

RESEARCH ARTICLE

The Role of Computer Games in Enhancing Primary School Student's Attitude Towards Mathematics

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Manuscript Info

Abstract

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..... Numerous research findings have applauded the integration of technology in the classroom especially in mathematic to develops positive attitudes. The advancements in technology may provide a better opportunity to impact mathematical literacy and skills on young learners. Perhaps, attitudes towards mathematics are declining in recent years. The study aimed to enhance the students' attitude toward learning mathematics by using games app embedded in computer software used as an instrument to teach the subject. A total of ninetyone primary school students drawn from different primary schools in the Kogi state participated in the study. The study adopted a quasiexperimental pre-test, post-test study design. The result revealed that the computer game influenced the respondent's attitude towards mathematics at MD = 13.65 (95% CI, 8.91 to 16.17), t (88) = 6.328, p = .001. Thus, the study concludes that computer game is an indispensable tool in impacting positive attitudes towards mathematics, especially among the primary school students. The recommendations are discussed.

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Introduction:-

Contemporary society is increasingly transforming into a science-based society due to the upsurge in technological advancements. The trend in scientific advancements and their implications for the growth and development of society, make this period a critical time for developing a unified vision for early childhood science education. Science education is widely considered one of the most integral parts of today's education(Kalogiannakis et al., 2021), and is advocated from the early years, especially in primary schools(Tavares et al., 2021). Perhaps, there is presently a quest for educational reforms worldwide(Tajudin et al., 2018). Also, the growing recognition of STEM (Science, Technology, Engineering, and Mathematics) as a universal approach to increasing the development of science education is currently trending in the Global Educational System. STEM has become the basis for a series of reforms for secondary and higher education in many countries (Liu et al., 2020). It emerges as a result of the growing gap in STEM-related disciplines and to meet the current demand of technological development (Fomunyam, 2019). Research contends that exposing young learners to STEM content is an essential pathway to creating a science and technology-driven society (Banks & Barlex, 2020).

One of the central bases of science education in mathematics. It is the central intellectual discipline of any technological society(Sule et al., 2016). Mathematics is a ubiquitous part of education in Nigeria and all over the world(Agashi & Adeniyi, 2021).Brkslich (2020)noted that mathematics is the foundation for the overall purpose of education. Proficiency in mathematics has been the basis for academic transition in all levels of

academics. Accordingly, The Education Committee (2021) stated that sustaining modern-day society is contingent on mathematical competency. Thus, numerous authors have linked mathematics with economic and technological development in any given culture (Etuk & Bello, 2016; Festus, 2014; Josiah & Olubunmi, 2014). More so, an extensive literature has highlighted the relevance of mathematics to society (see., Akinoso, 2018; Andrews, 2007; Charles-Ogan, 2015; Kachapova, 2014; khasim pasha sd, 2012; Kusmaryono, 2014; Lai et al., 2011; Obadare-Akpata, 2017). For this reason, competency in the subject becomes an essential aspect of Nigeria's education vision (Charles-Ogan, 2015). It is imparted to children in their early education years due to its relevance in thinking skills (Murni &Ruqoyyah, 2020).

Although, mathematics is a compulsory subject in the educational system of Nigeria (Adebule & Ayoola, 2015; Asikhia, 2021; Oyinloye & Popoola, 2013). However, teaching and learning mathematics are contingent on mental capabilities(Agashi & Adeniyi, 2021).Consequently, mathematics is perceived by most students as a frightening subject (Ifdil et al., 2019), thus decreasing mathematics enthusiasm among the learners. Research in recent years has underscored the trend of mathematics decline in Nigeria(Agberotimi et al., 2015; Agnes & Mathew, 2019; Aremu & Taiwo, 2014; Garba et al., 2020; Idowu, 2018; Muhammad, 2017). The phenomenon poses a critical implication to student's educational advancement. Nevertheless, numerous strategies have been advocated in the literature to increase student's favorable attitudes towards mathematics(Anuar et al., 2020; Baglama, 2019; Cahyono, 2019; Lazarov, 2019; Mavridis et al., 2017; Şengül & Katranci, 2014). However, one of the strategies that have attracted research attention in recent years regarding mathematical interest is computer games.

The advancements in mobile innovations provide opportunities capable of improving the young learner's motivation and interest in learning math(Yussop et al., 2019). Perhaps, computer technologies are fundamental in early learning (Schenke et al., 2020). Conversely, Chang et al. (2015) had noted that the effects of computer games on students' mathematics performance in classroom settings are still unclear. However, interactive, immersive games can consume children's attention for hours while providing practical instruction and an engaging learning experience. Mathematics embedded computer games are the technology of inserting math-related concepts and logical manipulations in a puzzle game-like interface(Tan et al., 2017). Computer games have been widely adopted to enhance children's mathematics motivation and performance in various domains (Bartoschek et al., 2013; Boulton et al., 2018; Coelho et al., 2019; Godejord et al., 2017; Rienow et al., 2020; Santiago et al., 2019; Sarvehana, 2019; Siew et al., 2016; Simsek, 2016; Spieler et al., 2018). Computer games have been used in various mathematical domains, such as in strategic and reasoning abilities(Bottino et al., 2007), critical geometry skills(Yang & Chen, 2010), and arithmetic procedures(Moreno & Durán, 2004). In addition, Hulse et al. (2019)found that low-performing students earned higher by completing more problems and engaging more with those problems.

Attitudes are a socio-psychological construct that reflects a person's cognitive, affective, and behavioral components that are critical in learning. Attitudes encompass likeness or dislikes of any aspect of a person's socio-world. Thus, a negative attitude limits performance reduces motivation and inhibits learning. Research has linked low achievement and engagement in mathematics with attitudes (Yáñez-Marquina & Villardón-Gallego, 2016). Nonetheless, enhancing student's mathematics attitude to learning (Agustina, 2017). Thus, the primary purpose of the present study is to answer the question; would there be a significant difference in attitudes towards mathematics between student's taught with the computer game and those taught with the conventional method.

Method:-

A quasi-experimental design with pre-test and post-tests and two groups (experimental and conditions) was adopted in this present study. Primary school students in Kogi State made up the population of the study. Ninety-one (n = 91) students comprising males and females within the ages of8 and 11 years with mean age of (M=9.14) and (SD=1.24) were randomly selected from different public primary schools in Kogi State as the study participants. The students selected primarily from the primary 5 and 6 classes were assigned to groups, with group A as the experimental condition. On the other hand, group B represents the control condition. Before the main study's commencement, students' attitude towards mathematics was established (pre-test) using an attitude towards mathematics questionnaire. In the post-test study, the treatment group student (group A) was exposed to a computer game. Prodigy is a free-to-use and adaptive game app that integrates basic math concepts into a fantasy-style game. Prodigy is widely used in the US and has been implemented as part of the math curriculum (NCT, 2018). Students in the control group were exposed to other mathematical activities excluding the game app in the post-test study. After that, the student's attitude towards mathematics was further assessed.

Ethical considerations

In other to abide by the research ethics in the process of the study. With the heads of the schools and teachers' aid, the participants were made to understand the study's purpose. They were told that the study is not a must and that they can withdraw anytime they want.

Result:-

Before the commencement of the experiment, the respondent's attitudes towards mathematics were ascertained. Table 1 below shows the mean scores of the two conditions in the pre-test study. Thus, it indicates that there is no significant mean difference between the conditions on attitude towards mathematics (M = 22.19, SD = 3.12) and (M = 22.33, SD = 2.98). Thus, it signifies that attitude towards the subject for both conditions are on the same level.

Table 1:- Table showing the mean and standard deviation scores of the students' attitudes towards mathematics for both conditions.

| Group | Ν | Mean | SD | |
|---------|----|-------|------|--|
| Group A | 43 | 22.19 | 3.18 | |
| Group B | 48 | 22.33 | 2.96 | |

More so, a post-study analysis was conducted to ascertain the difference in attitude towards mathematics. The obtained mean scores for both conditions were (M = 46.83, SD = 9.64, and M = 33.18, SD = 5.26) as shown in the Table 2 below. The data established a high mean score for the experimental conditions (46.831) compared to the control condition (33.18). The standard deviation scores also revealed an increased score of 9.64 for the study group and a lower score of 5.26 for the control group. Thus, it indicates that the mean scores increased significantly following the exposure of the students to the Prodigy Math game for the experimental condition.

Table 2:- Table showing the mean and standard deviation scores of the two conditions (A and B) following the Post-test study.

| Group | Ν | Mean | SD |
|---------|----|-------|------|
| Group A | 43 | 46.83 | 9.64 |
| Group B | 48 | 33.18 | 5.26 |

Furthermore, to answer the research question on whether computer games would impact positive attitudes towards mathematics among primary school students. An independent-samples t-test was conducted to determine if there were differences between the experimental and the control groups' attitudes towards mathematics in the post-test study. The result of the analysis established an increased positive attitude towards mathematics for the experimental condition (46.83 ± 9.64) when compared to the control condition (33.18 ± 5.26), a statistically significant difference of 13.65 (95% CI, 8.91 to 16.17), t (89) = 6.328, p = .001as shown in Table 3 below.

Table 3:- Table showing the t-test comparison of the differences in attitude towards mathematics.

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|---|----|-------|------|----|-------|-----|--|--|--|
| Source of variation | Ν | Mean | SD | df | t | Sig | | | |
| Group A | 43 | 46.83 | 9.64 | | | | | | |
| Group B | 48 | 33.18 | 5.26 | 89 | 6.328 | 001 | | | |

Discussion:-

This study was conducted to determine whether there would be a significant difference in attitudes towards mathematics between student's taught with the computer game and those taught with the conventional method. Following a pre-test, post-test study, the mean and standard deviation scores showed that the gaming app significantly influenced the experimental group's attitude towards mathematics in the post-test study (M = 46.83, SD = 9.64) compared to the control group (M = 33.18, SD = 5.26). An independent t-test was performed to answer the research question on whether there would be a significant difference in attitudes towards mathematics between student's taught with the computer game and those taught with the conventional method. The result established a significant different between the experimental conditions and the control conditions on attitude towards mathematics at MD = 13.65 (95% CI, 8.91 to 16.17), t (89) = 6.328, p = .001. Thus, the result provides an answer to the question signifying that the computer game could increase primary school students' attitudes towards mathematics. Thus, the present research result supports previous findings (Hung et al., 2015; Yussop et al., 2019). For example, Chang et al. (2015) found that participants in the game intervention group showed higher mathematics proficiency than those in

the paper-and-pencil group. The likely reason for this development could be attributed to the increasing innovation in mobile technologies that have reached every corner of society and have attracted the attention of children mostly by the flexibility and the innovative interface of computer games. Also, the increasing exposure of the youngsters to mobile phone integrated games may have attracted the students to the trending technology. Thus, when integrated into the classroom, the students tend to embrace the concept compared to the conventional classroom teaching methods. The study byBatzogiannis et al. (2018)contends that an increase in basic math skills can only be accomplished by motivating the students using technological innovations such as games. Therefore, computer games could be a pathway to impacting favorable attitudes towards mathematics among early learners. Indeed, attitudes are acquired through various means, and when formed, can influence behavior. In other words, computer games will enhance youngsters' mathematical capabilities and change their overall attitude towards the subject(Schenke et al., 2020)

Conclusion:-

The present research aimed to investigate whether computer games would improve attitudes towards mathematics. The analysis established a positive difference between the two conditions on attitudes towards mathematics in the post-test study. Thus, the study concludes that computer games would impact positive attitudes towards mathematics, especially among primary school students. Therefore, the study contributes to the mathematics literature by supporting previous researches that promote the integration of computer games in the classroom in Nigeria. Nevertheless, the sample size used in the study may pose a significant challenge for generalizing this result. Future researchers are advised to include more representative samples and explore other moderating variables that could broaden our understanding of this outcome. However, the study recommends the full integration of computer games in the classroom and consistent training of instructors in this direction.

References:-

- 1. Adebule, S. O. &, & Ayoola, O. O. (2015). Evaluation of Instructional Materials Commonly Used in the Teaching of Mathematics in Junior Secondary Schools in Ekiti State. Online), 5(18).
- 2. Agashi, P. P., & Adeniyi, S. G. (2021). Mathematics anxiety and choice of subject among junior secondary school students. Int. J. Adv. Res, 9(05), 527–537. https://doi.org/10.21474/IJAR01/12869
- Agberotimi, S. F., Olaseni, A. O., Oladele, O. T., & Temitayo Oladele, O. (2015). Efficacy of psychoeducation and problem-solving therapy on mathematics anxiety among selected secondary school students in Ilesa, Osun State, Nigeria. Edorium Journal of Psychology, 1. https://doi.org/10.5348/P13-2015-1-OA-1
- Agnes, P. A., & Mathew, O. O. (2019). Does Math-Anxiety Affect Senior School Students' Mathematics Performance? Evidence from Ekiti State, Nigeria. Journal of Mathematics Education, 4(2), 43–51. https://doi.org/10.31327/jomedu.v4i2.895
- 5. Agustina, L. (2017). Enhancing the Students' Positive Attitude in Learning Business English by Using Technology. Advances in Language and Literary Studies, 8(6). https://doi.org/10.7575/aiac.alls.v.8n.6p.51
- 6. Akinoso, S. O. (2018). Mathematics teachers' awareness of teachable moments in Nigerian classroom. Eurasia Journal of Mathematics, Science and Technology Education, 14(2). https://doi.org/10.12973/ejmste/80631
- 7. Andrews, P. (2007). The curricular importance of mathematics: A comparison of English and Hungarian teachers' espoused beliefs. Journal of Curriculum Studies, 39(3). https://doi.org/10.1080/00220270600773082
- Anuar, N., Abdullah, N., & Hod, S. N. S. (2020). Pre-university students' learning styles and attitude towards mathematics achievements. Advances in Science, Technology and Engineering Systems, 5(6). https://doi.org/10.25046/aj050632
- Aremu, A. O., & Taiwo, A. K. (2014). Reducing mathematics anxiety among students with pseudo-dyscalculia in Ibadan through numerical cognition and emotional freedom techniques: moderating effect of mathematics efficacy. African Journal for the Psychological Study of Social Issues (Vol. 17, Issue 1). http://www.ajpssi.org/index.php/ajpssi/article/view/63
- Asikhia, O. A. (2021). Gender Effect on Mathematics Anxiety of Secondary School Students in Ogun West Senatorial District, Nigeria. Asian Journal of Education and Social Studies. https://doi.org/10.9734/ajess/2021/v15i430386
- 11. Baglama, B. (2019). Using technology for improving attitudes of students with intellectual disabilities towards mathematics. Revista San Gregorio, 36. https://doi.org/10.36097/rsan.v0i36.1229
- 12. Banks, F., & Barlex, D. (2020). Teaching STEM in the Secondary School. In Teaching STEM in the Secondary School. https://doi.org/10.4324/9780429317736
- 13. Bartoschek, T., Schwering, A., Li, R., & Münzer, S. (2013). Ori-Gami-An App fostering spatial competency

development and spatial learning of children. Agile.

- 14. Batzogiannis, I., Hatzikraniotis, E., Papadopoulos, A., Papadopoulos, P., & Zoungouridis, P. S. (2018). Using a math game to improve basic math skills. INTED2018 Proceedings, 1. https://doi.org/10.21125/inted.2018.0634
- 15. Bottino, R. M., Ferlino, L., Ott, M., & Tavella, M. (2007). Developing strategic and reasoning abilities with computer games at primary school level. Computers and Education, 49(4). https://doi.org/10.1016/j.compedu.2006.02.003
- Boulton, H., Spieler, B., Petri, A., Schindler, C., Slany, W., & Beltran, X. (2018). The role of game jams in developing informal learning of computational thinking: a cross-European case study. In arXiv. https://doi.org/10.21125/edulearn.2016.0538
- 17. Brkslich, E. R. (2020). Importance of mathematics in general education. The Mathematics Teacher, 44(1). https://doi.org/10.5951/mt.44.1.0001
- Cahyono, A. E. Y. (2019). Improving Achievement and Attitudes towards Mathematics Using Problem-Based Learning Setting Team Accelerated Instruction. Journal of Mathematics Education, 4(2). https://doi.org/10.31327/jomedu.v4i2.1012
- Chang, M., Evans, M. A., Kim, S., Norton, A., & Samur, Y. (2015). Differential effects of learning games on mathematics proficiency. Educational Media International, 52(1). https://doi.org/10.1080/09523987.2015.1005427
- 20. Charles-Ogan, G. (2015). Mathematics as a tool for achieving the vision 20:2020 Goal of National Transformation. International Journal of Education, Learning, and Development, 3(8).
- Coelho, A., Cardoso, P., Camilo, M., & Sousa, A. (2019). Designing a mobile app for the development of pervasive games. ICGI 2019 - Proceedings of the International Conference on Graphics and Interaction. https://doi.org/10.1109/ICGI47575.2019.8955034
- 22. Etuk, E. D., & Bello, D. O. (2016). Challenges and Prospects of Mathematics Education in Nigeria. Journal of Assertiveness.
- 23. Festus, B. (2014). Assessment in Primary School Mathematics Classrooms in Nigeria. International Journal of Education Learning and Development, 2(2).
- 24. Fomunyam, K. G. (2019). Teaching Stem Education in Nigeria: International Journal of Mechanical Engineering and Technology, 10(12).
- Garba, A., Ismail, N., Osman, S., & Mohd Rameli, M. R. (2020). Exploring peer effect on mathematics anxiety among secondary school students of Sokoto State, Nigeria through photovoice approach. Eurasia Journal of Mathematics, Science and Technology Education, 16(2), em1815. https://doi.org/10.29333/ejmste/112622
- Georgewill, J. W. (1990). Causes of poor achievement in west African school certificate mathematics examinations in rivers state secondary schools, Nigeria. International Journal of Mathematical Education in Science and Technology, 21(3). https://doi.org/10.1080/0020739900210305
- 27. Godejord, B., Godejord, P. A., & Bostad, R. (2017). Ubiquitous technology in education context: an evaluation of a mobile learning application. ICERI2017 Proceedings, 1. https://doi.org/10.21125/iceri.2017.1300
- 28. Hulse, T., Daigle, M., Manzo, D., Braith, L., Harrison, A., & Ottmar, E. (2019). From here to there! Elementary: a game-based approach to developing number sense and early algebraic understanding. Educational Technology Research and Development, 67(2). https://doi.org/10.1007/s11423-019-09653-8
- 29. Idowu, O. O. (2018). Math Anxiety Among Junior Secondary School Children in Lagos, Nigeria: Gender and School Type Effects. In ProQuest Dissertations and Theses.
- Ifdil, I., Fadli, R. P., Zola, N., Erwinda, L., Sari, A., Churnia, E., Rangka, I. B., Solihatun, S., Suranata, K., Bariyyah, K., Ardi, Z., Afdal, A., Refnadi, R., Zufriani, Z., Nikmarijal, N., Dahlan, D., Fitria, L., & Barseli, M. (2019). Chromotherapy: An alternative treatment for mathematics anxiety among elementary school students. Journal of Physics: Conference Series, 1175(1). https://doi.org/10.1088/1742-6596/1175/1/012183
- Josiah, O., & Olubunmi Adejoke, E. (2014). Effect of Gender, Age and Mathematics Anxiety on College Students' Achievement in Algebra. American Journal of Educational Research, 2(7). https://doi.org/10.12691/education-2-7-7
- 32. Kachapova, F. (2014). On the importance of pure mathematics. Journal of Mathematics and Statistics, 10(4). https://doi.org/10.3844/jmssp.2014.421.422
- 33. Kalogiannakis, M., Papadakis, S., & Zourmpakis, A. I. (2021). Gamification in science education. A systematic review of the literature. Education Sciences, 11(1). https://doi.org/10.3390/educsci11010022
- 34. khasim pasha sd, khasim pasha sd. (2012). Importance of mathematics laboratories at the high school level. IOSR Journal of Mathematics, 1(4). https://doi.org/10.9790/5728-0142428
- 35. Kusmaryono, I. (2014). The importance of mathematical power in mathematics learning. International Conference on Mathematics, Science, and Education, May.

- 36. Lai, G., Tanner, J., & Stevens, D. (2011). The importance of mathematics competency in statistical literacy. Advances in Business Research, 2(1).
- Lazarov, B. (2019). Improving the attitude towards mathematics via an ICT rearrangement of the 8th-grade math curriculum. CSEDU 2019 - Proceedings of the 11th International Conference on Computer Supported Education, 1. https://doi.org/10.5220/0007744203910397
- 38. Liu, Z. Y., Chubarkova, E., & Kharakhordina, M. (2020). Online technologies in STEM education. International Journal of Emerging Technologies in Learning, 15(15). https://doi.org/10.3991/ijet.v15i15.14677
- Mavridis, A., Katmada, A., & Tsiatsos, T. (2017). Impact of online flexible games on students' attitude towards mathematics. Educational Technology Research and Development, 65(6). https://doi.org/10.1007/s11423-017-9522-5
- Moreno, R., & Durán, R. (2004). Do multiple representations need explanations? The role of verbal guidance and individual differences in multimedia mathematics learning. In Journal of Educational Psychology (Vol. 96, Issue 3). https://doi.org/10.1037/0022-0663.96.3.492
- 41. Muhammad, K. (2017). Gender difference in math anxiety and mathematics performance of secondary schools' students in Bauchi State Nigeria. International Journal of Education and Evaluation, 3(11).
- 42. NCT03706144. (2018). Evaluating Feasibility and Effectiveness of Computerized Mathematics Training. Https://Clinicaltrials.Gov/Show/NCT03706144.
- Obadare-Akpata, O. (2017). Construction and validation of mathematics achievement motivation scale (MAMS) for senior secondary school students in Nigeria. Turkish Online Journal of Educational Technology, 2017(December Special Issue ITEC).
- Oyinloye, O., & A. Popoola, A. (2013). Activating Junior Secondary School Students' Prior Knowledge for the Development of Vocabulary, Concepts, and Mathematics through Instructional Strategies. International Journal of Education and Literacy Studies, 1(2). https://doi.org/10.7575/aiac.ijels.v.1n.2p.1
- Rienow, A., Lindner, C., Dedring, T., Hodam, H., Ortwein, A., Schultz, J., Selg, F., Staar, K., & Jürgens, C. (2020). Augmented Reality and Virtual Reality Applications Based on Satellite-Borne and ISS-Borne Remote Sensing Data for School Lessons. PFG Journal of Photogrammetry, Remote Sensing and Geoinformation Science, 88(2). https://doi.org/10.1007/s41064-020-00113-0
- Santiago, J. M. S., De Albuquerque, M. C. N., De Almeida, F. K., Martins, F. R. F., & De Oliveira, Y. S. (2019). MathQuiz: A Game App for M-Learning. https://doi.org/10.5753/webmedia.2018.4569
- Sarvehana, Z. S. J. (2019). Study on effectiveness of Hana game application on cognitive problem-solving skill, attention and academic achievement linguistics and mathematics on the first-grade student. Proceedings of the 2019 International Serious Games Symposium, ISGS 2019. https://doi.org/10.1109/ISGS49501.2019.9047023
- Schenke, K., Redman, E. J. K. H., Chung, G. K. W. K., Chang, S. M., Feng, T., Parks, C. B., & Roberts, J. D. (2020). Does "Measure Up!" measure up? Evaluation of an iPad app to teach preschoolers measurement concepts. Computers and Education, 146. https://doi.org/10.1016/j.compedu.2019.103749
- Şengül, S., & Katranci, Y. (2014). Effects of Jigsaw Technique on Seventh Grade Primary School Students' Attitude towards Mathematics. Procedia - Social and Behavioral Sciences, 116. https://doi.org/10.1016/j.sbspro.2014.01.218
- 50. Siew, N. M., Geofrey, J., & Lee, B. N. (2016). Students' Algebraic Thinking and Attitudes towards Algebra: The Effects of Game-Based Learning using Dragonbox 12 + App. The Research Journal of Mathematics and Technology, 5(1).
- 51. Simsek, O. (2016). Use of a Game-Based App as a Learning Tool for Students with Mathematics Learning Disabilities to Increase Fraction Knowledge/Skill. In ProQuest Dissertations and Theses.
- 52. Spieler, B., Schindler, C., Slany, W., Mashkina, O., Beltrán, M. E., Boulton, H., & Brown, D. (2018). Evaluation of game templates to support programming activities in schools. In arXiv.
- 53. Sule, B., Hussaini, M. M., Bashir, U. S., & Garba, A. (2016). Mathematics Phobia among Senior Secondary School Students: Implication for Manpower Development in Science Education in Nigeria. In International Journal of Education and Evaluation (Vol. 2, Issue 8). www.iiardpub.org
- Tajudin, N. M., Puteh, M., & Adnan, M. (2018). Guiding Principles to Foster Higher Order thinking skills in teaching and learning mathematics. International Journal of Engineering and Technology (UAE), 7(4). https://doi.org/10.14419/ijet.v7i4.15.21445
- 55. Tan, C., Yu, P., Lin, L., Fung, C., Lai, C., & Cheng, Y. (2017). Teaching Computational Thinking by Gamification of K-12 Mathematics: Mobile App Math Games in Mathematics and Computer Science Tournament. International Conference on Computational Thinking Education (CTE 2017).
- 56. Tavares, R., Vieira, R. M., & Pedro, L. (2021). Mobile app for science education: Designing the learning approach. Education Sciences, 11(2). https://doi.org/10.3390/educsci11020079

- 57. The Education Committee. (2021). The Increasing Importance of Mathematics. The Mathematics Teacher, 46(1). https://doi.org/10.5951/mt.46.1.0003
- Yáñez-Marquina, L., & Villardón-Gallego, L. (2016). Attitudes towards mathematics at secondary level: Development and structural validation of the Scale for Assessing Attitudes towards Mathematics in Secondary Education (SATMAS). Electronic Journal of Research in Educational Psychology, 14(3). https://doi.org/10.14204/ejrep.40.15163
- 59. Yang, J. C., & Chen, S. Y. (2010). Effects of gender differences and spatial abilities within a digital pentominoes game. Computers and Education, 55(3). https://doi.org/10.1016/j.compedu.2010.05.019
- 60. Yussop, Y. M., Annamalai, S., & Salam, S. A. (2019). Hi-math mobile app: Effectiveness in improving arithmetic skills of primary school students. International Journal of Recent Technology and Engineering, 7(6).