



Effect of Game-Based Learning in Vehicle Air-Conditioning Course on Cognitive and Affective Skills of Vocational Students

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Abstract: Refrigerant and air conditioning course in vocational college is challenging to students and teachers as indicated by the unsatisfactory student's examination results. Students come diverse backgrounds with poor basic skills and low motivation which, is difficult to address using the traditional interactive teaching and learning methods as currently practiced by teachers. Therefore, game-based learning is suggested as an alternative to increase students' motivation and achievement. A study was conducted to assess the effect of game-based learning on learning of the cognitive (recall the fact, concept, and procedure) and affective (respond/reaction) skills of vocational students in automotive air-conditioning course. A quasi-experiment was conducted on 30 students from two vocational colleges who were randomly assigned to the experimental and control group. The experimental group underwent a game-based learning method and tested using pre-test, post-test, and questionnaire. Whereas the control group underwent the existing method and tested using only pre-test and post-test. The teaching and learning module were developed based on the ADDIE model. The module has been analysed for usability and method. The results of this experiment show that the achievement of the experimental group is better than the control group. The students show good responses and reactions towards game-based learning. In conclusion, game-based learning is effective for student's cognitive and affective skills in this course.

Keywords: Cognitive, affective, game-based learning, automotive air-conditioner

1. Introduction

Technical and vocational education (TVE) is an education system that is designed to specifically develop a workforce that possesses high technical skills as well as people skills (Kayan, Hamzah & Udin, 2010). Malaysian Vocational College is one of the institutions under the TVE system. The main objectives of these colleges are to supply a competent and able workforce for the future that are capable to fulfil industrial needs and entrepreneurship (Ministry of Education Malaysia (MoE), 2019). One of the current industrial needs is in automotive air-conditioning and thus a programme related to automotive air-conditioning has been offered at the Diploma level in dedicated Vocational Colleges. In the programme, students are required to complete the air-conditioning and refrigeration technology programme as a requirement for the award of the Malaysian Skills Diploma and the Malaysian Skills Certificate (SKM) upon graduation (MoE, 2019). Students are exposed to the theoretical and practical aspects of content associated with the programme in the Vocational Colleges (MoE, 2017). Most engineering students from vocational colleges have high kinaesthetic intelligence (Lee, Lai, & Wahid, 2017). Kinaesthetic Intelligence (KI) is one of the intelligence proposed under the

multiple intelligence theory by Gardner (2008). People with high KI tend to have stronger preferences towards hands-on activities, product creation and are highly capable in physical activities such as drawing, welding, and carving (Mustapha & Wahyudi, 2018).

In the first two semesters of the Air-Conditioning and Refrigeration Technology programme, the focus is on developing students' understanding of cooling and conditioning concepts and processes. In brief, students need to grasp the concept of refrigeration as a cooling process that utilizes heat transfer from a low-temperature source, medium or refrigerant to high temperature for thermal regulation (Kreith, Wang & Norton, 2018). In the 3rd semester, students enrol in a Vehicle Air-conditioning course that exposes them to the theory and practice of air-conditioning: diagnosis, repair and maintenance of a vehicle's air conditioning systems and components. The teaching and learning method is tailored to the students for better visualization and comprehension for the students to comprehend the complexity of the system (Rashid, Boon & Ahmad, 2017). Understanding the principles and methods to be used for the repair and maintenance of vehicle air conditioning are important to better explain the phenomenon that occurs due to damage to a main air conditioning system component. However, the traditional class learning sessions are often not effective in developing the necessary knowledge and understanding. Traditional teaching and learning techniques such as lectures are teacher-centred promote passive learning (Rashid et al., 2017) due to the absence of two-way communications as students passively receive information from their teachers. The traditional teaching and learning method are thus, ineffective in promoting students' engagements with the learning content and consequently fail to support learning.

The use of innovative teaching aids is crucial in supporting effective education (Isa & Ma'arof, 2018). However, innovative teaching aids in the teaching of air conditioning and refrigeration is not the practice in community colleges or other vocational institutions due to time and financial constraints (Muhadzir & Yusuf, personal communication, November, 2017). Using appropriate materials is important in capturing students' attention to promote engagement with and motivation towards learning. Motivation refers to the behaviour of oneself that is either driven, directed, or sustained to maintain (McInemey, 2013) success or an objective (Rashid et al., 2017). Motivation and confidence have a great influence on learning success (Mohamad et al., 2021; McInemey, 2013). Effective teaching and learning that promotes engagement and motivation will support the assimilation of new knowledge into an existing structure, enhancing proper students' understanding of theories and concepts.

Technology-supported teaching aid in the form of games albeit online or offline enables students to think critically and creatively as they attempt to solve problems faced in the games. Game application has the potential to become an effective tool for content delivery; through games, it motivates, connects, and stimulates a higher thinking order and able to manipulate time perception for a suitable learning experience (Van Eck, 2006; Gee, 2003; Alessi & Trollip, 2001; Rieber, Smith, & Noah, 1998). Commercially available game application has been successfully integrated into the teaching world, via gameplay, graphic, and audio, well into the game (Charsky & Ressler, 2011). The use of games to incite learning is not something new (Abt, 1970), but improvements have been made to further improve the game experience.

The objectives for this paper are to identify the effectiveness of game-based learning towards cognitive skills (recall, concepts, and process), and to identify the responds/reactions (evaluation/appreciation) of vocational students toward game-based learning.

1.1 Conceptual Framework

Figure 1 shows a conceptual framework for the effect of game-based learning in Vehicle Air-Conditioning topic towards the vocational student. This framework illustrated the student's appreciation toward the use of game material, it will motivate the student to study (the effort to study); when the student uses the game material, they will start showing appreciation by their effort to study and therefore will enhance student's achievement.

The student's cognitive skills were assessed via pre-tests and post-tests while their affective skills were assessed using a questionnaire. In this study, the independent variable was the teaching and learning method which was game-based and traditional learning, and the dependent variable was students' cognitive (test score) and affective skills (questionnaire score).

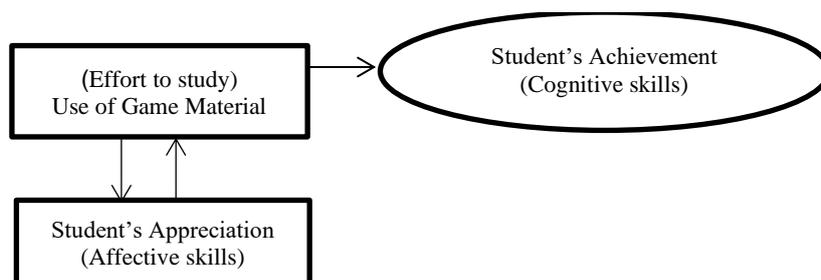


Fig. 1 - Conceptual framework

2. Game-based Learning: Theory and Practice

Game-based learning is learning through playing; where the game is structured in such a way that gives chances to students to explore something new, informally, independently while having fun (Rashid et al., 2017). Through play, students can enhance their self-potential, creativity, and critical thinking skills. Furthermore, game-based learning promotes cognitive, affective, and psychomotor skills development. However, the game-based approach must be suitable and safe based on the student's needs (Mamat & Ismail, 2010). Piaget's theory (1965) suggests the factors that contribute to the effectiveness of game-based learning. First, students can express their feeling, emotions, and ideas through play – thus reducing anxiety in learning new things. Second, students can learn to solve problems which can increase their intellect and they can practice the learning processes such as revision and exploring which further supports learning (Rashid et al., 2017; Mamat et al., 2010). Furthermore, when implemented in groups, learning through play can develop social skills, motivations, and self-confidence (Rashid et al., 2017).

Many research has been conducted on the effectiveness of game-based learning on student's achievement and motivation. Some findings indicate positive effects while there are a few that indicate negative effects. Based on research that been conducted by Hargaden, Papakostas dan Toomey, (2017), on the training conducted by an electrical engineering-based company, researchers suggest that the company need to use more appropriate learning method and consider using game-based learning to boost up the quality of, their training program (Hargaden et al., 2017). Another study that supports the use of game-based learning is that by Perera, Hewagamage and Weerasinghe, (2017). Game-based learning has also been found to be an effective method to motivate learning and useful in evaluating learning (Correia, & Santos, 2017). Positive effect on motivation is also supported by Yeh, Hung and Hsu (2017), Zhu, Zhang, Brown, Dabipi, Peterson and Joshi, (2017), and Papastergiou (2009). Game-based learning is also helpful in another way as students can engage actively in teaching and learning sessions (Wong, Hayati, Yatim & Hoe, 2017; Hargaden et al., 2017) whether in a small or big discussion group (Yeh et al., 2017).

Despite its benefits, there are also some concerns raised against game-based learning such as the usage of the smartphone during teaching and learning sessions (Correia et al., 2017) and difficulties faced by students in mastering the game application (Correia et al, 2017). These concerns are however not serious as they can be addressed through teachers' supervision (Charsky et al, 2011). There are also some suggestions to combine game-based learning with other learning methods that can enhance its effectiveness, such as integrating it with the Scaffold concept method (Charsky et al, 2011). This study did not include method integration however but limit its scope to game-based learning only. These potential negative effects are not expected in this research because there are limitations and control imposed on the usage of smartphones and gaming activities which were conducted strictly under the teacher's supervision.

3. Methodology

The quasi-experiment with pre-test and post-test design was used to evaluate the effectiveness of game-based learning. The design is illustrated in Figure 2.

Treatment	R	O	X	O'
Control	R	O		O'
R	participants randomly assigned to the group.			
O	participants were given a pre-test on the topic			
X	participants who received treatment			
O'	participants were given a post-test on the topic			

Fig. 2 - Research design

The treatment group was given the new approach, while the control group was excluded as suggested by Mertens (2014). Participants were selected at random and assigned to different groups (R). The two groups were then given the pre-test to assess their knowledge on the vehicle air-conditioning topic (O). After the pre-test, the game-based approach was prescribed to the experimental group (X), while the traditional teaching method was used on the control group. In the third phase, both groups were given the post-test (O'). The pre-test and post-test data for both groups were recorded.

The research population consisted of students who were enrolled in the Refrigeration and Air-Conditioning Technology course in Malaysian Vocational Colleges. Two Vocational Colleges were selected as the locations for the study namely, Temerloh Vocational College and Tengku Ampuan Afzan Vocational College in Bentong, Pahang. The colleges were selected based on similarities in the program offered (Refrigeration and Air-Conditioning Technology), expertise and facilities. Participants were selected at random within the selected vocational college and were assigned to the respective groups. There were 15 male participants and only Malay race for both groups. This shows that there were no female students and other races enrolled in this course for both vocational colleges. Therefore, most participants who are enrolled in the Refrigerant and Air-Conditioning Technology course for the control and treatment group are male.

3.1 Research Instruments

Three instruments were used in this research namely pre-test, post-test, and a questionnaire.

a) Cognitive skills test

The pre-test and post-test were used to evaluate student’s cognitive skills (fact, concept, and procedure recall) toward the teaching and learning methods of Vehicle Air-Conditioning topic. The question sets contained 14 objectives questions that have been verified by expertise. Cronbach’s Alpha for 14 test items were .077 and acceptable reliability.

b) Affective test

The questionnaire adapted by the Intrinsic Motivation Inventory (IMI) model, as shown in Table 1, was used to assess the effects of game-based learning on students’ affective skills. It was divided into two parts, Part A (demography) and Part B (reaction/response) that used 5-point of Likert scale. The reliability of the performance questionnaire was estimated using the Cronbach’s Alpha (α) method. The questionnaire consisted of 20 items ($\alpha = .907$) indicating highly reliable.

Table 1 - The Effects of Game-Based Learning on Students’ Affective Skills

Items
1. I am interested to this activity because I could learn more on this topic.
2. I able to perform well in this activity
3. I am satisfied with my performance at this activity.
4. I think this is an important activity.
5. I think this is important to do because it can improve my knowledge.
6. This activity makes me understand the importance of this topic in future.
7. I tried very hard on this activity.
8. I believe this activity improve my learning method.
9. I believe this activity could be of some value to me.
10. I will do this activity again because the activities are beneficial to me.
11. The content of this activity improves my ability to learn this topic.
12. After working at this activity, I felt motivated to improve my knowledge on this topic.
13. The content of this activity holds my attention.
14. The contents of the online game are related to my knowledge.
15. The contents of the online game are easy to understand.
16. I am satisfied for having chance to apply my knowledge in this activity.
17. I understand this content very well.
18. I gain more knowledge on this topic.
19. The activities content is suitable for my knowledge.
20. I have a good understanding of this online game contents.

3.2 Research Procedure

There are three crucial phases in this research procedure.

a) First Phase: Selection and Grouping Research Sample.

Vocational students were selected as participants and assigned to the control and treatment group. The pre-tests were distributed to both groups to acquire information on student’s existing knowledge and understanding of the topic.

b) Second Phase: Teaching and Learning Process.

Different teaching and learning methods were implemented for both groups which were game-based learning for the treatment group and the traditional learning method for the control group. The treatment group used an online game platform, Quizizz, as the method of game-based learning whereas the control group underwent traditional learning such as lectures and demonstration.

- c) Last Phase: Post-test
Questionnaires were distributed to the treatment group only to evaluate students' affective skills after undergoing the treatment method. This experiment was carried out for 8 weeks according to the syllabus of the Refrigeration and Air-Conditioning Technology program. The data from the pre-test, post-test and questionnaire were used for data analysis.

4. Data Analysis and Results

This topic is discussing the equivalent for both group results, the effect on cognitive skills and affective skills.

4.1 Equivalence between Control and Treatment Group of Pre-test's Result

To compare pre-test results between treatment and control group, an independent samples *t*-test was conducted. The *t*-test indicate that there was no significant difference, $t(28) = .272, p > .05$ (Table 2). These results show that pre-test result of Control group ($M = 59.87, SD = 12.46$) was not significantly different from Treatment group ($M = 58.53, SD = 14.29$). Thus, it can be concluded that the treatment and control groups are equivalent in terms of knowledge mastery.

Table 2 - Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Pre-Test	Equal variances assumed	.085	.772	-.272	28	.787	-1.3333	4.8948	-11.3599	8.6933
	Equal variances not assumed			-.272	27.492	.787	-1.3333	4.8948	-11.3683	8.7016

4.2 The Effect of Game-Based Learning on Cognitive Skills

Different distributions are observed for the two groups and the normality test shows one distribution to be normally distributed while the other is not normally distributed (Table 3). Therefore, the Mann-Whitney U test is used as one data set is not normally distributed and the sample size is small ($n < 30$) (Alias, Mohamed, Lai, Masek, & Suradi, 2016).

Table 3 - Normality test for Post-Test

		Group	p-value
Post-test		Treatment	0.025
		Control	0.197

Based on Table 4, the mean of post-test for Treatment group was 91.07 ($SD = 9.11$) whereas mean for Control group was 74.73 ($SD = 10.25$). The result was not normally distributed, with skewness of $-.57$ and $-.90$ respectively ($SE = .58$). In order to compare the differences results between the control and treatment group, Mann-Whitney test was conducted because one of the groups was not normally distributed. The ranks table (Table 5) shows the mean and sum of ranks for the control and treatment group and indicates. The highest mean ranks indicated the group that has higher results. The null hypothesis to be tested: There is no significant difference in mean ranking between the control and treatment group in cognitive skills.

	N	M	SD	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error
Control	15	74.7333	10.25020	-.567	.580
Treatment	15	91.0667	9.11409	-.899	.580
Valid N (listwise)	15				

Group	N	Mean Rank	Sum of Ranks
Post-Test Treatment	15	21.23	318.50
Control	15	9.77	146.50
Total	30		

	Post-Test
Mann-Whitney U	26.500
Wilcoxon W	146.500
Z	-3.631
Asymp. Sig. (2-tiled)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000 ^b

a. Grouping Variable: Student
b. Not corrected for ties

A Mann-Whitney U test indicated that the post-test result was greater for the treatment group (*Mdn* = 93) than the control group (*Mdn* = 71). There was a significant difference for both group, $U = 26.5$, $z = -3.631$, $p = .0003$. Therefore, the null hypothesis was rejected, the treatment group have greater achievement than the control group in cognitive skill.

4.3 The Effect of Game-Based Learning on Affective Skills (Students’ Response/Reaction towards Online Game Application)

This analysis is to identify the response/reaction (Affective Skills: Value/appreciate level) for the treatment group. The data from participants’ feedback shows the mean score for student’s response toward Quizlet activities is 4.41 (*SD* = .53). The highest mean recorded is 4.73 (*SD* = .53) which corresponds to item 10. The item states that the students will do this activity again because the activities are beneficial for them. Whilst the lowest mean is 4.07 (*SD* = 0.59) which is the second item, stating that “the student able to perform well in this activity” as shown in Table 7.

Items	Mean	Standard Deviation
2. I able to perform well in this activity	4.07	0.59
10. I will do this activity again because the activities are beneficial to me.	4.73	0.46

Based on Table 8, the mean score for the student’s response/reaction toward Quizlet’s learning content is 4.46 (*SD* = .52). The highest mean recorded is 4.60 (*SD* = .51) (item 14, 15 and 20). The lowest mean score is 4.27 (*SD* = .46) corresponding to a statement, “the activities content is suitable for student knowledge”.

Table 8 - Student's response toward content of online game application mean score

	Items	Mean	Standard Deviation
14.	The contents of the online game are related to my knowledge.	4.60	0.51
15.	The contents of the online game are easy to understand.	4.73	0.46
19.	The activities content is suitable for my knowledge.	4.27	0.46
20.	I have a good understanding of this online game contents.	4.60	0.51

5. Discussion

Based on data analysis, the treatment group showed better performance than the control group. This finding supports the hypothesis that the game-based approach is more effective for acquiring knowledge associated with the Vehicle Air-Conditioning topic. The positive result of this research shows that the invention learning methods effect the student's achievement compared to traditional learning methods. The research outcome is similar to the previous studies that support the claim that game-based learning is suitable for improving students' achievement (Correia et al., 2017; Yeh et al., 2017; Zhu et al., 2017; Papastergiou, 2009).

The new learning environment encourages them to feel the excitement (Troussas, Krouska, & Sgouropoulou, 2020) while learning a serious topic or a topic that they need to focus on especially game-based learning as the student able to learn meaningful experiences and new exploration (Wright, 2011). A meaningful and enjoyable experience helps students to enhance their knowledge or cognitive skills such as recall a fact or concept. Besides, a game design also effects the student's learning process. A good game design or a pleasant user interface can help students to develop their learning skills (All, Castellar, & Van Looy, 2021; Troussas et al., 2020; Chen, Tseng, & Hsiao, 2018). The game design of this research contained several modules such as learn, flashcard, quiz, gravity, and match. A serious game or adventure-based game can stimulate their cognitive skills such as critical thinking and problem-solving skills (Chen et al., 2018).

From the motivation aspects or affective skills (value/appreciation), students give a positive response and show great interest in game-based learning as the high percentage of evaluation toward game and game's content. The current finding supports previous research finding that found game-based learning affect students learning positively (Rashid et al., 2017) on student's affective skills. This could be due to the fun and informal learning session which can help to motivate students (Rashid et al., 2017; Yeh et al., 2017; Zhu et al., 2017; Papastergiou, 2009) which lead them to give positive responses to this learning method.

Moreover, this learning method can facilitate two-way communications between the students and teachers as suggested by Rashid et al., (2017) and students are engaged in active learning (Wong et al., 2017; Hargaden et al., 2017; Wright, 2011). Other studies suggested that game-based learning motivate students to develop their self-learning skills (In, & Ahmad, 2019) or could be parental gaming experienced if implemented for students at home (All, Castellar, & Van Looy, 2016). These studies indicate the important role of communication that increasing their intrinsic motivation or excitement during the learning process.

A balance of educational value and fun must be considered in a game design so that it will be an effective educational game and proved that it can reduce student anxiety and stress (Troussas et.al, 2020). These results are also supported by All et al., (2016) that claims a proper balanced influenced the outcome results. Hence, game-based learning shows positive results for cognitive and affective skills. The higher student appreciation toward learning material motivates them to study, then improving their performance.

6. Conclusions

The study set out to determine if game-based learning is effective for learning in air-conditioning content. The research outcome indicates a positive effect of game-based learning on student's cognitive skills. Students who are using game-based learning also give positive feedback on the learning method. Therefore, it can be concluded that specifically designed, structured game learning materials are able to stimulate the development of thinking skills and self-learning among vocational students who are learning to air-condition. The playful learning materials which correspond to students' kinaesthetic learning style enhances the student's learning motivation which leads to better learning performance. In conclusion, game-based learning is an effective way to boost up student's cognitive and affective skills in a skills-based course. The researchers hope this study can contribute to enhancing the teaching and learning methods in the TVET field and helps to overcome the constraints faced by the instructor such as time and finances so that it can be practised in the vocational institution. Besides, the researchers hope that this finding could benefit for instructors or other researchers to conduct further study on game-based learning that focused on TVET in Malaysia.

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References

- Alessi, M. S., & Trollip, S. R. (2001). *Multimedia for learning: Methods and development (3rd ed.)*. Boston: Allyn and Bacon
- Alias, M., Mohamed, W. A. W., Lai, C. S., Masek, A., & Suradi, Z. (2016). *Statistics for Educational Research*. Johor: ACTiVE, UTHM
- All, A., Castellar, E. P. N., & Van Looy, J. (2016). Assessing the effectiveness of digital game-based learning: Best practices. *Computers & Education*, *92*, 90-103
- All, A., Castellar, E. N. P., & Van Looy, J. (2021). Digital Game-Based Learning effectiveness assessment: Reflections on study design. *Computers & Education*, *167*, 104160
- Charsky, D., & Ressler, W. (2011). "Games are made for fun": Lessons on the effects of concept maps in the classroom use of computer games. *Computers and Education*, *56*(3), 604–615. <https://doi.org/10.1016/j.compedu.2010.10.001>
- Chen, M. H., Tseng, W. T., & Hsiao, T. Y. (2018). The effectiveness of digital game-based vocabulary learning: A framework-based view of meta-analysis. *British Journal of Educational Technology*, *49*(1), 69-77
- Correia, M., & Santos, R. (2017). Game-based learning: The use of Kahoot in teacher education. In 2017 *International Symposium on Computers in Education (SIIE)* (pp. 1-4). IEEE
- Gardner, H. E. (2008). *Multiple intelligences: New horizons in theory and practice*. Basic books
- Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave MacMillan
- Hargaden, V., Papakostas, N., & Toomey, J. (2017). An application of game-based learning in an electronics industry graduate training program. In 2017 *International Conference on Engineering, Technology, and Innovation (ICE/ITMC)* (pp. 284-289). IEEE
- In, F. C., & Ahmad, A. Z. (2019). Effectiveness of Interactive Learning Using Kahoot. *Online Journal for TVET Practitioners*, *4*(1)
- Isa, N. S., & Ma'arof, N. N. M. I. (2018). The Effectiveness of Computerized Graphics as A Teaching Tool Among Students of Design and Technology Subject. *Sains Humanika*, *10*(3-3)
- Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology*, *7*(4), 396
- Kayan, I. C., Hamzah, R., & Udin, A. (2010). Transformation of Technical and Vocational Education: Creating Future Leaders. *Journal Edupress*, *8*. Retrieved from Mac 5, 2019, www.unevoc.net/fileadmin/user_upload/.../Handbook_Foreword.pdf
- Kreith, F., Wang, S. K., & Norton, P. (2018). *Air conditioning and refrigeration engineering*. CRC Press
- Lee, M. F., Lai, C. S., & Wahid, W. A. (2017, November). Relationship between multiple intelligence and career interest among the engineering students in vocational colleges. In 2017 *IEEE 9th International Conference on Engineering Education (ICEED)* (pp. 76-79). IEEE
- Mamat, A., & Ismail, S. (2010). Teaching and Learning Method of Jawi Rehabilitation Teacher in Malaysia. In *Proceedings of the 4th International Conference on Teacher Education: Join Conference UPI & UPSI* (pp. 321-329)
- McInerney, D. M. (2013). *Educational psychology: Constructing learning*. Pearson Higher Education AU
- Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*. Sage publications
- Ministry of Education Malaysia (MoE). (2017). *Academic Vocational College Rules 2017 Edition: Diploma*. Department Of Academic Management Technical and Vocational Education. Retrieved on Mac 15, 2019 from https://www.academia.edu/37370504/Garis_Panduan_Peraturan_Akademik_KV_KPM_-_KVDSAZI/37370504/Garis_Panduan_Peraturan_Akademik_KV_KPM_-_KVDSAZI
- Ministry of Education Malaysia (MoE). (2019). *TVET. Vocational College*. Retrieved on January 30, 2019, from <https://www.moe.gov.my/index.php/tvet/kolej-vokasional/3925-penerangan-bidang>

- Mohamad, N. H., Ibrahim, B., Selamat, A., Ismail, A., & Kadir, Z. A. (2021). A Protocol for Development of Holistic-Entrepreneur Graduates: Emotional Intelligence Perspectives. *Journal of Technical Education and Training*, 13(1), 35-43
- Mustapha, R., & Wahyudi, W. (2018). Empirical Study on Student's Vocational Intelligence of Technical Secondary Schools. *Sains Humanika*, 10(3-3)
- Perera, H., Hewagamage, K. P., & Weerasinghe, T. A. (2017). Game-based learning as a supplementary approach in teaching mathematics. In 2017 Seventeenth *International Conference on Advances in ICT for Emerging Regions (ICTer)* (pp. 1-7). IEEE
- Piaget, J. (1965). *The child's conception of number*. New York: Humanities Press
- Rashid, N. A., Boon, P. Y., & Ahmad, S. F. S. (2017). *Student and Learning*. Oxford Fajar Sdn. Bhd
- Rieber, L. P., Smith, L., & Noah, D. (1998). The value of serious play. *Educational Technology*, 38(6), 29–37
- Troussas, C., Krouska, A., & Sgouropoulou, C. (2020). Collaboration and fuzzy-modeled personalization for mobile game-based learning in higher education. *Computers & Education*, 144, 103698
- Van Eck, R. (2006). *Building intelligent learning games*. In D. Gibson, C. Aldrich, & M. Prensky (Eds.), *Games and simulations in online learning research & development frameworks*. Hershey, PA: Idea Group
- Wong, Y. S., Hayati, M., Yatim, M., & Hoe, T. W. (2017). A propriety game-based learning mobile game to learn object-oriented programming—Odyssey of Phoenix. In 2017 *IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE)* (pp. 426-431). IEEE
- Wright, G. B. (2011). Student-centered learning in higher education. *International Journal of Teaching and Learning in Higher Education*, 23(1), 92-97
- Yeh, Y.-T., Hung, H.-T., & Hsu, Y.-J. (2017). Digital Game-Based Learning for Improving Students' Academic Achievement, Learning Motivation, and Willingness to Communicate in an English Course. 2017 6th *IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, 560–563. <https://doi.org/10.1109/IIAI-AAI.2017.40>
- Zhu, W., Zhang, L., Brown, W., Dabipi, I., Peterson, E., & Joshi, R. (2017). Game-based learning in improving students' derivative calculation skills. In 2017 *IEEE Frontiers in Education Conference (FIE)* (pp. 1-6). IEEE