ELEMENTS FOR DESIGNING A MOBILE LEARNING ENVIRONMENT FOR PROBLEM-SOLVING OF PROBABILITY: THE EXPERTS' CONSENSUS

Durga Gnanasagaran [1]
***Suzieleez Syrene Abdul Rahim**[1]
Dorothy DeWitt[1]
[1] Faculty of Education, Universiti Malaya
**suzieleez@um.edu.my*

Abstract: It is important for students in the Malaysian Matriculation System who learn probability to develop problem-solving skills as it could help in important roles encompassing various fields. This study aims to identify the essential elements for designing a mobile learning environment that facilitates problem-solving of probability based on the consensus of experts in the area. Fuzzy Delphi Method (FDM) was employed to collect data from a panel of nineteen experts whose expertise ranged from Mathematics Education, Matriculation Mathematics, Technology in Education and Instructional Technology. A semi-structured interview was first conducted to come up with the elements and sub-elements required for the FDM questionnaire instrument. The questionnaire was developed using a five-point linguistic scale. The conditions to be fulfilled were that the threshold value (d) needed to be less than or equal to 0.2 and percentage of expert consensus needed to be greater than or equal to 75%. For the defuzzification process meanwhile, the fuzzy score (A) was required to be greater than or equal to the alpha-cut value of 0.5. The results indicated the experts' consensus on the elements objectives, contents, instructional strategies for students' learning and suitable platform or technology. These findings have significant implications for designing the mobile learning environment for problem-solving of probability.

Keywords: Probability, problem-solving, Fuzzy Delphi Method, mobile learning

INTRODUCTION

Living in a data-driven world today, probability and statistics affect all aspects of life. Concepts such as data, randomness, chance, probability and risk are the concepts in the mathematical realm of probability and statistics that are encountered daily. In keeping up with the age of information, the internet, television and newspapers are widely used. People come face-to-face with a huge amount of data in the working world and need to solve problems and make decisions in uncertain situations. Hence, it is safe to say that most countries include probability and statistics in their curriculum because their use in daily life, their roles in other fields of study and their contribution to the logical inquiry process are recognized (Koparan, 2022). Knowledge in statistics is important to students as when they eventually go into the employment world, the practice of working with the collection, presentation, analysis and use of data becomes applicable in making decisions, solving problems and in designing products and processes (Montgomery and Runger, 2018). It is noted that an increased emphasis has been accorded to the subject of probability in the curricular and this is substantiated with the increasing number of studies on this subject (Koparan, 2019, 2022). However, probability is a top subject where the is a scarcity of comprehensive learning environments. Instructional strategies are often limited to drilling exercises and the chalk and talk approach. For effective learning of the subject, a suitable environment to develop statistical problem-solving skills is required with mobile technology playing a central role in the learning environment.

Due to the myriad of issues pertaining to the learning of probability, namely that of students' inadequate abstract reasoning skills, their weakness in developing their reasoning ability and their usage of inappropriate visualisation forms that causes attention diversion through the illustration of unimportant information, students encounter difficulty in problem solving involving conditional probability (Abdul Rahman & Ansari, 2016; Lukac & Gavala, 2019). The current pedagogy, which is deemed rather dated (Crompton & Traxler, 2018) employs a more teacher centred learning which also contributes to the existence of time constraint in the delivery of the lessons (Aziz, 2005), hence further halting the development of students' probabilistic reasoning ability which is the essence of conditional probability. This indirectly hampers their progress in conditional probability problem solving. Therefore, it is important to have a learning environment that incorporates the aspect of mobility as well as visualisation suited to the needs of students to assist with their current difficulties in mastering conditional probability problem solving. There does not seem to be any mobile learning environment addressing problem solving in conditional probability and therefore, the need to design one to address the issues faced by students is very much existent. The aspect of mobility of learners' and mobility of devices in mobile learning is also pivotal in addressing the issue of teacher centred learning and time constraint present in the delivery of lessons by enabling learning to happen anytime and anywhere (Rahamat, 2019). The aspect of visualisation through tree diagrams and contingency tables is vital to illustrate clearly and systematically the possibilities or cases that need to be analysed during the process of problem solving (Lukac & Gavala, 2019). Hence by recognising the issues present in students' learning of conditional probability problem solving and the potentialities of mobile learning in addressing the issues, a mobile learning environment integrating mobile technology is designed by taking into consideration the opinion of experts in the areas.

Since the number of mobile phone users have been increasing, pre-university colleges in Malaysia, namely the Malaysian Matriculation Colleges should embrace this technology of learning. This study will then allow the Matriculation Division of the Ministry of Education Malaysia to consider using mobile learning for problem solving instruction in the topic of Probability at matriculation colleges to develop students' problem solving skills. As for students, learning mathematics, namely that of conditional probability is not just to settle for the regurgitation of facts, but also to build up their understanding of the concept. Since students need more platforms to practice and communicate in probability language, it would be apt to adopt a mobile learning environment for learning independently or collaboratively with others. The integration of technology in teaching and learning acts as a means of assistance to students who face difficulties in grasping complex concepts. The mobile learning environment designed with the experts will allow conditional probability to be learnt and taught in a more active mode that incorporates a variety of media, namely written, visual and audio. Given the educational climate of Malaysia, this idea will promote greater engagement with the content material and a deep approach to its learning (Norman & Ghazali, 2022).

Since there has been no research investigating the elements needed to design a mobile learning environment at the moment, this study intends to provide insights on the suitable elements of the mobile learning environment (MLE) for conditional probability problem-solving by taking into consideration the opinion of experts. Thus, this study will be investigating what the suitable elements are for designing a mobile learning environment and will answer the following research question: what are the suitable elements of the mobile learning environment for conditional probability problem-solving according to experts?

METHODOLOGY

With the objective being to design a mobile learning environment (MLE) based on problem-solving of Probability for pre-university level according to the opinions and views of the experts panel, the Fuzzy Delphi Method employed for this purpose. Experts needed to fulfil the criteria of having more than five years of experience in their field (Berliner, 2004; Akbari & Yazdanmehr, 2014). Those who were considered as experts possessed the required expertise and were trained in that particular field (Needham, 1990; Mullen, 2003; Powell, 2003). In order to determine the learning environment's design, a consensus among a panel of experts needed to be obtained on the elements and sub-elements of objectives, content, instructional strategy for students' learning and suitable platform or technology.

Participants

The panel of experts were made up of eight males and eleven females. Their expertise ranged from that of Matriculation Mathematics, Mathematics Education, Mobile Learning, Instructional Technology, Problem-solving and Technology in Education. In particular, there were five matriculation college lecturers, twelve university lecturers, one lecturer from the institute of teacher education and one policymaker. This was to ensure that there was a balance of practitioners and academicians in the pool of experts. The eight experts who were interviewed for the development of the Fuzzy Delphi Instrument were included in the experts' pool that was involved in responding to the Fuzzy Delphi Questionnaire Instrument. The experts possessed eleven years to twenty-eight years of experience in their respective fields of expertise.

Table 1

Summary of Expert Panels' Details

Number of Experts	Area of Expertise	Years of Experience	Position	Highest Qualification
5	Matriculation Mathematics, Problem-solving	13 – 17	Senior Lecturer	Master's, PhD
5	Mathematics Education, Problem-solving	11 – 26	Associate Professor, Senior Lecturer	PhD
4	Technology in Education, Mobile Learning	13 – 28	Professor, Associate Professor, Senior Lecturer	PhD
5	Instructional Technology	11 – 19	Associate Professor, Senior Lecturer, Senior Assistant Director	PhD

Round 1 of the FDM: Semi-structured interview

The first part of the data collection in the FDM employed the semi-structured interview involving eight experts. The eight experts involved possessed relevant experience and expertise in the areas concerning mathematics education, matriculation mathematics, technology in education and instructional technology. These experts were deemed fit for their role as they were chosen due to their competence and knowledge which helped improve the study's validity. The thematic analysis done saw the emergence of the themes objectives of the MLE, content that was going to be the focus of the MLE, instructional strategies for students' learning and the suitable platform for the delivery of the MLE. Based on the elements and sub-elements that emerged from the opinions of experts, the Fuzzy Delphi Instrument in the form of a questionnaire was developed. Six items were formed for the theme of objective, twelve items for content, six items for instructional strategies for students' learning and thirteen items for platform respectively.

Round 2 of the FDM: Distribution of Fuzzy Delphi instrument

Based on the suggestions of the experts' panel during the interview process, the Fuzzy Delphi Instrument was designed. Through the emergence of elements and their respective sub-elements from the interview done in the first part, the instrument was administered to other experts to determine the agreement extent. In order to ensure there was consistency between the interview findings and elements chosen, the eight experts who were interviewed in Round 1 from the panel of nineteen experts were also included in the questionnaire round.

Data Analysis

Data yielded via experts' interview was analysed by means of the thematic analysis (Braun & Clarke, 2006). Through this, data was put in categories in order to spot elements to be incorporated into the mobile learning environment. Based on the categories suggested by the experts' panel during the interview process, the Fuzzy Delphi Instrument was designed. Through the emergence of themes from the interview done in the first part, the instrument was administered to other experts to determine the agreement extent. In order to ensure there was consistency between the interview findings and elements chosen, the eight experts who were interviewed in Round 1 were also included in the questionnaire round.

Data from the FDM instrument was analysed by using Microsoft Excel. The issue of fuzziness among experts was addressed through a linguistic scale similar to that of a Likert scale with the provision of additional fuzzy numbers. These considerations were given attention to in designing the Fuzzy Delphi instrument whereby the level of importance was placed upon the identified elements; objectives of the MLE, content that was going to be the focus of the MLE, instructional strategies for students' learning and the suitable platform for the delivery of the MLE of the problem-solving instruction related to the learning of conditional probability by using mobile learning. Only

juku.um.edu.my | E-ISSN: 2289-3008

the elements deemed to be relatively important were further considered for the study. The degree of importance, which ranged from 'very unimportant' to 'very important' could be positive or negative (Kardaras et al., 2013). It was represented in a 5-point linguistic scale with 1 = Unimportant, 2 = Little important, 3 = Moderately important, 4 = Important, 5 = Very important. This represents the 5-point linguistic scale for the agreement level. The steps involved in FDM are as follows:

Step 1: Selecting the eligible panel of experts according to the criteria of 10-15 experts (Adler & Ziglio, 1996) or 10-50 experts (Jones & Twiss, 1978).

Step 2: Determining the linguistic scale according to the triangular fuzzy number in order to frame feedback.

Step 3: Calculating the mean of experts' opinions for each dimension.

Step 4: Determining the distance between two fuzzy numbers to determine the threshold, d. If the value of d is less than or equal to 0.2, therefore the experts have all reached a consensus. Otherwise, it requires a round two.

Step 5: Determining the consensus of the group. The group consensus percentage needs to exceed 75%, otherwise needing round two to be conducted.

Step 6: Identifying the Alpha-cut level for the selection of elements to develop the mobile learning environment; literature mostly makes use of an Alpha-cut level of 0.05.

Step 7: Aggregating the Fuzzy Evaluation by adding up all the fuzzy numbers.

Step 8: Carrying out the Defuzzification process which is a conversion technique of the numbers into crisp real numbers.

Step 9: Choosing the elements according to the defuzzification value to rank. The element with the highest defuzzification value will be prioritised and ranked the highest.

FINDINGS

This section reports the FDM consensus from the nineteen experts. The aspects of which the consensus were obtained for are objectives, contents, instructional strategies for students' learning and suitable platform or technology to be used. The conditions to be fulfilled were that the threshold value (d) needed to be less than or equal to 0.2 and percentage of expert consensus needed to be greater than or equal to 75%. For the defuzzification process meanwhile, the fuzzy score (A) was required to be greater than or equal to the alpha-cut value of 0.5.

Objectives

Table 2

Sub-elements of Objective

No.	Item	Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)	Expert Consensus	Ranking
1.	Solve conditional probability problems.	0.194	89	0.704	Accepted	3
2.	Represent problems by by using diagrams.	0.183	100	0.705	Accepted	2
3.	Show the steps taken to solve conditional probability problems.	0.162	95	0.716	Accepted	1

Under the element of Objective, Items 1, 2 and 3 obtained an experts consensus of greater than 75% each and a d value below 0.2. Hence, these three items were accepted. Based on the defuzzification values of the accepted items,

juku.um.edu.my | E-ISSN: 2289-3008

Item 3 ranked the highest as it had the highest fuzzy score of 0.716 and this was followed by Item 2 which ranked second with a fuzzy score of 0.705 and Item 1 which came in third with a fuzzy score of 0.704 as can be seen on Table 2. This showed that most of the experts perceived “showing the steps taken to solve conditional probability problems” as the most important objective of the MLE.

Content

Table 3

Sub-elements of Content

No.	Item	Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)	Expert Consensus	Ranking
1.	Real-world contextual problem scenarios	0.154	95	0.726	Accepted	1
2.	Step-by-step instructions on how to solve the problems	0.186	89	0.695	Accepted	3
3.	Diagrams to assist with carrying out steps to solve the problems	0.168	95	0.653	Accepted	4
4.	Prior knowledge related to the problem	0.149	100	0.716	Accepted	2
5.	Independent and dependent events	0.186	89	0.695	Accepted	3

In order to map out the relevant content areas to be included in the MLE, experts’ opinions regarding the items under the Content element were acquired. The threshold value (d), experts consensus percentage, defuzzification value and ranking of each item contained under the banner of Content element with regard to the consensus of the experts are as portrayed in Table 3. Most of the experts were in agreement that Item 1 that is “Real-world contextual problem scenarios” is the most important content as it ranked top with the highest fuzzy score of 0.726. This was followed by Item 4 which was “Prior knowledge related to the problem” which had a fuzzy score of 0.716. Being jointly ranked third were Items 2 and 5 which were “step-by-step instructions on how to solve the problems” and “independent and dependent events” respectively. “Diagrams to assist with carrying out the steps to solve problems” came in fourth in ranking among all the items which were accepted according to the percentage of the experts’ consensus.

Instructional Strategies for Students’ Learning

Table 4

Sub-elements of Instructional Strategies for Students’ Learning

No.	Item	Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)	Expert Consensus	Ranking
1.	Problem based learning	0.102	79	0.758	Accepted	1
2.	Co-operative learning	0.186	89	0.684	Accepted	4
3.	Collaborative learning	0.168	95	0.684	Accepted	4
4.	Inquiry based learning	0.142	100	0.726	Accepted	2
5.	Game based learning	0.169	95	0.695	Accepted	3

The element Instructional Strategies for Students’ Learning contained items to plan the approaches in the MLE. The threshold value (d), expert consensus percentage, fuzzy score (A) and ranking of every accepted item under this element gauged considering the consensus of the experts is displayed in Table 4. Most of the experts were in agreement that the first item which was "problem based learning" was the most important one to be considered for inclusion in the MLE as it raked the highest fuzzy score (A) of 0.759.

Platform or Technology

Table 5

Sub-elements of Evaluation

No.	Item	Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)	Expert Consensus	Ranking
1.	Mobile phones/ smartphones	0.102	79	0.758	Accepted	1
2.	Laptops	0.168	95	0.705	Accepted	3
3.	Google Classroom	0.173	95	0.684	Accepted	4
4.	Websites	0.149	100	0.684	Accepted	4
5.	Education mobile applications	0.183	89	0.674	Accepted	5
6.	Interactive learning platforms	0.086	79	0.621	Accepted	7
7.	Youtube	0.097	79	0.632	Accepted	6
8.	Google Workspace for Education	0.162	95	0.716	Accepted	2

The platform or technology element contained items to plan the platform and technology to deliver and facilitate the MLE. The threshold value (d), expert consensus percentage, fuzzy score (A) and ranking of every accepted item under this element gauged considering the consensus of the experts are displayed in Table 5. Mobile phones came out as the top ranked item with a defuzzification value of 0.758 while the Google Workspace for Education was ranked second with a defuzzification value of 0.716.

DISCUSSION

This section discusses the findings from the analysis of the Fuzzy Delphi Method carried out to identify the experts' consensus of the elements for the mobile learning environment for problem-solving of probability at pre-university level. As stated in the findings earlier, the items under the respective elements were prioritised according to their rankings. The experts' consensus in this study depicted the priority listing of the required elements for the MLE in terms of the objective, content, instructional strategy for students' learning, and suitable platform or technology for delivery. While some elements showed absolute acceptance by the experts, there were also some elements that showed a substantial rejection of items and other elements where there were a balanced amount of acceptance and rejection of the items. These findings were used as a guide in coming up with a framework to develop a MLE for problem-solving of probability at pre-university level.

Under the aspect of objectives, in developing a MLE, it is important that the learning objectives chosen are a reflection of the needs of students in order to make sure that students can then achieve what the MLE intended to convey in the first place. The experts agreed that problem-solving skills needed to be emphasised as the skills were essential in developing higher order thinking skills. The objectives accepted by the experts were that by the end of making use of the MLE, students should be able to represent problems by using diagrams, show the steps taken to solve conditional probability problems and solve conditional probability problems. These items indicate that the strategy and process of problem-solving should be the focus of the MLE. This finding resonates with (Al-Khateeb, 2018) who acknowledged that these objectives as being slaves to time constraints and the traditional learning setup, hence much more reasonable to be accomplished in a mobile learning setting. Following the evidences put forth by (Shchedrina et al., 2020), the accepted learning objectives for the MLE were arranged according to their level of cognitive complexity.

In designing the content of the MLE, the experts agreed that real-world contextual problem scenarios, prior knowledge related to the problem, step-by-step instructions on how to solve the problem, independent and dependent events and diagrams to assist with carrying out the steps to solve the problems needed to be included in the MLE. The content which received the highest expert consensus here was real-world contextual problem scenarios. With students often questioning the need to study mathematics and statistics (Schukajlow et al., 2017), this was understandable as there have been concerns for mathematics educators related to the inadequacy and lack of relevance of traditional learning methods to engage students in problem-solving (Kohen & Orenstein, 2021; Sierpinska, 1995; Wu & Adams, 2006). Exposing students to authentic problems of conditional probability has the potential to improve their understanding of real-world situations from a mathematical perspective (Hernandez-Martinez & Vos, 2018). Prior knowledge related to the problem and the step-by-step instructions on how to solve the problem assisted by the usage of diagrams also achieved agreement between the experts for inclusion in the MLE. This shows that focusing on the mechanics of the problem solving coupled with emphasis on visual representation and underlying concepts are central to making a difference in students' ability to solve conditional probability problems (Chow & Van Haneghan, 2016; Even & Kvatinsky, 2010). In Brase (2007), he suggested that the evolution of human capabilities to address probabilities was linked to affordances of previous learning so much so that in cases where there was a lack of such affordances, problem solving was less intuitive. In addition to that, independent and dependent events of conditional probability also achieved the desired consensus of the experts to be considered in the MLE. The high misconception rate of independent and dependent events has been faulted on the lack of prominence they have been given in the curriculum resulting in them only being covered if time permitted (Molnar, 2016). Therefore, the inclusion of independent and dependent events in the MLE creates an opportunity for its learning with the affordance of learning happening anytime and anywhere in the MLE.

The outcome of the experts' agreement when it came to instructional strategy for students' learning ranked problem-based learning to be the top instructional strategy for the MLE. Problem based learning being a student-centred method of learning is suitable for mobile learning as it controls and guides the activities done by students in that learning environment (Binsaleh & Binsaleh, 2020; Othman et al., 2013; Yusof et al., 2016; Yusoff et al., 2021). The strategies of problem based learning plays an essential role in helping students transfer their experience of analysing the learning activities critically to their day-to-day activities in life especially when they need to solve problems (Chiang et al., 2009; Hawari & Noor, 2020).

Suitable platform or technology for the mobile learning environment, mobile phones, Google Workspace for Education, laptops, Google Classroom, websites, education mobile applications, YouTube and interactive learning platforms were accepted for inclusion. Previous research findings have suggested that mobile phones were a suitable technology for mobile learning environments, providing students with new learning opportunities that were not limited by place and time as well as supporting different learning styles (Ahmad, 2018; Al Hosni, 2016; Bernacki et al., 2020). Google Workspace for Education which has tools such as Google Classroom that acts as a virtual classroom positively impacted students' learning experience and the platform was accessible and easy to use on mobile devices (Gupta & Pathania, 2021). It has proven to be effective in improving students' access and attentiveness towards learning, and the knowledge and skills gained through the platform makes learning more efficient and enjoyable (Hussaini et al., 2020). Laptops are among the devices commonly used for mobile learning (Majeed, 2014). Laptops are suitable for mobile learning environments as they offer benefits of access to learning materials, self-directed learning opportunities and tools for collaboration and engagement (Demir & Akpinar, 2018; Mouza, 2008). Laptops are essential in a mobile learning environment for learning probability due to its capability of giving students the chance of supplemental thinking and enhancing problem-solving skills by enhancing communication and collaboration (Mouza, 2008; Sung et al., 2016). Google Classroom is a platform that is good for the landscape of learning today because through Google Classroom, students get to collaborate and discuss in groups while working on their tasks (Ching, 2022). Google Classroom offers several benefits for mobile learning environments such as flexibility, instantaneous deployment of material, mobile-friendly interfaces, more storage space and a platform that is both secure and versatile (Bradley, 2021; Chatterjee et al., 2023; Kayali et al., 2016). Mobile friendly websites are becoming increasingly popular for mobile learning environments given the increasing use of mobile devices for accessing online content.

CONCLUSION

This study intended to identify the required elements to design a mobile learning environment based on problem-solving of probability. The findings of this study suggest that the elements objective, content, instructional strategy for students' learning and suitable platform or technology are essential when wanting to come up with a mobile learning environment for students' learning of conditional probability. This can guide Higher Education Institutions to come up with learning environments which are relevant to students' needs and endorsed by experts in the field. More research can be carried out with experts from other pre-university institutions. The information gained from this study can be used as a concrete input to design a mobile learning environment for problem-solving of probability for pre-university level.

This study will add to the existing body of knowledge with regard to experts' consensus in determining elements for designing learning environments for learners. By addressing relevant concerns about creating and planning a mobile learning environment for students' learning, it is clear that focus needs to be paid to how these efforts are brought together and emphasised appropriately to ensure that the elements incorporated are for the betterment of the present and future learning of the students.

REFERENCES

Abdul Rahman & Ansari Saleh Ahmar. (2016). Exploration of mathematics problem solving process based on the thinking level of students in junior high school. *International Journal of Environmental & Science Education*, *11*(14), 7278-7285.

Adler, M. & Ziglio, E. (1996). *Gazing into the Oracle: The Delphi Method and Its Application to Social Policy and Public Health.* London: Jessica Kingsley Publishers.

Ahmad, T. (2018). Mobile phones as a learning tool: a lecturer's viewpoint. *Society and Business Review, 13*(2), 132-139.

Al Hosni, S. S. (2016). Mobile learning: enhancing learning through cell phones. *BEST: International Journal of Management, Information Technology and Engineering (BEST: IJMITE), 4*, 17-22.

Al-Khateeb, M. (2018). The effect of teaching mathematical problems solving through using mobile learning on the seventh grade students' ability to solve them in Jordan.

Bernacki, M. L., Greene, J. A., & Crompton, H. (2020). Mobile technology, learning, and achievement: Advances in understanding and measuring the role of mobile technology in education. *Contemporary Educational Psychology*, *60*, 101827.

Binsaleh, S., & Binsaleh, M. (2020). 4P-2E Model: Teaching and Learning Process through ICT Integration for Private Islamic Schools in Thailand. *Asian Journal of University Education*, *16*(4), 71-81.

Bradley, V. M. (2021). Learning Management System (LMS) use with online instruction. *International Journal of Technology in Education (IJTE), 4*(1), 68-92.

Brase, G. L. (2007). The (in) flexibility of evolved frequency representations for statistical reasoning: Cognitive styles and brief prompts do not influence Bayesian inference. *Acta Psychologica Sinica*, *39*(3), 398-405.

Chatterjee, P., Bose, R., Banerjee, S., & Roy, S. (2023). Enhancing Data Security of Cloud Based LMS. *Wireless Personal Communications*, 1-17.

Chiang, A., Wu, P.-H., & Baba, M. S. (2009). A study of educator workload in problem-based learning. Proceedings of the Internet and Multimedia Systems and Applications (IMSA 2009) Conference, Honolulu, Hawaii, USA,

Ching, M. C. H. (2022). GOOGLE CLASSROOM SEBAGAI SALAH SATU PLATFORM DALAM PENYAMPAIAN PENGAJARAN DAN PEMBELAJARAN: SATU KAJIAN TINJAUAN. *JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik*, *10*(1), 1-9.

Chow, A. F., & Van Haneghan, J. P. (2016). Transfer of solutions to conditional probability problems: Effects of example problem format, solution format, and problem context. *Educational Studies in Mathematics*, *93*, 67-85.

Demir, K., & Akpinar, E. (2018). The Effect of Mobile Learning Applications on Students' Academic Achievement and Attitudes toward Mobile Learning. *Malaysian Online Journal of Educational Technology*, *6*(2), 48-59.

Even, R., & Kvatinsky, T. (2010). What mathematics do teachers with contrasting teaching approaches address in probability lessons? *Educational Studies in Mathematics*, *74*(3), 207-222.

Gupta, A., & Pathania, P. (2021). To study the impact of Google Classroom as a platform of learning and collaboration at the teacher education level. *Education and Information Technologies*, *26*(1), 843-857.

Hawari, A. D. M., & Noor, A. I. M. (2020). Project based learning pedagogical design in STEAM art education. *Asian Journal of University Education, 16*(3), 102-111.

Hernandez-Martinez, P., & Vos, P. (2018). "Why do I have to learn this?" A case study on students' experiences of the relevance of mathematical modelling activities. *ZDM*, *50*, 245-257.

Hussaini, I., Ibrahim, S., Wali, B., Libata, I., & Musa, U. (2020). Effectiveness of Google classroom as a digital tool in teaching and learning: Students' perceptions. *International Journal of Research and Innovation in Social Science (IJRISS)*, *4*(4), 51-54.

Kayali, M. H., Safie, N., & Mukhtar, M. (2016). Literature review of cloud based e-learning adoption by students: State of the art and direction for future work. IOP Conference Series: Materials Science and Engineering,

Kohen, Z., & Orenstein, D. (2021, May). Mathematical modeling of tech-related real-world problems for secondary school-level mathematics. *Educational Studies in Mathematics, 107*(1), 71-91.

https://doi.org/10.1007/s10649-020-10020-1

Koparan, T. (2019). Teaching Game and Simulation Based Probability. *International Journal of Assessment Tools in Education*. https://doi.org/10.21449/ijate.566563

Koparan, T. (2022). How Does Simulation Contribute to Prospective Mathematics Teachers' Learning Experiences and Results? *Education Sciences*, *12*(9), 624.

Majeed, A. (2014). Mobile Learning and education. *i-Manager's Journal on Communication Engineering and Systems*, *4*(1), 30.

Molnar, A. (2016). High school mathematics teachers' understanding of independent events. 13th International Congress on Mathematical Education, Hamburg, Germany. http://iase-web/. org/documents/papers/icme13/ICME13_L9_Molnar. pdf. Accessed June,

Mouza, C. (2008). Learning with laptops: Implementation and outcomes in an urban, under-privileged school. *Journal of research on technology in education*, *40*(4), 447-472.

Norman, N. B., & Ghazali, M. A. B. (2022). APLIKASI METOD FUZZY DELPHI UNTUK PENILAIAN KESESUAIAN MODEL KANDUNGAN mPEMBELAJARAN PENDIDIKAN ROHANI REMAJA SECARA INFORMAL. *JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik*, *10*(2), 33-46.

Othman, M., Madani, S. A., & Khan, S. U. (2013). A survey of mobile cloud computing application models. *IEEE communications surveys & tutorials*, *16*(1), 393-413.

Schukajlow, S., Rakoczy, K., & Pekrun, R. (2017). Emotions and motivation in mathematics education: Theoretical considerations and empirical contributions. *ZDM*, *49*, 307-322.

Shchedrina, E., Galkina, E., Petunina, I., & Lushkov, R. (2020). Integration of Mobile Learning into Complex Problem-Solving Processes During STEM Education. *International Journal of Interactive Mobile Technologies*, *14*(21).

Sierpinska, A. (1995). Mathematics:" in Context"," Pure", or" with Applications"? A Contribution to the Question of Transfer in the Learning of Mathematics. *For the learning of mathematics*, *15*(1), 2-15.

Sung, Y.-T., Chang, K.-E., & Liu, T.-C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, *94*, 252-275.

Wu, M., & Adams, R. (2006). Modelling Mathematics Problem Solving Item Responses Using a Multidimensional IRT Model. *Mathematics Education Research Journal*, *18*(2), 93-113.

Yusof, K. M., Sadikin, A. N., Phang, F. A., & Aziz, A. A. (2016). Instilling professional skills and sustainable development through Problem-Based Learning (PBL) among first year engineering students. *International Journal of Engineering Education*, *32*(1), 333-347.

Yusoff, A. F. M., Hashim, A., Muhamad, N., & Hamat, W. (2021). Application of fuzzy delphi technique to identify the elements for designing and developing the e-PBM PI-Poli module. *Asian Journal of University Education (AJUE)*, *7*(1), 292-304.