ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ

Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ	N E W S
НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК РЕСПУБЛИКИ КАЗАХСТАН Satbayev University	OF THE ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN Satbayev University

SERIES
OF GEOLOGY AND TECHNICAL SCIENCES

4 (448)

JULY – AUGUST 2021

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

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APPLICATION OF AUGMENTED REALITY TECHNOLOGY AS AN INTERACTIVE LEARNING MEDIUM IN GEOGRAPHY SUBJECTS

Abstract: this research studies e-learning environments based on the Earth layers via Augmented Reality. It is a technology that can insert and provide input in the form of 3D virtual objects into a real-time environment. It can be applied in learning activities. In this research, authors offer to use it in geography subjects on the topic of layers and structures of the earth. Learning media on the topic of layers and structures of the earth in schools today is still conventional and difficult to present in-class learning. In addition, there is still a lack of technical knowledge to properly use digital technologies in lessons and this application is user-friendly. This study was conducted to determine the user's response regarding the learning media layer and structure of the earth-based Augmented Reality of secondary school students. Augmented Reality is a type of interactive technology that combines real and virtual objects to produce real 3D objects in life. The research was developed with the waterfall model. The results of the study showed that the learning media geography layer and Augmented Reality based earth structure are valid to be used as a learning medium in secondary school. Based on the conducted research, authors came to a conclusion that usage of the Augmented Reality technology showed a positive dynamic.

Key words: application, a*ugmented reality*, learning media, geography.

Introduction. The rapid development of technology has changed the face of education, where technology can be combined with an adequate pedagogical foundation [1] and can support the implementation of classroom learning [2]. There is intense competition between future technologies such as the Internet of Things (IoT) and Augmented Reality (AR) technologies. According to Savinykh, the Internet of Things introduces smarter environments through computing and sensing [3]. While Augmented Reality technology that depicts the space of real perception by presenting virtual media as a qualifier of the world. According to the results of the Global Education Census study [4], stated that most users of technology in the world are students from Indonesia. Data shows that more than 67% of Indonesian students use smartphones in their studies, and 81% of students use smartphones for homework. Digital technology is becoming increasingly integrated and becoming part of modern society. Augmented Reality is considered to be a more efficient technology for educators, researchers, and web developers. Although mobile devices are widely consumed by students, the use of Augmented Reality mobile apps as learning tools is not common among teachers.

L. Sauvé et al [5] explains that the advancement of teaching concepts, applications, and technological development, as well as the reduction of hardware costs in this decade, educational institutions have made it possible to use Augmented Reality technology on a small scale (assuming sustainable development at the same level) [6]. However, the potential of this technology requires careful attention before it can be used to improve the success rate of education.

There fore, this research was conducted to design and develop learning media layers and structures of the earth equipped with Augmented Reality technology. Learning media is the equivalent of materials and tools or a combination of software and hardware used in learning. The results of the needs analysis show that there needs to be the development of learning media in schools. In this study, researchers designed and developed

AR technology-based learning media in geography subjects on the topic of layers and structures of the earth for middle school students so that they better understand the concept of layers and structures of the earth.

Literature Review. The use of information technology in student textbooks is considered very helpful in providing abstract earth surface geography materials because multimedia-based teaching devices can support learning systems in schools that tend to use traditional lecture methods [5]. According to S. Cai, X. Wang, &F. K. Chiang, to facilitate understanding the material on the surface of the earth, it is necessary to design a book using AR technology [8]. In addition to combining virtual objects with real reality, AR technology can also allow users to interact directly in 3 dimensions to convey a better impression to users [1].

Learning activities move with the system of delivering teaching materials with learning media and start to move from teaching methods. Well-designed and creative learning increases the chances of achieving learning skills. As a bridge to effective and efficient teaching, the media needs the attention of teachers. According to H. K. Wu et al [9], the importance of the media in advancing students' learning will be tailored to the learning objectives. This kind of learning media is necessary because it helps students understand the process. The rapid development of technology, information, and communication makes learning media innovations must be able to adapt. There fore, innovation in learning media development needs to use existing technology for coaching and development. One of the innovations of learning media is Augmented Reality, which will teach students to play 3D and 2D roles.

From the point of the pedagogical and psychological view, e-learning materials create an interactive environment for students and make lessons more attractive than the traditional one [10]. In addition, due to the current COVID-19, a distance online education system could convince that digital technologies can benefit teachers, students and as well as the educational process [11]. The media will provide effectiveness and efficiency of learning resources, which can improve students' motivation, interests, and learning outcomes in geography subjects [15].

Methodology. The method used in this study is the Research and Development method, which is a method used to produce a particular product and test the effectiveness of the product. The stages of this research method can be seen in figure 1 below.

Figure 1. Stages of research methods

System Planning. The model in the design of the system for applications in this study uses a waterfall model which has the following stages [12]:

- The planning stage has a system design, which will be implemented into the application.
- The analysis stage gets information about a need of a system based on research data.
- The design stage creates a display and process architecture of an application that will be created in the form of design.
- The system implementation and testing stage implements and tests a starting application from the display, specification, and testing of the application to meet the needs.
- The evaluation atage evaluates a test conducted to determine the shortcomings of the system that has been implemented.

System Requirements. The analysis of system needs describes what the system must have in order to run properly. Analysis of system needs aims to find out what appropriate system is applied, what hardware and software are needed to develop this application.

Hardware. In the process of creating a basic learning medium for the introduction of layers and structures of the earth, the needed hardware should have minimum specifications to run Augmented Reality development application programs. The main application for developing Augmented Reality technology is Unity 3D. Table 1 shows the minimum hardware specifications for running Unity 3D version 5.3 application programs.

Table 1. Hardware specification for Unity 3D Application version 5.3

No.	OS*	
1	Desktop	a) OS: Windows 10 Enterprise LSC 64-bit (10.0, Build 17763) b) Graphics card: DX9 (Shader model 3.0) or DX 11 with 9.3 capabilitylevel feature. c)CPU:SSE2introduction setsupport (Intel4and AMD 2003 processors) d) 4 GB RAM

2	Andro id	OS 2.3.1 or later; ARMv7 (Cortex) CPU with NEON support or Atom CPU; OpenGL ES 2.0 or later.

OS* - Operating System

Software. Analysis of software needs is done to analyze the software needed to develop the basic learning media of the introduction of layers and structures of the earth. The software used for the creation of this media can be seen in table 2.

Table 2. Software specifications

No	Specifications
1	Unity 3D 5.3, the main software for *Augmented Reality* development
2	Vuforia SDK 6, software imported into Unity 3D for *Augmented Reality* as image recognition.
3	Java JDK 7, Java Development Kit is an essential component for building an Android application.
4	Microsoft Visual Studio 2015, a software for editing script programs with the C++ programming language.
5	Blender, a software to create 3-dimensional objects.

AR Book. The most important thing about the need for this AR Book is the selection of Geography materials that will be included in the AR Book. The selection of materials is based on the applicable syllabus and refers to reference books containing the required materials [13].

Evaluation. After the process of designing and building the basic learning media of the introduction of layers and structures of the earth with Augmented Reality and running on Android smartphones, the next step is testing media and materials experts. Testing is used to check the performance or functionality of developed software applications [14]. Testing by media and material experts is conducted to assess the feasibility of the developed learning media. After the learning media has been tested by experts, then students' responses to the learning media are analyzed in the experimental group.

Discussion. After the process has been designed and Geography learning media with Augmented Reality has been built and run on Android Smartphones, the next step is to test the feasibility of such learning media. But before conducting the feasibility test of the learning media, a test is firstly conducted on performance through black-box testing. After the Black Box test has been

completed, data analysis is done as a next step. Data analysis is performed to analyze validation data by experts (material experts and media experts) and user/student response data. Analysis of product validation data by experts aims to determine the level of feasibility of learning media according to media experts and material experts. While the analysis of student response data aims to determine the assessment of students as end-users of developed learning media. Figure 2 shows the results of the development of AR technology for Geography subjects on the topic of layers and structures of the earth.
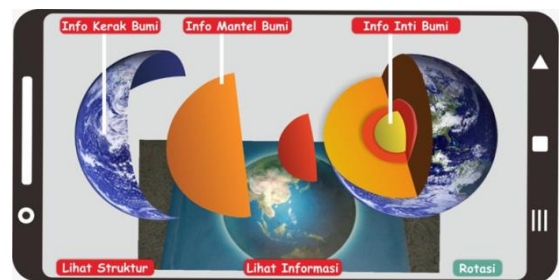
(a)

(b)

(c)

(d)

(e)

(f)

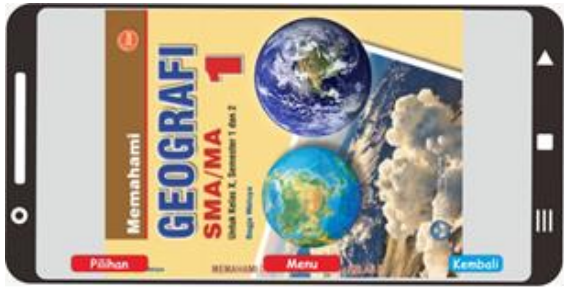Figure 2. (a) Display of learning material pages, (b) Display of the earth's crustal sub-material pages, (c)& (d) Display of sub-material pages of the mantle of the earth, (e) Display of Earth Core Sub Material Page, (f) *Augmented Reality* geography page view

Black Box Testing is used to determine the performance of *Augmented Reality* learning media by testing the functionality of the application without testing the program code. Testing is done by running each application input function on several Android Smartphones with different Android Versions and device specifications – different from multiple repetitions. The following results from the A Rapplication functionality test as a learning medium of Geography can be seen in table 3.

Table 3 Testing black box testing against Augmented Reality geography learning media

No	Statement	Answer	
		Working	Not Working
1	Success of Globe AR File Application installation	√	
2	*Augmented Reality* Geography Button Functions	√	

3	Learning Materials Button Function	√	
4	Use Hint Button Function	√	
5	About Button Function	√	
6	Menu Pane Button Functions	√	
7	Home Navigation Key Functions	√	
8	Camera Opening Function	√	
9	Tracking Image Marker Function	√	
10	Function Displays Earth Layer and Structure Objects After Marker Scan	√	
11	Home Button Function To Return To Main Menu Page	√	
12	Success of Globe AR File Application installation	√	
13	*Augmented Reality* Geography Button Functions	√	

Aspects of shopper design, material aspects, and benefits aspects have been converted into categories based on the results of material expert assessment of Augmented Reality learning media products. It can be explained in table 4 that the results of the assessment by material experts 1 get a score of 74 with a category of Very Worthy and by material experts 2 get a total score of 56 with a category of Worth. Data validation test results in every aspect conducted against material experts obtained data that aspects of learning design get an average score of 20 with a category of Very Worthy, aspects of the material get an average of 32 with a category of Decent and aspects of benefits get an average score of 13 with a category Worthy. Table 4 shows the results of the material expert validation test in detail.

Table 4. Material expert validation test results

No.	Validator	Assessed Aspects				Category	%
		Learn Design.	Material	Benefit	Total		
1	Material Expert 1	22	37	15	74	Very Decent	92,5%
2	Material Expert 2	18	27	11	56	Proper	70%
Average		20	32	13	65		
Category		Very Decent	Proper	Proper	Proper		
%		83,37%	80%	81,25%	81,25%		

Results of media expert assessment of Augmented Reality learning media products are based on media design aspects, software aspects, and benefits aspects that have been converted into feasibility level categories. It can be explained in table 5 that the results of the assessment by media experts 1 get a total score of 90 with the category "Very Worthy" and by media experts 2 get a total score of 84 with the category "Very Worthy'. Data validation test results conducted against media experts obtained data that aspects of media design get an average score of 56.5 with the category "Very Worthy", software aspects get an average score of 17 with the category "Very Decent", and aspects of benefits get an average score of 13.50 with the category "Very Worthy". Table 5 shows the results of the media expert validation trial in detail.

Table 5. Media expert validation test results

No.	Validator	Assessed Aspects				Category	%
		Media Design	*Software*	Benefit	Total		
1	Media Expert 1	59	17	14	90	Very Decent	90%
2	Media Expert 2	54	17	13	84	VeryProper	84%
Average		56,50	17	13,50	87		
Category		Very Decent	Very Decent	Very Decent	Very Decent		
%		88,28%	85%	84,38%			

A user response test was conducted among students in Indonesia who have Android phones. The data obtained is a product assessment by students in the form of questionnaire stuffing as many as 24 statements with 4 choices of answers statement. The statements in the questionnaire include aspects of learning design, aspects of the media display, software aspects, material aspects, and benefits aspects. The table shows the average aspects of learning design scored 61 with the category "Eligible", the average media display aspect scored 16.95 with the category "Eligible", the average aspect of the software scored 3.2 with the category "worthy", the average aspect of the material worth the score of 95.5 with the category "Eligible", and the average aspect of benefits worth a score of 3.4 with the category "Very Worthy" as shown in table 6.

Table 6. User response test assessment results

No.	Respondents	Aspects of design					Qty. Score	Category
		Learn. Design	Media Display	*Software*	Material	Benefit		
1	Student 1	12	35	7	18	8	80	Very Decent
2	Student 2	13	36	7	18	8	82	Very Decent
3	Student 3	13	32	6	18	8	77	Proper
4	Student 4	14	36	7	20	7	84	Very Decent
5	Student 5	13	36	7	18	8	82	Very Decent
6	Student 6	10	26	7	17	5	65	Proper
7	Student 7	13	35	6	21	6	81	Very Decent
8	Student 8	10	33	6	21	8	78	Proper
9	Student 9	13	36	7	18	4	78	Proper
10	Student10	11	34	5	22	7	79	Very Decent
	Total Score	122	339	65	191	69	786	
	Average Score	61	16.95	3.2	95.5	3.4	39.3	
	Category	Proper	Proper	Proper	Proper	Very Decent	Proper	
	%	75.62	80.12	80	78.12	83.75	75.62	

The product resulting from this study is an Android application in the form of Augmented Reality technology that is used as a learning medium for the introduction of layers and earth structures in Geography subjects that have application file format. This application file can be installed on Mobile devices with the Android operating system then run according to its usefulness as a learning medium for the introduction of layers and earth structures. Augmented Reality application introduction of layers and earth structures can operate on Android gingerbread version with 512 RAM and camera at least 2 Megapixels. The deployment of AR application to identify layers and structures of the earth is done using Bluetooth or other data sending applications that run on Android mobile devices.

The advantages of Augmented Reality learning media basic introduction layers and structures of the android-based earth is: learning media can be installed on all Android Mobile devices at least Gingerbread version that has camera features, learning media can be used as a learning media in school or independently anywhere and anytime, Augmented Reality technology invites students to think in real-time without bringing their practical tools directly by me display 3D animations of the introduction of layers and structures of the earth that resemble their original form, display learning materials, and evaluation tools in the form of questions used to measure the user's ability, display the score results in the evaluation feature so that students can know the level of understanding of the existing material, and have a simple design, neat and easy to use.

The disad vantages of Augmented Reality learning media introduction of layers and structures of the earth, among others, are the quality of the camera, lighting, and *hp* specifications affect the speed of displaying 3D objects when the camera reads markers, the ability to display 3D objects is still limited to 3D objects layers and active and passive earth structures, has not touched on the realm of applicative variations of evaluation questions that are still limited to only 15 questions.

Research results can be used into the educational process and commercialized through the sale of licenses for the right to use the application. Accelerating sales can be achieved by providing truncated demos with little functionality that allows you to get acquainted with the product [16]. The advantages of these technologies from the standpoint of project management in the process of commercialization is that such projects are not strongly susceptible to the passage of the "valley of death" and can be commercialized by students as they do not require high operating costs. However, it should be in mind that when creating a startup, the application will require constant updates due to changes in the requirements for software programs, which will also affect operating costs. One possible way to avoid this is to provide open source code to introduce changes to compliance with changing software requirements, subject to compliance with all legal regulations, including the payment of flat membership fees.

This application will be also effective to use in manufacturing industries where students can use it as a simulator in the laboratories to avoid being damaged by metals [17, 18, 19].

Conclusion. Based on aspects of learning design, materials, and benefits obtained a total average score of 65 from a maximum score of 80 or fall into the category of "Eligible". As for the results of the assessment of media experts based on aspects of media design, software, and benefits obtained a total average score of 87 from a score of 100 maximum or included the category "Very Worthy".

The response of user/student assessment to *Augmented Reality* Geography learning media is seen from the aspect of learning design, media display aspect, software aspect, material aspect, and benefit aspect which is 55% of students stated "Very Worthy" and 45% of students stated "Worthy" as learning media.

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ГЕОГРАФИЯ ПӘНДЕРІ БОЙЫНША ИНТЕРАКТИВТІ ОҚЫТУ ҚҰРАЛЫ РЕТІНДЕ КЕҢЕЙТІЛГЕН ШЫНАЙЫЛЫҚ ТЕХНОЛОГИЯСЫН ҚОЛДАНУ

Аннотация: бұл зерттеу кеңейтілген шынайылықты қолдана отырып, жер қабаттарына негізделген электронды оқыту ортасын зерттейді. Бұл нақты уақыт ортасында 3D виртуалды нысандар ретінде кірістіруге және ұсынуға болатын технология болғандықтан, оқу іс-әрекетінде қолданылуы мүмкін. Бұл зерттеуде авторлар оны география пәндерінде жердің қабаттары мен құрылымдары туралы қолдануды ұсынады. Мектептердегі жер қабаттары мен құрылымдары туралы Оқу материалдары бүгінде дәстүрлі түрде оқытылатындықтан, сыныпта оны көзге елестету қиындық тудырады. Сонымен қатар, сабақтарда цифрлық технологияны дұрыс пайдалану үшін әлі де техникалық білім жетіспейді. Бұл бағдарлама пайдаланушыға ыңғайлы. Зерттеу ортасы мектеп оқушыларының жер бетіндегі оқыту медиасының деңгейінде және кеңейтілген шынайылықтың құрылымына қатысты пайдаланушылардың реакциясын анықтау үшін жүргізілді. Кеңейтілген шындық – бұл өмірде нақты 3D нысандарын құру үшін нақты және виртуалды нысандарды біріктіретін интерактивті технологияның бір түрі. Зерттеу сарқырама моделін қолдана отырып жасалды. Зерттеу нәтижелері көрсеткендей, оқу географиясының қабаты мен кеңейтілген шынайылыққа негізделген жер құрылымы орта мектепте оқу материалы ретінде пайдалануға жарамды. Зерттеу негізінде авторлар кеңейтілген шынайылық технологиясын қолдану оң нәтиже көрсетті деген қорытындыға келді.

Түйін сөздер: қосымша, кеңейтілген шынайылық, оқыту ортасы, география.

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ПРИМЕНЕНИЕ ТЕХНОЛОГИЙ ДОПОЛНЕННОЙ РЕАЛЬНОСТИ В КАЧЕСТВЕ ИНТЕРАКТИВНОЙ СРЕДЫ ОБУЧЕНИЯ ПО ПРЕДМЕТУ «ГЕОГРАФИЯ»

Аннотация. это исследование изучает среду электронного обучения, основанную на слоях Земли с помощью дополненной реальности (Augmented Reality). Это технология, которая может вставлять и предоставлять ввод в виде трехмерных виртуальных объектов в среду реального времени. Ее можно применять в учебной деятельности. В данном исследовании авторы предлагают

использовать еепри изучении предмета «География» на тему слоев и структур Земли. Обучающие средства массовой информации по теме слоев и структур Земли в школах сегодня все еще обычны, и их трудно представить в классе. Кроме того, по-прежнему не хватает технических знаний для правильного использования цифровых технологий на уроках, аэто приложение удобно для пользователя. Это исследование было проведено, чтобы определить реакцию пользователя на уровень обучающей среды и структуру дополненной реальности на Земле – учащихся средних школ. Дополненная реальность – это тип интерактивной технологии, которая объединяет реальные и виртуальные объекты для создания реальных трехмерных объектов в жизни. Исследование проводилось с использованием модели водопада. Результаты исследования показали, что слой географии обучающих медиа и структура Земли на основе дополненной реальности могут использоваться в качестве среды обучения в средней школе. На основании проведенного исследования авторы пришли к выводу, что использование технологии дополненной реальности показало положительную динамику.

Ключевые слова: приложение, дополненная реальность, обучающие медиа, география.

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