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(IJEPC)<https://gaexcellence.com/ijepe>**DIGITAL TEACHING ACTIVITIES FOR ENHANCING
UNIVERSITY STUDENTS' PROBLEM-SOLVING SKILLS
IN MATHEMATICS: AN NGT STUDY**Liu Shuang¹, Azli Ariffin^{2*}¹Faculty of Human Development, Universiti Pendidikan Sultan Idris, Malaysia 909085342@qq.com <https://orcid.org/0009-0000-1969-7344>²Faculty of Human Development, Universiti Pendidikan Sultan Idris, Malaysia azli@fpm.upsi.edu.my <https://orcid.org/0000-0001-9764-7473>

*Corresponding Author

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Abstract:

Developing problem-solving skills among university students is a key objective of university mathematics education. With the widespread application of digital technology in higher education, digital teaching has become an important pathway to promote reform in university mathematics teaching. However, the application of digital technology in current university mathematics teaching still lacks systematic guidance for teaching activities, particularly in promoting students' problem-solving skills, where a clear activity system has not yet been formed. Therefore, identifying and selecting digital teaching activities that can effectively enhance university students' problem-solving skills is of great significance. This study aims to identify and select digital teaching activities suitable for university mathematics teaching that can promote students' problem-solving skills. The study employed the Nominal Group Technique (NGT), reaching consensus through procedures such as independent expert reflection, group discussion, and scoring. The results show that 22 digital teaching activities were ultimately identified. These activities cover the entire process of university mathematics teaching, including three stages: pre-class preparation, in-class learning, and post-class consolidation. Pre-class activities focus on learning preparation and diagnosis; in-class activities emphasize knowledge construction, interactive communication, and problem exploration; and post-class activities focus on assignment evaluation, learning reflection, and personalized support. The identified digital teaching activities constitute a structured teaching activity system, providing operable guidance for university mathematics teachers to design and implement digital teaching practices aimed at improving students' problem-solving skills.

Digital Teaching Activities, Nominal Group Techniques,
Problem-Solving Skills, University Mathematics



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Introduction

With the rapid advancement of digital technology and artificial intelligence (AI), every sector is facing significant disruption, forcing them to undergo digital transformation—and the education sector is no exception. Digital technology has become an essential means of ensuring that education, a fundamental human right, is realised. The United Nations Educational, Scientific and Cultural Organization (2024) is also committed to enhancing the digital literacy and skills of teachers and students, supporting the use of digital technology to create learning pathways, strengthening the management of education and learning, and effectively monitoring the learning process.

In recent years, China's education sector has also accelerated its digital transformation. In May 2023, General Secretary Xi Jinping noted that 'the digitalisation of education is a key breakthrough for our country in opening up new avenues for educational development and forging new competitive advantages in this field'; therefore, it is necessary to accelerate the construction of digital education (Yang, 2024). Huai Jinpeng, Minister of Education of China (2024), noted that the new round of technological revolution and industrial transformation is advancing rapidly, with digital technologies increasingly influencing human ways of thinking, production and living, and driving the comprehensive reshaping and development of society and the economy. Against this backdrop, digital transformation and artificial intelligence have become important drivers and major development directions for global education reform.

The development of higher education has always been an important component of China's socialist modernization. Xi Jinping's important discourses on higher education clarify its strategic position and future direction in national development, emphasizing that higher education is not only a key pathway to promoting the all-round development of individuals, but also an important foundation for supporting overall social progress and sustainable development. (Sun & Li, 2024). Meanwhile, digital transformation has provided a new context and meaning for the development and reform of higher education, driving innovation in educational philosophies and models. Digitalisation has become a vital pillar and an inevitable choice for higher education to achieve quality-driven development and cultivate high-calibre talent capable of meeting the demands of the digital age.

At the same time, digital technology is also driving the design and transformation of university mathematics courses. Teachers can use digital tools to update and expand teaching content and teaching models, thereby more effectively promoting the cultivation of students' problem-

solving skills and guiding students to deeply understand the internal logic of knowledge and the thinking methods it contains.

Research indicates that traditional teaching models are no longer suitable for developing students' problem-solving skills; educators are therefore re-examining the design and delivery of their curricula, striving to create teaching methods that foster students' abilities to analyse, evaluate and synthesise information (Rahman, 2019). In the field of higher education, the teaching models employed in university mathematics courses—including a range of teaching activities such as pre-class guidance from lecturers, in-class teaching optimisation measures and post-class reinforcement, as well as students' learning approaches—all influence undergraduates' problem-solving skills (Wu, 2025).

While numerous studies have explored the application of digital technologies in education, most have focused on the effectiveness of individual technologies such as artificial intelligence (AI) and learning management systems (LMS), and have largely remained at the level of broad aspects such as the transformation of classroom teaching and design. Few studies have systematically prioritized and integrated digital teaching activities into university mathematics classrooms to enhance students' problem-solving skills.

Therefore, expert consensus is needed to identify appropriate digital teaching activities to support the effective implementation of digital teaching practices in university mathematics education.

To this end, this study aims to use the Nominal Group Technique (NGT) to identify suitable digital teaching activities for university mathematics instruction. The goal is to integrate digital technology into daily university mathematics teaching, helping teachers improve classroom teaching quality and ultimately cultivate students' problem-solving skills.

Literature Review

Problem Solving Skill

Problem solving is the process of reaching an acceptable solution to a new problem, typically involving critical thinking and analytical reasoning skills (Simpol et al., 2017). Problem solving skill is a higher-level thinking skill that requires the ability to identify the nature of a problem, deconstruct it, and formulate effective actions to address the associated challenges (Oliveri, Lawless, & Molloy, 2017).

Recent studies have offered explanations for problem-solving skills. The researcher has summarized these explanations in table 1 below.

Table 1: Explanation of Problem-Solving Skill

Authors	Interpretations
Ulya., (2016)	Problem solving skills are the skills that students demonstrate by actually solving math problems as they learn math
Maimunah., Purwanto., Sa'dijah, & S. (2016)	Problem solving skills are students' comprehensive and practical skills to analyze and solve mathematical problems by applying their own ideas, knowledge, insights, and experiences
Rahmani, (2018)	Problem solving skills are defined as the skills to develop a synthesis of thinking skills and knowledge that enables students to explore a variety of appropriate solutions to real-world problems
Hidayat & Sariningsih, (2018)	Problem solving skills are a combination of skills that students achieve by understanding a problem, constructing an appropriate mathematical model, selecting an appropriate solution, and interpreting the results of the solution
Endah, Kesumawati & A. (2019)	Problem solving skills refer to the skills of students to synthesize and apply various knowledge and ideas acquired from multiple sources to effectively respond to and solve learning problems in the learning process
Andayani & Lathifah, (2019)	Problem solving skills are students' skills in solving mathematical problems, which are usually presented in the form of contextualized stories and are closely related to practical applications of mathematics in everyday life

Digital Education

In recent years, digitalization has been on the rise globally, permeating all aspects of our lives, including education (Abrosimova, 2020). The world today is enveloped in the digital economy, and the cultivation of digital skills and talent has become a focus in education (Wu, Zhu, Wang, 2024). Internationally, countries worldwide are making digitalization a common choice for educational development (Ding, 2024). Digital education is a current trend, helping learners acquire knowledge more easily and in different ways while reducing study time (Islam & Jahan, 2018).

Godin and Terekhova (2021) point out that education as an industry is undergoing an ongoing digital transformation. Researchers primarily focus on issues related to open education, as well as the development of online education in terms of design, support, and quality assurance with the widespread application of educational technologies and digital tools. Meanwhile, research

in the field of teaching and learning focuses on the application and implementation of educational technologies, media resources, and digital tools.

Integrating digital technology into higher education classrooms is essential. Specifically, we can utilize various digital tools and teaching platforms to assist in teaching activities, which will undoubtedly benefit student performance and ability development (Lv, 2026).

Chen and Tang (2026) point out that, starting from higher education curriculum teaching, course objectives should target the skills and abilities required in the digital age. Therefore, courses should undergo digital transformation, and teaching activities should shift from physical space teaching to a diversified teaching approach that combines online and offline methods. Digital transformation requires higher education curriculum teaching activities to go beyond the classroom and achieve a combination of online and offline learning, breaking the traditional time and space limitations of course teaching and realizing a shift from one-way teaching activities to interactive ones.

The Cultivation of Problem-Solving Skills through Digital Teaching

In recent years, numerous studies have aimed to cultivate students' problem-solving abilities using various digital technologies. The research by Saporbayeva et al. (2024) shows that the application of digital technology can significantly improve students' understanding of mathematical concepts and problem-solving skills, while also helping to enhance classroom interactivity and student participation. Integrating information technology into the teaching environment of the digital age, forming online collaborative learning, is beneficial to the cultivation of students' problem-solving abilities (Wang & Wu, 2022). Mobile learning applications, as an important tool of digital technology in education, have been widely used in higher education. Currently, mobile learning is quite popular among students, and related research shows that it can enhance the interest and interactivity of courses, help promote students' problem-solving skills, deepen their understanding of knowledge, and further cultivate their metacognitive abilities (Shchedrina et al., 2020).

The application of various learning management systems has promoted the development of online learning. Online learning breaks down geographical limitations, enabling more people to participate in learning and develop problem-solving skills (Kartinah & Prasetyowati, 2022). The rapid development of artificial intelligence (AI) offers unprecedented potential to support complex problem-solving, particularly in enhancing human cognitive, emotional, and social abilities (Joksimovic, Ifenthaler, Marrone, De Laat & Siemens, 2023).

Digital Teaching Activities in Higher Education

With the rapid development of digital technology in education, the integration of digital teaching activities in higher education has received increasing attention. These activities aim to support teaching through technologies such as artificial intelligence (AI) and digital platforms. Previous research has shown that the use of digital technology significantly improves students' learning status, increases their learning participation, and promotes the development of various higher-order thinking skills.

In previous studies, researchers have mentioned some digital teaching activities suitable for implementation before class. Wang and Ma (2026) designed a DeepSeek-driven BOPPPS teaching model, which suggests that pre-class assignments and quizzes can be posted on the Chaoxing Learning Platform before class. Wang and Cui (2026) pointed out that AI teaching assistants can be used to assist teachers in answering students' questions before class, thus solving problems that teachers cannot answer at any time. In other related studies, researchers have also proposed a series of digital teaching activities using knowledge graphs, such as pre-class preparation, online discussions, and mind mapping.

Classroom teaching is the most crucial part of the entire teaching process, and there is a relatively large body of research on teaching activities within it. Yang (2026), in his research on classroom teaching reform, mentioned that learning platforms can be used to publish classroom activities, case studies, and group discussions. Wang (2026) pointed out that at the beginning of classroom teaching, PPT should be used to present the key points and objectives of the lesson, followed by explanations of relevant cases, then the teaching of the lesson's key points, followed by online quizzes, and finally a systematic review of the lesson's content. This provides a complete teaching process, which fully utilizes various digital technologies to ensure the complete implementation of teaching.

The post-class stage is the culmination of the entire teaching process. In this stage, teachers can use various online learning platforms to assign homework, post Q&A sessions, expand teaching resources, and conduct a series of other teaching activities, aiming to consolidate students' learning and improve their grades (Wang & Ma, 2026; Yang, 2026; Wang 2026).

It can be seen that existing research shows that teachers have applied digital technology in higher education teaching and have also realized the importance of digital technology in cultivating students' problem-solving skills. However, most existing studies lack systematic guidance on digital teaching, especially on how to systematically use digital technology in the classroom. Furthermore, while previous research has proposed various digital teaching activities applicable to different teaching stages, most of these studies focus on teaching models and overall instructional design, with the identification of digital teaching activities only as one part, rather than a systematic process of recognizing and prioritizing them. Therefore, empirical research is still lacking to demonstrate which digital teaching activities are most important for improving university students' mathematical problem-solving skills. To address this, this study employs the Nominal Group Technique (NGT) to identify and prioritize digital teaching activities suitable for university mathematics instruction.

Methodology

Nominal Group Technique

This study used the Nominal Group Technique (NGT) to determine its suitability for digital teaching activities in university mathematics education, after expert discussion, voting, and scoring. Nominal Group Technique (NGT) is a structured brainstorming method designed to systematically generate a large number of relevant ideas around a specific problem, ensuring equal participation from all group members in the expression and formation of opinions. Therefore, this method is highly structured, effectively promoting the generation of ideas and supporting the ranking and prioritization of various ideas, thereby enhancing the scientific rigor

and consistency of collective decision-making (Mullen, Kydd, Fleming, & McMillan, 2021). Many researchers have applied this technology to the field of education, with their research focusing primarily on collective decision-making processes (Odu, 2017). The nominal group technique includes the following six implementation steps:

1. **Opening and Introduction.** The moderator introduces the theme of the conference: identifying digital teaching activities that can be implemented in university mathematics education and explaining the conference rules.
2. **Independent Idea Generation.** Participating experts will think independently in a quiet environment and write down their proposed digital teaching activities for approximately 10 minutes.
3. **Idea Presentation.** Group members will take turns verbally proposing digital teaching activities they deem suitable. The moderator will record all proposed activities on a whiteboard until all have been presented.
4. **Discussion and Clarification.** Group members will discuss the recorded digital teaching activities and clarify any unclear points.
5. **Voting and Scoring.** Group members will score all digital teaching activities on the list according to their importance (e.g., 1-5 points)
6. **Results Summary and Selection.** The moderator will tally the scores and select digital teaching activities with an average score of 4 or higher, ultimately forming a set of digital teaching activities that have passed expert consensus.

Participants

There are differing opinions in the research regarding the optimal size of NGT groups, but most studies suggest that the optimal number of members is between 5 and 10 (Dang, 2015). The participants in this study were a panel of 7 experts. Researchers selected panel members based on factors such as professional knowledge, qualifications, personal character, ability to compare differences, experience, understanding of the research question, employment experience, and willingness to contribute resources (Mustapha & Darussalam, 2018). All panel members had at least five years of experience in their respective fields and held a doctoral degree or senior academic title. The specific composition of the expert panel is shown in Table 2 below.

Table 2: Profile of Experts

Expert	Academic title	Field of Expertise
1	Professor	Dean of the Faculty of Mathematics; Mathematics education in colleges and universities
2	Associate Professor	Mathematics education in colleges and universities
3	Lecture	Mathematics education in colleges and universities
4	Lecture	Mathematics education in colleges and universities

5	Lecture	Mathematics education in colleges and universities
6	Professor/Doctor	Educational Technology
7	Professor/Doctor	Curriculum and instruction

Data Analysis

First, qualitative analysis was conducted during the discussion and clarification phase, summarizing the experts' statements. Then, quantitative analysis was performed, identifying the key elements within each topic and assigning scores based on the importance of each element. The scoring criteria are shown in Table 3.

Table 3: NGT Scoring Table

Score	Instruction
1	Least important
2	Unimportant
3	Normal
4	Important
5	Most important

In this study, all proposed digital teaching activities were scored from 1 to 5, a scoring method frequently used by researchers in the field of education in recent years (Dang, 2015; Abdullah & Islam, 2011).

After completing the scoring process, the researchers calculated the mean score for each digital teaching activity. Based on the scoring criteria, a mean score of 4 or above indicated a high level of agreement among the experts regarding the importance of the activity. Therefore, in the subsequent screening process, a mean score greater than or equal to 4 (≥ 4) was used as the inclusion criterion for the digital teaching activities; that is, activities with a mean score of 4 or above were retained for the final list. (Abdullah, M. M. B., & Islam, 2011).

Results

During the NGT workshop, seven experts initially proposed 52 digital teaching activities related to enhancing university students' problem-solving skills. The experts then discussed and clarified these activities, revising those that were unclear or ambiguous, ultimately reaching a consensus on the specific meaning of each activity. Based on this consensus, all activities were independently scored using a five-point rating system to assess their importance. Researchers then calculated the average score for each activity and determined its importance ranking accordingly. The final scoring results are shown in Table 4.

Table 4: Expert Scoring Results

No.	Idea	Mean	No.	Idea	Mean
1	Publish teaching videos	3.71	27	AI-Assisted Q&A	4.43
2	AI-Assisted Academic Q&A Integration	4.57	28	Inquiry-based activities	3.71
3	Release online before class exercises	3.29	29	Combined “quick-fire” and “select participant” modes	3.86
4	Publish introductory videos	3.43	30	Guide learning	3.57
5	Publish learning tasks/study guides	4.86	31	Performance assessment	3.57
6	Publish teaching materials (slides)	3.29	32	Online quiz	4.71
7	Publish teaching resources	4.71	33	Learning report analysis	3.71
8	Initiate before class discussion	3.57	34	Launching “poll” activities	3.43
9	Micro-assessment Diagnosis	4.86	35	One-minute questionnaire	4.86
10	Course Map Pre-Assessment	4.71	36	Publishing classroom discussions	3.57
11	Launch “quick response” activity	3.29	37	Knowledge Consolidation	4.14
12	Questionnaire survey	3.43	38	Teacher-led review + Key points displayed on screen	3.29
13	Assignment of “pre-study mind map” task	3.57	39	Comprehensive Evaluation	4.43
14	Case introduction	4.71	40	Knowledge Extension	3.14
15	Problem-based introduction	4.71	41	Chaoxing Xuexitong Platform release of key points and difficulties for this section	3.43
16	Play introductory video	4.57	42	Publish After class Assignment	5.00
17	Share students’ preparatory mind maps	3.71	43	Assign unit tests	3.29
18	Launch “check-in” activity	3.43	44	Assign personal development assignments	3.43
19	Open-ended Q&A pre-assessment	3.71	45	Assign mathematical modeling problems	3.29
20	Present knowledge, skills and competency objectives via PowerPoint	3.57	46	Publish Q&A Discussion	4.71
21	Publish teaching objectives via Chaoxing	4.71	47	Publish Supplementary Resources	4.71

22	Knowledge explanation and example demonstration	5	48	Online guidance	3.43
23	Publish teaching themes	3.29	49	Personalised tutoring	4.28
24	Publish learning pathway diagrams	3.43	50	Teaching reflection	5
25	Group collaboration task	4.71	51	Online feedback	3.29
26	Real-time interactive Q&A	5	52	Online Q&A sessions	3.43

Based on the selection criteria set in the methodology, digital teaching activities with an average score of 4 or higher were ultimately selected. Of the 52 proposed digital teaching activities, 22 met the criteria and received unanimous expert approval, thus being retained, representing 42.3% of the total activities generated during the NGT conference. Therefore, through this NGT workshop, 22 digital teaching activities that received expert consensus and are suitable for implementation in university mathematics teaching were identified, as detailed in Table 5.

Table 5: Final Digital Teaching Activities Identified through NGT

No.	Digital Teaching Activities	No.	Digital Teaching Activities
1	Knowledge explanation and example demonstration	12	Publish teaching objectives via Chaoxing
2	Real-time interactive Q&A	13	Group collaboration task
3	Publish After class Assignment	14	Online quiz
4	Teaching reflection	15	Publish Q&A Discussion
5	Publish learning tasks/study guides	16	Publish Supplementary Resources
6	Micro-assessment Diagnosis	17	AI-Assisted Academic Q&A Integration
7	One-minute questionnaire	18	Play introductory video
8	Publish teaching resources	19	AI-Assisted Q&A
9	Course Map Pre-Assessment	20	Comprehensive Evaluation
10	Case introduction	21	Personalised tutoring
11	Problem-based introduction	22	Knowledge Consolidation

The 22 selected digital teaching activities covered the entire teaching process. Among them, Knowledge explanation and example demonstration, Real-time interactive Q&A, Publish After-Class Assignments, and Teaching reflection received the highest average scores ($M=5.00$), indicating that experts highly recognized their importance. Furthermore, these activities demonstrate that effective digital teaching is not merely about using digital technology, but also about systematically integrating technology-supported activities into the entire teaching process.

Discussion

The main innovation of this study lies in the identification of 22 digital teaching activities that can be integrated into university mathematics teaching through expert consensus. These activities span the three stages of pre-class, in-class, and post-class teaching, providing a structured framework for the implementation of university mathematics instruction. The implementation of these digital teaching activities has important practical implications for the digital transformation of university mathematics teaching, as they provide students with multiple opportunities to actively engage in the problem-solving process.

During the pre-class stage, Micro-assessment Diagnosis, AI-Assisted Academic Q&A Integration, Course Map Pre-Assessment, Publish Teaching Resources, and Publish Learning Tasks/Study Guides can help teachers organize students' pre-class learning. By providing teaching resources (e.g., courseware and videos), knowledge maps, pre-class assessments, and learning tasks, teachers can help students prepare for learning and enhance their awareness of independent problem solving, thereby laying a foundation for subsequent problem-solving activities in the classroom.

During the in-class stage, these digital teaching activities can further support students' engagement in the problem-solving process. First, teachers can use activities such as Case Introduction and Problem-Based Introduction to introduce the knowledge to be covered in the lesson and stimulate students' interest in mathematical problems. Teachers can then use the Chaoxing Learning Platform to publish the learning objectives, followed by knowledge explanation and the demonstration of worked examples. Building on this foundation, group collaborative tasks can be used to organize students to discuss different problem-solving strategies. Online quizzes and one-minute questionnaires can then be used to conduct timely assessments and examine whether students' problem-solving skills have improved. Finally, the key knowledge covered in the lesson can be reviewed and summarized, and feedback can be provided on students' learning.

During the post-class stage, teachers can provide continuous learning support through digital teaching activities such as assigning post-class exercises, providing supplementary learning resources, and facilitating online Q&A and discussions, thereby encouraging students to reflect on and solve problems independently. These activities can help students consolidate what they have learned in class, reflect on the problem-solving process, and continue to engage in independent problem solving outside the classroom. Therefore, the 22 digital teaching activities can span the stages of pre-class preparation, in-class learning, and post-class extension, enabling the development of students' problem-solving skills to be integrated throughout the entire learning process.

These digital teaching activities highlight student-centered teaching philosophies, such as Real-time interactive Q&A, Micro-assessment Diagnosis, Group collaboration tasks, and Online quizzes. In today's digital age, integrating appropriate digital technology tools into teaching can break down time and space limitations and reinforce the student-centered nature of education (Duan, 2026).

Another noteworthy finding is the inclusion of AI-assisted academic Q&A activities, such as AI-Assisted Academic Q&A Integration and AI-Assisted Q&A. AI-Assisted Academic Q&A Integration refers to teachers using AI to conduct introductory Q&A activities before class to stimulate students' learning interest and motivation. AI-Assisted Q&A refers to students asking questions with the help of AI teaching assistants during classroom teaching when teachers are explaining knowledge or examples. This indicates that experts recognize the potential of AI technology in supporting mathematics learning, providing timely, personalized assistance and continuous learning support outside of class (Duan, 2026). These AI-assisted question-and-answer activities can improve students' problem-solving skills by encouraging them to actively participate and think critically.

It can be seen that these digital teaching activities can leverage digital teaching platforms, artificial intelligence technologies, and other digital tools to visualize complex and abstract mathematical concepts, thereby supporting students' conceptual understanding, collaborative inquiry, and self-regulated learning, all of which can contribute to the development of students' problem-solving skills.

Overall, the 22 digital teaching activities identified in this study not only constitute a specific list of activities but also provide a practical framework for university mathematics teachers to design digital courses. This framework can help teachers use digital technologies to integrate problem-solving tasks throughout the entire teaching process, including the pre-class, in-class, and post-class stages, thereby supporting more effective classroom instruction. This provides important practical guidance for university mathematics teachers in their teaching practice.

Conclusion

This study employed the Nominal Group Technique (NGT) and, through expert consensus, identified and ranked 22 digital teaching activities. These activities covered the entire teaching process, providing teaching support for university mathematics teaching and practical guidance for university mathematics teachers in fostering students' problem-solving skills. Furthermore, the digital teaching activities identified and validated in this study can provide guidance for instructional designers and relevant educational institutions in implementing digital teaching practices.

While this study has made contributions, some limitations remain. The results were derived from a limited number of experts and may not fully represent the views of all mathematics educators. Future research could employ methods such as the fuzzy Delphi method to further validate the identified activities and examine their applicability in different educational contexts. In addition, future empirical research could further examine the effectiveness of these digital teaching activities in promoting students' problem-solving skills.

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