Available Online at www.e-iph.co.uk
Indexed in Clarivate Analytics WoS, and ScienceOPEN

E-B
Environment - Behaviour Proceedings Journal

ISSEC-24
https://sites.google.com/view/issec-2024/home
International Social Science & Educational Conference 2024
Virtual conference, 07-08 Dec 2024
Organised by: CLM Publishing Resources, Malaysia

e-IPH
e-International Publishing House Ltd., United Kingdom

Your Additional Mathematics Coach: Elements of an intelligent mobile application

Indirani Munusamy, **Mohd Faizal Nizam Lee Abdullah***, **Selvi Rajamanickam**
**Corresponding Author*

Sultan Idris Education University, Tanjung Malim, Malaysia

indiranimunusamy9@gmail.com ,faizalee@fsmt.upsi.edu.my, tbernselvi77@gmail.com
Tel: 0195761279

Abstract
Additional Mathematics is a critical subject in Malaysia. This subject recorded the lowest passing level in public exams in the past five years (2019-2023). There is a pressing need for innovative learning solutions. Mobile applications, with their ability to offer interactive and accessible learning experiences, present a promising approach to engage students more effectively and improve performance. This article extracts the opinions of eleven professionals in the field of additional mathematics and technology to identify the important elements for developing a learning mobile application through the Nominal Group Technique (NGT).

Keywords: Additional Mathematics, Students, Nominal Group Technique, Mobile Application.

DOI: https://doi.org/10.21834/e-bpj.v10iSI24.6376

1.0 Introduction

Additional Mathematics is a branch offered as an elective subject at the upper secondary level in schools across Malaysia. Students who wish to take this subject are required to have an excellent academic record during their lower secondary education. According to Hui and Rosli (2021), mathematical intelligence is crucial in nearly all fields of education in this era of rapidly advancing technology. Therefore, this subject was introduced to prepare students for careers in Science, Technology, Engineering, and Mathematics (STEM) (Yahya & Amir, 2018).

The topics in this subject have been reorganized in the Standard Curriculum and Assessment Document (DSKP) for Additional Mathematics Form 4 and 5 (Curriculum Development Division, 2018). There are eighteen topics to be studied by students, grouped into five areas of learning: Algebra, Geometry, Calculus, Trigonometry, and Statistics. For Form 4, ten topics are to be covered from four of these areas. Additionally, significant emphasis is placed on using technological tools and materials in teaching and learning (Curriculum Development Division, 2018). Although it has long been introduced and established in education, it has yet to dominate it fully (Ompusunggu & Sari, 2019).

Given that the use of technological tools and materials is highly emphasized in this new DSKP, the researcher also aims to identify and prioritize the key elements for the development of a mobile application to support the teaching and learning of Additional

eISSN: 2398-4287 © 2025. The Authors. Published for AMER by e-International Publishing House, Ltd., UK. This is an open-access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/). Peer–review under the responsibility of AMER (Association of Malaysian Environment-Behaviour Researchers.
DOI: https://doi.org/10.21834/e-bpj.v10iSI24.6376

Mathematics. The main objective of the research is to analyze and prioritize the identified elements based on the consensus achieved through the Nominal Group Technique (NGT) process.

With more exciting and accessible teaching strategies, participation rates and academic performance can improve, setting them up to succeed in higher education and workforce realities. This research has attempted to meet these challenges by identifying the elements that need to be addressed in designing mobile learning applications for Additional Mathematics. Having defined pedagogical and user tasks through data publication and endorsement by educators, students, and expert participants during two iterations of the Nominal Group Technique (NGT), known as a structured group consensus approach (Dowling & St. Louis, 2000; Duggan & Thachenkary, 2004). The research then collects further data to apply the pedagogical and user tasks to an application that is both pedagogically usable.

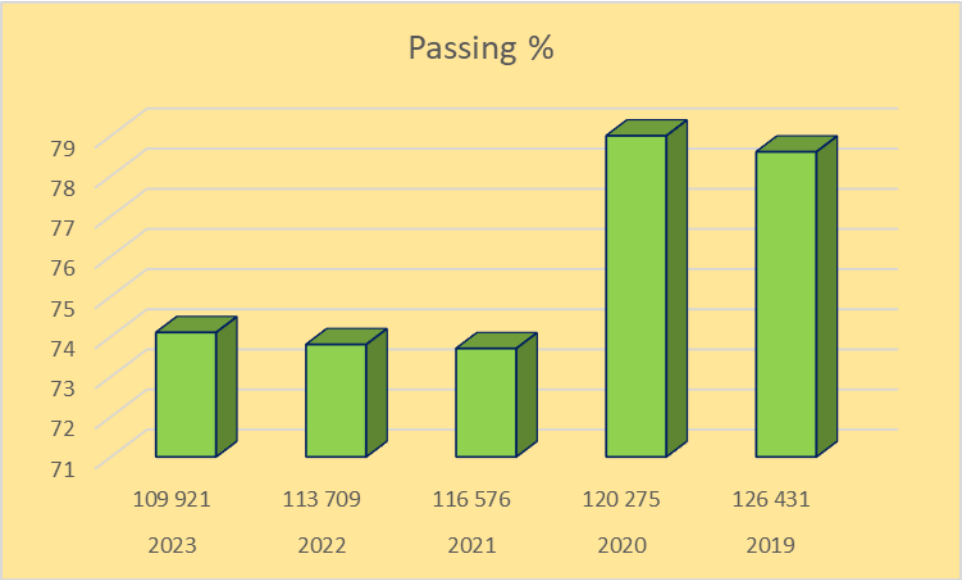

Figure 1: Passing percentage of Additional Mathematics in Sijil Pelajaran Malaysia (2019-2023). *(Malaysian Examination Board).*

From 2019 to 2023, the passing percentages for SPM Additional Mathematics examinations showed an alarming downward trend despite the number of candidates varying yearly. Thus, 126,431 students took the exam in 2019, and the pass rate was 78.6% — more than just a little high. This fell to 120,275 candidates in 2020, but the pass rate edged up to 79%. However, for the next few years, passing rates fell back. Meanwhile, in 2021, there were a total of 116,576 candidates who appeared for the exam, but only 73.7% were able to pass. For both 2022 and 2023, the number of candidates taking the exam continued to decrease, with 113,709 and 109,921, as the passing rate stood at 73.8% and 74.1%.

This consistent downward trend in passing percentages leads us to wonder what the key aspects causing the crashing results are. In 2020, the fact that there was slight improvement may be explained by new approaches in assessments, such as online learning and different test items, as we were faced with the COVID-19 pandemic (Ismail et al., 2021). However, the decline in the passing rates after that indicates these changes did not seem to enhance students' performance in the long run effectively. Indeed, increased difficulty in school subjects, poor teaching methods, and perhaps a mismatch between student needs and what is offered on the weather may also be important factors.

Importantly, while the number of candidates has fallen over time, much fewer students are passing this key subject, which means it is time to reconsider how the subject is taught, how well students are supported, and how the curriculum is delivered. The decline in passing rates makes Additional Mathematics a challenging area that points to the urgency for educational reforms to ensure that students are sufficiently equipped to do well in higher education, leading to careers in engineering, technology, and science, which are the pillars of economic growth.

2.0 Literature Review

Studies in mathematics education emphasized mobile learning, which has proven to not only help with engaging students, but also with information retention and learning differences. With respect to mobile learning, tangible gains have been reported in the comprehension of mathematics concepts, enabled by personalized, interactive learning tools (Supriyadi & Kuncoro, 2023; Yaniawati et al., 2022).

There are studies stating that mobile learning can provide a game-based approach or interactive modules that can help solve problems such as abstract concepts and low motivation in teaching topics like Additional Mathematics. While improvising the skills required for innovation in a digital era, game-based learning environments improve cognitive and affective skills while enriching problem-solving, teamwork, and self-efficacy (Albano et al., 2021; Ke & Villas-Boas, 2019).

The NGT offers a structured approach to identifying user needs that are ideal for effective design. It is an approach that has been used in education technology research to assess the prioritization of design elements with expert panels to ensure the application can be compliant with the educational and psychological needs of the audience (Ab Rahman et al., 2023).

Mobile applications are successful tools in mathematics education, providing interaction and flexible space. Studies by Çakir et al. (2020) and Hwang et al. (2019) pointed out gamified features and immediate feedback that can assist in developing problem-solving and engagement skills among students. However, these applications will only attain success if they achieve their curriculum targets and incorporate features catering to the specific needs of learners. Although all of these are promising research areas, a search of the literature found that these applications had not been developed to address difficult topics like Additional Mathematics.

The NGT is a consensus-building method used to gather and prioritize input from stakeholders. It has been widely applied in educational research to identify critical elements in curriculum development and technological design. Studies by Nunes et al. (2023) demonstrated that the NGT ensures inclusivity and relevance by incorporating diverse perspectives, making it a valuable tool for designing user-centric educational applications.

On the other hand, the previous research points out promising attributes of mobile learning for teaching mathematics with insufficient attention to applications targeting distinctive challenges facing Additional Mathematics. This gap is addressed by using the NGT to identify the important elements of a mobile application, providing a pedagogically sound design that is relevant to end users.

3.0 Methodology

This research employs the NGT as its primary methodology. It involved eleven experts specializing in additional mathematics and technology. The sessions were conducted in face-to-face meetings. A two-hour session was held, during which the experts participated in a brainstorming session to generate ideas and solutions based on their insights (MacPhail, 2001). A descriptive analysis, such as the score and the percentage, was conducted to determine the percentage of agreement. The percentage of agreement should be more than 70% (≥70%) as it can be accepted for further review in this study.

3.1 NGT techniques step

The NGT is a structured group decision-making process that ensures equal participation and effective prioritization of ideas, as utilized in the Identification of Elements for Developing a Learning Mobile Application for Additional Mathematics Using the NGT. The process involves five key steps. The first step is the introduction, where the moderator provides participants with the study's context and objectives (Harvey & Holmes, 2012). The second step is idea generation, which is facilitated by focused questions to prompt expert input (Benavides-Varela et al., 2020). The third step is Round-Robin Sharing, which allows participants to contribute their ideas equally without interruptions. The fourth step is Structured Discussion. During this session, all the ideas are clarified and elaborated upon collaboratively (Van De & Delbecq, 1971), and finally, the Prioritisation process, where participants rank or vote on the ideas, producing a prioritized list of critical elements for the study (Harvey & Holmes, 2012). This systematic approach ensures the identification of key components essential for the mobile application's development.

3.2 Sampling

This study used eleven experts in additional mathematics and technology. Following Harvey and Holmes (2012), this sample size falls within the recommended range of 6 to 12 participants for implementing the NGT.

3.3 *Limitations*

This study is subject to several limitations. Firstly, it focuses exclusively on the Additional Mathematics subject which restricts the generalizability of its findings to other subjects or educational levels. Secondly, the study utilized the NGT with input from 11 experts. Although this technique is a robust method for achieving consensus, the relatively small number of participants may have constrained the diversity and breadth of perspectives included.

4.0 Findings

Table 1: Results of the nominal group technique for identification of elements for developing a learning mobile application for Additional Mathematics.

Items / Elements	Percentage	Rank Priority	Voter Consensus
Internet/Offline facilities	100	1	Suitable
Usage guide	100	1	Suitable
Easy navigation	100	1	Suitable
Icons that are easy to understand	100	1	Suitable
Clear interface display	100	1	Suitable
Appropriate time usage	90.91	3	Suitable
Directed learning instructions	100	1	Suitable
Guidance from the teacher on the implementation of the application	100	1	Suitable

Interaction space between teacher and students	93.94	2	Suitable
Interaction space between students	93.94	2	Suitable

The results from the NGT survey highlight a strong consensus on the suitability of key elements related to the application's design and learning functionality. Items such as Internet/Offline facilities, Usage guide, Easy navigation, icons that are easy to understand, and clear interface display all received a 100% suitability rating, indicating that these elements are highly valued and considered essential for an effective user experience. Similarly, directed learning instructions and Guidance from the teacher on the implementation of the application also received 100% suitability, emphasizing the importance of structured guidance and teacher involvement in the learning process. The Interaction space between teacher and students and Interaction space between students ranked highly with 93.94%, reflecting the value placed on communication and collaboration between learners and instructors. The item with the lowest ranking, Appropriate time usage (90.91%), is still considered suitable but suggests a slightly less unanimous agreement than the other elements. Overall, the results indicate that the application's design is well-aligned with the needs and preferences of its users, ensuring a user-friendly and interactive learning environment.

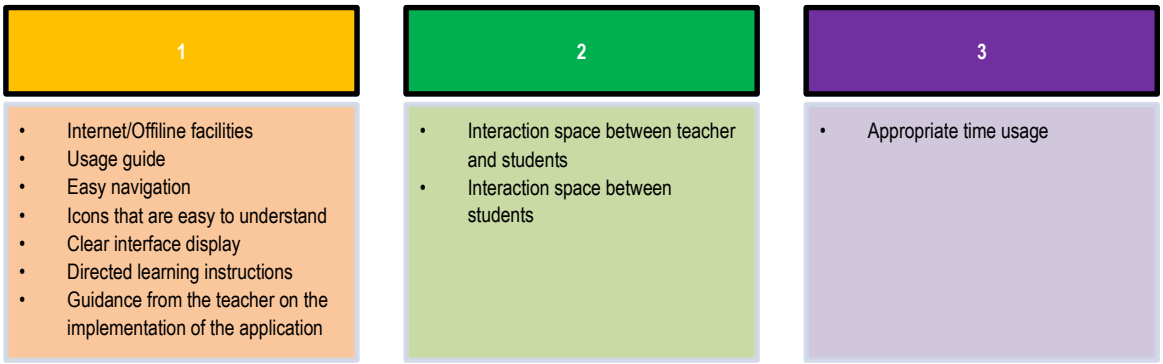

Figure 2.: Ranking of the elements.

In the NGT process, the ranking phase plays a critical role in prioritizing ideas based on their perceived importance or relevance. During this phase, participants evaluate and rank the items generated during earlier steps. The results can be categorized into first-ranking, second-ranking, and third-ranking based on the scores assigned to each idea.

The items or ideas that receive the highest votes or rankings are considered the first-ranking elements. These represent the most critical or impactful components identified by the participants. In this research, seven elements are selected as in the first ranking. They are internet/offline facilities, usage guides, easy navigation, icons that are easy to understand, clear interface display, directed learning instructions, and guidance from the teacher on implementing the application.

The second ranking includes important items but is less critical than the first-ranked ideas. Second-ranking elements include interaction space between teacher and students and interaction space between students.

The third ranking comprises ideas that received fewer votes but are still considered relevant. In this research, only one element is categorized as in third rank, which is appropriate time usage.

The NGT approach diffuses the concentration of dominance of any given person or small group of people, which gives an opportunity for quieter or less aggressive members to contribute as much as the other members. This technique of prioritization involves participants generating ideas, discussing and ranking them, which helps to ensure collective wisdom and not the opinions of a few guide the prioritization process. Additionally, the democratic priority-setting process works exceedingly well in complex decision-making situations, like educational technology design, that involve multiple stakeholders because these stakeholders can be expected to differ significantly from one another in their needs and priorities.

This process facilitates consensus and builds collective ownership and commitment to the outcomes, enhancing the likelihood of successful implementation. The group can systematically translate abstract ideas into actionable and well-prioritized plans through this method.

5.0 Discussion

In the NGT process, ten elements came forth to be critical to the successful acquisition of academic content, as both functional features and pedagogical dimensions assure a holistic learning environment. The initial set of elements is related to the application's usability, and the Internet, along with offline facilities, has a critical emphasis. These are to make sure that learners can consume the content online as well as offline, making the application more functional and suitable in diverse contexts. Also, a clear usage guide is important, which tells users how to use the app and how to get the most out of it.

Another key aspect considered was easy navigation, enabling users to seamlessly and smoothly navigate through other pages of the application. Also, obvious and meaningful icons enabling users to assimilate the tools and actions quickly will give a better user

experience. Moreover, the significance of a clear interface representation was highlighted, considering the requirement of the application to be visually attractive, well-structured, and with minimal distractions.

Along with usability, some other aspects of the learning processes were revealed as essential. Directive learning instructions were a must-have because they guide learners with a structure to proceed with the learning journey. These directions should make the learner aware of what is to be expected of them and navigate them procedurally and progressively. The importance of the implementation under the guidance of the teacher was also stressed, which provides an opportunity for teachers to inform how to administer this application to receive the features of the application by the students effectively.

Interaction spaces between teachers and students and between students themselves were considered a necessary factor in creating an environment of group communication. Such spaces enable real-time feedback, discussions, and collaborative learning, all of which boost engagement and support social learning. Finally, the efficient use of time was recognized. It was considered essential for a proper pace to prevent burnout and ensure deep engagement with the material from learners so that they have adequate time to consume the content.

The findings can guide the development of other mobile learning apps for different subjects or educational levels. The insights highlight how usability, collaborative features, and efficient time management can enhance not only mobile learning applications but also other digital platforms, such as virtual classrooms

6.0 Conclusion& Recommendations

The study highlights the suitability of key elements in a mobile learning application for Additional Mathematics, with all items receiving high ratings from respondents.

The results underline the potential of the application to enhance learning experiences by integrating intuitive design and pedagogical effectiveness. The high approval of interactive and guidance-based features signifies a positive shift toward fostering collaborative and directed learning. Furthermore, the study offers a valuable framework for developing mobile applications, which can inform both educators and policymakers aiming to implement technology-enhanced learning solutions.

Future research can explore using other methods, such as Delphi techniques or focus groups, to gather a broader consensus on the essential elements of mobile learning applications. These methods can complement or extend the NGT by incorporating input from a more diverse set of experts or stakeholders, including teachers, students, and developers. Additionally, experimental or quasi-experimental designs can be employed to test the application's impact on actual learning outcomes.

The results of this study can serve as a foundation for developing a comprehensive mobile learning application tailored to Additional Mathematics. Developers should integrate the identified key elements into the application design, focusing on usability, interactivity, and offline functionality.

Acknowledgments

The authors would like to express their sincere gratitude to the 11 expert participants who generously contributed their time and invaluable insights to this study. Special thanks to Sultan Idris Education University for supporting this research. Special thanks to Dr. Ramlan Mustapha, my parents, Mr P.K.Munusamy, Madam E. Lalitha, my brother Vijayan Munusamy, my sister Menaga Munusamy, my husband Jayasegaran Thavarajah and children Kayshna and Vilashna for their unwavering support, patience, and understanding throughout the research process.

References

Ab Rahman, N. H., Beng, A. L. Y., & Han, T. R. (2023). Implementation of APPGM-SDG solutions projects and impact evaluations in Malaysia's central region. *Journal of Technical Education and Training*, *15*(3), 182–191.

Albano, G., Arzarello, F., & Dello Iacono, U. (2021). Digital inquiry through games. *Technology, Knowledge and Learning*, *26*(3), 577–595. https://doi.org/10.1007/s10758-020-09459-1

Benavides-Varela, S., Zandonella Callegher, C., Fagiolini, B., Leo, I., Altoè, G., & Lucangeli, D. (2020). Effectiveness of digital-based interventions for children with mathematical learning difficulties: A meta-analysis. *Computers & Education*, *157*, 103953. https://doi.org/10.1016/j.compedu.2020.103953

Cakir, B. (2020). COVID-19 in Turkey: Lessons learned. *Journal of Epidemiology and Global Health*, *10*(2), 115–117. https://doi.org/10.2991/jegh.k.200520.001

Curriculum Development Division (2018). Secondary School Standard Curriculum Additional Mathematics, Curriculum Standard Document and Form 4 and 5 Assessment. Malaysian Ministry of Education

Dowling, K. L., & St. Louis, R. D. (2000). Asynchronous implementation of the nominal group technique: is it effective? *Decision Support Systems*, *29*(3), 229–248. https://doi.org/10.1016/S0167-9236(00)00073-7

Duggan, E. W., & Thachenkary, C. S. (2004). Integrating nominal group technique and joint application development for improved systems requirements determination. *Information & Management*, *41*(4), 399–411. https://doi.org/10.1016/S0378-7206(03)00080-6

Harvey, N., & Holmes, C. A. (2012). Nominal group technique: An effective method for obtaining group consensus. *International Journal of Nursing Practice*, *18*(2), 188–194. https://doi.org/10.1111/j.1440-172X.2012.02017.x

Hui, E. X., & Rosli, R. (2021). Kebimbangan dan efikasi kendiri terhadap pembelajaran matematik dalam kalangan pelajar tingkatan empat. Malaysian Journal of Social Sciences and Humanities (MJSSH), 6(3), 41-53.

Hwang, E. J., Park, S., Jin, K. N., Kim, J. I., Choi, S. Y., Lee, J. H., Goo, J. M., Aum, J., Yim, J. J., Cohen, J. G., Ferretti, G. R., & Park, C. M. (2019). Development and validation of a deep learning–based automated detection algorithm for major thoracic diseases on chest radiographs. *JAMA Network Open*, *2*(3), e191095. https://doi.org/10.1001/jamanetworkopen.2019.1095

Ismail, S., Husaini, M. I., Nazeri, M., Mohamad, & Syed, S. F. (2021). The impact of Covid-19 on online teaching and learning (TnL) towards teachers in Malaysia. *Malaysian Journal of Science Health & Technology*, *7*(2), 15–22. https://doi.org/10.33102/mjosht.v7i2.169

Ke, T. T., & Villas-Boas, J. M. (2019). Optimal learning before choice. *Journal of Economic Theory*, *180*, 383–437. https://doi.org/10.1016/j.jet.2019.01.005

MacPhail, A. (2001). Nominal group technique: A useful method for working with young people. *British Educational Research Journal*, *27*(2), 161–170. https://doi.org/10.1080/01411920120037117

Malaysian Examination Board. (n.d.). SPM results analysis report. Ministry of Education http://lp.moe.gov.my/index.php/laporan-analisis-keputusan

Naidoo, J., & Reddy, S. (2023). Embedding sustainable mathematics higher education in the fourth industrial revolution era post-covid-19: exploring technology-based teaching methods. *Sustainability*, *15*(12), 9692. https://doi.org/10.3390/su15129692

Ompusunggu, V. D. K., & Sari, N. (2019). Effectiveness of Edmodo-Based E-Learning Use on Mathematical Communication Skills. J. Curere, 3(2), 58-66.

Supriyadi, E., & Kuncoro, K. S. (2023). Exploring the future of mathematics teaching: Insight with ChatGPT. *Union: Jurnal Ilmiah Pendidikan Matematika*, *11*(2), 305–316. https://doi.org/10.30738/union.v11i2.14898

Van De, A., & Delbecq, A. L. (1971). Nominal versus interacting group processes for committee decision-making effectiveness. *Academy of Management Journal*, *14*(2), 203–212. https://doi.org/10.5465/255307

Yahya, S. Z. & Amir, R. (2018). Kebimbangan matematik dan pencapaian matematik Tambahan [Mathematics anxiety and additional mathematics performance].Journal of Nusantara Studies (JONUS),3(2), 124-133.

Yaniawati, P., Sari, N. M., Rokhmah, N., Fitri, N., & Hadiansyah, S. (2022). Development of M-learning teaching materials on trigonometric materials to improve mathematic connection ability. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *12*(2), 237–252. https://doi.org/10.30998/formatif.v12i2.11998