a beneficial impact on student's academic performance?" was the core question in the study. The following questions will be addressed in this research:

a) How to design metaverse-based augmented reality mobile learning media for fifth-grade students?
b) What if the effect of mobile augmented reality in the metaverse app on student learning outcomes in science class?

1.1 Educational technology

Computer hardware, software, and educational theories are used in educational technology [14]. Educational technology imposes high-quality information contributions for students, teachers, parents, and the community. For the production of instructional technology, theoretical knowledge from various fields is coupled with classroom experience. These domains include communication, education, psychology, sociology, artificial intelligence, and computer science. These include learning theory, computer-based training, online learning, and mobile learning, all of which use mobile technology.

The instruments and theoretical foundations used to support learning in teaching are referred to as educational technology. Educational technology does not just refer to high-tech devices; it encompasses anything that helps students learn better in the classroom [15]. Teachers leverage technology in the classroom to help students learn more effectively. As a result, instructional technology has become a significant part of modern society. Learning via the internet and mobile devices can be done from any location. Therefore, the learning situation can change to be more flexible and anytime.

Existing technology now brings many positive impacts to education [16], including facilitating reasoning, abstract thinking, problem-solving, and experimentation, and improving children's engagement and learning curve. Education is one of the principal objectives of developing human resources to meet a better direction.

The existence of mobile learning can ensure the availability and accessibility of learning materials and tools for acquiring knowledge [17]. Advances in self-education require technical and educational attestation as several challenges exist. It is necessary to determine whether such a transition will improve the quality of instruction without significant prior training, education, and preparation of teachers and students [18]. Teachers need to build communication entices that suit digital needs and understand the importance of technology in current learning to improve the quality of education through this activity.

Students must also improve their technological skills [19] to compete in future global economic competitions. Students must gain technology skills to help them compete in the worldwide economy. Critical thinking abilities, creative problem-solving skills, communication skills, cooperation skills, and technology-savvy citizen skills are just a few of the skills students must develop.

1.2 Augmented reality

The technological advancements of this century have led to the belief that technology's integrity in education can usher in a new age in education [20] as the existing technology has been designed to adapt to the learning materials. Technology can be used in several aspects of education; one example is Augmented Reality (AR). Modern technological means improve and develop the educational process, taking part in a critical part on students' motivation to learn.

AR is believed to improve education with interactive and enjoyable experiences in various disciplines ranging from science to language and other social sciences [21]. This interactive experience happens as AR technology combines the natural world and the virtual world, projected on the object, making the boundary between the two even thinner, making the information provided interactive and authentic.

AR apps are created using digital images or text to recreate the real world [22], helping visualize an abstract concept to look actual and blend into the real world. Students get an idea of something they may never experience, improving user perception and allowing us to hear, see and hear natural environments differently. AR can be applied with senses such as touch and hearing, as AR applications can take the actual object from the environment and add a virtual object.

While working in stimulating environments, AR technology can help students improve and facilitate learning, memory capacity, and decision-making [23]. By using AR in the learning process, students can learn through experiences both individual and group experiences that can be easily understood, helping them overcome the difficulty of complex abstract learning. One of the most popular mobile AR apps is the metaverse offering many educational benefits. For students, these benefits can be summarized as follows: enjoyment of classes, reduced cognitive load, increased motivation and interest in the class, more significant opportunity to ask questions, increased interaction between students, new opportunities for individuals to learn, the concretization of abstract concepts, increase in success. For teachers, these benefits consist of contributing to the development of students' creativity, ensuring effective student participation in the course, and the ability of students to carry out the course at their own pace.

Metaverse is a platform that allows anyone to create interactive content in Augmented Reality, including studio tools to support AR experiences integrating learning into online learning resources [24]. The use of moving icons or avatars is likely to facilitate students in understanding learning materials and improve student learning outcomes, especially in science learning.

AR could be used as an alternative technology that will improve the learning process, motivate students and revolutionize future learning paradigms [25], especially in math education, to enhance students' spatial skills development. This may positively reduce a phenomenon known as mathematical anxiety, which may affect STEM (science, technology, engineering, and mathematics) education. In general, AR is becoming a modern way to support and empower self-study according to the abilities of each student.

1.3 Learning outcomes

Learning outcomes result from a two-part learning process, namely affective and cognitive [26]. Non-cognitive outcomes are concerned with individual attitudes and personality values, while cognitive outcomes involve acquiring knowledge and abilities. Some examples of learning outcomes include computer and communication skills, the ability to perform analysis, synthesis, problem-solving and evaluation, and critical thinking. This research is limited to the cognitive realm.

Cognitive learning outcomes lead to human changes after the learning process in terms of thinking, such as increased knowledge, increased understanding, and achievements [27]. Cognitive strategies that can be adopted include memorizing, understanding, applying, analyzing, evaluating, creating, and deviating from the subject. Bloom's revised taxonomy can also be used to assess students' cognitive strategies.

For quality and outstanding learning, schools need to pay attention to these students' satisfaction and academic achievement. Student satisfaction plays a significant role in adding knowledge and skills to improve learning outcomes [28]. Highly autonomous and supportive learning environments have significantly increased the satisfaction of students' basic psychological needs, student motivation, course evaluations, and academic success. These results suggest that what is most important to students is not the specific techniques used by the instructors but the quality of the student and interactions with instructors.

Students who direct more effort into cognitive matters such as focusing on learning and doing assignments will have strong learning outcomes [29]. They can focus more on learning if they feel happy and interested in learning. Therefore, technology is indispensable to improving students' learning outcomes in school. Technology enhances teaching outcomes, which impacts students' learning outcomes. The quality of learning can be measured from the student's learning outcomes, whether the student understands and has mastered the learning material. In this situation, technology usage is expected to change learning outcomes, including technology that can improve teaching in schools, enhance the student experience, and improve the quality of learning [30–33]. Through the mastery of technology, the learning model in schools becomes more interactive, engaging, and keeps up with developments. The learning model is no longer

monotonous and boring as technology strongly supports the visualization of abstract ideas, can facilitate the learning system or understanding of the material taught by the teacher and allows positive interactions between teachers and students in the learning classroom. Mastering technology is a priority that all teachers must understand as a competency standard in the digital era. The role of technology can help the administrative management of educational institutions in managing organizational problems. With technology features, schools or educational institutions can provide more accurate information so that school policy-making can be more targeted. Technology does offer enormous advantages and benefits in supporting a higher-quality learning system. Students can access all knowledge or material insights provided through the latest technological devices.

This study aims to understand whether the use of metaverse apps in the study of digestive system materials in humans affects the learning results of fifth-grade elementary school students.

2 Method

This research was conducted in 2020 at elementary schools at the sub-district of Depok in West Java in Indonesia.

2.1 Design of research

The experimental research approach evaluated the link between causation and variables. Through experimental examinations, researchers were able to see how one independent variable affected one or more dependent variables. This study included a single group pretest and post-test; pretests (O_1), treatments (X), and post-tests (O_2). The initial phase in the study was selecting a sample and dividing it into single-class research. A pretest was given first, and the next step was using augmented reality apps in the sample. After the teaching intervention, a post-test was conducted, and the results were eventually measured.

Table 1. Metaverse application usage research design

Pre-Test	Treatment	Post-Test
O_1	X	O_2

Notes: O_1 = pretest before given treatment; O_2 = post-test after a given treatment; X = treatment in the form using metaverse applications.

2.2 Population and sample

Participants in this study were 92 Grade 5 elementary school students from the Cluster I Depok subdistrict. The sample was taken using a simple formula until it reached the number of 75 students. The study took place during the school year 2020/2021.

2.3 Data collection tools

Pre- and post-tests were provided to determine the intervention results utilizing the AR application. The data was analyzed using descriptive statistical methods, and the t-test was used to test whether the average values before and after the intervention differed significantly.

2.4 Data analysis

Normality tests were performed using Kolmogorov Smirnov formulas in compliance with Asymp regulations against pre- and post-test scores at a 5% alpha significance rate. The homogeneity tests were performed after normality tests, and homogeneity tests were conducted against pretests and post-test scores. To examine the average difference between the two groups, a paired sample t-test was used. SPSS version 26.1.0 was used for data analysis.

3 Results

3.1 Mobile augmented reality design for human digestive system materials

Based on information collected about the digestive tracts, functions, and food digestion processes in the human body, augmented reality models were built and paired in the system through the Metaverse application. This metaverse application can be accessed using smartphones or tablets by scanning images via QR Code, and some activities can be followed to study the material of the digestive system in the human body.

3.2 Development in human digestive system materials using mobile augmented reality

Making augmented reality media can be done through the website https://studio.gometa.io/discover/me. This website can be accessed for free and can b used to create augmented reality models in QR codes.

We created a medium based on information collected about digestive tracts, functions, and food digestion processes in the human body. Many models and scenes can be used in the storyboard can be created, and the choice of characters contained in the metaverse is varied.

Each scene had a different usage function. However, some scenes required additional tools in VR to use them. The characters provided by the metaverse are very numerous and varied, and they start from 2D to 3D.

The storyboard can be filled with several scenes that are mutually continuous. Each scene contains information about the digestive tracts, functions, and food digestion processes in the human body.

Before publishing, a user can fill in a description for the title and description of augmented reality media created. Once published, a QR Code will appear, which can be

scanned through the metaverse application. This metaverse application can be installed through the play store or app store.

Students can directly scan the QR Code resulting from augmented reality media created and instantly begin the experience of learning digestive system materials.

3.3 System interface

Figure 1 is a view of products that have been scanned through a QR Code in the metaverse application on smartphones.

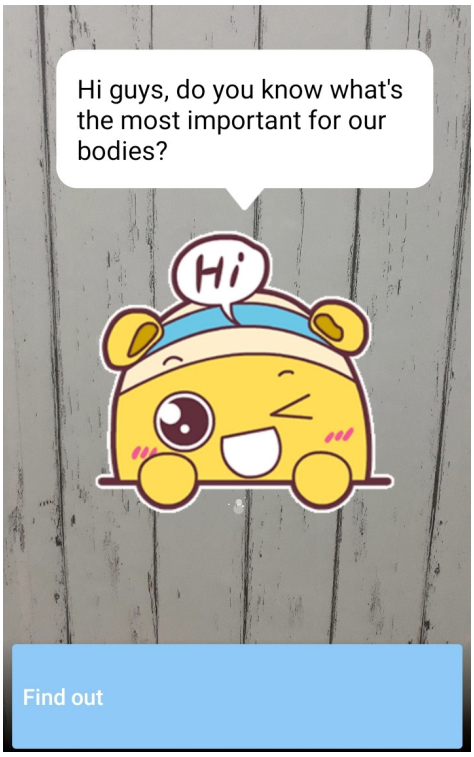

Fig. 1. Early look at the learning model of the human digestive

The smartphone has to be moved to the right or left to bring up the character. The response icon can be clicked to proceed to the next scene.

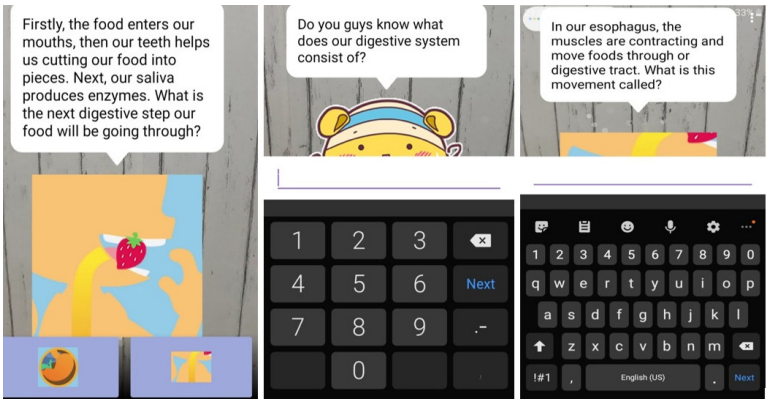

Fig. 2. Display multiple models of the response icon selection

In addition to writing, the selected response icon can also be an image. The use of images is considered to facilitate and strengthen students' memory of the shape of the human gastrointestinal tract. Students can also write a response directly according to the question asked. Responses can be text and numbers. Students must fill out this question with the appropriate response to move on to the next experience.

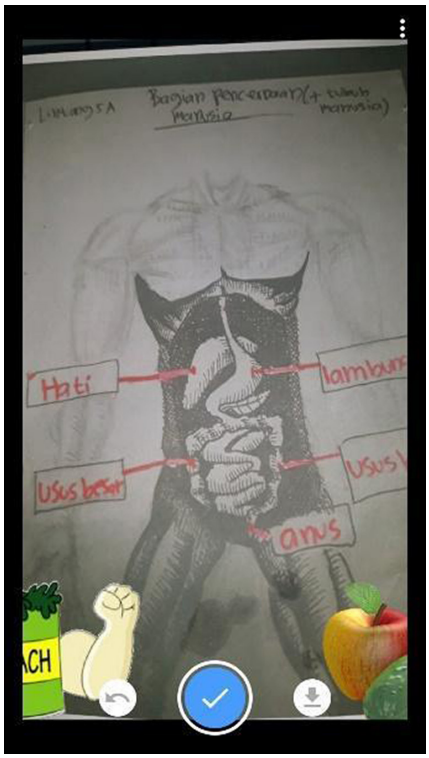

Fig. 3. Display for photographing objects directly

Students can also draw the digestive tract in humans equipped with its name and function. After that, the image can be photographed directly.

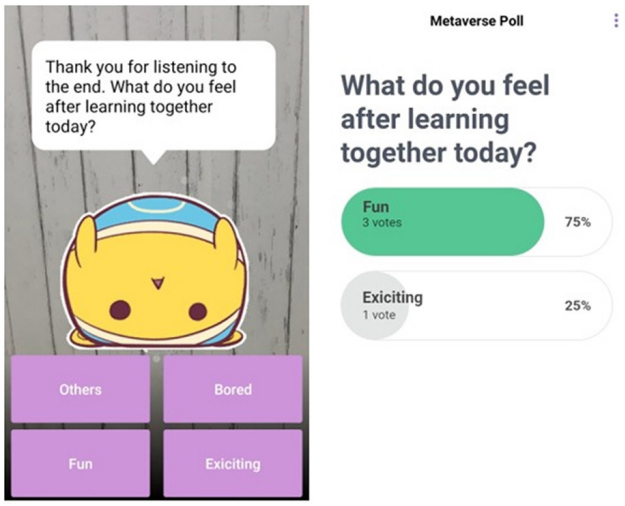

Fig. 4. Poll view

At the end of the learning, students asked about their feelings when studying the material of the digestive system in humans using this augmented reality mobile media. Students can immediately see the poll results of the question.

3.4 Effect of metaverse application on learning outcomes

The table and description below show changes in student learning outcomes related to metaverse applications. The normality and homogeneity of study data and pre- and post-test scores received by students before and after using the Metaverse application were evaluated using test data analysis procedures. In the Kolmogorov-Smirnov normalcy test, the Asymp criteria are applied, with Sig 5 per cent. The data is normal if $p > 0.05$. As indicated in the Table 2 below, the normality calculation was done with SPSS 26.1.0.

Table 2. One-sample Kolmogorov-Smirnov test

		Unstandardized Residual
N		75
Normal Parameters	Mean	.000
	Std. Deviation	8.209
Most Extreme Differences	Absolute	.078
	Positive	.078
	Negative	–.069
Test Statistic		.078
Asymp. Sig. (2-tailed)		.200

Based on the findings of Kolmogorov-Smirnov normality tests, we achieved a p-value significance of 0.200 > 0.05. Both the pre- and post-test data have a significance of greater than 0.05, indicating that H1 is acceptable. As a result, it is possible to deduce that the pre- and post-test data are normally distributed, and the study data is parametric.

Table 3. Test of homogeneity of variances

Levene Statistic	df1	df2	Sig.
2.000	1	128	.160

Homogeneity tests are performed utilizing significance value criteria computed above the threshold of 0.05 on pretest and post-test scores. Table 3 shows the results of homogeneity calculations using SPSS 26.1.0. This variance similarity test's hypotheses are as follows:

H0: All variants are equal or homogeneous
H1: All variants are not equal or not homogeneous

Conditions:

If the value of p > 0.05 (5%) then H0 is accepted; H1 rejected
If the value p < 0.05 (5%) then H0 is rejected; H1 received

Because the difference in significance value of 0.160 indicates larger than 0.05 and the data analyzed indicated the same variant, it may be assumed that H0 was received (homogeneous). According to the normality and homogeneity test results, this data is normal and homogeneous. The Paired Samples T-Test method then evaluates product efficiency using rheumatic statistics.

Table 4. Paired sample t-test

		Paired Sample t-Test						
Pair 1	Pretest-Posttest	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
		–17.949	74	.000	–24.360	1.357	–27.064	–21.656

The Sig value is known based on SPSS results. The known Sig value (2-tailed) is 0.000 < 0.05. If the (2-tailed) value is less than 0.05, it can be concluded that combining mobile augmented reality learning media with metaverse applications in learning has a beneficial impact. These results show that using metaverse applications can improve learning outcomes in human digestive system material science subjects.

4 Discussions

This study aimed to see whether mobile augmented reality influence learning outcomes of grade 5 elementary students in science subjects in cluster I Depok subdistrict, Indonesia.

These results show that the intervention successfully improved students' learning outcomes. The present study outcomes complement and expand knowledge of existing research outcomes [34]. This research supports previous findings that learning through augmented reality improves conceptual understanding during the learning process [35]. According to this study, augmented reality should be incorporated into specific learning methodologies in line with previous research integrating augmented reality in mathematical learning using digital technology strategies through photo math applications [36]. The study suggests that augmented reality changes will affect the new curriculum. In the meantime, past research has found that using augmented reality can aid in grasping the relationship between information and their comprehension of something presented with real-time visual assistance [37]. Accurate visualization helps make it easier for them to understand new information. This study backs up prior research, which shows that augmented reality can help students improve their spatial visualization skills and increase their interest in complex subjects [38]. Spatial visualization capabilities can be enhanced due to the realization of 3D forms and other complex learning when using augmented reality. Existing research also states that augmented reality can improve visual perception and overcome distance and time limitations in historical learning [39].

Augmented reality is also considered influential and beneficial for language learning, in line with previous research suggesting that augmented reality can increase motivation and result in positive student engagement in language learning [40]. Augmented reality allows students to engage in language learning actively [41]. Augmented reality places a premium on vocabulary in language learning, in line with previous research stating that students have increased arousal and attention in learning with 3D models equipped with live sound [42]. The study also showed that the use of vocabulary significantly contributed to language proficiency, and the results of learning vocabulary using augmented reality were positive.

According to another empirical finding of this study, students can increase their imagination skills and thus their learning results. This is also consistent with earlier studies, showing that augmented reality can overcome space and time constraints and free up teachers' time to focus on their students [43]. Creative visual experiences can also be used to solve abstract problems in keeping with an earlier study, which claims that by employing augmented reality, students may modify material by completing cognitive activities such as observing, manipulating, and analyzing into a rule in a step-by-step manner [44]. It is advantageous for students to deepen their understanding, connect with their daily lives and see how it affects learning. Students can explore independently and present complex and varied experiences [45]. Students can actively develop their cognitive talents in problem-solving and determine the best approach to a problem according to their immersion, interaction, and imagination.

Augmented reality-based learning outcomes positively impact student motivation, critical thinking skills, concept understanding, spatial visualization skills, language skills, and problem-solving, showing that augmented reality-based learning can be applied in schools [46–48]. Even students with lower achievement skills showed positive results when using this augmented reality mobile app. Augmented reality learning models can help students explain abstract concepts that are difficult to understand. Students will understand a subject matter more quickly if there is a direct or concrete form.

In today's world of education, technology is highly beneficial to students in terms of developing cognitive skills and accumulating information. Using technology related to the surrounding life and connecting it with learning methods can increase students' interest and motivation.

Based on the direct experience of the researchers studied, some of the limitations that occur may be more noticed for future researchers to improve and perfect it. Some of these limitations include: the number of samples is only 75 people, which is still very lacking in describing the actual situation. The research was conducted online due to the covid-19 pandemic situation that has not ended. In other words, researchers take data through the help of the google form application. The data of learning results provided by respondents through google form sometimes does not show actual results because we do not know how honest each respondent was when answering the pretest and post-test questions.

Students may now view images in the real world, but they cannot interact. Therefore, further research can be reviewed on interactive features involving students in this media. For example, it can help the child move their teeth when chewing with hand gestures or provide vivid animations that can later lead to new experiences that can be saved and unforgettable in the long run. Finally, the present augmented reality mobile media method has a positive application since it can develop cognitive skills and generate novel experiences in material acquisition. The primary goal is to improve students' learning results, and this will further reinforce the fact that mobile augmented reality learning media can be very effective when incorporated into school learning activities.

5 Conclusion

Overall, this study shows that augmented reality mobile media positively affects student learning outcomes in science subjects of digestive system material in humans. Students can quickly gain new experience in learning digestive system materials and independently understand them and access them under whatever conditions they wish. Learning in this way is considered more exciting and fun. Increased knowledge of various technology-based learning media must be utilized to make teaching materials easier to understand for students, as well as to offer learning materials more interestingly and efficiently, and to promote learning models in the globalization period.

This mobile augmented reality learning media with metaverse can be recommended for future investigation to enhance student learning outcomes in science classes at elementary schools providing direction to primary school instructors on improving student achievement. More research should be conducted worldwide to understand the impact of mobile further augmented reality learning media with metaverse on student learning outcomes.

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An Experimental Investigation of 'Drill-and-Practice' Mobile Apps and Young Children

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Abstract—The choice of mobile applications (apps) for learning has been heavily relied on customer and teacher reviews, designers' descriptions, and alignment with existing learning and human-computer interaction theories. There is limited empirical evidence to advise on the educational value of mobile apps as these are used by children. Understanding the impact of mobile apps on young children's learning is timely given the lack of evidence-based recommendations that could guide parents and teachers in selecting apps for their children. In this paper, we present the results of a series of Randomised Control Trials (RCTs) with 376 children aged 5 to 6 years old who interacted with two maths apps in three schools in the UK. Pre/post-test comparisons revealed learning gains in both the control and intervention groups, suggesting that the selected applications are equally good to standard maths practice. Implications for the selection and use of mobile apps are discussed.

Keywords—mobile apps, maths, learning, children, RCTs

1 Introduction

A plethora of mobile applications (apps), often labelled as 'educational', is targeting young children. The mobile and tactile nature of apps facilitates a great degree of independence enabling young children, or even toddlers and infants, to easily interact with them [1], [2]. Yet, the listing of an app in the education category of an app store does not necessarily mean that the app has an educational value [3] or that the app has been tested with children and has been shown to promote learning. Technical constrains such as a lack of resources (e.g., time, money) may inhibit app evaluation [4] or, in other cases, educational technology experts such as instructional designers are not involved in the process of design to ensure that effective pedagogical practices and relevant game mechanics are considered. Review ratings by customers, teachers or designers may not be particularly helpful either, as they often overstate information or are assessing aspects not directly related to the educational quality of an app [5]. A lack of transparency and information that can help assess the quality of apps is found to be missing from the app stores [6].

In addition to the use of review ratings, a top-down approach structured on existing learning and human-computer interaction theories, such as cooperative learning, human motivation, and usability design [7] has been applied to assess the quality of mobile apps. Amongst the design parameters used are: visual design and how this affects visual attention and perception, adaptability and accessibility, usability and simplicity of interaction, sounds effects, verbal communication, organisational design, navigation and screen consistency (e.g., [8]). Evidence suggests that good quality apps support specific learning goals and promote active, engaged, meaningful, and socially interactive learning. Such apps present features such as explicit instruction, repetitive and cumulative training in learning concepts, immediate feedback, challenge and early reward, and individualized, self-paced learning (self-regulation and control) (e.g., [3], [4]).

Although such frameworks can provide valuable insights as to which apps or specific design features facilitate learning and development, they do not engage children in the process of research and evaluation in a participatory manner. Such engagement would help designers improve the design of apps by identifying issues such as whether and what certain children learn from interacting with apps, whether and how educational outcomes align with designers' intentions, and which design aspects are challenging and potentially hindering learning processes and engagement. A few studies have examined the impact or effectiveness of mobile apps on children's learning and development using robust methodological approaches (e.g., [9], [10], [11]). A systematic review of the effects of mobile apps on young children's learning and development identified 14 studies reporting positive effects on children between 2 and 5 years old, four studies reporting mixed findings and one study with negative findings [9]. The majority of studies focused on language literacy and considerably fewer studies examined topics such as maths and science. Conditions facilitating learning included: (a) interactivity, narration and highlight functions, variety of representations, and varied levels of difficulty, (b) adult support while using an app, (c) age of children, with greater benefits reported for older children, (d) similarity between an app and assessment activities (near transfer), and (e) the use of one device per child especially for struggling students and girls. A meta-analysis quantified the impact of maths apps on learning by identifying medium-size effects (ES = 0.29), yet noting that this overall effect size masks the true variability in mean effects due to observed heterogeneity amongst examined apps. Factors inflating the overall effect size were the use of researcher-developed as opposed to standardized instruments measuring learning outcomes, measuring small and fixed learning outcomes, such as number recognition, as opposed to e.g., math problem solving skills, and participants' age with greater effects for pre-schoolers as opposed to kindergarten to third-grade children [12].

Overall, the number of studies examining the impact of educational apps on early years learning is rather limited and non-conclusive. These studies raise the need for further and systematic research in the field that can enhance our understanding of how certain apps facilitate learning and who of the children can benefit the most when interacting with them. Further research should take the form of large-scale randomized control trials [10] in order to produce robust insights about the impact of apps on specific groups of children. In terms of the latter, the educational value of an app should not be seen as an "one size fits all", for children with different demographic characteristics,

skills and knowledge may benefit differently from using a single app. The abilities of children can influence how an app is used and the degree to which this will be helping or hindering learning [13]. Such knowledge can help teachers and parents to make evidence-based decisions when selecting apps for children, and inform app designers resulting in better quality educational apps.

The examination of maths apps has attracted limited interest compared to other domains, such as language literacy [9]. Underachievement of children in maths is a global phenomenon [14], necessitating the development and testing of interventions that can help children reach (and exceed) minimum maths proficiency levels. The use of maths apps can be promising in this respect, especially if future research activities focus on testing specific app characteristics, align theory, design and outcome measures, and assess varied cognitive and skill-based outcomes [15]. This study aims to contribute to this line of work by examining the impact of two mobile apps on maths skills and knowledge and determining whether these apps can bring benefits to certain groups of children as defined by their age, gender and prior maths knowledge. Aligning with existing recommendations [10], it has deployed a Randomised Control Trial (RCT) methodological design. The two apps under study – *Moose Math* and *Monster Numbers* – could be described as "instructive" or "drill-and-practice" apps; they require limited cognitive effort in the form of remembering or recalling previously acquired knowledge [9], [10]. They resemble pen-and-paper activities with the advantage of providing immediate feedback. They are training children in automating tasks such as addition and subtraction through ongoing practice and repetition. Such apps are amongst the most popular and top rated in the app market [3], [16]. It is thus worthwhile to examine whether these widely used and positively perceived apps are beneficial for children and their learning.

2 Reviewing existing studies

An increasing number of studies, including systematic reviews, are found to examine or summarize the learning impact of selected mobile applications on young children [9], [10], [17], [11]. In particular for maths apps, positive effects have been observed on early maths learning in typically developing children in the areas of number recognition and naming, and simple addition and subtraction [10]. Prior knowledge and performance are found to be significant moderators of proposed effectiveness [11]. Although these studies are underpinned by a common goal – to determine the effects of mobile apps on early years maths development-, they present a great variation in terms of who the children under examination are and what the apps under study look like. This suggests that a closer examination of reported studies is needed to shed some light on who can benefit the most from interacting with apps and which design features or implementations are those that can support or promote these benefits. The skills or expertise of learners may interact with the cognitive load of tasks. For example, novice or less skilled learners may need considerable guidance and breaking down in steps complex instructions, whereas more skillful learners may find this as impairing their progress [18].

The few studies available measuring effects of mobile apps on early maths learning present rather mixed-findings in relation to who of the children can benefit the most from interacting with apps. In particular, Schacter and Jo [19] examined low-income children (Mean age = 4,6) who used the tablet-based curriculum app *Math Shelf*, in a classroom setting and identified that the intervention group outperformed the control group. While gender and race had no effects on outcomes, prior maths knowledge had a moderating effect; children with lower pre-test scores on number sense (<50%) benefited nearly twice from the intervention that those with higher pre-test scores, showing the value of the app especially for low performing children. Yet, another study testing the same app with the same age children showed contradicting outcomes. While the intervention group performed better than the control group aligning with previous findings, pre-test scores and gender were found to moderate effects. This time the higher performers (>50%) and female children had better post-test scores in number sense [20]. Enhanced learning outcomes in numbers, shapes, space, and measure were also reported in a number of studies with children 4 to 7 years old, who interacted with a set of apps from *OneBillion*. In one of the reported studies, low achievers 4–5 years old were found to benefit more from the apps than a similar age of high-achievers. No impact of socio-economic status and child's first language was found [21].

Age was shown to moderate effects on STEM learning (including quantity of different sets) in a study where a group of children played a game (*Mesozoic Math Adventures*) and another group watched the experimenter playing the same game [22]. Younger children (Mean age = 3,6) were found to learn more from watching rather than playing the game, while older children (Mean age = 4,7) learnt equally well from playing or watching the game. These differences were explained by cognitive load which is likely to increase when playing a game and make it difficult for the younger children to manage it. Yet, in another study comparing video versus tablet-based interactions, observed differences held true even after controlling for age. Children (3,7–5,6 years old) who played a tablet-based game about approximate measuring or viewed a video recorded version of the game demonstrated greater transfer of knowledge than a control group playing a zoo keeping game. Children in the interactive condition (tablet-based) had better outcomes in a near transfer test, whereas children in the video-recording condition were better in the far transfer test. Other co-variates including gender, verbal ability, parent's education, and household income were not significant [23].

Yet, in other studies, age as well as gender were not associated with post-test performance. A tablet-based maths implementation consisting of 32 different digital games was superior to a respective computer-based one in terms of developing numbering skills, numeral literacy, mastery of number facts, calculation skills and understanding of concepts with 4 and 5 years old (Mean age = 5,2) [24]. Also, the game-based app *Measure Up!* was found to result in enhanced learning gains in understanding measurement concepts such as height and length, weight, and capacity in the intervention condition (Mean age = 5) than the control condition [25]. Similarly, a numeracy app was found to improve numerical magnitude knowledge in 6 years old, yet a working memory game app did not result in any improvements compared to the control group. A combination of the two game apps was found to improve working memory for at least a month later. No differences in age, gender, ethnicity, race, and home languages

were observed between the intervention and control groups, hence these variables were excluded from the analysis [26].

A study that examined a game app, closely similar to the design of the two apps we examined in this paper, showed improvements in the arithmetic fluency of 7 years old; it helped children become fluent in adding and subtracting simple sums up to 20. The app gave an arithmetic addition or subtraction problem (e.g., 6 + 8 = ?) to the children and a number of possible answers. The speed and correctness of each problem were associated to game performance. Post-test comparisons showed significant gains for the intervention group in subtraction using non-symbolic (dots; ::) number representations than the control group. Improvements in non-symbolic problems required students to make a calculation in order to find the answer and therefore the authors concluded that the game improved calculation efficiency rather than retrieval efficiency, as originally expected [27]. Also, to the best of authors' knowledge, a single study was found to report on equally good pre-post test outcomes between the intervention and control groups (5 and 6 years old) in mathematical abilities, spatial awareness and working memory. This concerned a comparison between a programming app (*Bee-bot app*), programming with pen-and-paper, and a control group [28]. The lack of significant differences was explained by standard teaching practice in addition and subtraction that may have helped all groups perform equally well in the proposed tasks, a lack of statistical power and a possibility of Type II error.

In terms of the apps used in the aforementioned studies, these feature certain design characteristics. The apps of *OneBillion* used an in-app virtual teacher to guide children's learning with instructions and demonstrations [21]. A *racing game* in which children competed a virtual enemy helped children calculate correctly certain maths problems suggesting that non-symbolic arithmetic skills can be improved through simple multiple-choice tasks [27]. The *Math Shelf app*, structured around games that support short-term maths goals, can be tailored to students' needs. It assigns content based on an assessment children take which determines where in the curriculum they are [19]. The *Mesozoic Math Adventures* presented two games in which a character was indicating what the children should do, either by asking a question that could be answered by selecting from a number of options or asking children to test a hypothesis by, for example, arranging objects on the screen [22]. The *Measure that Animal* app introduces a zookeeper who needs to measure some animals, yet he has forgotten his measuring tape. Children can select an item from a box and place it on a line to measure the animal. This interactive approach has been designed to scaffold the process of measuring [29].

With the exception of one study, the outcomes of existing studies point to enhanced post-test performance after children aged 4 to 7 years old interacted with certain maths apps. Yet, the effects of prior knowledge, age, and gender on post-test performance are rather blurred. There are mixed-findings in respect of whether maths apps can help in particular the low or high achievers or whether older children (than younger ones) and female are those who can benefit the most from interacting with apps. None of the reported studies evidenced significant effects of socio-economic status, ethnicity, child's first language, verbal ability, parent's education, and household income. These insights raised the need to explore further the effects of moderating factors in order to determine who of the children benefit the most from interacting with selected maths apps.

2.1 Learning through "drill-and-practice"

Ealy years maths curricula are mainly focused on improving skills such as counting, using numbers, and calculating addition and subtraction problems [30], [31]. Mathematic skills such as number combination (e.g., 6 + 4 = ?, 10–4 = ?) can be solved by counting, decomposing, or by automatic retrieval of the answer from memory. Children make use of specific strategies that can help them solve number combination problems, often starting with "counting all", then moving to strategies such as counting starting from the biggest number and decomposing a whole into different combinations of parts. Over time, associations of problems with correct answers become established in memory and children retrieve answers rather than practising strategies to find the correct answer [32]. There are three stages to skills acquisition: cognitive – performance of calculations to produce the correct answer; associative – retrieving the answer from declarative knowledge; and autonomous – no strategy is used and retrieving the answer becomes a reflex [33].

Drill-and-practice is a significant part of learning about number combinations that can lead to the "autonomous" stage of skills acquisition or arithmetic fluency. It is a behaviourist-oriented approach to learning that can result in conducting lower level processes (such as addition or subtraction of small sums) with limited effort. This is a significant skill as it enables greater cognitive capacity for solving complex tasks [34]. Teaching the strategies for solving a task coupled with deliberate practice were shown to result in better learning outcomes than teaching without practice [32]. Developmental differences were found in terms of practising number combinations. A computer-based task showing children the strategy to use to solve an addition problem was found to be more beneficial for 3rd graders, while a process-based training (no strategy or scaffolding provided) was more beneficial for 5th graders. It is more likely the older children could develop their own strategies for solving the tasks by possessing relevant cognitive skills, and this resulted in becoming faster in finding the correct answer. On the contrary, younger children who were given a strategy to solve the task became more accurate after practice [18].

2.2 The maths apps under study

In this paper, we examined two commercially available mobile apps that have not been researched before, *Moose Math* by Duck Duck Goose and *Monster Numbers* by Didactoons. To select apps, we first reviewed the design features of available maths apps for early years and grouped existing apps in three main categories: (i) apps linked to physical artefacts, (ii) "drill-and-practice" apps with external rewards, and (iii) apps that combined gaming and learning elements, for example a racing maths game. In this study, we chose to study an exemplary app from the second and third categories. The criteria we used to select the specific apps were as follows: (a) free maths apps available in both the Apple and Google stores, (b) apps not used in previous published work, and (c) apps rated with at least 3.5/5. The apps under study were "instructive", that is, supporting learning through "drill-and-practice" [3] and targeting recalling of simple addition and subtraction tasks and counting. At the point of writing, *Moose Maths* was rated with 4.5/5 (iOS) and 4.4/5 (100,000 + installs) (Google store) and Monster

Numbers 4.5/5 (iOS) and 4.0/5 (10,000 + installs). In *Moose Math*, participating children were asked to interact with specific in-app learning activities that were deemed suitable to their age, in particular the Juice Mixer, Pets, and Pets Bingo.

2.3 The present study

This paper presents evidence from the project mEvaluate: Devising an evaluation framework for the design and use of mobile learning applications in early years' education funded by the British Academy Mid-Career Fellowship scheme, the aim of which was to devise an evidence-based evaluation framework for the design and use of mobile apps for math literacy (see [35]). Project data were collected from a series of RCTs in primary schools in the UK. The following Research Questions (RQs) were addressed in the study:

RQ1: What is the learning impact of the mobile apps Moose Math and Monster Numbers on 5–6 years old? We hypothesised that the performance of participating children would improve after interacting with the two apps under study. The apps would be an opportunity for practising maths concepts and processes taught in the classroom [32]. It would enable performance of lower level processes with limited effort and help to establish the correct number associations in memory [32], [34]. The added value of using mobile apps, rather than a pen-and-paper equivalent, is that children receive immediate feedback from the apps that can help quick recovery from mistakes and facilitate progress.

RQ2: How do children's characteristics in particular age, gender, and previous maths performance relate to learning using these apps? Existing studies present rather mixed findings about the impact of age and gender on maths learning with apps (e.g., [19], [22], [29]). Therefore, we hypothesised that these characteristics would not influence post-test performance. On the contrary, given the evidence to support that previous performance is related to post-test outcomes in a positive or negative way [21], [19], we hypothesized that previous maths performance, as measured by pre-tests and the assessment of teachers for each individual child, would moderate effects on post-tests.

3 Methodology

3.1 Context and process of data collection

We ran four RCTs in four self-selected primary schools in the UK, identified through announcements we shared with different teachers associations in England. Using a SPSS function, we numbered and randomly allocated students within each class into a control and an intervention groups. Ethical approvals were gained from the ethics committee of the Open University UK. Parental consent was obtained by the guardians of all children who took part in the study. Teachers were offered Amazon vouchers as a thank you gift for their participation in the study. No incentives were offered to participating children. We treated the first school (20, Year 1 children) as piloting of the process of implementation and data collection. In particular, we piloted and refined the pre/post-tests designed to measure impact on learning after interacting with the apps,

and the instruction documents we shared with teachers that detailed how to implement the study. Also, we monitored and gave feedback to teachers as to how to respond to students' queries when using the mobile app and when completing the pre/post-tests, to ensure that limited guidance is provided to children that could bias the results of this study.

In terms of the socio-economic status of participating schools, all four schools were public and presented a larger than the national average concentration of disadvantaged students (i.e., minority ethnic groups, English as an additional language, free school meals, children in care or adopted, and pupil premium – that is the governmental grant offered to school and families of disadvantaged children to minimise the attainment gap). The Index of Multiple Deprivation, that is, the official measure of relative deprivation of small areas in England classifies the area around School 1 at the 7th decile (the 10th decile is the least deprived small area nationally), and Schools 2, 3 and 4 at the 1st decile, an indication that the areas where those schools are located are amongst the most deprived 10% of small areas nationally. In terms of technological equipment, School 1 had 15 iPads shared across the entire school and School 2, 3, and 4 had no mobile devices. In these schools, mobile devices were provided to each child by the authors.

In this paper, we excluded the pilot school and are reporting on the outcomes from three schools (coded thereafter as School 1, School 2, School 3) with a total of N = 376 children as follows: School 1 – one Year 1 and one Reception classes (n = 46); School 2 – two Year 1 and two Reception classes (n = 100); School 3 – four Year 1 and four Reception classes (n = 230). The duration of the intervention ranged slightly across schools to accommodate the needs and availability of participating teachers: children in School 1 had 8 sessions with the mobile app of 15–20 minutes each, and Schools 2 and 3, 5–7 sessions of an average 15 minute duration (two sessions per week). Prior to the start of the intervention, we shared written instructions with participating teachers and debriefed them orally as to how they should use the devices. In School 1, the intervention took place during maths teaching. While the intervention group was interacting with the app, the control group was doing standard maths practice. In School 2 and 3, teachers organised the study around the school needs, therefore the control group in some sessions was doing standard maths practice while in others was practicing other subjects. The role of the teachers was to moderate or supervise the study and provide limited technical support if needed. This design aligned with existing studies examining the use of technology in classroom settings [21].

The first and last sessions at each school were coordinated by the research team, as a means to showcase to the teachers how to implement the study and also allocate and collect pre/post-tests. Children in the intervention group were sitting together and worked individually (one-device-per child) with the mobile devices. No guidance or help was provided by the teacher or the researchers, unless technical difficulties inhibited a child from interacting with the app. The research team contacted the teachers once a week as a means to monitor the progress of the study, resolve any issues they were facing, and enhance the fidelity of the implementation.

Pre and post tests were designed based on the learning objectives of the apps under study, piloted and revised during the piloting phase. The piloting indicated that the tests were relatively lengthy and therefore they were substantially shortened. The tests

followed the type of activities children were asked to complete in the app: (a) number recognition, (b) counting, (c) adding, and (d) subtracting numbers. Instructions on how to complete each activity in the tests were written in a separate document and shared with teachers across all classes. When children could not understand the instructions given, a non-related to the app example was given and explained by the teacher.

3.2 Sample

Table 1 summarizes the sample characteristics across schools. Overall, 376 self-selected children took part in the study. Participating schools had on average similar numbers of male and female children, aged between 5 and 6 years old. In terms of children's existing performance in maths, the teachers' assessment showed that in School 1 and 3 the majority of children had an average performance, whereas in School 2 a slight majority was above average. Another measure of students' previous maths knowledge and understanding is their scores in pretests indicating that School 1 had a lower maths average that the other two schools.

Table 1. Sample characteristics

School Name	No. of Students	Gender (%)	Age (months)	Class	Maths Performance*	Pre-test Performance (out of 100)
School 1	46	M = 41 F = 59	M = 68 SD = 6.4	1 X Y1, 1 X Reception	22% below average, 48% as expected, 30% above average.	M = 46 SD = 24
School 2	100	M = 55 F = 45	M = 70 SD = 7.1	2 X Y1, 2 X Reception	16% below average, 36% as expected, 39% above average. (9% missing)	M = 68 SD = 24
School 3	230	M = 120 F = 110	M = 69 SD = 6.8	4 x Y1, 4 x Reception	18% below average, 51% as expected, 9% above average. (22% missing)	M = 65 SD = 34

Note: *As assessed by the class teacher.

3.3 Mobile apps under study

To visualize the interaction pathways and design features of each app, we used the Activity Theory framework for analyzing serious games [36]. Moose Maths presents a cyclical interaction pathway that starts with: (a) selecting a learning activity, (b) selecting a reward, (c) completing correctly a learning task, and (d) receiving a reward (See Figure 1 and Table 2). It allows for maximum three wrong answers to a given task before proceeding to the next one. Instructions are provided in the form of oral help before a learning task starts. Help (oral and visual) is available on demand (See purple bird in Table 3).

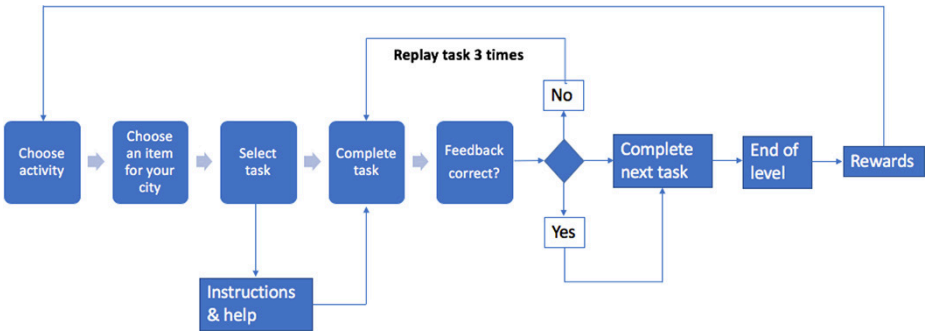
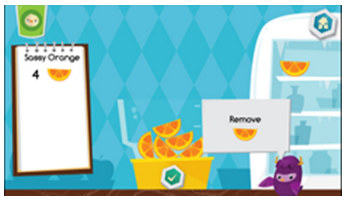


Fig. 1. The design of the mobile application Moose Math

Table 2. The game and learning components of Moose Math

		Choose Activity	**Choose an Item for Your City**	**Instructions/ Help**	**Complete Task**	**Rewards**
Gaming elements	Actions	Customisation	Choose	Obtain help	Matching	Performance evaluation
	Tools	Activity	Object	Oral or visual instructions	Fruits, bird, drink, oral and visual messages	Rewards
	Goals	Choose activity	Decorate	Learn interface	Solve task	Maximise performance
Learning elements	Actions			Observe	Repetition; recover from errors	
	Tools			Tips/help	Challenge	
	Goals			Provide guidance	Counting or addition or subtraction	

Table 3. Instructions and help provided by Moose Math

Automatic, Oral Instructions	**Optional Instructions (Help-on-Demand)**	
	Oral Help	**Visual Help**
Drag ingredients from the fridge to the blender. Put 3 oranges into the blender.		
1st wrong attempt: Let's try again.	Put two more in the blender. I am always here if you get stuck.	
2nd wrong attempt: Let's try again.	Put 2 more Or Remove one	
3rd wrong attempt: The app moves to the next task.		
Correct answer: Looks delicious, choose a cup. Press the cup or tab the recipe book to make another drink.		

Similarly, Monster Numbers presents a cyclical interaction pathway with separate learning and gaming tasks. The successful completion of a learning task follows a gaming session (racing game). There is no limitation as to the number of wrong attempts made neither in the learning nor in the gaming task (unlimited repetition of activity) (Figure 2). Instructions are both visual and written (but not oral) and presented before the start of a gaming or learning task. In learning tasks only, these can be skipped by pressing the start button (Table 4).

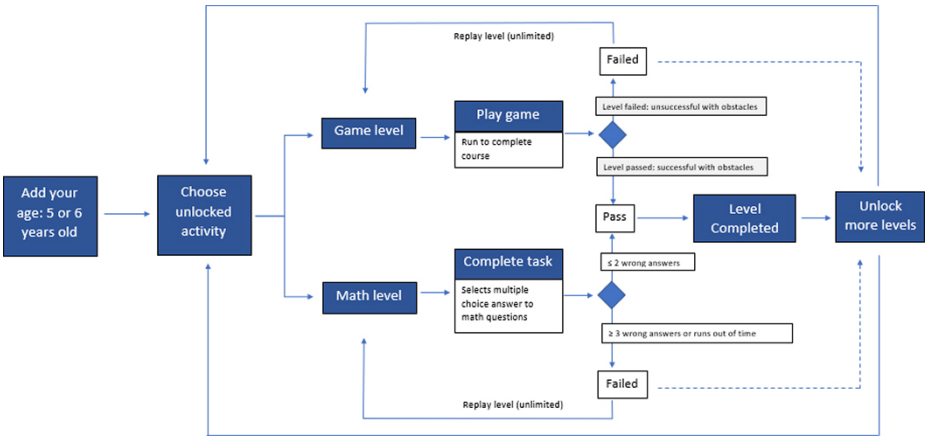


Fig. 2. The game flow of the "Monster Numbers" app

3.4 Process of data analysis

Aligning with [37], we used a multiple linear regression analysis; independent variables or predictors were the pre-test scores, the condition (intervention versus control), gender, age, and previous maths performance. We transformed all pre/post-test scores to percentages to allow for easier interpretation (see [37]). The analysis considered for only complete cases of children (listwise selection), that is cases where both pre and post-test values were available. Three pre-test and six post-test cases were missing and excluded from the analysis. In all three datasets (three schools), no values over .70 were observed in the correlation matrix, P-P plot and scatterplots showed linear relationship of standardized residuals, and Cook's distance was not greater than 1, meeting the assumptions for running a regression.

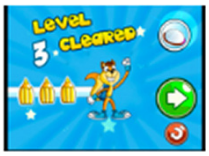
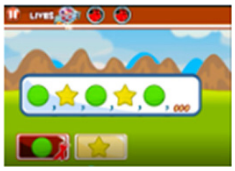
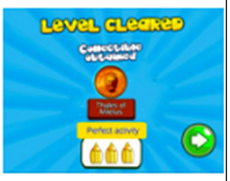
Moose Math app: This app was tested in Schools 1 and 2. We ran a separate regression analysis for each participating school. We first inspected the distribution of the dependent variable (post test scores) within each group (control, intervention) and within each school dataset. In Schools 1, the skewness and kurtosis measures and standard errors, and their histograms, normal Q-Q plots and box-plots and the Kolmogorov-Smirnov test of normality (School 1: control $p = .200$; intervention $p = .200$) showed that the data were approximately normally distributed. Levene's test verified the equality of variances between the control and intervention groups (School 1: $p = .65$).

In School 2, the data were found to be non-normally distributed. The Kolmogorov-Smirnov test of normality was significant for both the control ($p = .009$) and intervention groups ($p = .001$). Yet, we performed a regression analysis given that the sample size was 'sufficiently large' and over 80 participants which is considered appropriate for running a parametric test [38].

Monster Numbers app: This apps was tested in School 3. We first inspected the distribution of the dependent variable (post test scores) within each group (control, intervention). The skewness and kurtosis measures and standard errors, and their histograms, normal Q-Q plots and box-plots and the Kolmogorov-Smirnov test of

normality (control $p < .001$, intervention $p < .001$) showed that the data were not normally distributed. Levene's test verified the equality of variances between the control and intervention groups ($p = .793$). Despite the non-normal distribution, we performed a linear regression analysis given that the sample size was 'sufficiently large' as above [38].

Table 4. Instructions and forms of feedback in the "Monster Numbers" app

	Instructions	Forms of Feedback	Rewards
Gaming Levels	 In-game instructions given visually and as text. When instructions are given the running speed of the main character decreases. Children have no option of opting out of instruction. Instructions do not repeat when level is failed.	 Ongoing feedback is shown through score, coins collected, and potion collected. End of level evaluation based on performance.	 Rewards given as parts of spacecraft. Rating out of 3 is given.
Math Levels	 Instructions given at the beginning of level as text and visual representation. Children can skip the instructions by pressing play. Instruction repeat when level is failed.	 Ongoing feedback shown through progression bar, lives remaining, and timer. End of level evaluation based on performance.	 Rewards given as collectable coins. Rating out of 3 is given.

4 Results

School 1 (Moose Math): The results of the regression indicated that only one predictor explained 26% of the variance in the dependent variable (post-tests) ($R^2 = .26$, $F(2,40) = 6.99$, $p < .01$). Pre-test scores significantly predicted post-test scores ($\beta = .45$, $p = .003$) (See Table 5), while the condition (control versus intervention group) was not statistically significant ($\beta = -.12$, $p = .401$, NS). After entering demographic variables, the model remained significant ($R^2 = .29$, $F(5,37) = 3.1$, $p < .01$). The only variable predicting post-test scores was pre-test performance ($\beta = .39$, $p = .025$) indicating that

the greater the pre-test performance the better the post-test scores were. In particular, one point increase on the pre-tests corresponds to 0.39 increase in post-tests performance. Participating children had significantly better scores in post-tests, over and above the condition they were in, gender, age and previous maths performance.

School 2 (Moose Math): As with previous school, the results of this regression indicated that only one predictor explained 51% of the variance in post-tests ($R^2 = .51$, $F(2, 92) = 48$, $p = .001$). Pre-test scores significantly predicted post-test scores ($\beta = .68$, $p = .001$) (See Table 5), while the condition (control versus intervention group) was not statistically significant ($\beta = .13$, $p = .09$, NS). After entering demographic variables, the model remained significant ($R^2 = .53$, $F(5, 81) = 18.45$, $p = .001$). The only variable predicting post-test scores was pre-test performance ($\beta = .66$, $p = .001$). In particular, one point increase on the pre-tests corresponds to 0.66 increase in post-tests performance. No other significant differences were found.

School 3 (Monster numbers app): The results of the regression indicated that only one predictor explained 60% of the variance in post-tests ($R^2 = .596$, $F(2, 104) = 28.63$, $p < .001$). Pre-test scores significantly predicted post-test scores ($\beta = .59$, $p < .001$) (See Table 5), while the condition (control versus intervention group) was not statistically significant ($\beta = .002$, $p = .98$, NS). After entering demographic variables, the model remained significant explaining 54% of the variance in the dependent variable ($R^2 = .54$, $F(5, 76) = 6.21$, $p < .001$). The only variable predicting post-test scores was pre-test performance ($\beta = .46$, $p = .001$) suggesting that children had significantly better scores in post-tests, over and above the condition they were in ($\beta = .01$, $p = .91$, NS), gender ($\beta = .005$, $p = .96$, NS), age ($\beta = .05$, $p = .64$, NS) and previous maths performance ($\beta = .14$, $p = .21$, NS). In particular, one point increase on the pre-tests corresponds to 0.46 increase in post-tests performance.

Table 5. Means and standard deviations in the control and intervention groups

	Mobile Application	Control		Intervention	
		Pre-Test	Post-Test	Pre-Test	Post-Test
School 1	Moose Maths	M = 52 SD = 23	M = 68 SD = 24	M = 39 SD = 23	M = 56 SD = 27
School 2	Moose Maths	M = 64 SD = 26	M = 69 SD = 24	M = 71 SD = 22	M = 78 SD = 17
School 3	Monster Numbers	M = 62 SD = 34	M = 62 SD = 34	M = 67 SD = 34	M = 63 SD = 35

5 Discussion

In this paper, we conducted three RCTs with 376 children aged 5 and 6 years old to capture the impact of two popular and highly rated, "drill-and-practice" mobile maths apps at three primary schools located in relatively deprived areas of the UK. In contrast to the majority of existing studies reporting positive learning gains from using maths apps (e.g., [39], [10]), this study identified no significant differences between the app and non-app conditions. Participating children were found to have better learning outcomes in post-tests by the end of the intervention over and above the condition they

were in, suggesting that both conditions – interacting with a maths app and standard teaching practice – were equally beneficial to helping children complete basic maths tasks such as counting, addition and subtraction of small numbers. In contrast to our initial hypothesis for RQ1, the intervention group did not present improved learning outcomes compared to the control group. This finding aligns with a few studies that had reported non-significant gains post intervention for the app condition [40], [41] as well as insights suggesting inflated effect sizes in studies examining constrained maths skills as such skills have a ceiling effect, are mastered by most children and are influenced more by direct teaching [42]. The increased performance of children in post-tests in both conditions could also be explained by an overall progress in understanding early maths concepts over the period of the proposed intervention. Counting, addition and subtraction are core topics in early years maths instruction, hence systematic classroom practice may have had a positive impact on the performance of students as a whole.

Aligning with our hypothesis for RQ2, the only factor explaining post-test performance in both the control and intervention groups was pre-test scores. The greater the children's performance in pre-tests, the better their post-tests outcomes were. There was no effect of age, gender and previous maths performance (as assessed by teachers) suggesting that these factors are unrelated to post-test changes. These findings confirm studies showing that the effectiveness of mobile apps for learning is often related to prior knowledge and performance [11]. Children who were more skillful or knowledgeable might have performed better in the tests than other children either because they developed the strategies needed to solve the tasks in hand or they were at the "autonomous" stage of calculations in which they could recall answers from memory with no effort [33]. In contrast, the low performing children might have performed less well due to a lack of additional guidance or explanations (either from a teacher or the app) that could help them manage the cognitive load and cope with the tasks successfully [18].

Reflecting on the delivery of the intervention, there was a variation in the activities children in the control group were engaged with across sessions and schools. For example, practicing addition or subtraction using pen and paper or receiving instruction as to how to solve such problems may have benefited the control group and helped them perform equally well to the intervention group. Also, for the intervention group, the medium used to deliver the pre/post-tests was different to the medium used to practice maths concepts. Generalisation may not happen when children are instructed using a mobile device, whereas the assessment is completed using a different format such as pen-and-paper. Studies on computer-based maths instruction showed that students who practised only on a computer performed better in a computer-based assessment than a pen-and-paper one, whereas those who practised on a paper-and-pencil had similar outcomes in the computer-based and the pen-and-paper assessments [43]. These factors may have disadvantaged the intervention group and benefited the control group that was used to practising using pen-and-paper. On the other hand, the design of the pre/post tests followed the structure and content of the activities presented in the two mobile apps. In other words, they were closely aligned with the content of the in-app learning experience to facilitate near transfer [29]. Researcher-developed as opposed to standardised instruments were shown to inflate effect sizes for app conditions [12], suggesting that the tests may have favoured the intervention group. The combination of the above factors could explain why both groups improved after the intervention.

Other factors that may explain the lack of superior post-test performance in the intervention group is the design of the two apps under study and their focus on "drill-and-practice" of already acquired knowledge. The selected apps had no elements of explicit or direct teaching or structured instruction, an app feature that has shown to relate to enhanced learning outcomes [44]. Such features could showcase to children the strategies to use to solve tasks such as how to add up quantities, and help children understand and recover from mistakes in a constructive way. Given the young age of participating children (4 and 5 years old), these are more likely to be at the cognitive stage of calculations [33], that is practising strategies to find the correct answer rather than drawing from memory established number associations [32]. Aligning with existing studies [18], "drill-and-practice" apps may have been more beneficial for older children that are transitioning to the "autonomous stage" of skills acquisition or reaching arithmetic fluency. Therefore, a "drill-and-practice" app could help them become faster in finding the correct answers, a skill needed for solving more complex problems.

In addition, the delivery of feedback in the apps under study may have inhibited learning and recovery from mistakes. Studies have showed that specific (and not all) types of feedback can result in enhanced learning outcomes ([19], [45]). In this study, the Moose Math app provided verbal and emotional feedback (e.g., Let's try again or Looks delicious) (see Table 3) or at a 'self-level' referring to personal evaluations and affect in the form of reinforcement [46]. In contrast, help-on-demand provided feedback at a 'task-level', that is instructions about how to proceed. These instructions were verbal, written, and graphical. Yet, the most beneficial form of feedback has shown to be elaborative feedback, that is providing explanations as to why an answer is correct or wrong, as well as cues and suggestions as to how to modify a response [47]. In Moose Math, elaborative feedback is provided in the help-on-demand button (see Table 3, purple bird), yet not in the task feedback, suggesting that the latter could be enhanced by explaining why an answer is correct or wrong, or by providing personalised feedback that responds to specific actions on the screen. Examining the role of feedback in Moose Math using screen recordings, Herodotou [35] has shown that feedback is perceived differently by children of the same age, with some children being unable to recover from errors after accessing oral and visual help.

6 Limitations

In an effort to increase the ecological validity of the study and improve the fidelity of the implementation, we produced and piloted protocols of implementation with instructions as to how teachers should interact with children and children with the apps. Also, we had weekly email communication with teachers discussing progress and any issues related to the implementation. This is a rather common approach of conducting research with technology in educational contexts (e.g., [44]), where teachers receive training as to how to facilitate the study while the researchers are not present in all implementation sessions. Yet, we cannot rule out slight variations in the implementation by individual teachers that may have had an impact on outcomes. For example, participating children used the apps inside the classroom context. In some of the sessions (as reported by some teachers), children in the control group may have been in the same physical

environment implementing other maths-related activities. This may have posed a threat to internal validity due to contamination.

Also there was a variation in the length of the intervention across participating classes and schools, and the activities the control group was engaged with. In particular, we originally planned the study to span for four consecutive weeks with three sessions of 20 min in each week (total of 12 sessions). Yet, due to teachers' workload and last-minute school priorities, eight sessions ran in School 1 of 15–20 min duration each and 5–7 sessions in Schools 2 and 3 of 15 min duration each. The smaller duration of the intervention may have had an impact on the performance of the intervention group that could explain the lack of superior outcomes, often cited in the literature, compared to the control group. In addition to that, in School 2 and 3, children in the control group were not always engaged with standard maths practice. Despite the instructions given to teachers, there were sessions when children were studying other non-math related topics. This suggests that, in some cases, the exposure of the control group to maths content and teaching may have been less compared to the intervention group.

7 Conclusions

Although "drill-and-practice" maths apps are quite popular in the app market, highly rated and frequently downloaded, few studies have attempted to examine their impact on learning. In this paper, we conducted three experimental studies with a total of 376 children aged 5–6 years old from deprived areas in the UK, in an effort to assess their impact on early maths learning. Insights showed that the app condition was equivalent to standard teaching practice suggesting that popular apps, such as Moose Maths and Monster numbers, could help children practice basic maths tasks such as counting, addition and subtraction, yet they were not superior, or showed to have an added value compared to standard maths practice. Considering the development of early maths skills and in particular, the transition of children through different stages prior to calculating with no effort, it is suggested that teachers and app designers consider for the skills and knowledge children have developed prior to using or recommending the use of "drill-and-practice" apps. Children who have developed an understanding of the strategies needed to calculate and are starting to become more autonomous in performing such tasks are those more likely to benefit from these apps. Such apps can help them develop calculation efficacy (do tasks quickly) or establish number associations in memory, a skill needed for reducing cognitive load and enabling the solution of complex maths problems.

App designers should be cautious with the age recommendations they make for such apps (e.g., suitable for children 3–7 years old) as children up to 6 years old may not benefit from interacting with them. Apps with instructive or teaching features including more elaborated feedback and scaffolding might be more beneficial for these ages as they can help children develop the strategies needed to calculate effectively. To this respect, the role of instructional designers or experts in educational technology should be heavily considered in the process of design; they could provide valuable insights as to how children develop [35], which features or mechanisms are more appropriate for their age, and how to embed these to the app design to enable active and personalised

learning experiences. Partnerships between app designers and educational experts should be promoted to ensure that educational apps consider for pedagogical principles and have been tested with children prior to their release to the market [48]. Such evaluations could contribute to the development of an evidence base that could guide parents and teachers when choosing and using apps with children. Also, the design of apps should move from an "one size fits all" approach to more tailored and personalised approaches, using for example machine learning techniques, that consider for children's individual learning needs including prior experiences with maths and how these may relate to app use and understanding, thus presenting each child with a dynamic and tailored learning experience.

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An Empirical Analysis of User's Continuance Intention (UCI) towards Careem Mobile Application

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Abstract—This study aims at constructing a theoretical model to discover the main drivers on the user's continuance intention (UCI) to use the Careem application in Jordan. This study also focuses on exploring new factors appropriate to the Jordanian environment that can shape people's behavior towards adopting this smart service. Partial least square was performed to test the research model using 500 valid surveys. All constructs in this study were significant and accounted for 47.1% of the variance of continuance intention to use the Careem application. Careem user experience, E-word of mouth, financial benefits, and perceived platform quality are found strongest predictors toward intention to use at level (0.001). Two predictors were at level (0.01) including perceived enjoyment and perceived innovativeness. The findings also indicate that family confidence and women empowerment are the weakest effects at level (0.05). Some of the implications this study provides for designers and developers of mobile applications and institutions related to transport when providing mobile application services.

Keywords—Careem application, family confidence and women empowerment, user experience, E-word of mouth, Jordan

1 Introduction

Many countries, especially developing countries are facing economic problems due to globalization and the concentration of industries in large cities or capitals. In order to overcome these problems, there is an urgent need to improve urban transport to enhance economic growth and reduce poverty. Therefore, it is necessary to reduce reliance on traditional methods when doing business in the transport sector [1]. This matter has become easy to implement in the age of the Internet and with the recent advent of digitalization [2, 3]. One of the most important advantages of digitization is a quick response to changes, based on people's needs [4]. Digitization works to compare the resources owned by the units for the general benefit of society, based on that, establishing a shared and sustainable economic system in which everyone participates in sharing private assets [5]. Sharing private assets plus assisting technology enables untapped resources to be brought into mobilization [6]. Thus, achieving the maximum production, despite these limited assets. Smart service systems are considered a vital and

interesting field where information and communication technology, service offerings, and participants interact with each other to form an ecosystem to provide creativity or innovation [7, 8]. The emergence of Careem application in the transportation sector is threatening the existence of traditional businesses such as taxis and public buses. Smart applications also negatively affect other traditional business sectors such as Airbnb in the hotel industry [9]. The Careem app is an example of the interactive process that takes place between passengers, drivers and information technology to serve people as well as to construct a "smart service experience" [10].

Careem mobile app provides an online network for people to share rides by connecting drivers and riders [11]. The advantage of these smart applications is that the driver locates the rider and moves to the desired destination through the shortest ride path, after which the cost is calculated depending on the time and distance [12]. The application of Careem is active in 14 countries in the Middle East, North Africa and South Asia, where its service is spread in more than 120 cities. The latest statistics showed that the number of Careem drivers has reached one million and that 30 million users are using this application [13]. In Jordan, Careem operates in the three largest cities of Amman, Zarqa and Irbid, as well as transportation to and from Queen Alia International Airport [14]. In March 2019, Careem was bought by its competitor Uber in a deal worth $3.1 billion to control the passenger service in the Middle East after long negotiations that spanned months, while Careem maintained the brand and the application [15].

This study focuses on exploring new factors appropriate to the Jordanian environment that can shape people's behavior towards adopting this smart service. This paper consists of eight sections as follows. The second section summarizes the literature regarding theoretical foundation and hypotheses development. The third section covers the methodology of this study through four subsections. The fourth section presents the results of the hypothesis examination of the study. The fifth section discusses the results and concludes the paper. Section seven provides limitations and future research. Section eight explains theoretical and practical implications.

2 Theoretical foundation and hypotheses development

Figure 1 displays the conceptual model for this study. Constructs of this model were selected based on the results and recommendations of many previous studies in this field. For instance, "E-word of mouth" was extracted from [16], authors noted that E- Word-of-Mouth makes a strong impact on brand image. A "continuance intention to use Careem" was used in the study model as an indication of the intention to use Careem and continuity in the future. The current study also selected the factors that are expected to be most influential in a developing and conservative country such as Jordan. For example, "family confidence and women empowerment" were taken from [17], through interviews conducted with Careem users, authors found that the app increases family confidence and increases women's empowerment in society in Pakistan. This study attempted to build a robust model to measure the adoption of Careem application suitable for the environment in which the study was conducted (Jordan). Therefore, the models that were measured in previous studies such as TAM, UTAUT and IDT were not used in this study because these models were saturated in

studying this research area [18]. For example, authors [7], extended TAM to study determinants of ride-sharing (Uber) in Bangladesh and Pakistan. Article [19], used UTAUT to predict Passengers' Uber Adoption in Bangladesh. Article [20], used both IDT and TAM to investigate customer adoption of the Uber in the USA.

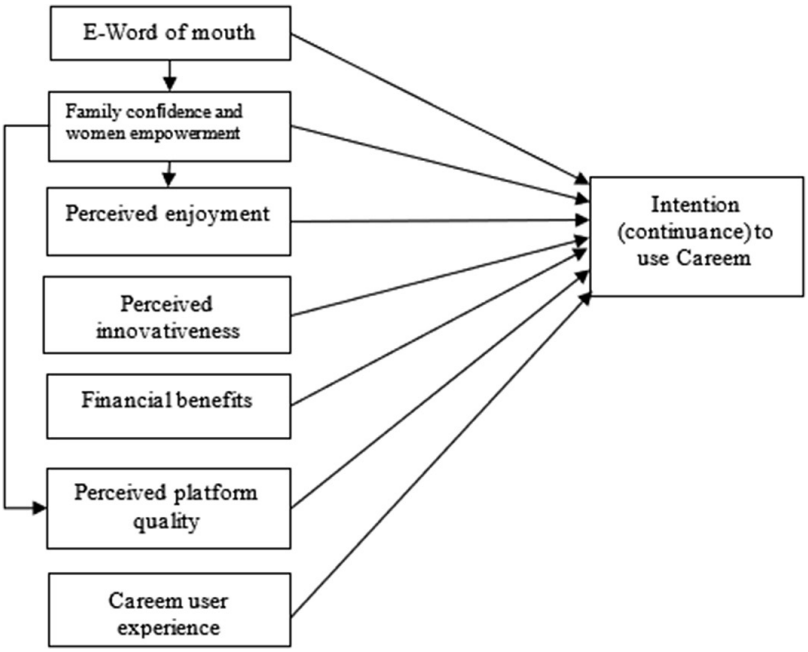

Fig. 1. Research mode

Source: Self developed.

2.1 E-word of mouth

The term word of mouth has evolved as the Internet environment has become an important factor for customers to influence them and direct their ideas regarding the consumption experience in a collective and unbiased manner. Therefore, E-word of mouth is a strong influence on the brand image of companies [16]. E-word of mouth plays a significant role typically for the customer through social sites with the product or service, where the customer can see the opinions of others who used this service, and therefore the customer makes the decision to use this service or not based on the recommendations and comments of others [21]. Previous studies also found that social sites (E-word of mouth) increase the level of trust through active communication in the product or service [22–24]. Since the Careem application service is fairly new in the Jordanian market, this study finds that the intention to adopt this service is largely determined through E-word of mouth. This study also believes that family confidence and women empowerment is a very important factor in affecting a customer's decision to use Careem Therefore, based on the above literature, this study hypothesize the following:

H1 There is a significant and positive relationship between E-word of mouth and consumer intention (continuance) to use Careem.
H2 There is a significant and positive relationship between E-Word of mouth and family confidence and women empowerment.

2.2 Family confidence and women empowerment

Jordan is an eastern Islamic country that has a collective culture different from the culture of the West. For example, one of the things known to Jordanians is that the man is the breadwinner, while the woman is the housewife, as well as the woman, represents the pride and honor of the family to the man. To put it differently, women in Jordan are not allowed to move around on their own. With the recent emergence of modernity and globalization, many concepts have changed, so women are freer to move around and an increasing number of women are working in the public sphere as well. Nevertheless, public transportation is a big problem. In a country without railway stations, the bus system in Jordan has not been reliable, efficient, and comfortable until recently. Local taxis have always been considered unsafe for women to travel alone, especially young girls, this study attempts to reveal the extent of confidence of customers, especially women, about the intention to use Careem. It is assumed that this service will be more compatible than local taxis or public buses for families in Jordan. In fact, there are several points that make Careem more preferred than other means of transportation, for example, the rider in Careem can evaluate the driver after the trip ends. The driver cannot start any conversation with the passenger unless the passenger allows it. Also, the fare in Careem is fixed, unlike the local taxi driver who may covet a higher fare. Hence, to further investigate this new relationship in the context of Jordan Careem's passengers, the authors can propose three hypotheses as follows:

H3 There is a significant and positive relationship between family confidence and women empowerment and consumer intention (continuance) to use Careem.
H4 There is a significant and positive relationship between family confidence and women empowerment and perceived enjoyment.
H5 There is a significant and positive relationship between family confidence and women empowerment and perceived platform quality.

2.3 Perceived enjoyment

Perceived enjoyment is defined here to the extent to which participation in the sharing economy is perceived as enjoyable in and of itself, regardless of any performance consequences that may be expected [25–27]. Previous studies indicated that enjoyment is an important inherent value for participation in the sharing economy [28]. Another example, article [29] indicated that participating in sharing economy services is a pleasure because it allows users to experience a remarkable variety of community interactions and engage in social contacts, in other words, offering customers a variety of options. It means that dealing with traditional companies was much less enjoyable than participating in the sharing economy [30]. Article [31] confirmed this view, they mentioned that Airbnb customers, in general, are using such a service because they

have a fun and different experience from it. In the Jordanian context, this study expects that there will be a significant and positive effect of perceived enjoyment in motivating customers to continue to use Careem, given that the company's criteria are in the interest of the passenger, such as that the cars for the service are modern, existence the driver's evaluation system after the completion of the trip, and the existence of a system that depends on the distance and time to determine the cost. Thus, we hypothesize that:

H6 There is a significant and positive relationship between perceived enjoyment and consumer intention (continuance) to use Careem.

2.4 Perceived innovativeness

Perceived innovativeness has been defined by [32] to "the degree to which a person tends to adopt new things such as new technologies, products, or services before others". Perceived innovativeness is a fundamental reason in customers' willingness in accepting new technologies [33]. Article [34] noted that a higher level of individual creativity increases one's confidence in adopting new technologies. Article [35] noted that the individuals with a higher degree of personal innovation will have clearer views of the innovative technology and thus increase the percentage of user adoption of these services. Article [36] stated that personal innovation actually affects an individual's personal perception of new technology: perceived ease of use and perceived usefulness. Including personal characteristics of users in technology acceptance models contributes to compensating for deficiencies in the research on accepting new green technology that focuses only on a technological perspective [37]. They concluded that personal innovativeness is a major feature that affects user acceptance of innovative technology. Article [38] concluded that personal innovativeness positively influences the intention to use ride-sharing services. The authors explained that "ride-sharing services is novel and attractive to consumers with high levels of personal innovativeness". Accordingly, the current study incorporates personal innovativeness in the proposed model to build a more integrated conceptual model to reveal the factors affecting consumers' intention to use Careem. Based on these arguments, the following hypotheses is proposed:

H7 There is a significant and positive relationship between perceived innovativeness and consumer intention (continuance) to use Careem.

2.5 Financial benefits

The term financial benefit refers to the perceived costs and the perceived monetary benefits resulting from any technology use [39, 40]. The financial benefit is defined in the context of this study that the customer considers the advantages of using Careem more than the financial costs [41]. Financial benefits have been found in previous studies under term "price value". In the UTAUT2 model, article [39] suggested that price value significantly contributes substantially to technology usage intention. It was found that the financial benefit positively affects a customer's intention to use technology in several contexts [42–45]. When a customer buys a service or product, he/she prefers to choose a specific brand over other alternatives based on looking at the financial value

achieved from the product or service [46, 47]. For sure, Careem's fees are significantly lower compared to alternative taxi services, as well as having an accurate ride cost calculation system. Moreover, through personal interviews conducted with several riders who used Careem, they confirmed that there is an increase in rewards and the winning rate increases with the increase in experience and rides through the application. They also confirmed that rewards motivate them to continue using this service. Other studies revealed that the perceived value is very important in actual online purchasing decisions in developing countries [48], thus the financial benefit is expected to play a decisive role in adopting Careem's service in a developing country like Jordan. Based on the previous discussions, this study assumes that:

H8 There is a significant and positive relationship between financial benefits and consumer intention (continuance) to use Careem.

2.6 Perceived platform quality

The platform quality is defined in this study as the customer's evaluation of the Careem platform that meets their requirements, as well as reflects the good impression of the quality of services provided on this platform [49]. Platform quality can be measured through three dimensions that considerably affecting the usage intention and acceptance of any new technology. First, "System quality is defined as the degree to which the system users believe that a system is easy to use, user-friendly, easy to learn, easy to connect to, and enjoyable to use" [50]. Second, "Information quality is defined as the degree to which system users think that online learning information is up-to-date, accurate, relevant, comprehensive, and organized" [51]. Third, "Service quality is referred to through these attributes: tangible, reliability, responsiveness, assurance, functionality, interactivity, and empathy" [52]. From the previous definitions of the quality elements, the customer considers the quality issue very important in the context of technology adoption. For example, the presence of accurate, sufficient, and available information on time, and an understandable and easy-to-handle interface, and a quick-response interactive experience that leads to faster use of technology among potential customers [53]. The perceived quality has been linked with the customer's intention to use technology in several contexts, as many studies have found that perceived quality is an important factor in determining the customer's intention to use the service [54–56]. In the context of ride-sharing, [30] found that perceived platform quality is considered one of the main predictors on passengers' intention to participate in Uber. Thus, we hypothesize that:

H9 There is a significant and positive relationship between perceived platform quality and consumer intention (continuance) to use Careem.

2.7 Careem user experience

In general, app user experience has been defined as "the difficulty that users find to use mobile applications thanks to its design of user experience, in which people perform activities in an automatic way, doing so as a consequence of their learning" [57, 58]. The user experience is defined in this study to the degree of difficulty that passengers

face in using the Careem application thanks to its design of the user experience, which in turn reflects the extent of the passengers' ability to use Careem in an automatic way as a result of their previous experience and learning. Previous studies have indicated how important the user experience is in accepting technology, for example [59] concluded that the group of younger customers tend to accept the use of mobile phone applications in tourism more than the elderly group, as they found in their study that the application user experience is the most important factor in the proposed study model. This study focuses on young people, as they are the largest group in the community and the most familiar with the use of new technology, as well as the most motivated to use mobile applications. This study is consistent with the results of previous studies, as it is assumed that the experience of a Careem user experience, especially young people, is excited to continue to try this service, so the last hypothesis of this research is:

H10 There is a significant and positive relationship between Careem user experience and consumer intention (continuance) to use Careem.

3 Methodology

Using convenience sampling, this study applied the questionnaire method in order to examine 10 hypotheses. The questionnaire consists of three parts, the first part offer information to the participants about the objectives of the research, the second part includes three questions related to the personal information of the participants, while the third part contains the measurement elements, which consists of 27 items, these items cover 8 variables. Table 1. shows the items used in this study, as each group of items represents a specific variable. The table also shows the codes for each item. A 5-point scale Likert from 1 "Strongly Disagree" to 5 "Strongly Agree" was utilized to capture the perception of each variable for the questionnaire. The sample of this study consists of 500 passengers who have experience in using Careem within two cities in Jordan; Amman and Irbid. Before participants filling out the questionnaire, a pilot test was performed by three experts to ensure items of research and to identify potential issues. After the pilot test, no major changes were recommended by the experts, knowing that they noticed that the questionnaire took about seven minutes to complete. The questionnaire has been distributed in public places such as gardens, malls, and shopping centers in a period that extended from the beginning of October 2020 to mid-November 2020.

Table 1. Items of research model

Constructs	Items	Origin
E-Word of mouth	1. I constantly follow specific online media that provide information about Careem service. 2. I often read other rider's online reviews to know whether Careem makes a good impression on others. 3. I often consult other user's review to use Careem service. 4. I frequently gather online information before I choose to request an Careem service.	[16]

(Continued)

Table 1. Items of research model *(Continued)*

Constructs	Items	Origin
Family confidence and women empowerment	1. I have high confidence in the services provided by Careem. 2. My family members have high confidence in the services provided by Careem. 3. For my female family members, I am confident to use Careem rather public transportation or taxis. 4. In general, I am confident in using Careem rather public transport or taxi.	Self-developed
Perceived enjoyment	1. I find participating in Careem enjoyable. 2. Participating in Careem is pleasant. 3. I have fun of participating in Careem.	[17]
Perceived innovativeness	1. If I heard about a new thing/technology, I would look for ways to experiment with it. 2. Among my peers, I am usually the first one to try the new thing/technology. 3. I like to experience a new thing/technology..	[18]
Financial benefits	1. I perceive that Careem has a fair pricing policy. 2. Careem provides acceptable value. 3. I can obtain adequate value for my money with Careem.	[19]
Perceived platform quality	1. The Careem platform enables me to get on to it quickly. 2. The Careem platform makes it easy to get anywhere in the platform. 3. The Careem platform provides me with all the information I need. 4. The information provided by the Careem platform is accurate.	[20, 21]
Careem user experience	1. The user experience in Careem is important for me. 2. I am addicted to using Careem because I like the design experience. 3. I prefer to ride with Careem that have high quality design experience.	[22, 23]
Intention to use	1. I intend to use Careem for transportation in future 2. I have a willingness to use Careem car services in future 3. I am likely to use Careem in future	[24]

The data were analyzed using two tools, SPSS version 25 to get descriptive statistics, while Smart PLS version 3.0 has been used by employing both techniques PLS algorithm and bootstrapping to test research hypotheses. 582 responses were collected after completing the questionnaire collection, 42 incomplete answers were deleted and 40 were deleted due to lack of seriousness in filling out the questionnaire, for example, some respondents whose answer was strongly disagreed with all the questionnaire questions, some responses have lack consistency, which resulted in a sample of 500 answers ready for statistical analyzes. Of the 500 respondents, 281 were male and 219 were female. The majority of respondents were young, with 53.6% between the ages of 20–35, and 38.4% between the ages of 36–50. In terms of education level, most of the respondents were in the category of bachelor's degree with 68.2.

4 Results

This section discusses the results in terms of normality, the measurement model and the structural model.

4.1 Normality

Skewness and kurtosis were calculated for each construct to test univariate normality [25, 26]. Skewness values were within the expected level (less than 3). Kurtosis values also were not higher than 8. It means that the items were normally distributed [27, 28]. Table 2 summarizes the results of the skewness and kurtosis approach.

Table 2. Normality test

Construct	Mean	Std. Deviation	Skewness	Kurtosis
E-word of mouth	4.09	0.527	0.011	0.362
Family confidence and women empowerment	4.09	0.569	–0.072	–0.231
Perceived enjoyment	4.11	0.578	–0.010	–0.115
Perceived innovativeness	4.10	0.359	1.352	3.365
Financial benefits	4.18	0.574	–0.019	–0.234
Perceived platform quality	4.13	0.482	0.036	0.550
Careem user experience	4.35	0.495	0.404	–1.343
Continuous intention to use	4.29	0.457	0.886	–1.220

4.2 Measurement model

In order to test Common Method Bias (CMB), this research utilized Harman's single-factor by employing Exploratory Factor Analysis (EFA) [29, 30]. From the results shown in Table 3, it can be concluded that 8 variables loaded highly on its items as well as eigenvalues have been found more than 1 for all variables included in this study. In other words, there was no variable accounting for more variance with another variable, therefore no signs for present problems in CMB.

Table 3. Factor loading

	CUE	EWM	FB	FCWA	IU	PE	PI	PPQ
CUE1	0.893	0.183	0.166	0.097	0.392	0.153	0.208	0.157
CUE2	0.905	0.164	0.162	0.093	0.439	0.191	0.202	0.208
CUE3	0.877	0.201	0.150	0.106	0.409	0.217	0.202	0.182
EWM1	0.175	0.865	0.172	0.205	0.382	0.219	0.129	0.175
EWM2	0.188	0.891	0.121	0.185	0.419	0.233	0.139	0.211
EWM3	0.205	0.918	0.138	0.177	0.391	0.222	0.160	0.210
EWM4	0.153	0.870	0.150	0.205	0.355	0.199	0.149	0.230

(Continued)

Table 3. Factor loading *(Continued)*

	CUE	EWM	FB	FCWA	IU	PE	PI	PPQ
FB1	0.129	0.138	0.865	0.241	0.273	0.236	0.152	0.183
FB2	0.200	0.166	0.909	0.221	0.351	0.268	0.177	0.180
FB3	0.135	0.127	0.882	0.261	0.287	0.234	0.153	0.161
FCWE1	0.093	0.196	0.244	0.855	0.246	0.128	0.163	0.096
FCWE2	0.155	0.199	0.252	0.886	0.300	0.117	0.195	0.135
FCWE3	0.063	0.171	0.198	0.878	0.230	0.125	0.228	0.138
FCWE4	0.067	0.190	0.243	0.862	0.234	0.152	0.217	0.173
IU1	0.446	0.400	0.319	0.263	0.936	0.365	0.311	0.363
IU2	0.411	0.396	0.339	0.270	0.937	0.362	0.286	0.369
IU3	0.420	0.409	0.296	0.271	0.879	0.309	0.319	0.348
PE1	0.190	0.208	0.225	0.121	0.312	0.880	0.163	0.244
PE2	0.149	0.195	0.238	0.101	0.300	0.880	0.160	0.245
PE3	0.213	0.246	0.273	0.167	0.379	0.899	0.184	0.302
PI1	0.185	0.187	0.135	0.194	0.295	0.180	0.886	0.190
PI2	0.201	0.112	0.159	0.221	0.280	0.170	0.909	0.249
PI3	0.227	0.138	0.194	0.207	0.319	0.167	0.898	0.187
PPQ1	0.191	0.167	0.177	0.099	0.339	0.251	0.215	0.852
PPQ2	0.174	0.253	0.132	0.144	0.348	0.240	0.177	0.882
PPQ3	0.186	0.166	0.195	0.116	0.304	0.232	0.206	0.867
PPQ4	0.167	0.216	0.184	0.177	0.366	0.314	0.207	0.875

As shown in Table 4, 3 kinds of analyzes have been used to test convergent validity; first, Cronbach's alpha values must be more than 0.7 [31], second, Composite Reliability (CR) values must be more than 0.7 [32], third, the Average Variance Extracted (AVE) values must be more than 0.50 [33]. This study found that all values in the previous 3 kinds of analyzes are higher than the recommended value as approved in previous studies. Therefore, it was ascertained that there are no potential problems in convergent validity.

Table 4. Reliability analysis

Factor	a	CR	AVE
EWM	0.909	0.936	0.785
FCWE	0.893	0.926	0.757
PE	0.865	0.917	0.786
PI	0.880	0.926	0.806
FB	0.863	0.916	0.784
PPQ	0.892	0.925	0.755
CUE	0.872	0.921	0.796
IU	0.906	0.941	0.842

For testing discriminant validity, it has been found that every single item loads significantly on its own variable and not significantly on other variables, as well as every variable share high variance with its measures than it shares with other variables. In variance analysis, the square root of every AVE is much higher than any correlation among any pair of latent constructs as presented in Table 5. Discriminant validity, therefore, was achieved herein [34].

Table 5. Correlation analysis

CUE	**0.892**							
EWM	0.204	**0.886**						
FB	0.178	0.164	**0.886**					
FCWA	0.110	0.218	0.270	**0.870**				
IU	0.464	0.438	0.347	0.292	**0.918**			
PE	0.210	0.247	0.279	0.150	0.377	**0.886**		
PI	0.228	0.163	0.183	0.231	0.333	0.192	**0.898**	
PPQ	0.206	0.233	0.197	0.156	0.392	0.301	0.231	**0.869**

Note: "The diagonal (bold) elements are the square roots of AVE values and the off-diagonal elements are the correlations among the constructs".

CUE Careem user experience, EWM E-word of mouth, FB Financial benefits, FCWA Family confidence and women empowerment, IU Intention to use, PE perceived enjoyment, Pi Perceived innovativeness, PPQ Perceived platform quality

4.3 Measurement model

Two methods were used in this study which includes PLS algorithm technique to check the research hypotheses as well as bootstrapping to determine the significance level for each construct. The ten hypotheses are in line with what was expected. More specifically, E-word of mouth is significantly affected family confidence and women empowerment ($\beta = 0.218$, $p < 0.001$) and intention to use ($\beta = 0.245$, $p < 0.001$). Therefore, both H1 and H2 were accepted. family confidence and women empowerment has been found significantly and positively influencing on three constructs, perceived enjoyment ($\beta = 0.150$, $p < 0.01$), perceived platform quality ($\beta = 0.156$, $p < 0.01$), and ($\beta = 0.097$, $p < 0.05$). Hence, H3, H4 and H5 were accepted. Perceived enjoyment is successfully associated with intention to use ($\beta = 0.129$, $p < 0.01$). Hence, H6 was accepted. perceived innovativeness is significantly affected intention to use ($\beta = 0.115$, $p < 0.01$), indicating that H7 was accepted. Financial benefits are positively related to intention to use ($\beta = 0.138$, $p < 0.001$). Hence, H8 was accepted. Perceived platform quality are positively related to intention to use ($\beta = 0.188$, $p < 0.001$). Hence, H9 was accepted. Finally, Careem user experience is positively related to intention to use ($\beta = 0.291$, $p < 0.001$). Hence, H10 was accepted. In summary, all predictors in this study were significant and accounted for 47.1% of the variance of continuance intention to use Careem application.

5 Discussion and conclusion

The results show that the E-word of mouth is high influences the intention to continue using Careem ($\beta = 0.245$). This can be attributed to the fact that E-word of mouth in Jordan plays an important role mostly through online reviews regarding the use of Careem [35], where the customer can see the opinions of others who have used this service, and therefore the customer makes a decision to use this service or not based on the recommendations and opinions submitted by others [36].

As expected, family confidence and women empowerment positively affected the intention to use, although the effect was not high. This weak effect can be justified by the fact that the effects of globalization and digitization have made families in Jordan more emancipated and thus the role of women is not limited to raising children only, but also in helping the family expenses like men. The results revealed that perceived enjoyment correlates positively with intention to use Careem, Possibly the cause of this relationship is that participating in Careem allows customers to experience social contacts and offering for them a variety of options. In fact, dealing with modern companies (e.g. Careem) is considered more enjoyable than participating in the traditional companies [37]. Careem criteria are in the interest of the passenger, such as that the cars for the service are modern, existence the driver's evaluation system after the completion of the trip, and the existence of a system that depends on the distance and time to determine the cost [38].

Our results indicated that the users' perceived innovativeness significantly influences the intention to continue using Careem. It is true that Careem services are relatively new and thus attractive to consumers with a great degree of personal innovation [39]. Nevertheless, the positive effect of personal innovativeness on the intention to use Careem's services is not high ($\beta = 0.115$). The justification could be that passengers are more influenced by their decision to use Careem's services based on the convenience and expected benefit of this service rather than their curiosity or desire to experiment with creativity. This study demonstrated that financial benefits significantly affect passengers' continuous intention to use Careem. Careem passengers in Jordan are often value-conscious and demand more quality service at a fair price. Although Careem's prices are higher compared to other means of transportation in Jordan, such as buses or taxis, passengers prefer Careem because of its well-known brand. Also, many passengers use the ride-sharing service through the Careem platform, thus saving more money through this service [40].

Another factor that was found to be important is perceived platform quality. The reason for this result is that the customer considers the quality issue extremely important when using Careem [41]. For example, it is noted that Careem has accurate, sufficient, and timely information, an understandable and easy-to-handle interface, and a quick-response interactive experience. This study concluded that the Careem user experience is the strongest factor in influencing customers' decisions to use Careem. It is clear and certain in this study that younger clients tend to use mobile applications in the transportation sector more than the elderly, so this study found that the Careem user experience is the most important factor in the proposed study model. This is because more than half of the respondents were in the age group from 20 to 35, this age group is the largest group in society and the most interested in using new mobile phone applications.

6 Limitations and future research

This article contains some limitations. First, this article only focuses on the intention to use Careem rather than the actual use behavior. In practice, intention and actual behavior are two different things. Therefore, it is recommended further investigation of actual use behavior of the respondents in the questionnaire. Due to the development in terms of design in the Careem application, it is likely that the questions mentioned in the survey did not cover all the features of the Careem application, and therefore may not fully include the consumer perspective of this application. On this basis, a better designing the questionnaire in the future is essential, thus obtaining an accurate, detailed and better treatment of the features of the Careem application. Another issue of importance to this study is the potential effects of different participants' demographics on the results. More than half of the respondents are between 20 and 35 years old. This sample may not be fully representative of the general population. The younger generation (under 20) may have different characteristics when looking at mobile phone technologies from the older generation. It is possible that they are more interested in new technologies or have a different perspective on these technologies. To understand the customer's intention to use Careem in a comprehensive manner, it is important to conduct a study that includes the younger generations that will help to better understand their attitude and behavior in adoption.

7 Implications

This study offers some vital theoretical implications. The proposed study model is relatively new and the factors within it have been carefully selected to fully reflect the passengers' understanding of the use of Careem. While most of the previous studies focused on understanding customer adoption of ride-sharing intention, this study chose to investigate the intention to use all services provided by Careem. Also, several previous studies focused on Uber, as the current research noted this point and approved more Careem study. Some of the implications this study provides for business operators and policymakers as well as institutions related to transport when providing mobile application services. The online marketer should focus on presenting the apps that have an excellent app user experience and offering awards for recommending the use of mobile apps for reservations or trips on social networks [17, 42, 43]. In this way, the value and perceived financial benefits are increased for the customer. E-word of mouth is also an important factor in this study since many customers in Jordan make the decision to use a specific service based on online reviews provided by others. Therefore, Careem and the transport companies must provide electronic material on social sites explaining the advantages of using these services [44].

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The Effectiveness of Darask Platform as E-Learning Tool to Improve the Educational Process during COVID-19

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Abstract—The globe is grappling with the COVID-19 pandemic, which has enslaved the economy, including the educational sector. This epidemic has caused recent changes and disruptions in all aspects of life, also this pandemic has compelled educational systems all across the world to find alternate methods to keep the process of education going on. To cope with the current case, the Darsak platform is authorized by the Jordanian Ministry of Education to be an alternative choice for proceeding with the educational process. The goal of the current study is to know the impact of the Darsak platform to be a compensation tool to perform the educational process during COVID-19. The data were collected by questionnaires, which distributed by web site, also it was conducted from (108) parents, (120) students, and (43) teachers' participation. So, this descriptive research used a relational survey approach. The responses which obtained from the participants were analyzed using SPSS tools. The result of the study showed that the Darsak platform was a new application to students, so it was found that facilities, flexibility appropriateness, and effectiveness of the Darsak platform were not up to expectation. Students were dissatisfied with the performance of the Darsak platform.

Keywords—COVID-19, Darsak, flexibility, appropriateness, facilities, effectiveness

1 Introduction

The Corona epidemic has spread most countries of the world. The global extent of this harmful virus has compelled educational institutions to close in order to control the virus's transmission. COVID-19 defined by [1] and [2] is known as spread through the respiratory tract when people have been in immediate contact or in touch with infected people. So that the almost of countries during COVID-19 made lockdown to minimize the spreading coronavirus. COVID-19, a highly contagious coronavirus epidemic, has altered every part of our life, along with how we teach. Under strict worldwide "social distancing" rules, most educational institutions, including schools, were closed.

Hence, to reduce coronavirus spreading and saving the children from the disease, the educational institutes, schools and universities have considered other teaching approaches. They almost utilized web-based method, e-learning, or online learning

approach. Learning has almost shifted into the digital way in today's environment [3], [4]. (Electronic-Learning EL) is a type of learning that has long been discussed and argued about the need to be integrate into the educational process. According to UNESCO COVID-19 and Children's Rights, the Coronavirus outbreak has forced the closure of schools and higher education institutions in more than 188 countries, which causing more than 1.5 billion children and youth to stay at home [5]. In light of the current status, many countries have changed from traditional face-to-face methods to e-Learning.

E-learning is the process of imparting skills and knowledge to a large number of individuals across a network at the same time or over a period of time. It was previously unrecognized since it was thought that this approach lacked the crucial human element for learning. Instruction that is planned and prepared based on the characteristics of the class utilized in such curricula, as well as the methods and strategies that allow the learner to absorb as much information as possible using electronic devices. Like CD-ROM, DVD, teleconferencing, video conferencing, email, live chats, and web blogs are all examples of technology. In proportion to its ability in the current time, coronavirus forced institutions to use a new alternative method to continue educational process during Covid-19 pandemic. Kuatbekov et al. [6] believe that e-learning emerged as a result of technological advancements, particularly after the educational process was directly impacted by industrial automation. The development of "artificial intelligence" technology and the "Internet of Things," as well as the information technology revolution that entered the classroom has become an integral part of education. Amin et al. [7] noticed that, in the momentum of the worldwide to provide shrewdness and high-speed solutions to any or all the changes that unprecedented, which occurred within the world because of the Coronavirus, most of the countries were being tried to provide compensation solutions for the deficiency that affected the education process in schools.

Most of the countries try to get solution to avoid corona virus obstacle, so several solutions were proposed, such as e-learning, blended learning, and so on. With this trend, various tools emerged to be utilized for this purpose such as Zoom, Googlemeet. From the above studies, the researchers noticed that E-learning education require so many devices to make communication channel between students and teachers. Jordan is one of the countries which tries to introduce solution to face corona virus pandemic which caused to lock educational institutions. Although Jordan has limited capabilities and material resources, but it tried to face the obstacle of corona pandemic. It tries to create a technical solution to ensure the permanence of the educational process for its young community and serve the students. Since the programs have started, several of challenges and obstacles have emerged that threaten to stifle its growth and effectiveness: Do all students have adequate electronic devices (computers, tablets, cellphones) to use for distance learning? The students can access and benefit from programs aired on the Internet Distance education channels if they have a good internet connection. Do all schools in villages and remote places have excellent internet connection? All these questions help the researchers to reach to certain result. So that the researchers try to know appropriateness and flexibility to indoctrinate the lesson for students through Darsak platform. Also, to know social benefit and the facilities which produced through Darsak platform to students to avoid the spreading of the coronavirus.

This paper is organized as follows. Section 2 presents the profile for Darsak platform. Section 3, 4 and 5 present the problem of the study, the objectives, and the questions of the study consequently. Section 6 presents the background of related existing approaches. Section 7 is the development of the methodology. Section 8 and 9 discuss about the study in details. Section 10 will summarize the main findings as a result of data analysis. Finally, the study will conclude with a discussion of the study recommendations and conclusion.

2 Profile for Darsak platform

Jordan government established free online educational Jordanian platform (Darsak) platforms for E-learning to be outlet for educational process of semi paralyzed life due to lockdown of corona virus in all the world [8], [9]. Jordan government has established Darsak platform with the aim to deliver lessons of all courses for all grades of Jordanian students with intention to face the challenges of emergence cases and spreading Covid-19 pandemic. So it was provided students with smart and equivalent solution to avoid any delays in the progress of educational system in the schools. So that, the lessons were presented in the form of video clips and fragmented throughout the week that connects the Darsak platform between education service providers and the Jordanian Ministry of Education. Darsak platform mostly tries to contain whole students' subjects. Teachers try to provide their students with available facilities as, sounds, videos, and images. These teachers try explaining the information on the blackboard through Darsak platform.

Multiple teams within an integrated workshop ensure that the lessons are error-free. Teacher introduce the lessons to the students by using various teaching aids which help for promoting the educational process. The student chooses his class from the Darsak platform icon. Automatically, the materials that will be taught in the said day will appear – which varies from day to day – for example the student might chooses the mathematics topic. The students watch the videos devoted to this day and its topic, in most cases. The platform enables the students to have access to the material taught in the particular day only for 24 hours, then these materials will be replaced by the materials of the second day.

On the website of the platform, there are instructions for students on how to deal with lessons. Before starting to browse the platform, students should be aware of the most important steps about the Darsak platform for presenting and distributing lessons for all students according to their grades. A thorough instructions were provided by the Jordanian Ministry of Education on the procedures of Lessons and lectures. Furthermore, teaching process is shown on educational Jordanian television channel for primary to secondary school, with all of its branches on the same platform, This TV show makes the students familiar with utilizing this platform. Students can access the website at any time. However, browsing between 6 a.m. to 4 p.m. is free. The student is not charged the cost of surfing the Internet and is not deducted from his balance upon this browsing. Lessons are offered on a daily basis and are renewed daily. Also, the platform shows the current day's schedule to the student and the content of the previous day is removed. The student cannot browse the previous day's program, bearing in mind

that the Ministry of Education and its partners are currently studying the possibility of providing repetition of some lessons on public holidays days which are Friday and Saturday. Darsak platform offers lessons that correspond to the school calendar. During the presentation of the educational content, the teachers try to support explanation with practical examples that help them communicating the idea and concepts to the student.

3 Problem of the study

E-learning plays a vital role in the success of the educational process during the Coronavirus period. Taking into account the great technological development and the spread of modern means of communication such as computers, the Internet, and multimedia such as audio, image, and video, which are the means that allow a large number of students to receive education easily, and timely.

Due to the conditions that the whole world suffers at the present time represented by the spread of the Corona virus, so educational institutions suddenly found themselves forced to switch to distance learning to ensure the continuity of the teaching and learning process, and the use of the Internet, smart phones and computers to communicate remotely with students.

The Darsak platform is one of the Jordanian online educational platforms, which is employed for communication between students and their teachers in Jordanian schools. Therefore, it is vitally important to know and evaluate the effectiveness of e-learning tools, the extent to which it achieves the objectives of education, its ability to encounter the needs of students, and to create an interactive environment that compensate face-to-face learning.

4 Objectives of the study

- The study seeks to reveal the effectiveness of the Darsak platform as an e-learning tool in light of the spread of the Coronavirus from the viewpoint of the students and their teachers in high school in Ma'an, Jordan.
- To know whether Darsak platform has the capacity of appropriateness and Flexibility to indoctrinate the lesson for students from point of view of (students, teachers, and parents).
- To investigate the surrounding facilities which assist the E-learning through Darsak platform from the point of view of (students, teachers, and parents) and its Effectiveness.

5 Questions of the study

The study attempts to answer the following questions:

1. Whether Darsak platform has the capacity of appropriateness and Flexibility to indoctrinate the lessons for students from point of view of (students, teachers, and parents).

2. Are there environment facilities for Darsak platform to perform the role of E-learning from the point of view of (students, parents and teachers) to enable students for tracking their lessons?
3. What is the effectiveness of Darsak platform from the point of view of (students, parents and teachers) for progressing the educational process for students' lessons?

6 Literature review

6.1 E-learning

E-learning is defined as the use of information and communication technology to help students learn better [10]. E-learning, according to [11], is a system's ability to electronically transmit, manage, support, and control learning and learning resources. E-learning platforms and social media applications are very common, allowing users to contact information directly through the internet.

Many benefits of using e-learning such as: it can be covered vast geographic and many places, learner control (in terms of flexibility and suitability), and cost-effectiveness in course of delivery and management. Educational institutions and professional organisations are embracing e-learning by implementing an expanding array of technology-enabled platforms.

6.2 Advantages of e-learning

1. Teacher able to link the numerous resources in numerous varying forms of audio or video.
2. Teacher can use effective way of delivering online courses.
3. Web-based learning promotes active and independent learning.
4. Students can access to the lessons 24x7, they can do revision for their lesson anytime and from anywhere.
5. E-learning allow students to train themselves on a day to day when they have the free time if there is no hard and fast rule.
6. It encourages students to do discussion boards and chats, they will be able to interact with everyone online.

6.3 Disadvantages of e-learning

1. Some online platforms of E-learning make very limited time and date to access the educational materials.
2. Unavailability of the Internet in some countries.
3. It is easy for cheating if there is no moral.
4. The absence of seriousness of some students.

6.4 Previous studies

COVID-19's proliferation poses a threat to humanity, as it has forced numerous global operations, including educational process, to shut down [12]. Despite the obstacles that this fast transition presents, education institutions have been obliged to transition to e-learning using accessible educational platforms to minimize the virus's spread. This study focuses on E-learning from the viewpoints of students, instructors and parents to investigate the adoption and implementation of E-learning system in a public institution during the COVID-19 epidemic through Darsak platform. The research focuses on the information society, which includes students, educators and parents in order know the role of Darsak platform as E-learning process during covid-19 crisis. In the following the researchers focus on the studies that have similarity to current study that E-learning considered as the alternative choice for proceeding educational process during covid-19.

The study in [13] assessed the perception of Saudi parents towards distance education during Covid-19 pandemic. The questionnaire was administered as a random sample of 310 parents of elementary school kids in Riyadh. The study found that distance education in primary schools in Riyadh was a successful experience from the perspective of parents, with an average of (2.93), and a high degree of appreciation, despite a discrepancy in the degree of parents' evaluation of different levels. On the experience of distance training, where their assessment of the experience of distance schooling considering the Corona pestilence at the degree of guardians came in any case, with a normal of (3.54), and with a serious level of appreciation, then, at that point the assessment and the involvement with the degree of understudies came in runner up with a normal of (3.17), with a severe level of appreciation, and the assessment of the involvement with the level of the methods for correspondence and innovation utilized came in the third spot. , with a normal of (3.08), and with a serious level of appreciation, as the assessment of the experience came at the degree of educating and learning, and the educational programs positioned fourth, with a normal of (2.85), and with a high appraising. The experience was evaluated at the instructor level, with an average of (2.49) and an average rating. Finally, an average of (2.48) and an average grade were assigned to the experience at the level of elementary school administration. The study concluded with a set of recommendations based on the findings, the most important point to introduce advice to primary school administrations to increase parental participation in distance education instructional plans. Also, to design a plan to train instructors in distance education.

The study in [14] investigated Pakistani university students' opinions about taking mandatory digital and distance learning courses in the face of the COVID-19. The study's findings revealed that great majority of Pakistani students are unable to use the internet owing to technical and financial barriers, online learning is unable to generate intended results. Other difficulties raised by higher education students included a lack of face-to-face engagement with the instructor, reaction time, and the lack of typical classroom socializing.

The study in [15] aimed to distinguish the basic achievement factors for E-picking up during COVID-19 utilizing the multi-measures Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

strategies to improve the instructive interaction. Information was created by taking 69 E-learning chiefs in instructive organizations during COVID-19 dependent on characterized assessment standards and E-learning approaches through a few channels. The researchers found that innovation the board, support from the executives, expanded understudy attention to utilize E-learning frameworks, and requesting a significant degree of data innovation from educators, understudies, and colleges were the most powerful factors for E-getting the hang of during COVID-19. Among the five learning frameworks, mixed learning was the most appropriate learning framework to rehearse. These outcomes showed that, paying little heed to how uncommon the innovation is in an instructive organization, the status of E-learning execution assumed a huge part in boosting the instructive cycle during the COVID-19 pandemic.

The study in [16] discovered college students' perceptions of their acceptance, use, and receiving of emergency E-learning. The issues investigated were attitude, affect, and enthusiasm; perceived behavioral control (ease of use of technology, self-efficacy, and appropriateness), and cognitive engagement. Quantitative and qualitative data were collected from 270 students. The results present how attitude, stimulus, self-efficacy, and use of technology performance a significant role in the intellectual engagement and academic performance of students. Also, participants preferred face-to-face learning over E- learning. This study offers suggestions on how to increase the acceptance of alternative E- learning.

The study in [17] explored the relationship between school administrators' COVID-19 fear and their work–family conflict, family–work conflict, and overall life satisfaction. A total participation of 356 school administrators took part in this descriptive study, which was constructed using the relational survey approach. The study's data were obtained using online surveys, and the finding showed that Female school administrators had higher levels of COVID-19 phobia than their male according to the findings. Female school administrators, on the other hand, reported much greater levels of life satisfaction than male school administrators.

The study in [2] intended to give conceptual and methodological recommendations for future sustainable research initiatives. Through a bibliometric review of publications on management, leadership, and administration related to COVID-19. The study's data was collected from the web of Science Core Collection (WoSCC) bibliographic database, which was then evaluated using thematic content analysis and bibliometric methodologies. The study's units of analysis include countries, journals, keywords, research models, sample/study group, and time to publication. VOSviewer software and visualization maps were used to report the findings derived from the studied data. When the study's findings are compared to the number of relevant publications and total citations, it's clear that Anglo-American, Chinese, and European supremacy persists in COVID-19-related research.

During the COVID-19 epidemic, the study in [18] explored teachers' perceptions and experiences with their school principal's digital leadership responsibilities and technology skills. The study was done with a study group of 89 Master's degree-holding instructors utilizing a case study-based qualitative technique. In determining the study group, maximum diversity sampling, one of the purposive sampling methods, was selected, and the data produced from the research were evaluated using content analysis. "Digital technology usage, support for the digital transformation, support for technology-based

professional development, support for digital learning culture, and digital leadership abilities" are the five primary themes selected based on the opinions and experiences of the participants. The study found that school principals' digital leadership skills were divided into three groups: technology usage, management skills, and individual talents.

In study [19], the researchers looked for potential roadblocks that Primary and Secondary school instructors encounter when handling Digital Learning Objects (DLOs) and/or Digital Simulation Tools (DSTs) in science classes. The questionnaire was completed by 176 teachers from all throughout Greece. The findings revealed that the technological equipment is the primary barrier to dealing with DLOs and DSTs. Furthermore, due to a lack of proper level B training, around 25% of instructors are unfamiliar with the DSTs, and 30% are unfamiliar with the DLOs. Teachers' attitudes against being engaged with the DLOs and DSTs are negatively affected by factors such as teaching experience, specialty, Pan-Hellenic tests, classes taught, and number of pupils per class. Finally, the unfavorable attitude appears to be connected to a lack of faith in curricular material, since teachers prefer to use the internet to look up DLOs and DSTs. Additional study using varied techniques of analysis might aid in achieving satisfying results.

As it noticed that COVID-19 spread unexpectedly in the world and E-learning introduced into students without previous experiences. So that, the effectiveness and the appropriateness is very little to students. But the students who have experience in digital learning they acquired the lessons and got the benefit of E-learning during COVID-19.

7 Methodology

This study relied on its procedures on the descriptive and analytical approach, which relies on collecting data from the study sample from teachers, students, and parents by using the questionnaire which was already prepared to apply the purpose of current study. Also, to analyze the responses which will be obtained from the participants.

7.1 Data collection tool

Data were gathered by an organized structured questionnaire that was created by scientists and reexamined in accordance with the perspective on five of specialists to give it a last structure. The structure included multiples choices. These inquiries were proposed to know the role of Darsak platform as E-learning during Corona pandemic. At the following stage, the data was gathered online by questionnaire were inquired educators, students, and parents to know their attitude of Darsak platform during Corona virus.

7.2 Sample of the study

The sample of the study was selected from high school in Ma'an, Jordan. The participants were 271 members of the students of high school and their teachers and parents. Whereas the numbers of participants as the following, the parents (108), students (120), and (43) from teachers.

8 Discussion

Table 1. Students' questionnaire

	Students' Questionnaire	Mean	Std.	Level
Appropriateness	1. Darsak platform is an option that relatively covers the curriculum for scientific subjects and mathematics during the Corona pandemic.	2.78	1.08	Neutral
	2. I can pursuit my lessons one by one through Darsak platform.	2.81	1.11	Neutral
	3. Teacher enriches the scientific and mathematics lessons with sufficient explanation and examples to convey the scientific material in a way that apply students' needful.	2.88	1.06	Neutral
	Total	**2.82**	**.924**	**Neutral**
Flexibility	4. Darsak platform allow teacher to convey mathematics and science subjects with Flexibility for all experiment fields.	2.86	1.14	Neutral
	5. During online sessions, teachers give appropriate breaks so that students have time to think about the topic and formulate questions as doubts.	2.53	1.02	Disagree
	Total	**2.69**	**.927**	**Neutral**
Facilities	6. I have sufficient computer knowledge and IT skills to learn lessons and lectures online so, it is easy to deal with the lessons of Darsak platform.	2.91	1.08	Neutral
	7. My parents provide me with educational aids which support me to manage with the services of Darsak platform.	3.01	1.11	Neutral
	Total	**2.96**	**.875**	**Neutral**
Effectiveness	8. Through Darsak platform teachers attach videos and photos in order to deliver the scientific through material during their lessons.	2.83	1.15	Neutral
	9. The home environment is suitable for conducting online lectures through the Darsak platform.	2.75	1.05	Neutral
	10. Darsak platform conveying the main content of the subject to make students sufficient of the main purpose of the lessons.	2.88	1.08	Neutral
	Total	**2.820**	**.9339**	**Neutral**

In the following steps, the researchers discussed in detail the responses obtained from students' questionnaire.

Table 1 shows that E-learning performance in Ma'an City in Jordan was not accepted from view of point of students. The findings of the students of E-learning through Darsak are discussed in the details in the following.

The first question (1) of Table 1 was focused on the inclusive idea of students' question whether the Darsak platform good tool to teach all the scientific and mathematic lessons. The mean is (2.78) with standard deviation (1.084) and the level is neutral. The results of this question considered the platform to be officinal channel as mediator between students and their teachers during Corona pandemic to support educational process. Due to insufficient of its performance in introducing the lessons to students.

The second question of Table 1 of appropriateness section that asked students whether they can pursuit the lessons or not. The mean is (2.81) and the standard

deviation is (1.113) with the level of responses were neutral. It inducted to hesitation of the students that they sometime can pursuit their lesson and sometimes they cannot due to their circumstances.

The last question (3) of appropriateness section of Table 1, which is considered more specific question. It focused on the method that students received their lesson through Darsak platform. The mean is (2.88) and standard deviation (1.066) which means that the level of the responses was also Neutral. Which refers to Darsak platform may be not good tool to convey the lessons for students with step which has possibility to apply students' equipment of the lessons.

In the next section which it related to the flexibility of "E-learning through Darsak platform". The first question (4) of Table 1, the question focused on transfer the material of all subjects of high school through Darsak platform, on how the flexibility of the platform lessons for students. The mean is (2.86) with standard deviation (1.142) and the level of the response is neutral that refers to multi probability of the students to Darsak platform. The students may be new for the situation so that they may not be accepted the lessons. So that the researcher's emphasis that with the second question which focused on the communication between students and teachers through Darsak platform which it may be create feedback and evaluate the performance of education process through platform.

In the next, question (5) of Table 1, the question indicates to the procedure of education process which access by Darsak platform. The mean is (2.53) and the standard deviation is (1.025) and the level of response is disagreed, which means that there are no flexibilities of E-learning through Darsak platform. The researchers asked the students to know the environment facilities that it supposed to be available to help E-learning process through Darsak platform during Corona virus pandemic. The researchers obtained the following findings, the predictable question to know the facilities which supposed to be for students from parents and government to enhance their education process. So that the students asked if they have knowledge how to deal with new technology which enable them to receive their lessons.

In the following question (6) of Table 1, the researchers delivered question to students to know their ability of an opulent of electronic devices which enable them to communicate with Darsak platform. The mean is (2.86) and the standard deviation is (1.142) with the level Neutral. From this point that the finding refers to probability case, students maybe haven't facilities tools as computers, laptop, and TV, and may they have, but it is not sufficient to pursuit their lessons.

The next question (7) of Table 1 emphasized on the responses of the first question that some students have modern technology and some of the students haven't to enable them to receive their lessons. The question is considered as conformation for the facilities which parents facilitate educational process for their children. The means is (3.01) with standard deviation (1.114) and level of the response is Neutral. As the researchers discussed that the majority of the students' responses with neutral which refers to many probabilities as discussed above.

In the following point it focuses on the effectiveness of E-learning through Darsak platform. The result of the first question (8) of Table 1 indicated that E-learning through Darsak Platform hasn't effectiveness from students' perspective. That teacher may not be attaching videos and photos to Darsak platform to make the lesson more effective and attractive. The mean is (2.83) and the standard deviation is (1.150) which refers to

level of the responses Neutral of students answer. Here are some of explanation that students' probability hasn't effectiveness of E-learning through Darsak platform.

Then the students asked whether they have a suitable tool to enhance the education through E-learning, the responses of question (9) of Table 1 were in the side of Neutral with mean (2.75) with standard deviation (1.059). It inducted that their home may be not encourage E-learning due to lack of electronic devices for students' lessons so that the responses were in the neutral level.

The last question, (10) of Table 1, this question considered as emphasis question to the pervious questions that E-learning through Darsak platform is not good tool for effective learning for students to study during pandemic of Corona virus. The mean is (2.88) with standard deviation (1.085) that refer to the level of neutral. Which emphasis the case of probability. That students in the case of hesitation neither they conform of the effectiveness, nor they answered with disagree. So, it can say there is no effectiveness of E-learning through Darsak platform.

Looking at Table 1, it can be observed that when Darsak platform comes to be a tool for online classes, students noticed the online classes lack quality. Things such as technological difficulties through Darsak platform, lack of appropriateness of the E-learning, disturbance some notable variables lowering the efficiency of E-learning classrooms included disruptions in class flow, difficulties in explaining doubts, a lack of enthusiasm, and motivation on perform with sessions. Despite the fact that today's generation is technologically advanced, the majority of the respondents of the students stated that their lack of computer skills made it difficult for them to access the internet.

9 Discussion with details

Table 2. Parents' questionnaire

	Parents' Questionnaire	Mean	Std.	Level
Flexibility	1. There is no difficulty in direct communication between teachers and students (where ideas and opinions can be exchanged through personal confrontation through Darsak platform.	2.48	1.351	Disagree
	2. Teachers have sufficient skills to design and produce effective electronic content that is suitable for using computers and the Internet. Teachers have sufficient experience and skills.	2.22	.927	Disagree
	Total	**2.35**	**.738**	**Disagree**
Appropriateness	3. Teaching through Darsak platform during Corona pandemic fills the gap of traditional teaching provide in schools.	2.28	1.089	Disagree
	4. Parents express their satisfaction with the side of Darsak platform to teach the lessons so that male and Female students do not stumble in the educational stages.	2.07	1.215	Disagree
	5. Parents feel comfortable as a result of the teachers' Performance through Darsak platform.	2.79	1.479	Neutral
	6. The performance of teachers through Darsak platform attracts the attention of students, which helps them in improving the educational process to apply the needs of students.	1.96	1.224	Disagree
	Total	**2.28**	**.995**	**Disagree**

(Continued)

Table 2. Parents' questionnaire *(Continued)*

	Parents' Questionnaire	Mean	Std.	Level
Effectiveness	7. Teaching through Darsak platform is relatively equivalent to traditional teaching in terms of covering lessons in science and mathematics subjects.	2.30	1.084	Disagree
	8. The e-learning system is compatible with the type of subjects, both theoretical and practical.	2.35	1.100	Disagree
	Total	**2.33**	**.783**	**Disagree**
Facilities	9. Parents of students can provide educational requirements through Darsak platform for all their children in secondary school.	2.28	1.089	Disagree
	10. The education at home has sufficient time so that the educational facilities at home is available and I am satisfied with Darsak platform and its performance for my children.	1.92	1.180	Disagree
	Total	**1.97**	**1.068**	**1.068**

In the following steps the researchers discuss in detail the responses as shown in Table 2 which obtained from the point view of the parents for the role of Darsak platform in enhancing students' education as E-learning. First section discusses about flexibility of Darsak platform in E-learning lessons for high school in Ma'an city, Jordan. The researchers wanted to conform about the performance of Darsak platform from parent's point of view so that, the researchers asked the following questions.

Question (1) of Table 2, teachers' performance on the Darsak platform is flexible and draws students' attention, assisting them in refining the educational process and tailoring it to students' requirements. It discussed about the performance and the flexibility items so that the obtained findings of arithmetic mean is (1.96) with standard deviation (1.224) and the level of responses were disagreed. Which means that parents not satisfied with the performance of E-learning through Darsak platform. The researchers wanted to measure up the Darsak platform work, hence, asked whether the Darsak platform allowed students to access it anytime, so they are willing to enhance their information.

Question (2) of Table 2, students can access educational materials at any time via the Darsak platform system. The arithmetic mean is (2.35) and the standard deviation is (1.100) with the. level of findings disagrees for the question from all the responses which refers to, that parents emphasized that the access of platform may not allow students to access with sufficient time to pursuit their lessons.

The next section has four questions to know whether E-learning through Darsak platform is appropriate or not; the obtained findings as following.

In the question (3) of Table 2, the researchers related to the situation which made the education to switch from traditional education to E-leaning and the performance of Darsak platform. So that the question enquires about teaching through Darsak platform, whether E-learning equity to the traditional education or even it compensates the traditional education.

Question (4) of Table 2 during the Corona pandemic, teaching via the Darsak platform hits the spot caused of closed traditional schooling. The mean is (2.28) with standard deviation (1.089) and the level of obtain responses were disagree. The point of

view of the parents that E-learning is not being suitable or proper in the circumstances of COVID-19. So that, the researchers asked another question to get more explanation of the parents whether they are satisfied with the performance of Darsak platform.

Question (5) of Table 2 parents express their gratitude for Darsak's role in teaching the lessons, indicating that their children have not stumbled along the educational phases. Hence, the mean is (2.07) and the standard deviation of the responses were (1.215) with the level of the response was disagree with the performance of Darsak platform. They noticed that E-learning is not doing well for their children so that the responses with disagree of the performance of Darsak platform for convey the education as traditional education.

In the next question (6) of Table 2 the researchers asked the parents if they are comfortable with the result of E-learning through Darsak platform, the mean is (2.79) with standard deviation (1.479) and the level of responses were neutral. That refers to probability or eventuality of outcome of the E-learning through Darsak platform. The teachers' output on the Darsak platform has made parents happy and satisfied. The parent did not give clear responses for the outcome of the Darsak platform. They may expected to improve Darsak platform itself or they may noticed that it is as continues process may it give students little compensate of knowledge instated of nothing. The last question is considered as emphasize question to make the appropriateness clear whether the parents are appropriate or not with Darsak platform performance.

Question (7) of Table 2 to conform whether the parent notice that Darsak platform is well to be act during the pandemic period. The mean is (2.48) with standard deviation (1.351) and the level of parents' responses were disagree.It means that the parent don't satisfy with Darsak platform. They may notice it is not qualified for transmission the mathematic and scientific subject for their children.

The next section discusses about the effectiveness of Darsak platform as E-learning for students from the parents' perspective. Question (8) of Table 2 deliberate about the opinion of parents for teachers' skills when they deliver the lesson through Darsak platform. The mean is (2.30) and the standard deviation is (1.084) with the level of parents' responses were disagree. They noticed that teachers may not produce a sufficient skill of the teaching during delivering the lessons.

The last section discusses about the facilities which parents produce for their children to help them in their education. Question (9) of Table 2 focused on the facilities which available at home and parents' stratification, so the mean is (2.28) and the standard deviation is (1.089) with the level of responses of the parent as mentioned in arithmetic mean were disagree of performance of Darsak platform. The reason of rejection of ideas of E-learning it can be due to inability of parents to provide their children the E-learning tools. It also may they have tools, but it may be not sufficient for all children to learn in on times.

The researchers asked the parent with question (10) of Table 2 which refers to the point whether they provide their children with all tools which may be required in E-learning education. But the obtained result of requirements question is unexpected, they all responded with disagree, so that the arithmetic mean is (1.92) and the standard deviation is (1.180) which refers to disagree level of their ability to provide their children with E-learning equipments.

Table 3 illustrates the teachers' questionnaire. The first section of the teachers' questionnaire deliberates about the flexibility of E-learning through Darsak platform. Here are some questions which the researchers directed it to teachers to know their perspective of flexibility of Darsak platform.

The first question (1) of Table 3 discusses the process of the educational material delivery through Darsak platform, whether the teachers deliver the lessons easily or they face difficulties during the lesson's delivery with their educational materials. The mean is (2.57) and the standard deviation is (1.085) with disagree level of responses. From this point the researchers noticed that teachers have difficulties during delivering their lessons through Darsak platform. So, it is better for the executive director of Darsak to make evaluation for the problems and the difficulties which the teachers' face and try to solve them.

Table 3. Teachers' questionnaire

	Teachers' Questionnaire	Mean	Std.	Level
Flexibility	1. Through Darsak platform, the educational material is attached to the students easily.	2.57	1.085	Disagree
	2. The educational content includes exercises, activities and assignment that help to deliver the scientific material.	2.86	1.138	Neutral
	3. The student can ask any questions and inquiries through Darsak platform.	2.48	1.131	Disagree
	Total	**2.63**	**.987**	**Neutral**
Facilities	4. The speed of the internet is suitable, and I can give any lessons without any interruption.	2.64	1.226	Neutral
	5. There is no difficulty in direct communication between teachers and students (where ideas and opinions can be exchanged through personal confrontation through Darsak platform).	2.55	1.173	Disagree
	6. Darsak platform system allows the teacher and students to access the educational material at any time.	3.33	1.119	Neutral
	Total	**2.84**	**.929**	**Neutral**
Appropriateness	7. Training courses were held, and teachers prepared during the Corona crisis for of using e-learning technique through Darsak platform.	2.60	.964	Disagree
	8. Through Darsak platform, transfer the scientific material adequately in science and mathematics subjects.	2.50	1.065	Disagree
	Total	**2.55**	**.903**	**Disagree**
Effectiveness	9. Teaching through Darsak platform is very effectiveness and teachers overcome on problems that face them during preparing video lectures.	2.98	1.024	Neutral
	10. E-learning during Corona pandemic is more effective in terms of using time than traditional education.	2.67	1.119	Disagree
	Total	**2.82**	**.909**	**Neutral**

The next question (2) of Table 3 asked the teachers about the curriculum itself and the ability to deliver it with activities to motivate the students. The responses were neutral with the mean (2.86) and the standard deviation (1.138) which refers to probability of the ability of the curriculum to solve students' problem. But the main obstacle which fit may be face students with Darsak platform during delivering the lessons to students.

Question (3) of Table 3 discusses about the communication channel between teachers and students through Darsak platform. The mean is (2.48) and the standard deviation is (1.131) with the level of responses were disagree. The Darsak platform should has an icon to allow student to communicate with their teachers during the lessons.

The next section deliberates about the facilities which the teachers should be faced to help them to deliver their lesson.

Question (4) of Table 3 the researchers enquire whether the teachers can deliver their lessons without any interruption form the side of network. The question dedicated on the speed of internet which it is the best method to deliver E-learning process. The mean is (2.64) with standard deviation (1.226) and the level of responses were tended to neutral. It has the probability case. It may be the problem from the Network side.

In the next question (5) of Table 3 determined on the communication during the lessons between students and their teachers. It also focused on the ability of the students for exchange the ideas and ambiguous questions. The mean is (2.55) and the standard deviation is (1.173) with disagree level of teachers responses that there is no communication, no discussion between students and their teachers during the lessons.

The last question (6) of Table 3 focuses on the Darsak website itself whether it has option to help the students and the teachers to access to the materials of lessons at any time. It is good option for students to make revision at any time for their lessons. The mean is (3.33) with standard deviation (1.119) and the level of responses were neutral. It is probability answer, it may be available option, but it may have not sufficient time to access the materials to do the revision. It refers to that students have limited time to access the lessons. It may not be sufficient for students to do revision for their lesson and they prefer if they have sufficient time.

The next section discusses about Darsak platform appropriateness from teachers' perspective. The first question asked to know teachers' satisfaction for their work through Darsak platform.

Question (7) of Table 3 deliberate about teachers' preparation for delivering the lessons before they started the lesson on the Darsak Platform. The mean is (2.60) and the standard deviation is (.964) with level teachers' responses is disagree. It means that teachers didn't receive lessons' training well before they stated the lesson on Darsak platform. It may refer to spread of COVID-19 suddenly with unexpected time.

In the question (8) of Table 3 refers to more explanation and more conformation of teachers' satisfying with transform the sciences and mathematic subject through Darsak platform. The mean is (2.50) and the standard deviation is (1.065). It refers to the level of teachers' responses is disagreed.

The last section of teachers' questionnaire discusses about E-learning effectiveness through Darsak platform. It consists of two questions as follows:

Question (9) of Table 3 asked about the effectiveness of Darsak platform and whether the teacher overcome on the challenges which may it face them during delivering the lessons through the platform. The mean is (2.98) and standard deviation is (1.024)

which refers to neutral of level of teachers' responses. This point refers to the probability responses which it may refers to the possibility to improve E-learning through Darsak platform to be more effectives. It also may be referring to actual case which it means there may be some actual effectiveness of Darsak platform.

The last question (10) of Table 3 which discusses about the effectiveness of E-leaning during corona virus pandemic with the comparative with traditional learning. It is direct question whether E-learning is effective for students' performance. The arithmetic mean is (2.67) and the standard deviation is (1.119) with level of teachers' responses is disagree for the effectiveness of E-learning during Corona virus.

10 Findings

The findings of the study were discussed in the following Questions:

1. Whether Darsak platform has the capacity of appropriateness.
2. Flexibility to indoctrinate the lesson for students from point of view of (students, teachers, and parents). This question has two parts: the appropriateness and the flexibility of "E-learning through Darsak platform".
3. Are there environment facilities for Darsak platform to perform the role of E-learning from the point of view of (students, parents, and teachers)?
4. What is the effectiveness of Darsak platform from the point of view of (students, parents, and teachers)?

The result in Table 1 showed that the mean of the appropriateness of E-learning through Darsak platform during spread of the Corona virus from the point of view of the students, the mean was (2.82) with a standard deviation of (.924) with a medium degree which refers to Neutral. The mean of the appropriateness of E-Learning through the Darsak platform is (2.55) with standard deviation (.903) and the Disagree level of the teachers' responses. The results which obtained from parents from the side of the appropriateness of the E-learning through Darsak platform, the arithmetic mean is (2.28) with standard deviation is (.995) and the level of responses is disagree. The findings show that students, teachers and parents in Ma'an city in Jordan consider Darsak platform to be inappropriate as E-leaning during coronavirus. From teachers view of point, Darsak platform was not able to help them to transfer the scientific material adequately in science and mathematics subjects. It indicated to the lack of preparation for teachers to be familiar with Darsak platform work. Teachers tried to do extremely effort, but they couldn't fill up the gap which created in students lesson due to the absence of traditional mode of education [20]. The following is the order of importance: school policy support for E-learning instruction, network speed and stability, course selection for online instruction, online technical service support, teachers' teaching training and equipment support. The findings of the current study from the point view of students, teachers and parents indicated that Darsak platform performance not appropriate, although, it is the only E-learning possibility to deliver lessons instead of face-to-face lectures. In the high school for example, teachers would not be able to convert all their school curricula into an online resource abruptly. They faced many

problems, for E-learning teaching such as distance, scalability, and personalized teaching and learning. Institutional measures can only support the students in combating this pandemic [21]. So that the performance was not acceptable to the society due to that they may be not crackling with new style of education [22]. It also indicated on the lack of electronic facilities which enable teachers to deliver their lessons smoothly.

The flexibility of E-learning through Darsak platform were reached (2.69) with a standard deviation of (.927) with disagree level of the student's opinion. The mean of flexibility of E-learning through Darsak platform from point of view of teachers is (2.84) with standard deviation (.929) and the level is neutral. The mean for the flexibility of E-learning through Darsak platform from point of view of the parents is (2.35) with standard deviation (.738) with the level is disagree of the parents for the flexibility of Darsak platform. The combination of the mean and standard deviation of flexible side of E-learning through Darsak indicated that all participated were not accepted the idea that Darsak platform have flexibility in its performance. There wasn't flexibility between channel of education and the teachers who deliver the lessons to students regarding of receiving and answering questions. In the other hand the second questions discuss the facilities and the effectiveness of E-learning through Darsak Platform which may be assist students in their educational process. Although some studies refer to satisfaction outcomes from the worth of E-teaching and learning in online environments [23], opposite of the previous studies that supported the time factor as a critical component in online teaching and learning, as well as the fact that flexible study time and the utilization of numerous sources of media to supplement instruction influenced students' online learning. The current study examines Darsak platform which it came with unexpected time with COVID-19 so that, there weren't flexibility in E-learning process through Darsak platform.

Regarding the question related to environment facilities, the findings showed that mean of the facilities which supposed to be available to encourage high school students' in Ma'an city, Jordon, the mean is (2.96) and standard deviation is (.875) with the score of students' opinion Neutral. The mean is (2.84) with standard deviation (.929) and the degree is neutral from point of view of parents. The mean for the facilities which supposed to be tools for enhancement the E-learning is (1.97) with standard deviation (1.068) and the level of the responses is disagree from the point of view of teachers. The findings showed that there were not facilities for students' E-learning through Darsak platform amongst students from the point view of students, teachers and parents. The innovative and flexible operations of Darsak platform insufficient for students' lessons. Regrettably, it appears that most responses have not been acceptable of E-learning Darsak platform performance. Many factors might be responsible for these in the Ma'an city, Jordan such as student population, training of lecturers and students, sustainable internet facilities and electronic devices which facilitate students' E-learning [24]. Theses facilitate may help students of indoctrinate the lessons instead of traditional mode.

Regarding the mean of effectiveness of E- learning for students through Darsak platform is (2.8209) and the standard deviations is (.93397) with level of score Neutral, also, according to the finding which obtained from the teachers approximately same to the students results. In addition, from the point of view of parents, the arithmetic mean of the effectiveness of E-learning through Darsak platform is (2.33) and standard

deviation is (.783) with disagree level of the effectiveness of Darsak platform for the lessons which their children gaining from the Darsak platform. It should not only focus on the benefits of using E-learning during times of crisis, but also on how to build up and develop the quality of virtual courses offered in such situations. in the last section of the effectiveness of E-learning through Darsak platform indicated that all of responses (students, teachers, and parents) were not agree with the effectiveness of E-learning through Darsak platform. It means that the role of E-learning through Darsak platform was not sufficient to inordinate students 'lessons during COVID-19 pandemic.

11 Suggestions and recommendations

The researchers introduce many recommendations for students, teachers, and parents and the responsible of Darsak platform to get little of tangible improvment of E-learning during the emergency's cases. Students should be aware and serious towards their lessons, also follow their teachers' lessons assignment. Students must study seriously as if they are in the face-to-face classes. The researchers recommend that teachers must prepare the lessons and provide them with more explanation to attract students' attentions. Parents should provide their children with electronic devices to enable them to have an easy access to the lessons.

12 Conclusion

COVID-19 crisis has affected many countries and forced it to close schools, colleges, and universities to stop the extent of the corona virus. Due to the long-lasting negative significances of all school closings would have on educational skill growth, many educational systems moved rapidly toward E-learning on an exceptional scale. Darsak platform was used as channel to compensate students lesson in Jordan. The researchers used Ma'an city as sample to investigate of role of Darsak platform as E-learning for students to proceeding educational process. The researchers collected data and analyzed it using SPSS and conclude to certain results. The findings showed that Darsak platform has not good impact among students from the point of view of parents, teachers, and students. Their response fell under neutral or disagree categories with most of questions which refers to appropriateness. The findings indicate that the students, teachers, and parents in Ma'an city perceive Darsak platform is improper for E-leaning during coronavirus. Darsak platform was not able to assist teachers in effectively transferring scientific content in science and math disciplines, according to teachers. It pointed to a lack of teacher training in terms of understanding how the Darsak platform operates.

Regarding flexibility and facilities from the perspective of students, teachers, and parents, the findings revealed that there were no facilities for students to study using the Darsak platform. The Darsak platform's creative and adaptable operations are insufficient for students' learning. Regrettably, it appears that the majority of replies were unsatisfactory in terms of the E-learning Darsak platform's performance.

In the concluding section of the effictiveness of E-learning through Darsak platform, all of the respondents (students, instructors, and parents) showed that the effectiveness of E-learning through Darsak platform was not agreed upon. It suggests that E-learning via the Darsak platform was insufficient to provide students' lessons during the COVID-19 epidemic.

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An Analysis of Elderly Use of Digital Technology in Thailand

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Abstract—The number of older people worldwide aged 60 years and over has increased. The continuous change in population structure has become a concerning global issue. Thailand is one of the countries that face the problem. The number of older people is higher than the number of children under 15 years old. This changing situation requires preparing the elderly to live to their fullest potential. The elderly population is on the rise globally. It's an age group that should live to their fullest potential to enhance the quality of their life, and they should be prepared to live life in a way that benefits them, their family, and society. The elderly should be able to access digital technology and benefit from it. Therefore, it is necessary to educate the elderly to choose the right digital technology for their quality of life and to protect themselves from cyber threats. This study performs an exploratory factor analysis of digital technology competency—a multistage random sampling method was used to obtain a sample of 225 older people in Thailand. The tool used was a questionnaire on digital technology competency, which included 45 questions on a 5-point scale. Data were analysed using descriptive statistics and exploratory factor analysis using the varimax rotation method. The exploratory factor analysis of digital technology competency for the elderly in Thailand found six essential components: 1) use of mobile operating systems, 2) data file management, 3) cloud data management, 4) use of support applications, 5) use of communication applications, and 6) use of technology for security. Thus, the elderly needs to develop online media literacy to safely navigate the internet while creatively using data found in the virtual domain.

Keywords—elderly, career preference, digitalization, digital technology, digital skill

1 Introduction

Technology can benefit the elderly by helping them make full use of their free time, improving their self-esteem, and reducing their dependency on others [1] [2]. The elderly population is on the rise globally. With advancements in medicine and public healthcare, humans are becoming healthier and living longer lives. This change in the demographic structure, leading to an aging society, has brought about specific

challenges that must be addressed [3] [4]. Agencies involved in improving the quality of life of the elderly in Thailand should prepare the elderly to live life to the fullest in a way that benefits them, their family, and society. Thailand, for instance, needs to cope with various challenges to improve the quality of life of the elderly. Technological advancements have forced people to adapt, or they will be left behind in this rapidly evolving era. Learning to use digital technology is essential for the elderly: It can help the elderly find information on health care, which can aid self-care. It can facilitate enjoyment, make them happy, and improve mental health. Increased social engagement helps the elderly to be aware of movements in society. The elderly can use digital technology to communicate with family members and thereby get closer to and bond with their families. Knowledge of digital technology can also help the elderly find jobs and earn income, reducing their financial dependency on their families. All these factors/aspects of digital technology can help make the elderly feel more valuable [5] [6]. Assisting the elderly in understanding and accepting the benefits of using digital technology will help improve their quality of life [7] [1]. Although the number of information users who are elderly is increasing, this group accesses and uses less technology than other groups. Technology adoption depends on different factors [8] [9]. The study found that only a small group of older people have computer use activities. The study of [10] [11] found that the elderly had limited access to online resources even though the technology is essential for finding information for health-related decisions and healthcare options. Adaptation of modern technology is a significant problem for the elderly in Thailand. Only a small number of the elderly are starting to adapt to technology. Many older people are still not interested in technology. This reason may be because the elderly was born and raised before modern technology. Humans gradually develop technology skills through learning experience. However, because technology is advancing rapidly, most of the elderly cannot keep up with the changes. As a result, this has caused concerns about accessing information technology for the elderly.

To this end, this research analyzed the use of digital technology by exploratory factor analysis (EFA) to identify factors that affect the elderly population's ability to use digital technology in Thailand. The researchers used the result to analyze digital technology skills for the elderly in Thailand to appropriately develop the elderly's skills to use various technologies in their lives. As a result, the elderly will be able to use technology creatively to create new opportunities for learning to take care of themselves. Furthermore, it will enable the elderly to access information and encourage them to use their free time to create benefits, build self-esteem, and reduce dependence on other people under the context of the need for the elderly to adapt to the Next to Normal era.

2 Review of the literature

An aging society has resulted in a reduction of the working population. Without adequate preparation for this shrinkage in the workforce, there will be a substantial negative impact on economic and social security. Helping the elderly develop desirable skills for the future, especially the ability to use digital technology, will encourage them to engage in lifelong learning to reskill and upskill in the workforce [12]. In addition, the COVID-19 pandemic is an emerging disease that spreads rapidly with severe

impacts around the world. The elderly is one of the socially vulnerable groups affected by this pandemic. In addition, people's lifestyles and behaviors have changed. Travel restrictions, lockdowns, and social distancing affect almost every person's daily life, causing increased stress and anxiety.

This rapid change has made the elderly turn to online activities and spend more time online. They use more technology as communication tools. The elderly needs to change their behavior and use technology to reduce the impact of the pandemic, reduce stress and make good use of free time [13] [14]. They also need to use technology to search for information, especially healthcare-related topics [15] [16]. Their use of digital technology may also be due to the social influence of family and friends. An enabling environment, good infrastructure, and using digital technology can bring more comfort into the life of the elderly [17] [18]. The researcher also found the effects of digital technology use by the elderly to help foster family interactions and friends. It also helps them find up-to-date information [19] [20]. However, the elderly does have some concerns about the use of digital technology, including physical pain from using computers for an extended time, fear of technological complexity [21] [22], and a general lack of experience because they do not possess their own smartphones or tablets [23].

3 Research methodology

3.1 Design

The researcher uses exploratory factor analysis (EFA) to identify factors that affect the elderly population's ability to use digital technology from the study of concept papers and related research.

3.2 Research sample

The research sample comprised 225 older people in Thailand using multistage random sampling. We first conducted random cluster sampling, with the northern, central, northeastern, and southern regions as arbitrary units. We then applied simple random sampling to select provinces in each area. We used factor analysis, an extensive sample size method, to determine the appropriate sample size [21] have proposed that the sample size for composition analysis should be five units per variable. In this study, there were 45 variables; therefore, a minimum sample size of 225 was determined. The researcher collected the samples from areas frequented by many older people, such as older persons at home, local communities, a center for quality-of-life development, nursing homes, and elderly clubs.

3.3 Research instruments

The researcher used an online questionnaire to solicit the opinions of the elderly on the different components of digital technology competency and divided it into two parts: The first inquired after the respondent's general information and the details of digital technology competency obtained from the study of related concepts and theories.

The second part of the questionnaire was a 5-level scale ranging from lowest (1) to highest (5), consisting of 45 items. Five experts examined content validity. The value was between .80–1.00. The questionnaire was tested on 30 older people (not part of the sample) to check its reliability using Cronbach's alpha coefficient formula. The value obtained was .987.

3.4 Data analysis

The researcher analyzed the data by exploratory factor analysis using the varimax rotation method after selecting components with an eigen value greater than .50.

4 Research findings

Our exploratory factor analysis results on the digital technology competency of the elderly, considering an eigen value of 1.00 or higher that is the sum of squares of the coefficients of each component, identified 12 significant components. The variance of these 12 components accounted for 77.42% of the total variance. Orthogonal rotation analysis was performed using the varimax method to clarify the variables related to the components, as shown in Figure 1.

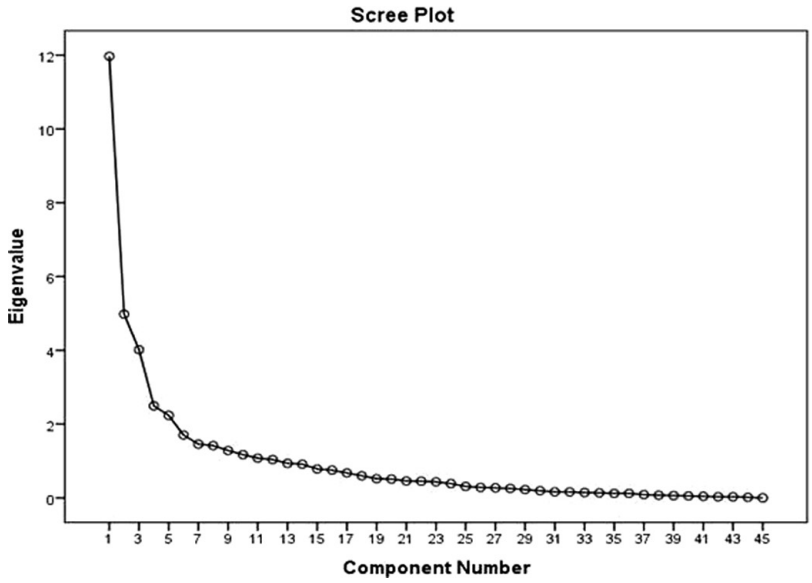

Fig. 1. Variables related to the components

Of the 45 components, 12 components had factor loadings greater than .50. The prominent components must have at least three variables to be considered components.

Six components passed this criterion with factor loadings greater than .50. The factor loadings after orthogonal rotation using the varimax method are shown in Table 1.

Table 1. Factor loading

Factor Name	Eigen Value	% of Variance	Variable	Factor Loading
Use of mobile operating systems	11.97	26.61	Able to store data in their mobile phone.	.921
			Able to delete applications and files on a mobile phone.	.856
			Can connect to the internet using a mobile phone.	.848
			Able to set security settings on a mobile phone.	.779
			Able to set notifications.	.735
			Able to download and install applications on a mobile phone.	.685
			Able to adjust display font size on a mobile phone.	.634
Data file management	4.98	11.06	Able to move a file into a designated area.	.846
			Able to rename a file on mobile.	.817
			Able to categorize data management properly.	.781
			Able to manage files on a mobile phone correctly and adequately.	.638
			Able to share data files to other applications or others safely.	.625
Cloud data management	4.02	8.92	Able to share files or information with others through the cloud correctly and securely.	.895
			Able to manage files on the cloud correctly and securely.	.888
			Able to manage data privacy in the cloud correctly and securely.	.885
			Able to subscribe to cloud services for data storage.	.775
Use of support applications	2.49	5.54	Able to create video clips on purpose.	.775
			Able to design graphics or illustrations for a specific purpose.	.741
			Able to use the application to calculate answers as needed.	.739
			Able to use the calendar to schedule necessary appointments and set notifications.	.591
			Able to use digital media properly for a specific purpose without infringing copyright laws.	.579

(Continued)

Table 1. Factor loading *(Continued)*

Factor Name	Eigen Value	% of Variance	Variable	Factor Loading
Use of applications for communication	2.24	4.97	Able to use electronic banking systems correctly and securely.	.910
			Able to register an application to receive privileges from the public and private sectors correctly and securely.	.894
			Able to store contact information, phone numbers, etc.	.727
			Able to use Line application securely and adequately.	.575
Use of technology for security	1.70	3.79	Able to bookmark a webpage of interest.	.736
			Able to manage the display window of a website properly and securely.	.655
			Able to screen information securely.	.620
			Able to use email to communicate and register with other applications correctly and safely.	.519

5 Discussion and conclusion

An aging society in the digital age is a challenge, given the continuous lifestyle changes and technology. From the analysis of these six components, we found the critical components of useful digital technology include smartphones, applications, cloud systems, electronic transactions, and searching for information, which has changed the lifestyle of the elderly. The people closest to the elderly (friends and family) are a driving force behind their acceptance of technology. However, the study of [24] found that smartphones that were complicated to use may cause the elderly to have difficulty using the device. As shown in the research, knowledge of equipment and functionality helped the elderly be self-reliant. If the elderly has developed a higher understanding of usage, they will use and benefit from the device more. This is consistent with research by [25] [26], who provided technology skills training for the elderly. Our study, similarly, found that our sample of elderly folk was knowledgeable and optimistic about technology. They view technology as valuable and necessary for them to keep up with changes in the world by providing access to news, health issues, and national events. Therefore, technology has become an integral part of their lives. According to [27] [28], the elderly had access to communication technology via the internet to conveniently communicate with family members. Although the technology is complex, it is a channel that allows the elderly and their family members to share and experience a new form of family bonding. Nearly half of the active older people use social networks almost every day. In addition, [29] [30] claimed that technology is essential for the elderly to gain online media literacy, keep themselves safe while using the internet and creatively access data in the virtual world. They were preparing to live life to the fullest in a way that benefits them, their family, and society. This research can lead to the development of knowledge

and skills for the elderly to use technology creatively to create confidence and take full advantage of technology.

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A Novel Approach to Support Scalable Multicast Routing in Wireless Ad Hoc Networks

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Abstract—Nowadays, group communications over Mobile Ad hoc Networks (MANETs) have received significant attention. Multicasting plays an important role in simultaneous delivery of information to group of receivers. Thus, it is necessary to design efficient and effective multicast routing protocol to support group communication applications. Several efforts have been put to improve multicast routing. However, they do not consider scalability issue. This paper introduces a a novel Scalable Geographic Multicast Routing Protocol (SGMRP). The main objective of this protocol is to design a lightweight scalable multicast routing scheme irrespective of the number of multicast members and network size. To achieve this, a virtual clustering strategy has been introduced. This strategy based on partitioning the network into sectorial zones. The proposed solution performs efficient packet forwarding with reduced communication overhead. The proposed scheme eliminates the duplicate packets between clusters and reduces the number of participating nodes.

Keywords—mobile Ad hoc networks, multicast routing, scalable, location-based routing, GPS

1 Introduction

Recently, the advances in portable computing and wireless technologies are opening up exciting possibilities for the future of wireless mobile networking. This rapid penetration has stimulated a change in the expectations of wireless users. MANETs have evolved a great deal over the past two decades and considered as one of the most important and essential technologies to support future pervasive computing scenarios [1, 2].

Mobile Ad hoc Network (MANET) is a multi-hop autonomous network composed of self-organized mobile nodes connected through a wireless link without any network infrastructure. MANETs have gained significant interest and popularity since they have enormous potential in several fields of applications. Over the past few years, the necessity of applications where many users have to interact in a close manner over MANETs gains high popularity [3]. Multicast communication is essential in such type of applications to reduce the overhead of group communication [4].

Multicast routing has many benefits. It is more efficient as it builds a multicast delivery infrastructure, which allows the multicast source to transmit only one copy of the

information and the intermediate nodes will duplicate the information when needed. Only nodes that are part of the targeted group will receive the information. So multicasting plays an important role in MANETs [5].

With the continuing revolution in wireless communications and decreasing cost of wireless hardware, a mobile device became able to obtain its location information [6]. Awareness of position information has been utilized to improve network scalability and efficiency through restricting the broadcast region of routing packets. As a result, location-based routing has emerged as a promising routing technique. Location-aware multicast routing protocols use position information to establish reliable routing and reduce the maintenance overhead. However, many challenges face implementing reliable and scalable multicasting over wireless communication. For example, in geographic unicast routing, a data packet carries the position of the receiver in the packet header to guide the packet forwarding. On the other hand, multicast routing considers a group of nodes as multicast receivers which increases the packet size and the routing overhead, especially in large scale MANETs. Despite of these challenges, research efforts have recognized these challenges and worked on developing scalable and efficient multicast routing protocols [7].

The rest of the paper is organized as follows: In the consequent section, some related works are discussed. Section 3 provides description of the proposed protocol. Finally, concluding remarks are summarized in Section 4.

2 Related works

Recently, location-based multicast routing protocols have attracted the attention of many researchers because these protocols scale quite well in large wireless networks in addition to the commercial proliferation of GPS devices [8]. In position-based routing, geographical location information is used to localize the control message propagation and to help the routing layer scale to support very large networks [9]. Position-based routing is scalable to large networks, since it uses only knowledge of the source and the destination locations and is independent of network topology and size.

The location Aware Multicast Protocol (LAMP) proposed in [10] supports scalable multicast routing using greedy multicast forwarding. LAMP divides the network into hexagon zones to manage the group membership efficiently and to track the position of the multicast receivers. For each hexagon cell, the node closer to the center is elected as zone leader to maintain the membership table of the multicast receivers. The tree construction starts by initiating a broadcast packet to the whole network, containing all multicast members. Each node is aware if it is a multicast receiver, if yes, it replies by a join request message to its local zone leader to construct the tree. When a source node wants to send data packets to the list of receivers, it splits the network region into 3 regions (120^{o}) and a copy of the data packets is sent to each region using greedy multicast forwarding. LAMP shows scalable performance, however the multicast tree construction results in large number of packets and increases the routing overhead. In addition to the overhead of network construction and node self-mapping.

An Efficient Geographic Multicast Protocol (EGMP) is proposed in [11] to enhance scalability of location-aware multicast protocols by exploiting two-layer structure.

EGMP partitions the geographic area into non-overlapping square zones, and a leader is selected in each zone to represent its local zone on the upper tier. The leader gathers the membership information for each zone to manage joining and leaving the multicast sessions. At the upper layer, the leaders of member zones contact directly with sources to report the zone memberships through a virtual reverse-tree-based structure or along the home zone.

Recent research efforts showns that geographical routing significantly improves the performance of MANETs. Based on this view, a new routing protocol has been designed to exploit the location information to eliminate flooding and simplify the routing strategy. The proposed protocol tries to overcome some of the problems of the existing schemes along with enhancing the scalability and reducing the control overhead. The details of this protocol are presented in the following sections.

3 Protocol overview

The proposed protocol is a source-tree multicast routing protocol to enhance scalability of multicast routing over MANETs. The protocol aims to be implemented in large networks with large number of multicast members. To achieve this, a virtual clustering strategy has been introduced to partition the network coverage area into 8 sectors.

This protocol exhibits the efficiency of multicasting and forwards the packet to multiple destinations relies on the location information of the destination nodes, which is assumed to be known. The protocol exploits nodes positioning information to reduce the number of nodes participating in forwarding control packets. This is achieved through Restricted Directional Flooding (RDF) [12]. Based on nodes positions and location information of the destination (obtained through location service algorithm), nodes in RDF only forward the packets if their positions are closer to the destination, this eliminates broadcast storm and utilizes the network resources efficiently.

The protocol operation is divided into multiple phases. These phases include network construction, routing discovery and maintenance as well as data transmission. Network construction includes dividing the network area into several sections and determines the distrbution of multicast receivers within these sections. In network construction, the entire network area is partitioned into 8 sectors based on the location of the source node. This construction minimize the number of routing packets and accordingly reduce the routing overhead. Route discovery phase discovers the shortest paths towards each multicast receiver and establish a path for data transmission using the location information of the mobile nodes.

3.1 Route discovery

In our protocol, the sender can transmit packets without specifying the next hop node, because the receiving node can decide to forward or drop the packet based only on its location and the location of the destination node. This mechanism does not require routing tables, neighbor tables, in addition to eliminating the need to tree creation.

When a source node decides to initiate a multicast session, it splits the network into four rectangles based on its network coordinates and then splits each rectangle into

two sectors as shown in Figure 1b. After that, it sends a separate RREQ packet to each sector that contains multicast receivers. The sectors are numbered from 1 to 8 based on predefined algorithm.

In multicast session initiation, the source node "S" sends a Route Request (RREQ) packet including all multicast members identifiers and their position coordinates. The source node determines the sector numbers that contains one or more multicast members and splits a copy of the RREQ packets only to those sectors. This is performed based on the position of the source and the destination nodes. When a copy of the RREQ packet is received by the intended sectors, the packet is forwarded using RDF towards different destinations. Using RDF eliminates network flooding storm and restricts packet forwarding to the nodes in the way to the intended destinations. Since RDF is used for forwarding route discovery packets, the number of nodes that participate in forwarding these packets depends on the euclidean distance between the sending node and the intended destination. In other words, upon receiving the route discovery packets, a node with lower euclidean distance (towards any destination in the sector) will be considered as forwarding node. This strategy helps in reducing the resulted overhead compared to broadcast strategy (in which all nodes existing in the network participate in forwarding the route discovery packets).

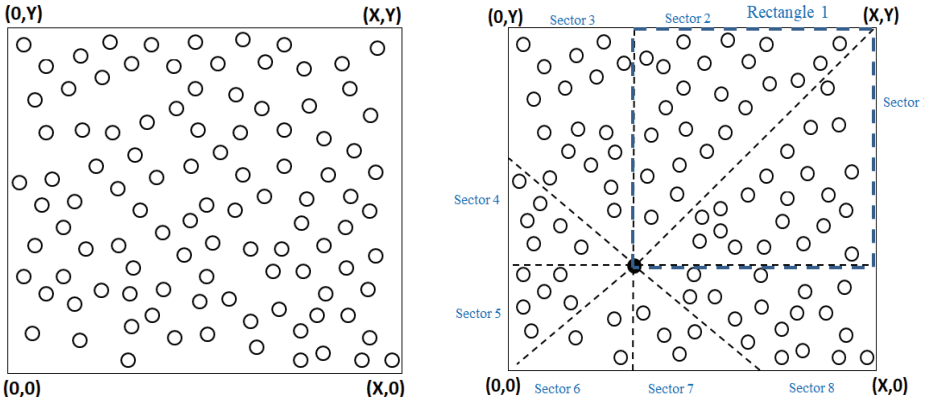

Fig. 1. Network partitioning based on source position

When an intermediate node receives a RREQ packet, if the node is a multicast member, it removes the fields belongs to that node ID_D, (X_D, Y_D) and forwards the packet to next node using RDF. Otherwise, it computes the distance between itself and the destined multicast receiver node and compares it with the "Res_Dist" field which is stored in the packet. If the intermediate node is further than the previous node, the packet is dropped. Otherwise, it stores its previous hop node to be used in the reverse path and forwards the packet using RDF.

3.2 Route reply process

Upon receiving RREQ packet by each destination node, it replies by the following RREP packet shown in Table 1.

Table 1. RREP packet format

Pkt_ID (RREP)	(RREQ)_ID	ID_S	ID_D

Where Pkt_ID(RREP) is the ID for the first RREQ packet and RREQ_ID is the request ID for the received RREQ packet and the fields "ID_S and ID_D" contains the address of the sending source and the destination address respectively. When the RREP packet traverses back from each destination to the source, each node along the chosen path realizes that it becomes a forwarding node and re_forwards the packet until it reaches the source node. When the source receives the selected routes to the multicast members, it starts sending data packets to the multicast members using selected routes.

3.3 Route maintenance

During data transmission, some nodes may not receive data packets due to broken links caused by nodes failure or movement. When a link break is detected, the upstream node of the broken link sends RERR packet backward to the upstream nodes to inform them about this failure until it is received by the source node. Intermediate upstream nodes, upon receiving this packet, re_forward the packet towards their upstream nodes. Also, the downstream nodes of the broken link clear related entry when a predefined time is elapsed without receiving data from the upstream nodes. When the source node receives the RERR packet, it initiates a new route discovery process towards the affected destinations as discussed previously.

4 Conclusion

The current paper proposes a tree-based multicast protocol called Scalable Geographic Multicast Routing Protocol (SGMRP) to solve scalability issue. The proposed protocol virtually divides the network plane into 8 sectors. This type of structure constructs a minimum length multicast tree with reduced communication overhead. The protocol performs restricted position-based route discovery which potentially reduces the number of packet transmissions with reduced hop count to each multicast receiver.

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