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From Experts to App: Crafting an Engaging Mobile Learning App for Form Four Additional Mathematics Using Nominal Group Technique

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ABSTRACT - This study outlines the design phase of the Interactive Surd, Indices & Logarithm Mobile App (INSUMA), a mobile learning (m-learning) application developed for Form Four Additional Mathematics students using the Design and Development Research (DDR) model by Richey and Klein. The design was guided by insights from the Nominal Group Technique (NGT), involving nine subject matter experts in a face-to-face session. Through structured consensus, seven key constructs were identified to inform both instructional and interface design. Construct 1 had four elements (one selected), Construct 2 had ten (eight selected), Construct 3 had four (two selected), while Constructs 4 to 7 had a total of 23 elements, all selected. These validated constructs shaped the app's pedagogical and functional components, ensuring content relevance, usability, and alignment with learners' needs. Overall, this design phase establishes a strong foundation for the subsequent development and implementation of INSUMA, which aims to enhance students' understanding of challenging mathematical topics through a mobile-based, game-enhanced learning experience tailored to the Malaysian curriculum.

INTRODUCTION

In the digital era, education is undergoing a rapid transformation, especially to meet the learning preferences of Generation Z (Gen-Z). These digital-native learners thrive in interactive, engaging, and mobile-friendly environments (Twenge, 2020; Seemiller & Grace, 2019). Around the world, mobile learning (m-learning) applications have gained traction as tools to boost motivation, support individualised learning, and enhance achievement, especially in Science, Technology, Engineering, and Mathematics (STEM) subjects (Crompton & Burke, 2021; Alrasheedi et al., 2022).

In Malaysia, although m-learning apps have been developed for subjects such as Science, History, and Bahasa Melayu, there remains a significant gap in m-learning tools for Additional Mathematics. This is particularly true for those aligned with national curriculum standards, which are designed with input from subject matter experts. Notably, the Malaysian Examinations Board (2023) reported a declining trend in Additional Mathematics performance at the SPM level, highlighting the urgent need for innovative pedagogical strategies.

As part of Phase 1 of the Design and Development Research (DDR) model proposed by Richey and Klein (2007), a needs analysis was conducted to identify the most challenging topics in Form Four Additional Mathematics. Based on student feedback and performance data, the topics of indices, surds,

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and logarithms emerged as the most challenging areas. These findings underscore the need for targeted instructional interventions that are engaging, scaffolded, and digitally accessible.

To address this issue, this study proposes the development of the Interactive Surd, Indices & Logarithm Mobile App (INSUMA), a m-learning application tailored to the Malaysian Form Four Additional Mathematics syllabus. To ensure the app design is pedagogically sound and aligned with curriculum and learner needs, expert input is gathered using the Nominal Group Technique (NGT), a structured, consensus-based method for eliciting and prioritising expert ideas. Accordingly, this study focuses on Phase 2 (Design) of the DDR framework, where key instructional and technical elements for app development are determined.

BACKGROUND OF STUDY

M-learning has emerged as a transformative tool in secondary education, offering flexibility, accessibility, and the potential to enhance student engagement. Through interactive features and adaptive learning pathways, mobile applications support personalised learning, especially in subjects that require abstract thinking, such as mathematics. Correspondingly, learners benefit from the ability to review concepts at their own pace, which is particularly useful for complex topics (Alrasheedi et al., 2022; Crompton & Burke, 2021; Sharples et al., 2022).

In the context of Malaysian education, Additional Mathematics remains a cognitively demanding subject, with students consistently struggling with topics such as indices, surds, and logarithms. Notably, these topics are abstract, algebra-heavy, and often lack immediate real-life applications, making them challenging for students to grasp using traditional instruction alone. As a result, many students lose interest and perform poorly (Lee et al., 2023). Furthermore, current pedagogical approaches may not adequately accommodate the diverse learning needs of students in increasingly heterogeneous classrooms.

To bridge this gap, game-based learning has gained traction as an innovative and engaging instructional approach. For example, gamification incorporates elements such as points, levels, feedback loops, and rewards into the learning process, creating a more engaging and interactive experience. Research demonstrates that game-based mobile applications significantly improve student motivation, engagement, and achievement in mathematics education (Deterding et al., 2011; Noorhidawati et al., 2021). These elements are especially effective when aligned with specific learning outcomes and integrated into m-learning environments.

To ensure that educational technologies, such as mobile apps, are pedagogically sound and contextually appropriate, it is essential to incorporate expert input. The NGT offers a structured method for gathering expert consensus, prioritising ideas, and validating instructional content. In addition, NGT has been widely employed in educational research to support curriculum development, instructional design, and technological innovation. Its strength lies in promoting balanced contributions from all participants and generating data-driven decisions (Van de Ven & Delbecq, 1972; Abdul Raheem & Ahmad, 2022). In the context of this study, NGT was employed to identify and validate the core design elements for the proposed mobile application, ensuring the content was both relevant and feasible.

This study is grounded in the DDR model developed by Richey and Klein (2007), which outlines four main phases: analysis, design, development, and evaluation. DDR provides a systematic framework for developing and validating instructional interventions. In this study, the design phase incorporates the NGT method to determine essential pedagogical and technical features for the mobile application. Concurrently, this integration ensures that the app development process is participatory, data-driven, and aligned with the needs of both learners and educators.

Despite the global growth in mobile applications for education, a significant gap remains in curriculum-aligned m-learning tools specifically for Malaysian Additional Mathematics. Few existing apps address the national syllabus in depth, and even fewer are developed with structured expert input or grounded in established instructional design models. This gap highlights the need for context-specific, gamified, and expert-informed tools like INSUMA, which aim to improve student learning in challenging mathematical domains (Zainudin et al., 2023).

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METHODOLOGY

This study employed the design phase of the DDR model as proposed by Richey and Klein (2007), which focuses on systematic planning and validation of educational innovations prior to implementation. The objective of this phase was to identify and refine essential instructional and interface elements for the development of the INSUMA m-learning application. This is specifically targeted to address students' difficulties in understanding the topics of indices, surds, and logarithms in Form Four Additional Mathematics.

Nine subject matter experts were purposively selected to participate in this study, following the recommendation by Van de Ven and Delbecq (1971). The authors suggested that a group size of five to nine participants is ideal for the NGT to ensure effective idea generation and meaningful consensus. Notably, all selected experts possessed a minimum of five years of professional experience in mathematics education, curriculum development, or educational technology. Their primary role was to critically evaluate and validate the proposed instructional, content, interface, and evaluation elements for the m-learning application. This, ultimately, ensures that the design aligns with pedagogical principles and curriculum standards.

The NGT was adopted due to its structured format, which enables consensus-building among experts. To support the process, this study utilised NGT Plus, a specialised software that facilitated real-time idea collection, scoring, and ranking, thereby improving the efficiency and transparency of the data collection process.

The NGT session was conducted in person, bringing all nine experts together in one location to enable direct engagement and collaborative evaluation of the proposed design elements. The process followed five structured phases as outlined by O'Neil and Jackson (1983) and further refined in subsequent applications (Dobbie et al., 2004; Aizzat et al., 2006; Williams et al., 2006; Perry & Linsley, 2006).

In the first phase, the facilitator explained the objectives and structure of the session to all experts. Meanwhile, in the second phase, each expert silently generated ideas related to instructional content, interface design, and game mechanics. Moreover, the third phase involved a round-robin sharing of ideas, where each participant contributed one idea at a time until all suggestions were documented. Subsequently, the fourth phase focused on clarification and discussion to eliminate duplication and refine the phrasing of each idea.

In the final phase of the NGT session, a structured voting process was implemented using the NGT Plus software. This digital tool enabled experts to systematically evaluate each proposed item based on its relevance to the pedagogical aims, learner needs, and design principles of the INSUMA application. Accordingly, each expert was asked to rate the listed ideas using a three-point Likert-type scale, where a score of 1 indicated "Not Suitable," 2 signified "Neutral," and 3 represented "Suitable." To establish consensus, a threshold of 70% agreement or higher was adopted to retain elements deemed necessary or suitable for inclusion in the application design. This threshold was guided by established research practices in consensus studies (Deslandes, Mendes, Pires, & Campos, 2010; Dobbie et al., 2004; Mustapha et al., 2022).

FINDING AND DISCUSSIONS

Contruct 1 : Device													
Items / Elemen	Voter1	Voter2	Voter3	Voter4	Voter5	Voter6	Voter7	Voter8	Voter9	Total item score	Percentage	Rank Priority	Voter Consensus
1. Desktop	1	1	1	1	1	1	1	1	1	9	33.33	2	Not Suitable
2. Laptop	1	1	1	1	1	1	1	1	1	9	33.33	2	Not Suitable
3. Smart phone	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
4. Tablet/IPaD	1	1	1	1	1	1	1	1	1	9	33.33	2	Not Suitable

Figure 1. Results of construct 1

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The first construct evaluated was the type of device most suitable for accessing the m-learning application. Among the options are desktops, laptops, tablets, and smartphones. Only the smartphone received unanimous agreement from all nine experts as being the most appropriate. This 100% consensus reflects the pervasiveness of smartphone use among students, particularly those in the Gen-Z cohort, who are already highly familiar with mobile interfaces and functionalities. Meanwhile, the experts rejected other devices due to concerns about accessibility and practicality in the classroom and home settings. This finding highlights the critical importance of mobile responsiveness and accessibility in the design of educational apps today.

Contruct 2 : Learners' Requirements													
Items / Elements	Voter1	Voter2	Voter3	Voter4	Voter5	Voter6	Voter7	Voter8	Voter9	Total item score	Percentage	Rank Priority	Voter Consensus
1.Online Usage	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
2. User Guide	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
3. Easy Navigation	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
4. Understandable Icons	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
5. Clear User Interface Display	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
6. Appropriate Time Usage	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
7. Directed Learning Instructions	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
8. Teacher Guidance in Using the Application (if needed)	3	3	3	3	2	3	3	3	3	26	96.3	2	Suitable
9. Interaction Space Between Teacher and Student	2	1	2	1	2	2	1	2	1	14	51.85	3	Not Suitable
10. Interaction Space Between Student and Student	2	1	1	1	1	2	1	2	1	12	44.44	4	Not Suitable

Figure 2. Results of construct 2

The second construct focused on learners' technical and functional requirements for effective engagement with the application. Elements such as online usage, clear user interface display, easy navigation, user guide availability, understandable icons, and directed learning instructions all achieved full consensus, each scoring 100%. In particular, slightly lower agreement (96.3%) was recorded for teacher guidance, indicating that while the app should enable self-directed learning, optional scaffolding remains essential. However, features that allowed interaction between teacher-student or student-student were deemed less relevant, likely due to the individualistic nature of m-learning. These insights underscore the need to prioritise intuitive design and independent usability in the app structure.

Construct 3 : Objectives of Teaching and Learning													
Items / Elements	Voter1	Voter2	Voter3	Voter4	Voter5	Voter6	Voter7	Voter8	Voter9	Total item score	Percentage	Rank Priority	Voter Consensus
1. Clear teaching and learning objectives	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
2. Objectives aligned with the Standard Curriculum and Assessment Document (DSKP)	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
3. Objectives focused on assessment elements	2	2	2	1	3	1	1	1	3	16	59.26	2	Not Suitable
4. Objectives that enable assessment based on students' proficiency levels	2	1	1	3	1	1	2	2	3	16	59.26	2	Not Suitable

Figure 3 Results of construct 3

Experts unanimously agreed on the necessity of clearly defined learning objectives that align with the national curriculum, particularly the Dokumen Standard Kurikulum dan Pentaksiran (DSKP). Both clear teaching and learning objectives and alignment with DSKP received full scores (100%), reinforcing the significance of maintaining curriculum fidelity. In contrast, items focusing on assessment differentiation received only moderate support (59.26%), suggesting that while experts value outcome clarity, they may prefer simpler, standards-aligned assessment goals over highly customised proficiency-based evaluations. This construct confirms that pedagogical goals must be explicit and grounded in national educational standards.

Construct 4 : Content of the Application													
Items / Elements	Voter1	Voter2	Voter3	Voter4	Voter5	Voter6	Voter7	Voter8	Voter9	Total item score	Percentage	Rank Priority	Voter Consensus
1. Content suited to students' ability levels	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
2. Content aligned with the current curriculum	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
3. Content division in the application matches the topics appropriately	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
4. Problem-solving examples to support teaching and learning	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
5. Use of appropriate and accurate language	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
6. Relevant audio/video usage	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
7. Language selection (Malay/English)	3	3	3	3	3	3	3	3	3	27	100	1	Suitable

Figure 4. Results of construct 4

Content-wise, the experts reached full consensus (100%) on all proposed elements. These include content tailored to students' abilities, alignment with the current curriculum, topic-based content segmentation, use of relevant problem-solving examples, appropriate and accurate language, multimedia support (audio/video), and language selection. Furthermore, the comprehensive approval across all nine experts signals the non-negotiable importance of content relevance, clarity, and accessibility. This reinforces the principle that engaging content must stimulate interest and support cognitive scaffolding through structured, linguistically appropriate, and multimedia-enhanced delivery.

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Construct 5 : Application Interface Layout													
Items / Elements	Voter1	Voter2	Voter3	Voter4	Voter5	Voter6	Voter7	Voter8	Voter9	Total item score	Percentage	Rank Priority	Voter Consensus
1. Attractive content display	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
2. Appropriate layout of the user interface	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
3. Visually engaging icons used in the application	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
4. Logical sequence of content based on learning topics	3	3	3	3	3	3	3	3	3	27	100	1	Suitable

Figure 5. Results of construct 5

Aesthetics and functionality were central to the fifth construct, which assessed the application's interface layout. All listed items are attractive content display, logical sequencing of topics, engaging visual icons, and a user-friendly layout, which have scored a perfect 100%. Accordingly, experts emphasised the significance of intuitive navigation and visual appeal in sustaining learners' attention, especially when navigating abstract mathematical topics such as indices, surds, and logarithms.

Construct 6 : Arrangement of Learning Activities													
Items / Elements	Voter1	Voter2	Voter3	Voter4	Voter5	Voter6	Voter7	Voter8	Voter9	Total item score	Percentage	Rank Priority	Voter Consensus
1. Selection of appropriate activities	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
2. Activities that support learning	2	3	3	3	3	3	3	3	3	26	96.3	2	Suitable
3. Activities that motivate students	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
4. Activities aligned with the Standard Curriculum and Assessment Document (DSKP)	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
5.Activities that can be carried out through self-directed learning	2	3	3	3	3	2	3	3	3	25	92.59	3	Suitable
6.Engaging activity content that captures students' attention	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
7. Activity implementation aligned with learning outcomes	3	3	3	3	3	3	3	3	3	27	100	1	Suitable

Figure 6. Results of construct 6

This construct explored how learning activities should be sequenced and structured. The experts unanimously supported items such as activity selection aligned with the DSKP, motivational and engaging content, and opportunities for self-directed learning. One item activity that support learning received slightly lower but still strong support (96.3%). These findings highlight the need for the app to include differentiated tasks that address curricular goals and promote autonomy, motivation, and mastery learning. Experts also underscored the need for logical activity progression, which can help students develop a deeper conceptual understanding over time.

Construct 7 : Student Learning Evaluation													
Items / Elements	Voter1	Voter2	Voter3	Voter4	Voter5	Voter6	Voter7	Voter8	Voter9	Total item score	Percentage	Rank Priority	Voter Consensus
1. Appropriate time allocation	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
2. Motivation provided at each level of the game within the application	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
3. Includes student achievement scores in the game	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
4. Allows retries if the answer is incorrect	3	3	3	3	3	3	3	3	3	27	100	1	Suitable
5. Provides answer tips for the game questions	3	3	3	3	3	3	3	3	3	27	100	1	Suitable

Figure 7 Results of construct 7

The final construct focused on the evaluation and feedback mechanisms integrated into the mobile app. All proposed features, such as appropriate time allocation, motivational elements at each level, achievement scoring, retry options, and answer tips, garnered full agreement (100%) from the experts. This strong consensus highlights the significance of timely and meaningful feedback in digital learning environments. As such, gamified feedback, retry chances, and embedded scaffolding support error correction, sustain student motivation, and encourage perseverance. These elements are vital in transforming a digital app from a passive resource into an active learning experience.

CONCLUSION

This study demonstrates the critical value of expert input in the design of educational technology, specifically through the application of the NGT during the design phase of the DDR model. In essence, the structured consensus-building approach of NGT enabled the identification and validation of seven key constructs essential for designing a curriculum-aligned, learner-centred m-learning application for Form Four Additional Mathematics, named INSUMA.

The use of NGT ensured that each design decision was informed by practitioners and scholars with deep expertise in mathematics education, instructional design, and m-learning. This approach enhanced the pedagogical soundness of the proposed application while increasing its relevance, usability, and engagement potential for Gen-Z learners. In addition, the unanimous and near-unanimous agreement across all constructs from content and interface to evaluation and feedback reflects the robustness of the NGT process in extracting high-quality insights for educational product design.

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Overall, by grounding the design of INSUMA in expert consensus, this study lays a strong foundation for the subsequent development and implementation phases of the app. The findings affirm that m-learning tools for Additional Mathematics must be strategically designed, data-informed, and pedagogically aligned to effectively support learners in mastering challenging mathematical concepts. Ultimately, this research contributes to the growing body of work in mobile-assisted learning and provides a replicable methodology for future educational app development rooted in participatory and evidence-based design

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI was used in the writing of the manuscript.

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