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The implications of the use of asynchronous technology in the form of augmented reality in the primary years program towards self-directed learning

Hana Triana[1*], Rudi Permadi[2]

Universitas Negeri Jakarta, Indonesia[1]
Universitas Islam Tasikmalaya[2]

hanatria83@gmail.com
rudi123313@gmail.com

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Abstract

The purpose of this study was to evaluate the impact of the use of augmented reality (AR)-based learning materials within the Primary Years Programme on students' academic development and their perceptions of the use of augmented reality applications. This study used a mixed-methods approach. A descriptive study was conducted to understand the relationship with perceptions of use. The type of data used to identify the developments was a combination of quantitative and qualitative data. Qualitative data were collected to identify currently available solutions and their impact on learning aspects. Meanwhile, quantitative data also played a significant role in answering the research questions. On the qualitative side, data were obtained through interviews and observations. This study had two main objectives. First, this study examined the relationship (correlation) to understand the combined effect on attendance in the asynchronous learning environment that participants participated in. Furthermore, this study provided empirical data and insights to educators regarding future trends in online learning, including those related to learning processes and instructional techniques. The results of this study have important implications for students' readiness to use augmented reality, which is a crucial aspect in the implementation of online learning.

Key words: Augmented-Reality, E-Learning, Self-Directed Learning, Students' Perception, Asynchronous technology.

Abstrak

Tujuan dari penelitian ini adalah untuk mengevaluasi dampak penggunaan bahan ajar berbasis augmented reality (AR) dalam kerangka Primary Years Programme terhadap perkembangan akademik siswa serta persepsi mereka terhadap penggunaan aplikasi augmented reality. Penelitian ini menggunakan pendekatan mixed-methods. Studi deskriptif dilakukan untuk memahami hubungan dengan persepsi penggunaan. Jenis data yang digunakan untuk mengidentifikasi perkembangan yang terjadi merupakan kombinasi antara data kuantitatif dan kualitatif. Data kualitatif dikumpulkan untuk mengidentifikasi solusi yang saat ini tersedia serta dampaknya terhadap aspek pembelajaran. Sementara itu, data kuantitatif juga memiliki peran penting dalam menjawab pertanyaan penelitian. Pada sisi kualitatif, data diperoleh melalui wawancara dan observasi.Penelitian ini memiliki dua tujuan utama. Pertama, penelitian ini mengkaji hubungan (korelasi) untuk memahami efek gabungan terhadap kehadiran dalam lingkungan pembelajaran asinkron yang diikuti oleh peserta. Selain itu, penelitian ini memberikan data empiris dan wawasan kepada para pendidik mengenai tren masa depan dalam pembelajaran daring, termasuk yang berkaitan dengan proses belajar dan teknik instruksional. Hasil penelitian ini memiliki implikasi penting terhadap kesiapan siswa dalam menggunakan augmented reality, yang merupakan aspek krusial dalam implementasi pembelajaran daring.

Kata kunci: Augmented-Reality, E-Learning, Self-Directed Learning, Students' Perception, Teknologi asinkronus

INTRODUCTION

By using technology and creating virtual learning settings, online learning offers an alternative to traditional classroom instruction (Rovai and Jordan, 2004). The online curriculum gives students more freedom to choose how and when to participate because of its largely autonomous structure (Milligan & Littlejohn, 2014). There are several methods for implementing the newest computer technologies to assist students' online learning, including e - learning, flipped classrooms, blended learning, and problem-based learning (Mo & Tang, 2107). (Tang & Yu, 2018). The fact that these new learning technologies facilitate mostly asynchronous learning, however, overwhelms many pupils. Although synchronous and asynchronous learning have been utilized by educators for a long time (Francescucci & Rohani, 2019), the adoption of asynchronous technology is the way to engage, adaptable, frequently self-paced, and can be finished whenever suits your schedule. In addition, Students can pursue their education from anywhere and are not impacted by relocation or travel thanks to distance learning.

Asynchronous learning is a type of learning that is typically self-directed and excludes the involvement of an instructor or fellow students. Asynchronous learning, which is often thought of as course-based, self-paced learning, only involves the student and the content (Barto, 2021). To facilitate the exchange of online learning materials and information and to encourage peer-to-peer discussions and interactions, asynchronous learning uses computers or mobile devices. Asynchronous online learning removes time and place restrictions so that students can learn whenever and wherever they want. In order to facilitate collaborative student learning, Holenko et al. (2020) adopted synchronous mobile computer-supported technology. According to Martin and Parker (2014), synchronous contact between students and teachers was made possible by the usage of virtual classrooms, which offered a variety of useful features like audio, video, chat boxes, whiteboards, information sharing, etc. According to Mayadas (1999), an asynchronous learning network (ALN) is a setting that "combines intense, quick, asynchronous interaction with others with self-study. In ALN, students use computers and communications tools to interact with distant learning resources, such as coaches and other students, without having to be online at the same time.

In addition, The term "augmented reality," or simply "AR," refers to a real-time, interactive experience that uses data like computer-generated visuals, video, GPS, and other aspects to enhance real-world environmental factors. The addition of virtual images and graphics to real-world visuals without departing from reality, but rather by enhancing it with the aid of various software and technology, creates a completely new form of experience. The goal of augmented reality applications is to give the user a virtual experience that seems as real as the physical world and the present moment. By adding numerous virtual things to the image of the location where the person is located, a new environment is produced. Images, sounds, graphics, and GPS data generated in the digital world enhance the actual world.

This study examines how student motivation, self-directed learning, and preparedness to use technologies to support online learning correlate with one another and how those three factors together affect how asynchronous technology is perceived. This research has two main effects: (1) The study is important for the education sector in developing new teaching methods for students to engage in online learning/ asynchronous learning; (2) The study is

important for supporting education in developing teaching and learning materials such as augmented reality toward self-directed students.

The objective and significance of the research The development of educational technology and their integration into learning settings is happening extremely quickly today. Compared to earlier generations, the engagement of students enrolled in the educational system with technology grows with each passing day. Their schools must adjust to these new technologies and satisfy the needs of the younger generations if they are to live up to the expectations of these pupils. Students' motivation is decreased and their connection to the school is weakened by conventional lessons that use the direct expression method of instruction. However, when augmented reality technology is used in the course materials, it makes it simpler for students to understand abstract concepts that are challenging to learn, gather accurate information, and draw better inferences (Abdüsselam & Karal, 2012).

The majority of students have trouble comprehending abstract concepts of learning materials, particularly those that have to understand abstract concepts and stimulate their senses of primary education subjects. The advantages that Augmented Reality (AR) Apps provide to students are the driving force behind this new trend in education. This includes giving them more motivation, attitudes toward learning over their education and access to cutting-edge technology.

When the literature is analyzed, it becomes clear that there has been numerous research done on the usage of augmented reality applications in education. Yilmaz's classification of AR's benefits, accomplishments, and learning strategies is detailed in Table 1.

Advantages AR in education	Providing a sense of reality	Gains of using augmented reality in education	Making learning attractive and effective
	presenting a natural experience		Providing motivation
	Visualize complex relationship		Providing interaction
	Offer experiences that cannot be in real life		Facilitating understanding
	Concrete abstrat concepts		Conecting with real world experiences
	Having fun learning		Creating contextual awareness
	Presenting safe learning environment		Increasing enggagement
	Saving time and space		Ensuring permanent learning
	Increasing student participation		Improving communication
	Providing flexibility		Increasing collaboration
Supported learning approaches	Authentic learning environments		Triggering creativity
	Situational leaening environments		Developed imagination
	Constructivist learning environmnets		Controlling self-learning
	Learning by doing environments		Increasing spatial ability
	Inquiry-based learning environments		Enhancing problem-solving skills
	Research-based learning environments		Improving interpretation skills
			Increasing attention

Tabel 1. Advantages of AR, gains achieved, and learning approaches it supports

In this examined research, the degree of education was first looked into. Results indicate that primary and graduate school are where AR technology has been used the most. However, further research is required to determine how AR can be used in early childhood and secondary school education. Figure 1 presents a summary of all outcomes.

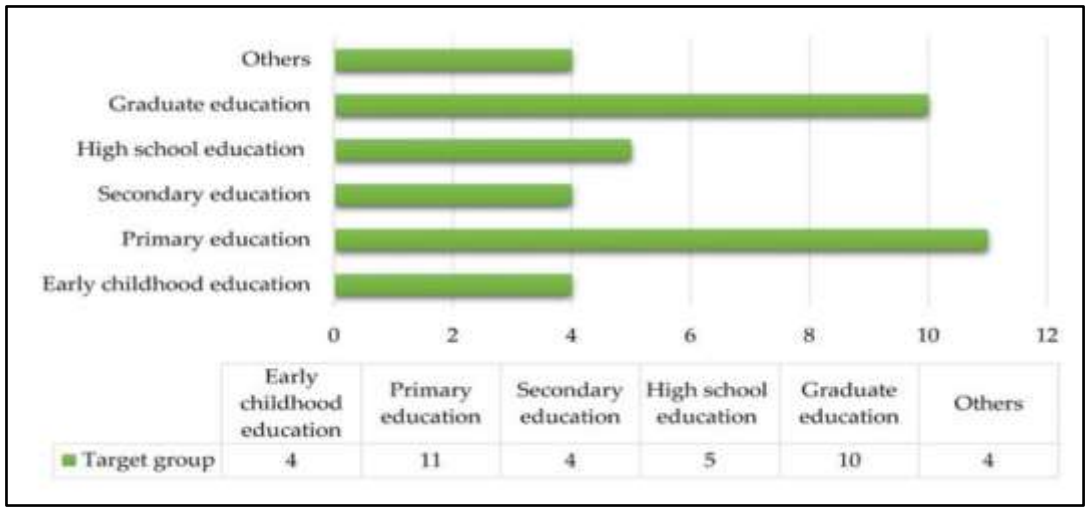

figure 1: Target group of reviewed articles

Science education (f = 16) is the most researched field of education when analyzing AR by educational field. Studies that have been peer-reviewed have primarily concentrated on "mathematical education," "storytelling," "foreign language education," "cultural education," and "health education." Figure 2 displays all data related to using AR by educational field.

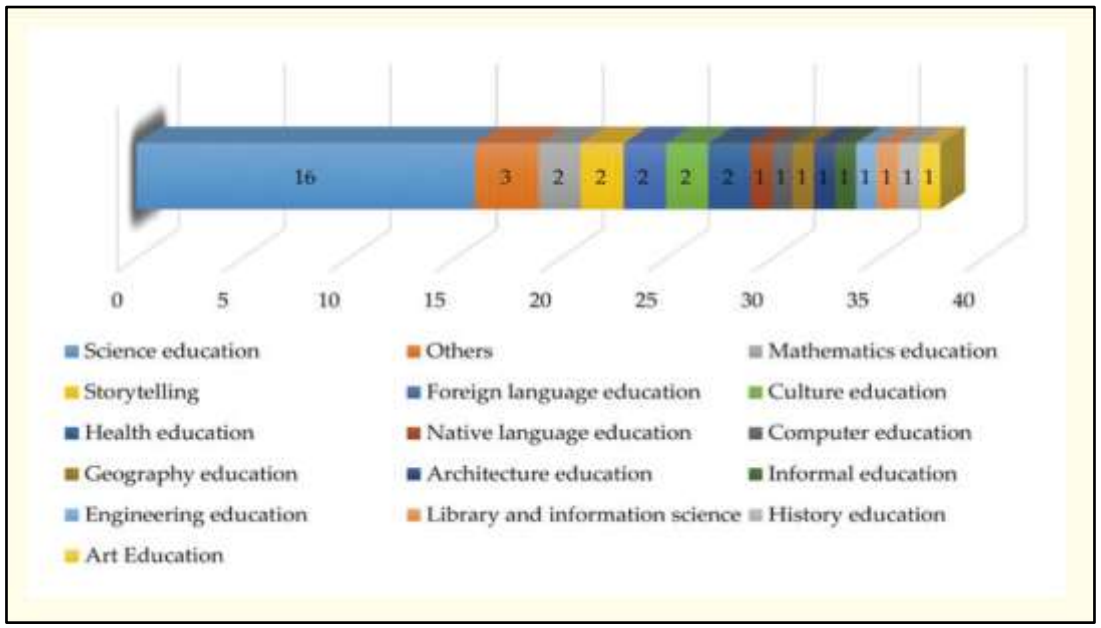

Figure 2: Using AR by field of education in reviewed articles

In studies that have been evaluated, several AR material kinds that are used in education have been investigated. They have been largely chosen in mobile applications (f = 16) and marker-based materials on paper (f = 12). Additionally, several of the research have made use of AR games and image books. Figure 3 displays associated findings.

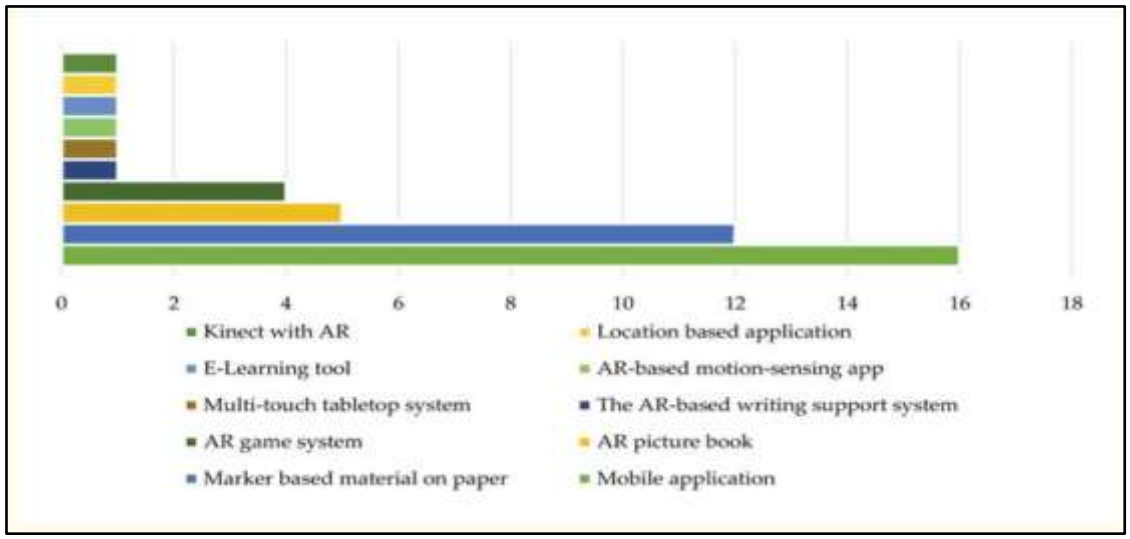

Figure 3: Material types of AR used in education

This review has also looked into the "Reported Educational Advantages of AR" area. Table 2 displays the findings in relation to them in the publications examined. One study was able to show multiple benefits, therefore their overall frequency is high. According to the findings, the three main benefits are "Learning/Academic Achievement" (f = 23), "Motivation" (f = 9), and "Attitude" (f = 6). Additionally, a number of factors have been concentrated on, including academic procrastination, writing abilities, cognitive component, the amount of mistakes they made, recall of the material, page design, teachers' acceptance and opinions, prospective applications of augmented reality in education, social, emotional, and cognitive improvement, performance in story comprehension tests, time spent, acquired knowledge, metacognitive perception, experiential activity, and possibilities of using AR for study.

Advantages	Number of studies	Percentage (%)
Learning/academic achievement	23	34.33
Motivation	9	13.43
Attitude	6	8.96
Satisfaction	4	5.97
Usability	4	5.97
Interaction	3	4.48
Spatial ability	3	4.48
Emotions	2	2.99
Cognitive load	2	2.99
Learning anxiety	2	2.99
Perception	2	2.99
Retention	2	2.99
Behaviors	2	2.99
Enjoyment	1	1.49
Flow experience	1	1.49
Communication	1	1.49

Table 2: Reported educational advantages of AR

AR application was introduced in the scientific lesson to aid with the understanding of PYP learning materials. Working to improve Primary subjects is more crucial when teaching a subject using AR. The purpose of this study is for students to use an augmented reality application to learn about any topics/learning materials. Accordingly, educational activities supported by augmented reality (AR) technology (Apps/platforms) are created for specific topics in all subjects of PYP, with the intention of determining whether the augmented reality technology increases the students' motivation or is self-directed for learning. The following issues are examined with this in mind:

1. Which augmented Reality (AR) approaches are currently being used in asynchronous technology for primary subjects and are thought to be helpful for student learning?
2. Which augmented reality (AR) methods are most appropriate and often utilized for increasing learners' learning, given that all asynchronous models have some significant effect towards students' motivation of self-directed learning?
3. Could the augmented reality (AR) method aid a student who is having trouble understanding a concept?
4. If implemented, how much would the teachers value this novel method of learning?

METHOD

Design a descriptive study to understand the relationship with perceived usage. The type of data that would help in identifying the development so far would be augmented reality (AR) and qualitative data. Qualitative data collection would be useful to identify the solutions that are currently available and what impact it has made on the learning aspects. On the other hand, quantitative data will be equally important to answer this research question.

Participants

1. Primary School Students - Quantitative
2. Primary School Teachers - Quantitative

Table 1: Showing Sample Size of the population

	No of Teachers	**No of Students**	**Instrument Used**	**Research Method**
	5	75	Google Form	Quantitative
	3	75	Google Form	Qualitative
Total	**8**	**150**		

Setting

It's a cross-sectional non-contrived study. Online survey form has been shared with the respondents to collect their views on the perceived ease and usage of blended learning technology in a school environment.

Data gathering Procedure

As the research majorly involves the students and faculty of the primary school, a google form questionnaire was prepared which took into consideration four different aspects. These are the gender of the respondents, faculty and their department, and their augmented reality (AR) views. The second part was planned to analyze their skills developed through augmented reality (AR) which was to be done through observations in the schools. However, this part was also included in the questionnaire (Appendix 1) to collect students' responses.

Instrumentation or Sources of Data

A survey consisting of direct questions based on ratings by the respondents has been collected. The captured data will be used to identify patterns which will help in identifying the impact that existing solutions have done to the mass users.

In this chapter implement augmented reality (AR) for any specific areas of primary learning materials/subjects. However, there are only some subjects or areas of learning. Here are some examples: several topics can be implemented in augmented reality (AR) in an asynchronous technology mode namely science, math, social studies, arts, ICT, and civics.. This research evaluated potential AR in education media. Table below shows augmented reality (AR) implementation in education areas for each subject in the primary school:

Figure 1 is a hypothesized model that demonstrates the connections between SDL, motivation, technological preparedness, and students' perceptions of online learning.

Impacts SDL's

Due to their proactive participation in the learning process, self-directed learners have a substantial impact on learning effectiveness (Tullis & Benjamin, 2011). Students have more freedom and opportunity to use SDL thanks to vibrant online learning content (Geng et al., 2019). Self-directed learners typically take more initiative to engage in online learning and have more focused intentions to complete their learning objectives. The Community of Inquiry (CoI) framework was shown to have a good association with the role of self-directed learning (Garrison & Akyol, 2013). SDL is also connected to the ability to motivate oneself to improve learning by implementing

AR implementation for Primary Subjects Learning Materials

Subjects	Learning materials	Learning Objectives	AR feature	Media
Science	Astronomi (Outer Space)	Recognize objects in the outer space	Planet models	Ipad Apps, Platform (Rumah Belajar)
Math	Geometry (concept the properties of 2D and 3D shapes)	Identify the properties of 2D and 3D shapes	Properties of 3D shapes	Apps
Literacy and language arts	Traditional stories and fairy tale	Explain the elements of the story	Elements of the story	Apps
Islamic Studies	Beliefs Culture	Explore the beliefs and religions's celebration	3D arts and culture model	Apps
Social Studies	Earth Feature	Find Earth features	Environments and physics Geography	Ipad Apps, Platform (Rumah Belajar)
STEM	Building and structure	Identify building and structure in the surrounding	Modern Building and structure/ bridges	Apps

Dance and Drama	Traditional Dance	Recognize traditional dance movement	Indonesia's traditional Dance	Ipad Apps, Platform (Rumah Belajar)
Physical Exercise	Sporting Events			

Literature Review

AR in Education

Augmented Reality (AR) is a technology that combines the real world with virtual objects (e.g., sound, text, video and 3D objects; Klopfer & Squire, 2008; Yuen, Yaoyuneyong & Johnson, 2011). The technology known as augmented reality (AR) blends the physical world with virtual Over the past few decades, advances in and research into augmented reality technologies have accelerated. Aside from the fields of marketing, architecture, entertainment, and defense, research on augmented reality has also started to gain popularity in the field of education (Lee, 2012). One of the perhaps interesting technologies in teaching is augmented reality (Johnson, Adams & Cummins, 2012).

Studies on the use of augmented reality (AR) applications in educational settings have been conducted in a number of disciplines, including geography (Carbonell & Bermejo, 2017), language (Ho, Hsieh, Sun & Chen, 2017), math (Kaufmann & Dunser, 2007), science (Cai, Wang & Chiang, 2014), and medicine (Ferrer-Torregrosa et al., 2015; Liu, Jenkins, Sanderson, Fabian By capturing students' attention, AR improves students' attitudes about the course (Wojciechowski & Cellary, 2013), their motivation for learning (Clark, Dunser & Grasset, 2011; Di Serio, Ibanez ve Kloos, 2013), and their learning performance (Cai, Wang & Chiang, 2014; Hwang, Wu, Chen & Tu, 2016), as well as makes the course more interesting and enjoyable by increasing students' motivation for learning (Chiang, Yang & Hwang, 2014; Kesim & Ozarslan, 2012).

In conclusion, there is a need for research that reviews recent AR articles from throughout the world and pinpoint study trends. In fact, these individual investigations are crucial for enabling a comprehensive evaluation of earlier AR-related studies and for identifying the requirements for AR. These motives serve as the basis for our investigation. However, it is anticipated that it will act as a guide for academics about what areas of AR research should be prioritized in the future.

Self-Directed Learning

Self-directed learning (SDL) describes how students understand knowledge directly and establish goals for themselves (Gilbert & Driscoll, 2002; Lee & Teo, 2010; Geng et al., 2019). SDL supports the adoption of collaborative learning and e-learning (Lee et al., 2014). Collaborative learning can improve a student's self-directed learning (SDL), according to studies on self-directed learning with technology (SDLT). Additionally, it was discovered that students who were competent in SDL used learning more frequently (Kizilcec et al., 2017).

Learning motivation

Motivation for Learning Intrinsic motivation are two key ideas in a student's motivation to learn. The enjoyment of the task at hand or a sense of fulfillment one experiences after engaging in an activity related to interest or curiosity is known as intrinsic motivation. A student is generally motivated by intrinsic factors to work actively and without being rewarded (Amirkhanova et al., 2016). Extrinsic motivation, by contrast, is the student's desire and drive to complete a task or reach a goal that has external benefits or rewards (Riswanto & Aryani, 2017). Students' propensity to participate and engage in class and their attendance are both influenced by their want to learn, whereas those who lack this enthusiasm are unlikely to learn very much. Students that lack learning motivation are likely to learn limited in class and generally find the exercises difficult and unpleasant. They are also less likely to participate and interact in class (Filogna et al., 2020).

RESULT AND DISCUSSION

To what extent use of Asynchronous Technology in the Form of Augmented Reality in the Primary Years Program towards Self-Directed for the learning materials/subjects students?

A survey was conducted in three schools having implemented augmented reality (AR)technology for the introductory asynchronous technology for primary school students. These schools are based in Jakarta and data was collected from 25 students each. All three schools are offering IB and Cambridge curriculum and follow BYOD (Bring your own device) concept. The names of these schools are kept undisclosed due to privacy reasons.

Student and Teachers' response about skills on Augmented Reality

Statistics have shown that a significant percentage of students from around the world are more interested in learning through blended learning than through traditional learning (CAE, 2017).

S/N	Skills of Augmented Reality	Students		Teachers	
		Yes	No	Yes	No
1	Improve Problem solving skills	83.50%	16.500%	50.0%	50.0%
2	Increase creative thinking skills	82.40%	17.600%	90.0%	10.0%
3	Understand and comprehend a high-level of learning materials	68.10%	31.900%	70.0%	30.0%
4	Understanding the concepts easily	69.70%	30.300%	86.0%	14.0%
5	Can do self enrollment	88.20%	11.800%	82.0%	18.0%
6	Can use the feedback section for sending the feedback	68.10%	31.900%	70.0%	30.0%

Table 4: Adapted from survey results, skills for using Augmented Reality (AR)

According to the above table, a high percentage of pupils—between 50% and 100% for students and between 30% and 50% for teachers—need training in the usage of Augmented Reality (AR). This finding surprised the author somewhat because she had assumed that the percentage of teachers who needed training would be higher than the percentage of students. But it's probable that not all teachers who need training chose to declare such in order to conceal their true position. However, this information reveals that the majority of students and teachers stated a wish to receive training in order to adopt a

1.2 The intentions of the students and teachers with regard to use of blended learning for introductory programming.

Statistics have shown that a significant percentage of students from around the world are

No	Strengths	VL	L	A	H	VH	Mean	Std Dev
1.	Access to the content within and outside the school	12.9	6.5	19.9	21.9	38.8	3.68	1.378
2.	Willingness to use blended learning as a learning solution	5.5	9.2	26.3	31.4	27.6	3.68	1.133
3.	Ability to learn better and develop more skills	2.3	9.7	31.5	33	23.4	3.67	1.011
4.	Friendly learning approach	1.8	12.4	31.5	35.1	19.2	3.56	0.989
5.	Usefulness and utility	6	12.9	24.1	39.4	17.6	3.51	1.014
6.	Acess to more reliable content	2.8	11.3	34.7	35.6	15.5	3.51	0.976
7.	Adaptations to the proposed change	6.5	8.1	36.8	26.7	21.8	3.5	1.114
8.	Use friendly interface	9.7	16.1	27.3	24	22.9	3.35	1.262
9.	Easy access of the controls	8.1	16.1	32.1	25.6	18.1	3.31	1.176
10.	Good learning resourcess	8.1	16.1	29.4	31.4	14.9	3.3	1.148
11.	Self paced learning	5.5	18.7	34.7	25.6	15.5	3.28	1.102
12.	Past experience of using Augmented Reality for learning	15	5	28.9	24.5	16.5	3.14	1.285
Where	VL-Very Low, L-Low, A-Average, H-High, and VH-Very High							

more interested in learning through blended learning than through traditional learning (CAE,

The benefit of AR learning for introductory school's learning activities

No	Strengths	SD	D	N	A	SA	Mean	Std Dev
1.	Can be shared with large number of students at once	0.2	4.2	4.2	43.8	3.96	4.36	0.757
2.	School willingness to support AR in ansycronous learning	4.4	5	24.5	28.4	3.52	3.92	1.093
3.	Accessibility within and outcide the school	6	7.1	15	39	3.47	3.87	1.127
4.	Minimum skills required to access technology	1.8	7.6	20.8	44.2	3.46	3.86	0.943
5.	School's leadership commitment to implement asyncronous learning	7.6	9.7	14.5	36.3	3.37	3.77	1.211
6.	Able to understand the asncronous learning concepts easily	6	11.8	20.8	36.3	3.25	3.65	1.139
7.	Ability to visualise the aysncronous learning effectively	3.9	7.6	26.1	46.4	3.25	3.65	0.965
8.	Ability to learn independently	5	12.4	24	37.4	3.19	3.59	1.1
	SD-Strongly Disagree, D- Disagree, U-Uncertain, A-Agree, and SA- Strongly Agree							

2017).

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	SD-Strongly Disagree, D- Disagree, U-Uncertain, A-Agree, and SA- Strongly Agree							

Q1: To what extent do you or your school use AR technology in the teaching learning process?
Q2: What are the different ways that AR technology is used (e.g as a learning resource (multimedia tutorials), for learning activities, for students' work etc.
Q3: What is the school's policy with regard to adoption of AR technology for a purpose that is beneficial to the students?
Q4: Is the school open to AR technology integration even if there is some investment needed for hardware/software?
Q5: Does the school use an AR learning Model for any of the subjects? If so, how is the feedback from students?
Q6: What are different AR technological tools that students use in their any subjects in PYP?
Q7: Based on your experience, do you think an asynchronous model will help students learn better? Why do you think so?

Q8: What aspects would you like to be included in an AR method that would benefit the students the most?
Q9: Do you have anything more to add?

Adaption of Augmented Reality for students' Primary Years Programme	
Descriptive statistics for AR awareness	Rating
1. AR increase academic achievement (e.g. grades).	Strongly Agree
2. AR is much better than traditional learning methods.	Strongly Agree
3. AR is effective learning methode and It can implement it successfully.	Strongly Agree
4. AR promotes student collaboration.	Strongly Agree
5. AR is expected to achieve intended use.	Strongly Agree
6. AR promotes the development of communication skills (e.g., writing and pesentation skills).	Strongly Agree
7. AR is much better than traditional learning method.	Strongly Agree
8. AR is suitable for different ages.	Strongly Agree
9. AR is suitable for different gender.	Strongly Agree
10. AR is appropriate to apply in various subjects.	Strongly Agree
11. AR saves time and effort for the students.	Strongly Agree
12. AR will assist in learning and teaching.	Strongly Agree
13. AR will help improve learning outcomes.	Strongly Agree
14. AR meets learning satisfaction and goals.	Strongly Agree
15. AR as a learning tool will increase students learning performa.	Strongly Agree
16. AR will promote self-learning.	Strongly Agree
17. AR takes less time to deliver the information.	Strongly Agree
18. AR as a learning tool is engaging.	Strongly Agree
19. AR is a cooperative learning tool.	Strongly Agree
20. AR will assist learning efficiency.	Strongly Agree
21. AR helps accommodate student's personal learning styles.	Strongly Agree
22. AR motivates students to get more involved in learning activities.	Strongly Agree
23. AR is an effcetive too for students of all abilities.	Strongly Agree
24. AR is effective tecnologies to be integrated with others subjects.	Strongly Agree
25. AR is effective when the medias resources are available.	Strongly Agree
26. AR will reduce amount of stress and axiety students experience.	Strongly Agree
27. AR successful even only without support of parents.	Strongly Agree
28. AR gives theachers the opportunity to be learning facilitators instead of information providers.	Strongly Agree
29. AR can be access anywhere and anytime.	Strongly Agree
30. AR gives students' choices of instructional materials.	Strongly Agree
Figure 1: Adapted from (Alahmari, 2019)	

CONCLUSION

Building tools, material, techniques, and a community while adapting to evolving technologies and expectations was the goal of Augmented Reality Freedom Stories. We intended to improve both digital and historical literacy by cultivating new maker and user communities, and we hoped to better understand AR technology and its possibilities by making and establishing new opportunities for information exchange.

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