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Development of Augmented Reality Learning Kit for the TVET Course at Vocational College

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ABSTRACT

The advancement of the Industrial Revolution 4.0 has a direct impact on various fields including education because it is the basis for the provision of human capital that is balanced with current technological developments. Nowadays, students are more interested in learning by using Teaching Aids based on Augmented Reality (AR) Technology. However, Teaching Aids which is not use AR technology will make it difficult for students to learn an abstract subject, poorly understood and easily bored through traditional teaching approaches. The purpose of this study was to develop a learning kit by using AR technology to improve student visualization, understanding and motivation. Meanwhile, this study also used the Design and Development Research (DDR) approach in developing a learning kit for Types of Lathe Defects assisted by AR. The instrument of this study uses a questionnaire to collect information related to the functionality of the learning kit based on visualization, understanding and motivation of students. The sample of this study consisted of 48 students of Kota Tinggi Vocational College who took the Industrial Machining Course. The data obtained were collected and analyzed using Descriptive Statistics, Central Tendency and Independent T-Test using SPSS version 25. The reliability value of the questionnaire obtained was r = 0.903 which indicates a high level of reliability. The majority of participants gave positive feedback and were interested while using this AR technology. Overall, students can visualize the process of occurrence of the defect, understand how it can occur and be more motivated to learn technical subjects by using AR technology learning kit. The results also showed that there was no significant difference in the mean of visualization score, understanding score and motivation score for this AR technology learning kit. Therefore, the use of this learning kit can help and facilitate students to learn technical courses more effectively.

1. Introduction

The ongoing globalization has driven towards technological sophistication that can create the development of simple multi-purpose machines and be able to perform critical tasks. The

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development of technology today is driven by the changing needs of industrialized focus towards the Industrial Revolution 4.0 (IR4.0). According to Abd Aziz [2], the potential impact of the implementation of Industry 4.0 in the country is also expected to be higher with industry experts projecting added value to the manufacturing sector of 35% to 40%. Along with these changes, various modern technological improvements are being vigorously used in the manufacturing industry to increase productivity.

The education demand is a matter that needs to be emphasized to ensure the balance of development of the country in the future. According to Samian and Awang [50], education can take steps towards the achievement of the desired job. Pursuing quality education requires learning that follows current developments so that it is more relevant and acceptable. The application of technology in education helps to improve student achievement. Various methods can be used to apply the use of technology in learning. According to Tamuri and Ajuhary [56], instructor methods need to use appropriate techniques to increase students' interest during the teaching and learning process. Teachers should also master various forms of teaching and learning techniques in response to the challenges of 21st-century classroom learning [4]. The use of attractive teaching aids can attract students to learn. Accordingly, there is a positive effect on student academic excellence with the use of teaching aids among teachers in schools [20]. A study conducted by Francis [17] showed that students feel motivated through the use of specialized technology in the classroom. Therefore, the use of technology teaching aids can help increase students' motivation to be more motivated to learn.

Various teaching methods should be explored such as the use of applications and teaching aids in learning to ensure that the time allocated can be utilized well [34]. Nevertheless, the lack of teaching aids for some subjects is one of the barriers to the effectiveness of learning delivery [21]. Visualization skills in learning should be emphasized to students in understanding teaching in the field of skills. The reason is, visualization skills are among the important elements in learning engineering subjects [18]. According to bin Nordin *et al.,* [40], the field of engineering requires students' ability to process visual information as well as the ability to develop mental images, draw diagrams or develop symbols to represent their imaginations. Students' visualization skills are weak in skills subjects because students difficult to understand, imagine and visualize an image in 3D through conventional teaching that only uses the method of 'chalk and talk' [55]. This statement is supported by Saidin *et al.,* [49] wherein his study found that the use of the latest technology such as Augmented Reality (AR) can improve visualization compared to using traditional methods.

Students' understanding can be seen in various methods to show the effectiveness of teaching and learning sessions by teachers. According to Lee *et al.,* [32], students' lack of understanding of teacher descriptions cause them to be easily bored and disinterested by using the teacher-centred learning method. Moreover, most students lack understanding while in theory classes that use a teacher-centred approach and cause students to have difficulty understanding while conducting practical work [29]. In the study of Mukhtar *et al.,* [19], the development of the teaching aids IBS component assembly model that uses a video approach can provide understanding to students in showing the real concept of IBS component assembly at a construction site. The reason is, in the study of Noor and Jamaludin [38], to increase higher understanding, the reception of information must use sight senses and hear senses simultaneously. According to Daud *et la.,* [15], the evaluation results from his study showed that the development of AR video application can help students in increasing motivation in completing the next task and will improve their understanding and performance in learning compared to using the old method. It is also supported by Chiang *et la.,* [13] who found that students who learned with an Augmented Reality-based mobile learning approach showed higher motivation in the dimensions of attention, confidence, and relevance than those who

learned with a conventional inquiry-based mobile learning approach. The effect of the use of AR technology can be seen through the study conducted by Wei *et la.,* [57] students 'learning motivation increased by using the application.

2. Education 4.0

The development of technology has intensified in recent times, has now entered the Industrial Revolution 4.0. The Industrial Revolution 4.0 is a concept first introduced by Professor Klaus Schwab while in Geneva at the World Economic Forum in 2016. He is the Founder and Executive Chairman of the World Economic Forum. According to Effoduh [16], the introduction of Industrial Revolution 4.0 is to uncover the technological revolution of the present day and explore how one world is witnessing a transformation that is sure to affect the way we live, interact and work. There are Nine things covered in Industrial Revolution 4.0 among them are cyber security, Augmented Reality (AR), big data, robot autonomy, additive manufacturing, simulation, system integration, cloud computing and the internet of things (IoT).

Education 4.0 is also defined as the use of technology in the context of teaching and learning [31]. The use of technology for teaching and learning is to encourage to open up space for students' interest in current technology. The success of bringing Education 4.0 in the present should adopt a cybergogy approach in line with the Industrial Revolution 4.0 [60]. According to Braund [9], cybergogy is a framework for creating engaging online learning. It uses online approaches and devices to conduct learning and teaching sessions. Zubaidah [61] also says that cybergogy learning encourages students to use computers, devices and the internet to access information. Several approaches can be used in cybergogy learning, including using Augmented Reality (AR) technology [47] and Virtual Reality (VR) [39] which can be practised in 21st-century learning (PAK21).

3. Augmented Reality (AR)

Augmented Reality (AR) is a direct or indirect view of the physical environment of the real world that has been enhanced or augmented by adding virtual computer-generated information to it [10]. Augmented Reality can be seen in several ways, such as through AR glasses that combine the surrounding scenery with computer graphics, or on a smartphone display that does the same using a phone camera to see and manipulate the world in front of an audience. Augmented Reality will keep you still in the real world and place virtual elements as a visual layer in the environment. Immersive AR systems can combine computer elements with real-world elements with depth, perspective and rendering features.

4. Defect In Lathe Machining

According to Kim *et al.,* [28], operating conditions are not always ideal during conventional machining processes due to various faults that occur during the material removal process. Machining defects easily occur when if there is negligence occurs before or during machining if not emphasized. Many defects in machining are inaccuracies in surface roughness dimensions. In the study of Singh *et al.,* [52], defects in lathe have three main factors namely inaccurate cutting parameters, blunt cutting tools and workpiece not secure clamp in the chuck. If cutting parameters such as feed rate, spindle speed or cutting depth is too high, the workpiece surface will be rougher than desired and there may be scratches or worse part is burn effects.

Large cutting depths can make the tool vibrate and cause inaccuracies in cutting. According to da Silva [11], the high cutting speed with a low feed rate is generally the best combination to obtain good surface roughness. In addition, sharp tool points will wear out and become dull with frequent use. With increasing cutting time, the cutting tool eye becomes blunt due to the wear of the tool eye or sharp parts [7]. Blunt tool points will result in inaccurate cutting or machining. Next, if the work part is not installed properly in the chuck, the workpiece can vibrate and change the desired cut. A worse situation can also occur likes an accident while cutting. According to Akinyemi *et al.,* [54], workpieces that are not tightly tied to the chuck can cause accidents in the workplace. All three factors causing these machining defects will be used to develop learning kits using Augmented Reality (AR) technology.

5. ADDIE Model

The development process of this learning kit uses the ADDIE model to solve the problems that have been stated. It covers all the required steps that are present in the ADDIE model (analysis phase, design phase, development phase, implementation phase and evaluation phase). In the design and development phase, researchers use the Design and Development Research (DDR) popularized by Rahma *et al.,* [47] for use in the ADDIE Model. In addition, several tests will be conducted to test the learning kits emphasized in DDR to demonstrate their applicability before use. Researchers use product and tool research types that require using a learning kit development approach and application development. Among the methods used are expert assessment, interviews and questionnaires.

5.1 Analysis

The researcher made an observational and short interview analysis of the problems faced by students in learning the types of lathe defects. The sampling group consisted of industrial machining students of Kota Tinggi Vocational College. This preliminary study is very important to determine the objectives of the development of teaching kits for the types of lathe defects using Augmented Reality (AR). The lack of teaching aids related to lathe defects in learning while using lathe machines causes students not able to understand the content of the lesson.

5.2 Design

In this phase, the researcher will produce a learning kit design that meets the criteria used by teachers during the teaching and learning process. Some of the criteria that are emphasized in this phase are taken from the study by Ismail *et al.,* [24] namely ergonomics, safety, materials and cost. In addition, the design of this product includes preliminary sketches for the development of learning kits. The sketch contains five samples that are lined up showing defects when performing the lathe operation.

5.3 Development

At early development, the Zappar app platform will use to create Augmented Reality (AR). The researcher will incorporate several videos, photos, quizzes, brief notes and descriptions of lathe defects. In this phase, a learning kit will be developed based on the design that has been sketched in

the design phase. Meanwhile, expert validation will also be made to ensure whether the learning kit and the items in the questionnaire follow the specifications and are reliable to run.

5.4 Implementation

In this implementation phase, the learning kit that has been developed will undergo Alpha testing and Beta testing. The researcher will perform an Alpha test to obtain Cronbach's alpha value by using Statistical Package for the Social Sciences (SPSS) version 25. The Alpha test was conducted at the Pusat Latihan Teknologi Tinggi (ADTEC) Batu Pahat consisting of 29 students who took the Diploma of Manufacturing Technology (Machining). The importance of making this test on the learning kit is to see its effectiveness when used by students of Kota Tinggi Vocational College. Next, the researcher conducted the Beta test on users consisting of Malaysian Vocational Certificate (SVM) and Malaysian Vocational Diploma (DVM) students who took the Industrial Machining course at Kota Tinggi Vocational College.

5.4 Evaluation

The results of the feedback will be analyzed using standard deviation and mean. The researcher will conduct a normality test that uses the Shapiro-Wilk method. It is one of the steps before conducting the T-Test or Mann-Whitney U Test to know differences between the two groups with the use of Statistical Package for the Social Sciences (SPSS) version 25. Data analysis includes four parts that are evaluated, namely Part A (Demographics), Part B (Visualization), Part C (Understanding) and Part D (Motivation).

6. Results And Discussion

The use of the Five-point Likert scale became the measurement in the questionnaire. The scores used were strongly disagreed with score 1, disagree for score 2, less agree for score 3, agree with score 4 and strongly agree for score 5. This five-point Likert scale is categorized and interpreted into four levels. Table 1 shows the interpretation of the mean scores for the five source-point Likert scale from Dakir *et al.,* [14] and Kadira *et al.,* [1] adapted from Pallant [45].

Table 1
Interpretation of mean

Mean score	Interpretation
1.00 to 2.33	Low
2.34 to 3.67	Moderate
3.68 to 5.00	High

Data from respondents is an important component. The interpretation of the average score of this questionnaire instrument involves three constructs of elements of visualization, understanding and motivation of the learning kit. Each of these constructs has seven different question items.

Table 2 shows the results obtained from Kota Tinggi Vocational College students who answered the questionnaire according to questionnaire items V1 to V7. Calculations using Descriptive Statistics (standard deviation) and Central Tendency (mean) were made where the mean has a high value based on the interpretation of the mean score as in Table 1. This value also shows, the majority of students agreed with each item of the question asked in the questionnaire. The low mean score on the visualization construct was on the V7 item “I find it easy to interpret visualization using this

learning kit." with a mean value of 4.11 and still at a high level. While the high mean score is on the fifth question item "I am interested in a brief note with a picture that combines colour combinations." with a mean value of 4.59. Based on the calculation of this mean score, the researchers found that students at Kota Tinggi Vocational College agreed with a brief pictorial note that combines colour combinations and the use of this learning kit can improve their visualization.

Table 2
Mean and standard deviation values for visualization variable

No	Item	Mean	Standard deviation
V1.	My visualization power increased with the help of graphics and video displays.	4.22	0.554
V2.	I was able to understand the types of defects found on real objects with the help of the videos shown.	4.30	0.553
V3.	I focus entirely on interactive graphics in the use of Augmented Reality (AR) applications during learning sessions.	4.20	0.619
V4.	I find the use of Augmented Reality (AR) apps and graphic presentations can help improve my visualization skills.	4.35	0.526
V5.	I was intrigued by the brief pictorial notes that incorporated colour combinations.	4.59	0.498
V6.	I easily understand lessons that use a lot of visual approaches rather than words.	4.41	0.580
V7.	I find it easy to interpret visualizations using this learning kit.	4.11	0.567

Table 3 shows the results obtained from the questionnaire according to the items K1 to K7. For the understanding construct, students also agreed with each item of the questionnaire. The low mean score on the visualization construct was on the V4 item "I expect the learning process to be easier by using a learning kit." with a mean value of 4.15 and still at a high level. While the high mean score is on the sixth question item "Brief notes provided in the learning kit become clear when combined with Augmented Reality (AR) technology" with a value of 4.37. As a result of this mean calculation, the researcher found that students' understanding of using this Augmented Reality (AR) assisted learning kit increased.

Table 3
Mean and standard deviation values for understanding variable

No	Item	Mean	Standard deviation
K1	The learning content regarding the types of running disabilities becomes clear with the help of learning kits.	4.28	0.688
K2	The use of this learning kit gives a true picture of how disability occurs when running.	4.26	0.648
K3	When using this learning kit I can learn on my own even at home.	4.33	0.598
K4	I expect the learning process to be easier by using learning kits.	4.15	0.595
K5	Learning the types of running disabilities becomes easy by using interactive methods such as Augmented Reality (AR).	4.24	0.524
K6	The brief notes supplied in the learning kit become clear when combined with Augmented Reality (AR) technology.	4.37	0.532
K7	Content learning using this learning kit is easier than conventional learning.	4.24	0.639

Table 4 shows the results obtained from the questionnaire according to items M1 to M7. As a result of calculating the mean in this motivation construct, the researcher found that students agreed with all the items questioned in this questionnaire. The lowest mean value at M2 item "I pay full attention during the learning session while using this learning kit" with a value of 4.24 but it is still at

a high level according to the interpretation of Table 1. While the highest mean value in this Motivation constructs on the first item "I am excited to use Augmented Reality (AR) technology during the learning session" with a value of 4.50. The conclusion obtained from this mean value shows that the students' motivation at Kota Tinggi Vocational College increased by using Augmented Reality (AR) assisted learning kits.

Table 4
Mean and standard deviation values for motivation variable

No	Item	Mean	Standard deviation
M1	I am excited about using Augmented Reality (AR) technology during learning sessions.	4.50	0.548
M2	I pay full attention during the learning session while using this learning kit.	4.24	0.524
M3	I am excited to study the sub-topics of the types of running disabilities using the help of this Augmented Reality (AR).	4.35	0.566
M4	I would like to study the sub-topics of the types of running disabilities using this learning kit to understand the content of learning.	4.37	0.532
M5	I feel the use of this learning kit encourages me to learn technical subjects.	4.30	0.511
M6	The use of this learning kit can give a boost in the mastery of technical subjects.	4.37	0.532
M7	I am eager to learn a variety of subjects using this learning kit method.	4.37	0.532

6.1 The Significance of the Elements of Visualization, Understanding and Motivation Towards Gender.

To see the differences between male and female students in terms of visualization, understanding and motivation of the learning kit of the types of lathe defects, Independent T-Test has been using. Researchers have listed hypotheses regarding the differences between the two groups based on the mean of visualization score, mean of understanding score and mean of motivation score for male and female students on the learning kit.

Ho = There was no significant difference between male and female students in the mean of the visualization, understanding and motivation scores of Augmented Reality Learning Kit in Type of Lathe Defect.

H1 = There was a significant difference between male and female students in the mean of the visualization, understanding and motivation scores of Augmented Reality Learning Kit in Type of Lathe Defect.

The use of the null hypothesis (Ho) is a formal approach to deciding between two interpretations of statistical relationships in a sample [46]. The alternative hypothesis (H1) is the hypothesis that we want in conducting the study. The null hypothesis (Ho) will be rejected or not accepted if the proof of the alternative hypothesis is accepted through the p-value conducted through the Independent T-Test. The p-value should be below 0.05 (p-value <0.05) to reject the null hypothesis. Table 5 shows the statistical values for male and female students.

Table 5
Independent T-Test

		Levene test	**t**	**df**	**Sig. (2-tail)**	**Mean dif.**
Visual score	The same variance is assumed	0.217	0.513	46	0.610	0.500
	The same variance is assumed		0.615	12.381	0.549	0.500
Understanding scores	The same variance is assumed	0.896	0.236	46	0.814	0.275
	The same variance is assumed		0.238	10.090	0.816	0.275
Motivation score	The same variance is assumed	0.485	0.582	46	0.563	0.600
	The same variance is assumed		0.511	9.003	0.622	0.600

The results of the Independent T-Test conducted on the visualization score, understanding score and motivation score found that the value of the Levene Test for similarity of variance for the three scores exceeded 0.05. The p-values on the visualization score, understanding score and motivation score were greater than 0.05, then, the alternative hypothesis (H1) was rejected and the null hypothesis (Ho) was accepted. There was no significant difference in the mean visualization scores of Augmented Reality Learning Kit in Type of Lathe Defect Machining between male students (M = 30.25, SP = 2.6) and female students (M = 29.75, SP = 1.98); t (46) = 0.513, P = 0.61. Furthermore, there was no significant difference in the mean score of understanding of Augmented Reality Learning Kit in Type of Lathe Defect Machining between male students (M = 29.9, SP = 3.01) and female students (M = 29.625, SP = 2.97); t (46) = 0.236, P = 0.814. Finally, there was no significant difference in the mean motivation score of Augmented Reality Learning Kit in Type of Lathe Defect Machining between male students (M = 30.6, SP = 2.57) and female students (M = 30, SP = 3.117); t (46) = 0.582, P = 0.563. This means that the values of visualization score, understanding score and motivation score for male and female students using this learning kit have no difference due to different gender factors.

The development of an effective learning kit can enhance the elements of visualization [41], understanding [35] and motivation [58] of students. This Augmented Reality (AR) assisted learning kit, can help students visualize learning and understand the types of lathe defects. In the context of visualization, the researchers found that the students of Kota Tinggi Vocational College were very interested in the short pictorial notes that combine colour combinations. This is because top students in polytechnics mostly adopt a visual learning style in receiving input [12]. This is supported by Ali and Abdul Kadir [6] who said that simple and pictorial notes can attract students to understand the content of learning. The use of colour also has an impact on consumers in controlling their emotions. In a study, Sheng and Teo [51] stated that the use of colour can affect a person's emotions. In addition, the use of video projection in Augmented Reality-assisted learning kits to understand the learning content of the types of disabilities can improve their understanding. As in the study conducted by Nurdin *et al.,* [42], video-assisted learning can improve students' understanding of the topics they study.

Furthermore, the increase in test scores that conducted by Lan [30] on students showed an increase. With a combination of Augmented Reality (AR) technology, pictorial brief notes and video projections on the learning kit, students are easy interpret visualizations of learning content. According to Iqliya and Kustijono [22], the use of learning kits that use Augmented Reality (AR) technology can help improve user visualization. Visualization between the genders of male and female students was also increased by using learning kits using Augmented Reality (AR) [25]. There was no significant difference in visualization scores between male and female students on the use of learning kits of the types of lathe defect using Augmented Reality (AR). This situation also occurred in a study conducted by Tahar *et al.,* [55] and also, Isah and Hock [23] in using teaching aids to see the difference in scores between genders. However, the value of the visualization score on the use of learning kits for male and female students got a high value. Mastery of high scores on visualization constructs can have a positive effect on understanding the content of learning. According to Yahya and Abdul Rahman [59], in their study found that the use of visual models can speed up student understanding.

Improving the understanding of the content of learning among students with the help of additional materials in the learning and learning sessions is one of the added values that should be emphasized to strengthen students' understanding. As in this study, the researchers found that brief notes combined with Augmented Reality (AR) technology can make the learning content easy to understand and clear. The use of teaching aids can increase students' interest and understanding in

the lessons from Mohd Bakhir and Zamri [8] study. This is because the use of technology in teaching and learning activities has been proven to increase students' knowledge of a subject. After all, the use of advanced technology can attract students to pay careful attention during teaching and learning sessions [5]. Furthermore, researchers found that the use of learning kits can give a true picture of how a process occurs, especially technical learning. A study conducted by Abd Jalil *et al.,* [3] found that the development of teaching aids can help facilitate students to understand the concepts and views of visualization angles in the subject of engineering drawing. It can be seen from the study by Salsidu *et al.,* [53] that use interactive learning modules can overcome the problem of students' understanding of a topic.

The learning process also becomes easier by using interactive methods such as the use of Augmented Reality (AR) technology compared to traditional learning. According to Arip *et al.,* [37], students easily focus on the content of learning by using teaching aids. The excitement of male and female students can be seen because they easily understand the content of learning in the study of Saad and Wan Mamat [36]. The score value for the understanding score did not show a significant difference between male and female students on the use of learning kits of the types of lathe defect using Augmented Reality (AR). A study conducted by Othman and Pakar [44] showed no significant difference in understanding performance scores between male and female students on the use of interactive software. The understanding between male and female students on the content of learning is increased in a balanced way by using interactive learning materials and the value of the score is also at a high level. Unconsciously, the pleasure of learning can also be evoked and students are easy to motivate themselves in future learning.

Next, the researchers found that students were excited about the use of Augmented Reality (AR) technology during the learning sessions. According to Daud *et al.,* [15], the evaluation results from the study he conducted showed that the development of Augmented Reality (AR) applications can help students in increasing motivation in completing assignments. In addition, in the study of Johar and Abdullah [26], the use of Augmented Reality (AR) on the learning of technical subjects can increase student motivation and stimulate students to continue to focus in teaching and learning sessions. Opinions from study participants conducted by Omar *et al.,* [43] say he is more eager to learn new topics with the help of interactive teaching aids. Researchers also found that this study has the same opinion on the use of Augmented Reality (AR) technology to encourage students to be more enthusiastic to learn technical topics. It is proven that some previous researchers agree that the use of Augmented Reality (AR) technology can increase student motivation. Such as the study conducted by Zulkapli and Suparmaniam [62] in which the application of Augmented Reality (AR) technology can increase the motivation of students' understanding in learning. In addition, the use of learning kits based on Augmented Reality (AR) technology can increase students ’motivation to complete assigned tasks [15]. The motivation of male and female students increases when students can imagine and interact through Augmented Reality (AR) technology in the classroom [27]. The gender differences of males and females in this study did not have significant differences in motivation scores on the use of learning kits of the types of lathe defect using Augmented Reality (AR). Similar to the study conducted by Maarof *et al.,* [33] who showed no significant difference between male and female students on motivation scores on the use of interactive teaching aids.

7. Conclusion

The development of this learning kit has achieved its goal with the help of the use of Augmented reality technology in learning the types of defects in lathe machining. The results of the study conducted on the Kota Tinggi Vocational College students found that they agreed that the use of this

learning kit can improve visualization, understanding and also their motivation towards learning the types of defects in lathe machining. The use of interesting brief notes as well as the Augmented reality technology approach in this learning can increase their learning motivation. The level of improvement in visualization, understanding and motivation can be seen evenly increase despite different genders. As in the study, there were no significant differences between the males and females students in the scores of visualization, understanding and motivation. This study can further expand the use and function of other machines to facilitate students to learn online.

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References

[1] Kadira, R. B. A., T. S. A. Saidb, and L. Thangaveluc. "IR 4.0 knowledge and readiness of lecturers at the Teachers Education Institute, Technical Education campus, Malaysia." *International Journal of Innovation, Creativity and Change* 11, no. 11 (2020): 1-29.
[2] Abd Aziz, M. (2019, November). Aplikasi teknologi lonjak produktiviti. Berita Harian.
[3] Abd Jalil, Siti Arfah Binti, Zafarida Binti Kadir, and Normawar Binti Ali. "Pembangunan Alat Bahan Pembelajaran Lukisan Kejuruteraan 'Orthographic Projection Box'." *Journal on Technical and Vocational Education* 4, no. 3 (2019): 155-161.
[4] Abdullah, Rabaah, Wan Noorlizawati Wan Mat Ali, and Adnan Jusoh. "The Use of Teaching Aids (BBM) in the Subject Theme of "Colonization in Southeast Asia in the 19th Century": Penggunaan Bahan Bantu Mengajar (BBM) dalam Subjek Tema "Penjajahan di Asia Tenggara pada Abad ke-19"." *Perspektif Jurnal Sains Sosial dan Kemanusiaan* 13, no. 1 (2021): 1-13.
[5] Ali, Azita, Lutfiah Natrah Abbas, and Azrina Mohmad Sabiri. "Keberkesanan Pembelajaran Gamifikasi dalam Pencapaian Pelajar bagi Topik Nombor Kompleks: Effectiveness of Gamification Learning in Studentâ€™ s Achievement for Complex Number Topic." *Online Journal for TVET Practitioners* 6, no. 2 (2021): 108-122.
[6] Ali, Dayana Farzeeha, and Nurkhadijah Abdul Kadir. "M-Pembelajaran Aplikasi Android bagi Kursus Binaan Bangunan (M-Learning-based Android Application for Building Construction Course)." *Innovative Teaching and Learning Journal* 2, no. 2 (2018).
[7] Aramcharoen, Ampara, and Shaw Kah Chuan. "An experimental investigation on cryogenic milling of Inconel 718 and its sustainability assessment." *Procedia Cirp* 14 (2014): 529-534. https://doi.org/10.1016/j.procir.2014.03.076
[8] Mohd Bakhir, Norfarizah, and Mohd Zazril Ikhmal Zamri. "Penggunaan bahan bantu mengajar berasaskan papan pelbagai sentuh untuk pembelajaran sains tahun tiga." (2016).
[9] Braund, A. (2018). Engagement of Distance Students Cybergogy. 2018 Scholarship of Teaching Conference.
[10] Furht, Borko, ed. *Handbook of augmented reality*. Springer Science & Business Media, 2011. https://doi.org/10.1007/978-1-4614-0064-6
[11] da Silva, Lucas FM, ed. *Materials Design and Applications II*. Springer International Publishing, 2019. https://doi.org/10.1007/978-3-030-02257-0
[12] Kob, Che Ghani Che, Mai Shihah Abdulah, Arasinah Kamis, Zaliza Hanapi, and Ridzuan Che Rus. "Amalan gaya pembelajaran pelajar cemerlang di Politeknik Seberang Perai: Kajian pelajar Malaysia berdasarkan model Felder Silvermen (Learning styles of high achievers at the Seberang Perai Polytechnic: A study of Malaysian students based on the Felder Silvermen model)." *Geografia* 12, no. 3 (2016).
[13] Chiang, Tosti HC, Stephen JH Yang, and Gwo-Jen Hwang. "An augmented reality-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities." *Journal of Educational Technology & Society* 17, no. 4 (2014): 352-365.
[14] Dakir, Jawiah, Mohd Yusof Hj Othman, Ab Halim Tamuri, Zakaria Stapa, Shamsul Azhar Yahya, Siti Ismail, and Ibrahim Maheran. "Islamic education and level of character internalization of secondary school students in Malaysia." *Mediterranean Journal of Social Sciences* 6, no. 4 (2015): 602. https://doi.org/10.5901/mjss.2015.v6n4p602
[15] Daud, Rafizah, Noor Azah Abd Raman, and Zarulrizam Ab Jalil. "Penggunaan Augmented Reality video di dalam pendidikan TVET." *International Journal of Education and Pedagogy* 2, no. 1 (2020): 253-263.
[16] Effoduh, Jake Okechukwu. "The fourth industrial revolution by Klaus Schwab." (2016): 4. https://doi.org/10.60082/2563-4631.1023

[17] Francis, James. "The effects of technology on student motivation and engagement in classroom-based learning." (2017).
[18] Abang Ibrahim, Dayang Suryati, and Abdullah Mat Rashid. "Pengaruh Pencapaian Akademik dan Tahap Memori Visual Jangka Pendek terhadap Tahap Kemahiran Visualisasi Murid yang Mengambil Mata Pelajaran Lukisan Kejuruteraan." *International Journal of Education and Training (InjET)* 1, no. 2 (2015): 1–8.
[19] Mukhtar, Marina Ibrahim, Rohayu Roddin, and Muhammad Hazriq Khudhairi. "Model Pemasangan Komponen Industrial Building System (IBS) Sebagai Alat Bahan Bantu Mengajar (ABBM)." *Online Journal for TVET Practitioners* 4, no. 2 (2019): 127-132.
[20] Ilias, Mohd Faeez, Kalthom Husain, Mohd Amin Mohd Noh, Zetty Nurzuliana Rashed, and Murihah Abdullah. "Sumber bahan bantu mengajar dalam kalangan guru Pendidikan Islam sekolah bestari." *e-Academia Journal* 5, no. 2 (2016).
[21] Ilias, Mohd Faeez, Muhamad Faiz Ismail, Kamarul Azmi Jasmi, M. F. Ilias, M. F. Ismail, and K. A. Jasmi. "Faktor dorongan dan halangan penggunaan bahan bantu mengajar oleh guru Pendidikan Islam di sekolah bestari." In *3rd International Conference on Islamic Education*, vol. 5, no. 1, pp. 943-953. 2013.
[22] Iqliya, J. N., and R. Kustijono. "Keefektifan media augmented reality untuk melatihkan keterampilan berpikir kritis siswa." In *Proceedings of the Universitas Negeri Surabaya Physics Seminar*, vol. 3, pp. 19-25. 2019.
[23] Isah, Noornabilah, and Tan Tong Hock. "Penggunaan peta pemikiran I-THINK dalam amalan pedagogi Matematik dalam kalangan guru pelatih Institut Pendidikan Guru." *Jurnal Penyelidikan Teknokrat II* JILID XXI (2020).
[24] Ismail, Mohd Erfy, Anies Faziehan Zakaria, Irwan Mahazir Ismail, Hasyamuddin Othman, Mohd Ali Samsudin, and Pipit Utami. "Design and development of augmented reality teaching kit: in TVET learning context." *International Journal of Engineering & Technology* 8, no. 1 (2019): 129-134. https://doi.org/10.14419/ijet.v8i1.1.24792
[25] Jamen, Kherul Jefri, Nor Syatilla Haerany Abd Ghani, Siti Zahirah Nordin, and Ilyana Mohammad Kamel. "Keberkesanan 3-D Molecular Visualization Augmented Reality (V-Max) Terhadap Pencapaian dan Kemahiran Visualisasi Pelajar dalam Topik Ikatan Kimia." *Journal on Technical and Vocational Education* 6, no. 2 (2021): 42-68.
[26] Johar, Siti Hajar, and Nurhanim Saadah Abdullah. "Pembangunan e-Modul Augmented Reality bagi Subjek Semiconductor Devices untuk Guru TVET." *Online Journal for TVET Practitioners* 4, no. 2 (2019): 99-104.
[27] Kaur, Deepti Prit, Archana Mantri, and Ben Horan. "Enhancing student motivation with use of augmented reality for interactive learning in engineering education." *Procedia Computer Science* 172 (2020): 881-885. https://doi.org/10.1016/j.procs.2020.05.127
[28] Kim, Dong-Hyeon, Thomas JY Kim, Xinlin Wang, Mincheol Kim, Ying-Jun Quan, Jin Woo Oh, Soo-Hong Min et al. "Smart machining process using machine learning: A review and perspective on machining industry." *International Journal of Precision Engineering and Manufacturing-Green Technology* 5 (2018): 555-568. https://doi.org/10.1007/s40684-018-0057-y
[29] Kong, H. P., Mei Heong Yee, Md Y. Jailani, Tze Kiong Tee, Boon Ching Kok, and O. Widad. "Pembangunan Model Sistem Sanitasi, Perparitan Dan Pembentungan Sebagai Alat Bahan Bantu Dalam Subjek Sistem Sanitasi, Perparitan Dan Pembentungan." *Online Journal for TVET Practitioners* 3, no. 2 (2018).
[30] Lan, Yong Shu. "Gabungan pendekatan konstruktivisme dan behaviorlisme bagi meningkatkan prestasi mata pelajaran sejarah tingkatan tiga." In *Seminar Pendidikan Sejarah Dan Geografi. UMS.(29–30 Ogos)*. 2013.
[31] Lawrence, Rasika, Lim Fung Ching, and Haslinda Abdullah. "Strengths and weaknesses of education 4.0 in the higher education institution." *International Journal of Innovative Technology and Exploring Engineering* 9, no. 2 (2019): 511-519. https://doi.org/10.35940/ijitee.b1122.1292s319
[32] Lee, Ming Fong, W. K. Goh, and K. H. Tan. "Meningkatkan kemahiran dan penguasaan topik hidroponik murid darjah enam dengan teknik DIY." *Online Journal for TVET Practitioners* (2018).
[33] Maarof, Nurul Hafizah, Norfiza Apfandi, Nurul Suzaina Joli, and Rorlinda Yusof. "ITRACK dalam PDP Sejarah: Tinjauan terhadap motivasi pelajar." *International Journal of Education and Pedagogy* 2, no. 1 (2020): 83-97.
[34] Md Azhar, S. N. A., and Abd Rahman, M. J. "Aplikasi telegram sebagai media pembelajaran interaktif secara global." In *International Conference on Global Education V.* April, 10–11. 2017.
[35] Zahri, Azyan Binti Md, and Mohammed Isa Bin Osman. "Kit Pembelajaran Litar Siri, Selari Dan Siri-Selari." *Journal on Technical and Vocational Education* 4, no. 1 (2019): 15-22.
[36] Saad, Norhana Mohamad, and Wan Norsilawati Wan Mamat. "Geome3 Smart Kit Meningkatkan Kefahaman Konsep Poligon Dalam Kalangan Murid Tingkatan 2 Al Bukhari." *International Online Journal of Language, Communication, and Humanities* (2022): 41-51.
[37] Arip, M. A., F. B. Sa'ad, Norhidayah Binti Jaapar, Khairiyah Binti Mohd Ali, Najwa Hananie Binti Athdzar, and W. N. B. W. A. Rashid. "Faktor, kesan dan strategi menangani permasalahan kurang tumpuan pelajar sekolah menengah di dalam kelas: suatu kajian kualitatif." In *International counseling conference and work*. 2014.
[38] Noor[1], Norani Mohd, and Norhanis Jamaludin. "Kesan Penggunaan Perisian Kursus Pengajian Kejuruteraan Mekanikal Terhadap Gaya Pengajaran Guru Kejuruteraan Mekanikal Di Sekolah Menengah Teknik Di Terengganu."

[39] Nisha, Bobby. "The pedagogic value of learning design with virtual reality." *Educational Psychology* 39, no. 10 (2019): 1233-1254. https://doi.org/10.1080/01443410.2019.1661356
[40] bin Nordin, Mohd Safarin, Kamalularifin bin Subari, and Mohd Zolkifli bin Abdul Hamid. "Visualization skills and learning style patterns among engineering students at Universiti Teknologi Malaysia." *Procedia-Social and Behavioral Sciences* 93 (2013): 1769-1775. https://doi.org/10.1016/j.sbspro.2013.10.114
[41] Noviani, Evi, Helmi Helmi, Mariatul Kiftiah, Yudhi Yudhi, Fransiskus Fran, and Meliana Pasaribu. "Pelatihan Visualisasi Materi Pembelajaran Matematika dengan Geogebra." *Jurnal Abdimas* 25, no. 1 (2021): 1-9.
[42] Nurdin, Erdawati, Zubaidah Amir, Risnawati Risnawati, Noviarni Noviarni, and Memen Permata Azmi. "Pemanfaatan video pembelajaran berbasis Geogebra untuk meningkatkan kemampuan pemahaman konsep matematis siswa SMK." *Jurnal Riset Pendidikan Matematika* 6, no. 1 (2019): 87-98. https://doi.org/10.21831/jrpm.v6i1.18421
[43] Omar, Salmah, Mohamed Ali Haniffa, Nor Hanani Ismail, and Mohan Rathakrishnan. "Aplikasi kuiz interaktif kahoot dalam pembelajaran dan pemudahcaraan (P&P) kursus kenegaraan Malaysia di Universiti Utara Malaysia." (2020).
[44] Othman, Yahya, and Dayang Raini Pakar. "Kesan aplikasi perisian cerita interaktif semasa mengajarkan kemahiran bacaan dan kefahaman dalam kalangan murid tahun 4 di Brunei Darussalam." *Jurnal Pendidikan Bahasa Melayu* 1, no. 1 (2021): 27-49
.[45] Pallant, J. "Manual, SPSS Survival. A step by step guide to data analysis using the SPSS program." *SPSS Survival Manual* 494 (2010).
[46] Price, P., R. Jhangiani, and I. Chiang. *Research methods of psychology–2nd Canadian edition. Victoria, BC: BCcampus*. 2015.
[47] Rahma, Rezka Arina, Yessi Affriyenni, and Monica Widyaswari. "Cybergogy as a Digital Media to Facilitate the Learning Style of Millennial College Students." *World Journal on Educational Technology: Current Issues* 13, no. 2 (2021): 223-235. https://doi.org/10.18844/wjet.v13i2.5691
[48] Richey, Rita C., and James D. Klein. *Design and development research: Methods, strategies, and issues*. Routledge, 2014. https://doi.org/10.4324/9780203826034
[49] Saidin, Nor Farhah, Noor Dayana Abd Halim, and Noraffandy Yahaya. "A review of research on augmented reality in education: Advantages and applications." *International education studies* 8, no. 13 (2015): 1-8. https://doi.org/10.5539/ies.v8n13p1
[50] Samian, Samruhaizad, and Azahan Awang. "Pendidikan sebagai komponen kualiti hidup masyarakat pinggir bandar (education as quality components of life in the suburban community)." *Asian Journal of Environment, History and Heritage* 1, no. 1 (2017).
[51] Sheng, Margaret L., and Thompson SH Teo. "Product attributes and brand equity in the mobile domain: The mediating role of customer experience." *International journal of information management* 32, no. 2 (2012): 139-146. https://doi.org/10.1016/j.ijinfomgt.2011.11.017
[52] Singh, Karamjit, Gurpreet Singh Bhangu, and Supinder Singh Gill. "Optimization of surface roughness in Cnc turning of aluminium using Anova technique." *Advancements in Engineering and Technology* (2015): 583.
[53] Salsidu, Siti Zulaidah, Mohamed Nor Azhari Azman, and Hendri Pratama. "Trend pembelajaran menggunakan multimedia interaktif dalam bidang pendidikan teknikal: Satu sorotan literatur." *Sains Humanika* 10, no. 3 (2018). https://doi.org/10.11113/sh.v10n3.600
[54] Akinyemi, Olasunkanmi Oriola, Solomon Olanrewaju Giwa, Hezekiah Oluwole Adeyemi, Adeshinaayomi Lawal Akintan, and Mebude Oladapo. "Fault tree analysis of fly-outs in metal lathe machine operations." *Safety Engineering* 5, no. 1 (2015): 9-19. https://doi.org/10.7562/se2015.5.01.02
[55] Tahar, Mohd Salleh, Ahmad Esa, Mohd Bekri Rahim, Jamil Abd Baser, Syazwani Shuib, and Yahya Buntat. "Keberkesanan Penggunaan CD Interaktif Lukisan Isometrik Terhadap Kemahiran Visualisasi Pelajar." *Journal of Technical, Vocational & Engineering Educational* 3 (2011): 104-115.
[56] Tamuri, Ab Halim, and Mohamad Khairul Azman Ajuhary. "Amalan pengajaran guru Pendidikan Islam berkesan berteraskan konsep mu'allim." *Journal of Islamic and Arabic Education* 2, no. 1 (2010): 43-56.
[57] Wei, Xiaodong, Dongdong Weng, Yue Liu, and Yongtian Wang. "Teaching based on augmented reality for a technical creative design course." *Computers & Education* 81 (2015): 221-234. https://doi.org/10.1016/j.compedu.2014.10.017
[58] Wulandari, Murfiah Dewi. "Media Pembelajaran Kit IPA untuk Meningkatkan Motivasi Siswa: Media Pembelajaran Berbasis Kurikulum 2013." In *SEMINAR NASIONAL DAN CALL FOR PAPERS*, 91–100. 2013.
[59] Yahya, Faezah, and Muhammad Shaiful Azmi Abdul Rahman. "Keberkesanan Kefahaman Penggunaan Model Visual Of Commercial Planning Standard Oleh Pelajar Diploma Perancangan Bandar Dan Wilayah Dalam Penyediaan Pelan Cadangan Susun Atur Perniagaan." *Journal on Technical and Vocational Education* 2, no. 1 (2017): 62-70.
[60] Zubaidah, Siti. "Pendidikan biologi dalam perkembangan revolusi industri." In *Seminar Nasional Pendidikan Biologi Dengan Tema "Biologi Di Era Revolusi Industri"*, vol. 4, pp. 1-22. 2019.

[61] Zubaidah, Siti. "Self Regulated Learning: Pembelajaran dan Tantangan pada Era Revolusi Industri 4.0." In *Prosiding SNPBS (Seminar Nasional Pendidikan Biologi dan Saintek)*, pp. 1-19. 2020.

[62] Zulkapli, Rohayu, and Chitra Suparmaniam. "ART_ISM: Aplikasi Pintar dengan Penerapan Teknologi Augmented Reality dalam Meningkatkan Motivasi Kefahaman Dan Daya Mengingat Karya Sejarah Seni Abad Ke-20." *Pembangunan Penyelidikan Dan Inovasi Dalam: Teknologi, Pendidikan Dan Sains Sosial* (2020): 25-36.