JURNAL PENDIDIKAN SAINS DAN MATEMATIK MALAYSIA
VOL 11 Special Issue 2021 / ISSN 2232-0393 / eISSN 2600-9307

Gamification in Mathematics: Students' Perceptions in Learning Perimeter and Area

[1]Fatini Zakirah Zaharin, [2*]Nor Suriya Abd Karim, [3]Nur Hamiza Adenan, [4]Noor Wahida Md Junus, [5]Rawdah Adawiyah Tarmizi, [6]Nor Zila Abd Hamid, [7]Latifah Abd Latib

[1,2,3,4,5,6,]Department of Mathematics, Faculty of Science and Mathematics,
Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia
[7]Department of Communication, Faculty of Communication,
Visual Arts and Computing, Universiti Selangor, Bestari Jaya, Selangor

[*]*Corresponding author: suriya@fsmt.upsi.edu.my*

Published online: 04 February 2021

To cite this article (APA): Zaharin, F. Z., Abd Karim, N. S., Adenan, N. H., Md Junus, N. W., Tarmizi, R. A., Abd Hamid, N. Z., & Abd Latib, L. (2021). Gamification in Mathematics: Students' Perceptions in Learning Perimeter and Area. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *11*, 72-80. https://doi.org/10.37134/jpsmm.vol11.sp.7.2021

To link to this article: https://doi.org/10.37134/jpsmm.vol11.sp.7.2021

ABSTRACT

A quantitative survey involving 60 students in Form Two using purposive sampling technique has carried out to investigate student's perceptions in the aspects of acceptance, interest and soft skills in learning Perimeter and Area towards the implementation of gamification in learning Mathematics. The questionnaires were administered to the respondents after conducting a learning session using gamification on them. Data obtained were analysed descriptively and represented by frequency, percentage, mean score and standard deviation. The findings of this study showed that students' acceptance, interest and soft skills incurred are high. These findings reflect that students' acceptance of gamification in learning perimeter and area high and thus can help educators in diversifying teaching techniques and approaches to attract students in learning.

Keywords: gamification; teaching mathematics; perimeter and area

INTRODUCTION

Mathematics as a hard and tough subject is not bizarre to be heard. People's perception of mathematics lingers decades ago until now. Researches in mathematics education have grown rapidly in terms of resources, contents, assessment, instruments as well as methods and approaches (Simons et al., 2020; Gore et al., 2017; Tosuncuoglu, 2017; Benzehaf, 2017; Larnell et al., 2016).

Gamification is referred to as the elements or mechanics of a game based on a non-game context (Deterding et al., 2011). People always thought that learning is a tedious process where learners shall passively receive all learning content from the teacher. However, gamification in learning is a process of learning through games activity. The games activity could be an education tool or technique, gamification facilitates learning while encouraging learner's motivation, engagement and participation and hence stimulate their knowledge (Dichev & Dicheva, 2017; Kapp et al., 2014).

Learning mathematics makes many people struggle. There are many researchers and educator all around the world propose diverse methods in learning mathematics (Stanislav, 2013). One of the methods is by using gaming environments in learning mathematics concepts (Stanislav, 2013). In order to make sure that the mathematics concepts are gamified, the gaming environments should relate the elements of games and what learners want to achieve that is the own goals to accomplish the

games (Nicholson, 2012). There are some examples of games activity in mathematics have been implemented such as by using flipped learning with gamification in mathematics enrichment of grade 9 students (Lo & Hew, 2018), embedding intelligent tutoring system with gaming technologies in learning quadratic equations (Faghihi et al., 2014) and digital-based games in learning mathematics such as ordered pair in graph lines (Moye-Packenham et al., 2019). Therefore, it is important to determine the students' perceptions of learning mathematics in order to diversify the teaching and learning methods.

The measurement concept is a major concern in mathematics (Reinke, 1997). Thus, learning Perimeter and Area can be a bit hard for students especially for young students as they have to understand the concept of perimeter and area which is the extension of the measurement concept (Winarti et al., 2012). In mathematics education, the perimeter is the distance around a region while the area is the amount of surface of a region (Dickson, 1989). Meanwhile, the definition of the area is the number of squares needed to cover a shape (Leonard, 2008). There is a relation between perimeter and area in the very first phase of the learning process (Winarti et al., 2012) and therefore there is a possibility that students might mix up the concepts will occur. Hence, inadequate prior knowledge about perimeter and area may cause the misconception on these concepts. Beside that, learning mathematics by gamification could help students to understand the measurement concept of perimeter and area since Gauteng Institute for Curriculum Development (1999) suggest that conceptual understanding about perimeter and area can be developed through kinaesthetic such as using bricks and cuttings so that they can conduct experiments and experienced the concepts. Thus, games based learning and gamification could be suggested in the teaching and learning method since kinaesthetic learning methods supported by bodily interaction provide leverage to different types of learners. Therefore, students' perception in learning perimeter and area using gamification should be determined in order to suggest better methods in teaching and learning mathematics.

PROBLEM STATEMENT

Peoples nowadays have a perception that Mathematics is a challenging subject. This perceptions in mathematics may affect their interest and cause anxiety in learning mathematics. Thus, this may contribute to low proficiency and performance in Mathematics since interest in certain subjects play a role in students' performance and achievement (Yu & Singh, 2016) especially to those who are weak in that subjects (Wong & Wong, 2019).

Align with global development, children's talents and capabilities need to be developed and enhanced in order to suit in the 21st century era. The curriculum that has been developed nowadays are focusing on the 21st century thinking skills such as creative thinking, critical thinking, logical thinking in order to nurture higher-order thinking (Arshad et al., 2017). The same goes to the teaching and learning process where teaching approaches and methods have been developed and evolved so that learners with 21st century skills can be produced. The implementation of 21st century learning gives freedom to students to speak up their minds and encourage 21st century skills in class.

Games-based learning and gamification are widely used in teaching since these methods can improve students' mathematical skills as well as functional skills (Brown et al., 2012). This method also can give a positive impact on the classroom environment and student's attitudes towards mathematics (Afari et al., 2013) as well as their achievement (Yildirim, 2017). Besides, this method also can embed 21st century skills that every student shall have (Larson & Miller, 2011) with the effectiveness of the learning depend-on the game design (Qian & Clark, 2016).

Students understanding about length, area and volume measurement is not a new thing as it has been investigated by many studies (Kozulin & Kazaz, 2017; Sisman & Aksu, 2016; Huang & Witz, 2013; Moyer, 2001; Chappell & Thompson, 1999; Carle, 1993) and this problem can become the root of misconceptions in learning perimeter and area. Since the basic concept in the area's topic is the area

of triangle and rectangle, some of the students showed over generalisation that the formula for rectangle could be used for other shapes in determining its area (Machaba, 2016).

Another common misconception in a learning Perimeter and Area is students always thought that the areas and perimeters of objects are corresponding, that is when two objects have the same area then their perimeter is equal (Machaba, 2016; Carle, 1993). In addition, previous research found that students have difficulties in learning Perimeter and Area. This happened because of confusion they faced on the concepts of perimeter and area (Ada & Kartulus, 2010; Gal & Lichevski, 2010) as they meet these concepts at the same time and thus students tend to get confused with the formulas.

Therefore, this study is conducted in order to see students' perceptions on the gamification in learning perimeter and area. In this paper, students' perceptions are measured in the aspect of their acceptance and interest towards the learning as well as the soft skills enhanced from the learning.

OBJECTIVE AND RESEARCH QUESTIONS

This study describes on the students' perceptions in the aspects of acceptance, interest and soft skills towards the implementation of gamification in learning Mathematics specifically in the topic of Perimeter and Area with the research questions of this study are:

i. How far students' acceptance on gamification in learning Perimeter and Area?
ii. What is students' interest level about the gamification in learning Perimeter and Area?
iii. Do students able to enhance their soft skills by learning using gamification?

METHODOLOGY

This study is a quantitative study conducted on Form Two students from a school in Kuala Kubu Bharu, Selangor. 60 students were selected by purposive sampling as a sample of this study. A set of questionnaires was used as the research instrument and has been distributed to the participants after a learning session by using gamification has been conducted. This questionnaire consists of three parts that measure participants' perceptions towards learning perimeter and area using gamification that they have experienced in the aspect of acceptance, interest and soft skills enhanced from this learning. A total of 30 items were listed in the questionnaire in order to measure these aspects.

As to control the quality of the output of the research, the validity and reliability of the research instrument which includes a daily lesson plan and questionnaire survey set has been developed before being administered. The validation process has been done by two experts in the field of mathematics and both of them have experience in teaching for more than ten years. The validity test result of agreeing percentage for a daily lesson plan is 0.782 indicates high validity (Sidek Mohd. Noah & Jamaludin Ahmad, 2005; Jamaludin Ahmad, 2002; Tuckman & Waheed, 1981). On the other hand, to test the reliability of the research instrument a pilot study has been conducted among 15 participants of the same population. The result found that the reliability measurement using Cronbach alpha is 0.942 that indicate the questionnaire have high reliability (Lim, 2007).

The quantitative result using descriptive statistical analysis was conducted on the data gathered in order to answer the research questions. The data are shown in the form of frequency, percentage, mean and standard deviation. The mean scores are interpreted based on 4 points Likert scale that is adapted from Zainudin et al., (2007) as in Table 1.

Table 1: Average Mean Scale Interpretation

Min Score	Interpretation of mean
1.00-1.99	Low
2.00-2.99	Moderate
3.00-4.00	High

RESULTS AND DISCUSSION

This study was conducted on 60 Form Two students in a Secondary School in Kuala Kubu Bharu, Selangor. The results obtained on their acceptance, interest and soft skills incurred when learning the topic of Perimeter and Area using gamification are presented in Table 2, Table 3 and Table 4, respectively.

Frequencies and percentage derived for each item for the construct of students' acceptance towards the gamification approach in learning the topic of perimeter and area are presented in Table 2. This result indicates that students accepting the gamification approach in learning perimeter and area. However, the last item in this construct show 13.3% of the respondents does not agree that they know how to play the games without the teacher's help. In overall mean and standard deviation for this construct is 3.26 and 0.449 respectively. These results indicate the students exhibited consistently positive response and highly accepted the gamification approach in learning perimeter and area. It is shown that gamification approach is most recommended and suitable methods to be used in teaching and learning process by educators as this approach indirectly bring the student to the real-life situation especially in term of learning concepts and skills.

Table 2: Students' Acceptance on Gamification in Learning Perimeter and Area

No.	Item	Frequency & Percentage (%)			
		1	2	3	4
1.	Gamification help me to understand the concepts of perimeter and area.	0	6 (6.7)	30 (50.0)	26 (43.3)
2.	Gamification is suitable to be used in learning perimeter and area.	0	2 (3.3)	29 (48.3)	29 (48.3)
3.	Gamification help me to differentiate the concept of perimeter and area.	0	2 (3.3)	32 (53.3)	26 (43.3)
4.	I can master the topic of Perimeter and Area using gamification.	2 (3.3)	8 (13.3)	29 (48.3)	21 (35.0)
5.	I can remember the concept of perimeter and area easily by learning using gamification.	0	7 (11.7)	34 (56.7)	19 (31.7)
6.	I can apply the concept of perimeter and area using gamification.	0	6 (10.0)	33 (55.0)	21 (35.0)
7.	I can follow all the rules stated for the games.	1 (1.7)	4 (6.7)	21 (35.0)	34 (56.7)
8.	I can understand all instructions given while playing the games.	1 (1.7)	1 (1.7)	27 (45.0)	31 (51.7)
9.	I do not need extra time to understand the instructions given in order to play the games.	1 (1.7)	12 (20.0)	28 (46.7)	19 (31.7)
10.	I know how to play the games without teacher's guidance.	8 (13.3)	21 (35.0)	11 (18.3)	20 (33.3)
	Average Mean Score		3.26		
	Average Standard Deviation		0.447		

This result is aligned with Sayed Yusoff et al. (2014) that found that gamification approach in Mathematics can develop well understanding of the concept and mathematics application among students.

Table 3: Students' Interest on the Application of Gamification in Learning Perimeter and Area

No.	Item	Frequency & Percentage (%)			
		1	2	3	4
1.	I have fun in learning Perimeter and Area.	0	3 (5.0)	29 (48.3)	28 (46.7)
2.	I am interested to learn about Perimeter and Area.	0	5 (8.3)	28 (46.7)	27 (45.0)
3.	I am excited because I can understand the concepts of Perimeter and Area.	0	1 (1.7)	32 (53.3)	27 (45.0)
4.	I am more motivated to learn this topic.	0	3 (5.0)	34 (56.7)	23 (38.3)
5.	I am thrilled when gamification is used in learning Perimeter and Area.	0	1 (1.7)	33 (55.0)	26 (43.3)
6.	I am not easily bored when gamification is used in learning session.	0	8 (13.3)	26 (43.3)	26 (43.3)
7.	I like gamification more rather than solely listening to teacher's explanation.	1 (1.7)	6 (10.0)	18 (30.0)	35 (58.3)
8.	I like to learn perimeter and area because this topic can enhance my thinking skills.	0	6 (10.0)	29 (48.3)	25 (41.7)
9.	I am interested to active atmosphere in learning Perimeter and Area.	0	1 (1.7)	31 (51.7)	28 (46.7)
10.	I love the implementation of gamification in learning because I can improve my soft skills.	1 (1.7)	3 (5.0)	33 (55.0)	23 (38.3)
Average Mean Score			3.38		
Average Standard Deviation			0.407		

On the other hands, Table 3 shows the frequency and percentage for each item in the constructs of interest of learning when the gamification approach has been used in teaching perimeter and area. Results show that 13.3% of the respondent did not agree with the statement of they easily feel bored to learn perimeter and area while at least 10% of the respondents state that they do not agree that they preferred GBL approach compared to only teachers explanation. At the same time, 5% of the respondent also not agree with the statement that they love the gamification approach as it will improve their soft skills. In general, the mean and standard deviation for this construct is 3.38 and 0.407, respectively. These results indicate that the students show a high level of interest in learning Perimeter and Area using the gamification approach. It is proved that majority of the students have a high interest in the gamification approach of learning compared to the traditional approach. Besides this approach will bring an active learning style which indirectly involved all the student with-a good environment of learning that is significant and made the student happy while they are involved in the learning process (Liu et al., 2014).

Table 4: Students' Soft Skills Incurred on the Application of Gamification in Learning Perimeter and Area

No.	Item	Frequency & Percentage (%)			
		1	2	3	4
1.	I can improve my confident while playing the games.	0	2 (3.3)	39 (65.0)	19 (31.7)
2.	I always give supports to my friends.	0	7 (11.7)	39 (65.0)	14 (23.3)
3.	I can interact actively with my friends.	2 (3.3)	6 (10.0)	31 (51.7)	21 (35.0)

4.	I can deliver a good explanation to my friends about teacher's instructions.	0	11 (18.3)	37 (61.7)	12 (20.0)
5.	I can enhance my communication skills.	2 (3.3)	6 (10.0)	28 (46.7)	24 (40.0)
6.	I can give a good cooperation to my friends.	0	3 (5.0)	28 (46.7)	29 (48.3)
7.	I offer assistance to my friends who need a help all the time.	0	7 (11.7)	32 (53.3)	21 (35.0)
8.	I am able to contribute thoughtful ideas.	0	15 (25.0)	31 (51.7)	14 (23.3)
9.	I can think critically.	0	11 (18.3)	37 (61.7)	12 (20.0)
10.	I can think creatively.	1 (1.7)	7 (11.7)	28 (46.7)	24 (40.0)
	Average Mean Score		3.18		
	Average Standard Deviation		0.464		

Table 4 shows the frequency and percentages for each item in the construct of students' soft skills toward gamification for the topic of Perimeter and Area. The results show that 18.3% of the respondents did not agree with the statement that they can explain well the teacher instructions to their friends. Meanwhile, 25% of the respondents did not agree with the statement that they can give a good idea and 18.3% not agree that they can think critically. In general, the mean and standard deviations for this construct are 3.18 and 0.464 respectively. This result indicates that the respondents highly agree that the students enhance the soft skills when they use gamification approach in learning Perimeter and Area. This result aligns with Morris et al., (2013) that states that 21st century skill can be gathered through game-based learning. Besides Hwang et al. (2014) also states that game-based learning will help students to improve their motivation and creative problem-solving skill which indirectly improve their Mathematics level of knowledge.

CONCLUSION

This study found out that students' perception in the aspect acceptance towards gamification in learning the topic of Perimeter and Area is high. This show that student can accept the application gamification during learning this topic and can help them in understanding this topic further. These findings align with the study conducted by Sayed Yusoff et al. (2014) that found the usage of games in learning Mathematics can help students in constructing a good understanding of concepts and applications in Mathematics.

This study also found that students showed interest in learning using gamification is high since this method can attract students' interest and reduce their boredom during a learning session. Besides, students also found that this learning method reassures meaningful learning and provides the learning process actively. Gogal et al. (2017) state that playing games in learning can encourage students to experience learning cooperatively in an exciting and enjoyable way.

Therefore, it is a good thing for teachers to be attentive towards students' needs and diversify their teaching methods and approaches in order to nurture and improve students thinking skills as well as learning development holistically. In addition, through this study, we found that soft skills can be nurtured and incurred by undergoing gamification. The skills included are leadership, communication, collaborative as well as creative and critical thinking skills.

Moreover, this study obtained that students' soft skills while gamification in learning Perimeter and Area is high. The soft skills measured were of the form of 21st century skills involving leadership, communication, collaboration and thinking skills. This finding is supported by the findings that state

game-based learning can encourage 21st century learning skills among students (Moris et al., 2013) as well as improve students' motivation and problem solving skills (Hwang et al., 2014) and hence students' performance can be improved.

However, the usage of games in the learning process without an efficient teaching technique will not give a meaningful experience and impact on the students (Eow et al., 2010). From the result obtained through this study, it can be concluded that gamification is good to be conducted as one of the methods used in teaching and learning since by using this method students' interest in learning and their soft skills can be incurred and improved for their self-improvement and academic performance. Therefore, teachers and educators can diversify teaching techniques in conveying lessons to students so that students can enjoy learning despite having abstract mathematical concepts to study on.

ACKNOWLEDGEMENT

Authors are thankful to the reviewer(s) for constructive comments and suggestions.

REFERENCES

Ada, T. & Kurtulus, A. (2010). Students' misconceptions and errors in transformation geometry. I*nternational Journal of Mathematical Education*, 41(7), 901-909

Afari, E., Aldridge, J. M., Fraser, B. J. & Khine, M. S. (2013). Students' perceptions of the learning environment and attitudes in game-based mathematics classroom. *Learning Environ Res*, 16, 131 – 150.

Arshad, M. N., Atan, N. A., Abdullh, A. H., Abu, M. S. & Mokhtar, M. (2017). Improving the reasoning skills of students to overcome learning difficulties in Additional Mathematics: A review. *Journal of Science and Mathematics Letter*, 5, 28 – 35.

Benzehaf, B. (2017). Exploring teachers' assessment practices and skils. I*nternational Journal of Assessment Tools in Education*, 4(1), 1 – 18.

Brown, D. J., Ley, J. Evett, L. & Standen, P. (2011, Nov. 16 - 18). *Can participating in games based learning improve Mathematics skills in students with intellectual abilities?* [Conference session]. 2011 IEEE 1st International Conference on Serious Games and Applications for Health (SeGAH), Braga, Portugal. DOI: 10.1109/SeGAH.2011.6165461

Carle, S. M. (1993). Student-held misconceptions regarding area and perimeter of rectangles. *Critical and Creative Thinking Capstones Collection*. Paper 46.

Chappell, M. F. & Thompson, D. R. (1999). Take time for action: Perimeter or area? Which measure is it?. *Mathematics Teaching in the Middle School*, 5, 20 – 23.

Deterding, S., Khaled, R., Nacke, L. E. & Dixon, D. (2011). Gamification: Toward a definition. In *CHI 2011 Gamification Workshop Proceedings*, Vancouver, BC, Canada.

Dichev, C. & Dicheva, D. (2017). Gamifying education: what is known, what is believed and what remains uncertain: a critical review. *International Journal of Educational Technology in Higher Education*, 14 (9), 1 – 36

Dickson, L. (1989). Area of a rectangle. In Johnson, D. (Ed.), *Children's mathematical frameworks: A study of classroom teaching* (pp. 76–88). Berkshire: NFER-Nelson.

Eow, Y. L., Ali, W. Z. B. W., Mahmud, R. B. & Baki, R. (2010). Computer games development and appreciative learning approach in enhancing students' creative perception. *Computers and Education*, 54(1), 146-161.

Faghihi, U., Brautigam, A., Jorgenson, K., Martin, D., Brown, A., Measures, E., & Maldonado-Bouchard, S. (2014). How gamification applies for educational purpose specially with college algebra. *Procedia Computer Science, 41*, 182–187.

Gauteng Institute for Curriculum Development (1999*). Mathematical Literacy, Mathematics and Mathematical Sciences draft progress map.* Johannesburg: Gauteng Department of Education.

Gal, H. & Linchevski, L. (2010). To see or not to see: Analyzing difficulties in geometry from the perspective of visual perception. *Educational Studies in Mathematics*, 74(2), 163-183

Gogal, K., Heuett, W. & Jaber, D. (2017). CHEMCompete: An organic chemistry card game to differentiate between substitution and elimination reactions of alkyl halides. *Journal of Chemical Education*, 94(9), 1276 - 1279.

Gore, J., Lloyd, A., Smith, M., Bowe, J., Ellis, H. & Lubans, D. (2017). Effects of professional development on the quality of teaching: Results from randomized controlled trial of Quality Teaching Round. *Teaching and Teacher Education*, 68, 99 – 113.

Huang, H. M. E. & Witz, K. G. (2013). Children's conceptions of area measurement and their strategies for solving area measurement problems. *Journal of Curriculum and Teaching*, 2(1), 10 – 26.

Hwang, G., Hung, C. & Chen, N. (2014). Improving learning achievements, motivations and problem-solving skills through a peer assessment-based game development approach. *Education Tech Research Dev*, 62, 129-145.

Jamaludin Ahmad. (2002). *Kesahan, kebolehpercayaan dan keberkesanan modul program maju diri ke atas motivasi pencapaian di kalangan pelajar sekolah menengah negeri Selangor.* Serdang: Universiti Putra Malaysia.

Kapp, K. M., Blair, L. & Mesch, R. (2014). *The gamification of learning and instruction fieldbook*. John Wiley & Son Inc.: San Francisco.

Kozulin, A. & Kazaz, S. (2017). Developing the concept of perimeter and area in student with learning disabilities. *Eur. J. Psychol. Educ*., 32, 353 – 366.

Larnell, G. V., Bullock, E. C. & Jett, C. C. (2016). Rethinking teaching and learning Mathematics for social justice from a critical race perspective. *The Journal of Education*. 196(1), 19 – 29.

Larson, L. C. & Miller, T. N. (2011). 21st century skills: Prepare students for the future. *Kappa Delta Pi Record*, 47(3), 121-123.

Lau, G. L. (2012). Kesan penggunaan kaedah bermain sambil belajar dalam proses pembelajaran Sains Tahun Empat. *Jurnal Penyelidikan Tindakan IPG KBL*, 6, 195 – 209.

Leonard, M. K., Tipps, S. & Johnson, A. (2008). *Guiding Children's Learning of Mathematics*. 7th Ed. Thomson Wadsworth: USA.

Lim, C. H. (2007). *Penyelidikan pendidikan: Pendekatan kuantitatif dan kualitatif.* Selangor: McGraw-Hill.

Liu, M., Rosenblum, J. A., Horton, L. & Kang, J. (2014). Designing science learning with game-based approaches. *Computers in the School*s, 31(1), 84-102.

Lo, C. K., & Hew, K. F. (2018). A comparison of flipped learning with gamification, traditional learning, and online independent study: the effects on students' mathematics achievement and cognitive engagement. *Interactive Learning Environments*, 28 (4), 464 - 481.

Machaba, F. M. (2016). The concepts of area and perimeter: Insights and misconceptions of Grade 10 learners. *Pythagoras*, 37(1), a304.

Morris, B. J., Croker, S., Zimmerman, C., Gill, D. & Romig, C. (2013). Gaming science: The "Gamification" of scentific thinking. *Frontiers in Psychology*, 4, 1-16.

Moyer-Packenham, P.S. (2001). Using representations to explore perimeter and area. *Teaching Children Mathematics*, 2001, 52 – 59.

Moyer-Packenham, P. S., Lommatsch, C. W., Litster, K., Ashby, J., Bullock, E. K., Roxburgh, A. L., Shumway, J. F., Speed, E., Covington, B., Hartmann, C., Clarke-Midura, J., Skaria, J., Westenskow, A., MacDonald, B., Symanzik, J., & Jordan, K. (2019). How design features in digital math games support learning and mathematics connections. *Computers in Human Behavior*, *91*, 316–332.

Nicholson, S. (2012). A User-Centered Theoretical Framework for Meaningful Gamification. *Proceedings GLS 8.0*. Madison. https://www.semanticscholar.org/paper/A-User-Centered-Theoretical-Framework-for-Nicholson/df1315c007ecebb6d195e0844df4aa41b820a699

Qian, M. & Clark, K. R. (2016). Game-based learning and 21st century skills: A review of recent research. *Computers in Human Behaviours*, 63, 50 – 58.

Reinke, K. S. (1997). Area and Perimeter: Preservice Teachers' Confusion. *School Science and Mathematics, 97*(2), 75–77.

Sayed Yusoff S. H, Tan, W. H. & Muhammad Zaffwan Idris. (2014). Digital game-based learning for remedial Mathematics students: A new teaching and learning approach in Malaysia. *International Journal of Multimedia and Ubiquitous Engineering, (11), 325 - 338.*

Sidek Mohd. Noah & Jamaludin Ahmad. (2005). *Pembinaan modul. Bagaimana membina modul latihan dan modul akademik.* Serdang: Universiti Putra Malaysia

Simons, M., Coetzee, S., Baeten, M. & Schumulian, A. (2020). Measuring learners' perceptions of team-taught learning environment: development and validation of the learners' team teaching perceptions questionnaire (LTTPQ). *Learning Environments Research*. 23, 45 – 58.

Sisman, G. T. & Aksu, M. (2016). A study on sixth grade students' misconceptions and errors in spatial measurement: length, area and volume. Int. J. of Sci. and math. Educ. 14, 1293 – 1319.

Stanislav, V. (2013). *Online Problems for Mathematics and Computer Science Education* [Unpublished Bachelor Thesis]. Universitas Masarykiana.

Tosuncuoglu, I. (2017). Importance of assessment in ELT. *Journal of Education and Training Studies*, 6(9), 163 - 167.

Tuckman, B. W. & Waheed, M. A. (1981). Evaluating an individualized science programme for community college students. *Journal of Research in Science Teaching*, 18(6), 489-495.

Winarti, D. W., Amin, S. M., Lukito, A., & Van Gallen, F. (2012). Learning the Concept of Area and Perimeter by Exploring Their Relation. *Indonesian Mathematical Society Journal on Mathematics Education*, *3*(1), 41–54.

Wong, S.L. & Wong, S. L. (2019). Relationship between interest and mathematics performance in a technology-enhanced learning context in Malaysia. *Research and Practice in Technology Enhanced Learning*, 14 (21), 1-13.

Yildirim, I. (2017). The effects of gamification-based teaching practices on student achievement and students' attitudes toward lesson. *The Internet and Higher Education*, 33, 86 – 92.

Yu, R. & Singh, K. (2018). Teacher support, instructional practices, student motivation, and mathematics achievement in high school. *The Journal of Educational Research*, 111 (1),

Zainudin A. B., Meor I. K., Megat A. Z. M. Z. & Mohd A. I. (2007). Kemahiran ICT guru pelatih Universiti Teknologi Malaysia. *Prosiding Seminar Kebangsaan JPPG 2007*. Seremban: Royal Adelphi.