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Needs Analysis of Interactive Multimedia Courseware for Hydrology Engineering Education in Malaysian Polytechnics

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ABSTRACT

In the rapidly evolving field of hydrology engineering, the integration of interactive multimedia courseware into educational practices offers significant potential to enhance learning outcomes. This study presents a comprehensive needs analysis aimed at developing effective interactive multimedia weblog courseware tailored for hydrology engineering education. Courseware development needs were identified using questionnaire surveys with educators, students, and industry professionals. The analysis revealed a strong demand for courseware that incorporates dynamic simulations, real-time data analysis, and interactive problem-solving exercises. It also revealed that students were more engaged and performed better when using hypermedia compared to hypertext. The multimedia presentations enhanced their understanding, confidence, and happiness, leading to higher grades. The study concludes with recommendations for the design and implementation of interactive multimedia courseware, emphasizing its potential to improve engagement, comprehension, and practical application of hydrological concepts. These insights aim to guide future development efforts and inform educators and developers in creating robust, effective educational tools in the domain of hydrology engineering.

1. Introduction

The progress of Technical and Vocational Education (TVE) in Malaysia is accelerating, particularly in the field of Hydrology Engineering. This circumstance facilitates the transition of the nation into an agrarian, resource-rich, industrial, and manufacturing-based society [1]. Hydrology engineering courses involve theoretical concepts and practical skills crucial for infrastructure development, water resource management, and environmental sustainability. An effective teaching and learning model are required to ensure that students have a solid understanding of Hydrology Engineering and produce highly skilled graduates.

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However, past studies found that students struggled to understand fundamental engineering principles, hence, limited their ability to achieve high academic performance scores. Conventional teaching methods, which often rely on lectures and printed materials, may not fully engage students or address diverse learning styles. The static nature of textbooks and limited real-world applications in traditional classrooms can lead to a gap between theoretical knowledge and practical implementation. Traditional learning should be transformed into a technology-based pedagogy that is more active, self-directed, and collaborative, and able to increase learning output [2]. Interactive multimedia courseware is one of viable approach for facilitating teaching and learning experience.

Interactive multimedia weblogs have emerged as a promising solution to these challenges. Interactive multimedia refers to a form of digital content that integrates various media types such as text, images, audio, and video into a cohesive and engaging learning experience. A weblog (web-based log or blog) can host diverse multimedia content such as videos, simulations, interactive diagrams, and discussion forums, making learning dynamic and collaborative. By leveraging these tools, educators can provide students with real-time, context-rich resources that enhance understanding and application in hydrology engineering. According to Nova *et al.,* [3], an effective interactive multimedia design may help students to visualize difficult concepts, promote problem-solving and critical thinking, as well as provide opportunities for self-assessment through quizzes.

Interactive multimedia courseware has been widely recognized as an effective tool for enhancing student engagement, motivation, and learning outcomes across various disciplines. Studies by Septiani *et al.,* [4] and Fitrawati *et al.,* [5] have demonstrated the positive impact of interactive multimedia courseware on student learning and critical thinking skills. By integrating interactive elements such as animations, videos, and simulations, courseware can provide a dynamic and immersive learning experience for students. On the other hand, Sabu [6] and Yue *et al.,* [7] have shown that interactive multimedia courseware can improve student comprehension, retention, and ability to apply complex concepts in various engineering disciplines.

Before developing new tools, the initial step is conducting a needs analysis study. Needs analysis is a fundamental step in the instructional design process, especially in the development of educational courseware. Identifying the gap between the current state and desired outcomes in educational settings ensures that developed courseware meets the specific needs of its target audience. In hydrology engineering education, interactive multimedia courseware can address specific needs and challenges. Needs analysis able to help educators pinpoint key learning objectives, content requirements, and instructional strategies for effective learning. Study by Widayana *et al.,* [8] have highlighted the importance of customizing courseware to meet the unique needs of learners in specialized fields such as hydrology engineering.

Needs analysis is rooted in various instructional design models such as the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The initial analysis phase is critical, as it shapes the subsequent design and development stages. According to Brown [9], needs analysis serves to identify learning goals, learner characteristics, and contextual factors, thereby aligning the courseware with educational objectives and learner needs.

Interactive multimedia courseware, which includes animations, simulations, videos, and interactive assessments, has been shown to enhance learning by engaging multiple senses and providing interactive experiences [10]. Conducting a needs analysis specific to multimedia courseware involves understanding the technological competencies of learners, the availability of resources, and the pedagogical goals of the courseware.

An analysis conducted by Jong *et al.,* [11] for a physics course revealed that students benefited from interactive simulations that visualized complex concepts. The needs analysis indicated a preference for real-time feedback and hands-on problem-solving activities. Meanwhile, Branch [12]

reports that effective needs analysis for multimedia courseware should involve iterative cycles of feedback and refinement. Engaging stakeholders, including educators, learners, and technical experts, throughout the process ensures that the courseware is relevant, accessible, and pedagogically sound.

2. Problem Statement

The conventional method of lecturing with “chalk and talk” presents a challenge for students to comprehend and master the Hydrology Engineering course, which is characterized by its technicality, abstraction, and complexity. This may be a contributing factor to the students' subpar performance on the examinations.

Prior research has suggested that students encountered substantial difficulties in understanding fundamental engineering principles, unable to create visual and graphic representations of natural phenomena, and had difficulty in performing engineering calculations. These challenges impeded their capacity to achieve high academic performance scores. Furthermore, the examination results report from the Malaysian Technical Education Department demonstrated that the students' proficiency in Hydrology Engineering within the Civil Engineering diploma course was significantly deficient. At present, Malaysian polytechnics do not implement interactive multimedia weblog courseware as a teaching method.

Consequently, the primary goal of this investigation is to evaluate the needs of students and lecturers for interactive multimedia weblog courseware in Hydrology Engineering.

3. Methodology

3.1 Research Design

The study design utilized the Hannafin Peck model, fulfilling the instructional design features [13]. The needs analysis was the first step in the procedure to identify the causes and solutions of the problems and the learning requirements which would benefit a learning system. The needs analysis was divided into three parts:

i. the lecturers’ needs analysis,
ii. the students’ needs analysis,
iii. the experts’ analysis of the Hydrology Engineering course.

The lecturers’ and the students’ needs analysis were conducted using the questionnaires as the forms enabled the respondents to answer in the shortest time possible. The experts’ needs analysis was conducted using the Delphi technique.

3.2 Population and Samples

The sample was randomly divided into three groups: students, lecturers, and experts. The chosen sample was a purposive sample. The students were chosen at random from thirteen Malaysian polytechnics that offered the Hydrology Engineering diploma course as part of the Civil Engineering program. There were 420 students who enrolled in the course, and a sample of 201 students was successfully collected. Meanwhile the population of lecturers teaching the hydrology course was 26, and the selected sample exceeded the minimum sample size recommended by Krejcie and Morgan [14].

The Delphi technique was used to select a sample of Hydrology Engineering course experts based on a schedule in order to determine reliability and average group error in reaching a consensus

Boonan [15]. There were ten experts selected, with an error reduction of 0.58 to 0.54 and an effective change of 0.04. The experts included three experienced engineering lecturers, an engineer from JPS's Hydrology Engineering Department and a lecturer from JKR's Hydrology Engineering Department, two Hydrology Engineering professors from public universities, two ICT experts from private firms, and a 15-year-experienced Hydrology Engineering textbook author.

3.3 Study Instruments

The study instruments utilized during this needs analysis phase consisted of carefully designed questionnaires. To ensure the relevance and effectiveness of the questions, the researcher constructed the questionnaires by consulting and adapting questions from previously established and validated questionnaires, including those used in the studies conducted by Jamaludin Harun and Zaidatun Tasir [16] and Rozinah Jamaluddin [17]. This approach helped to align the new questionnaires with proven methodologies and ensured that they addressed pertinent issues and objectives relevant to the current study.

The initial step involved conducting a comprehensive need analysis among the students. The area was partitioned into three distinct sections. The demographic information of the respondents was provided in Section 1. Section 2 discussed the appropriate learning materials to be used in the courseware, while Section 3 addressed the learning difficulties encountered by students in the Hydrology Engineering course.

The second instrument employed was a lecturers' needs analysis, conducted through a questionnaire consisting of four sections. Section 1 encompassed the demographic data of the respondents. Section 2 examined the educational resources utilized and utilization of teaching materials whereas section 3 focused types of electronic media used by instructors. Section 4 identified the learning needs of students and the suggestions made by lecturers to enhance the learning approach for the Hydrology Engineering course.

The multiple-choice questions necessitated the respondents to select the appropriate answers. The 4-point Likert scale was employed, offering the following options: 1 = Infrequently, 2 = Seldom, 3 = Often, 4 = Very often. In addition, open-ended questions were included to allow lecturers and students to provide their comments and perspectives within the designated area.

3.4 Validity and Reliability of Instruments

A pilot study was conducted to assess the instrument's reliability using the Alpha Cronbach coefficient. A total of 10 students were selected at random to participate as non-chosen respondents in the study. The reliability test conducted using SPSS revealed an Alpha Cronbach value of 0.977.

Consequently, the other items included in the questionnaire demonstrated a strong level of reliability, as their scores surpassed 0.6. A higher Alpha Cronbach value indicates a greater level of reliability for the instrument, as stated by Majid Konting [18].

3.5 Data Analysis

The SPSS software was employed to analyze the study data. This investigation was qualitative and quantitative in nature. The percentage, mean, and standard deviation were used in the descriptive analysis to address the study questions from 1 to 5. The purpose of these questions is to identify the requirements for developing an interactive multimedia weblog courseware to enhance teaching and learning in the subject.

The research questions for the Need Analysis were presented in Table 1. It focusses on identifying courseware needs, current use of electronic media, student learning material needs, lecturer learning material needs, as well as learning challenges faced by students. These questions help in shaping a targeted and effective interactive multimedia weblog courseware by aligning it with the needs, preferences, and challenges of both students and lecturers in Hydrology Engineering.

Table 1
Research questions for the need analysis for students and lecturers of the Hydrology Engineering Course

No.	Research Questions
1.	What are the needs of the students and lecturers of the Hydrology Engineering course in terms of the materials which need to be developed in the Hydrology Engineering interactive multimedia weblog courseware?
2.	What are the materials and types of electronic media utilized by the lecturers of the Hydrology Engineering course?
3.	Which learning materials of the Hydrology Engineering course are needed by the students to be included in the Hydrology Engineering interactive multimedia weblog courseware?
4.	Which learning materials of the Hydrology Engineering course are needed by the lecturers to be included in the Hydrology Engineering interactive multimedia weblog courseware?
5.	What are the learning problems faced by the students of the Hydrology Engineering course?

4. Results and Discussion

The demographic data analysis of the respondents is presented in Table 2. It also presents skill-related information about respondents, categorized into students and lecturers.

Table 2
Frequency and percentage of respondents (students and lecturers)

Respondent Information		Students		Lectures	
		Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
Gender	Male	121	60.2	10	38.5
	Female	80	39.8	16	61.5
Ethnic group	Malay	103	51.2	15	61.5
	Chinese	62	30.8	5	57.7
	Indian	45	22.3	2	7.7
	Others	35	17.4	4	15.4
Age in 2016**	8-18 years old (Gen. Z) Born in 1998-2009	0	0.0	0	0.0
	19 - 39 years old (Gen. Y) Born in 1977-1997	201	100.0	2	7.7
	40 – 50 years old (Gen. X) Born in 1965 - 1976	0	0.0	24	92.3
Skills in using the Internet	Extremely skilled	91	45.3	21	80.8
	Skilled	80	39.8	4	15.4
	Not so skilled	13	6.5	1	3.8
	None	17	8.5	0	0.0
CGPA	< 2.00	23	11.4		
	2.01 – 2.99	129	64.2		
	3.00 – 3.49	34	16.9		
	3.5 – 4.00	15	7.5		

The survey included 201 students out of 420 enrolled students, with 60.2% male and 39.8% female participants. Meanwhile, the study included 26 lecturers, with 38.5% male and 61.5% female.

Ethnic distribution revealed a majority of Malay students and lecturers, and strong presence Chinese lecturers, while Indian representation is lower.

It also can be seen that skill levels in using the internet varied, with 45.3% of students and 80.8% of lecturers reporting being extremely skilled. This suggests that lecturers generally have stronger internet skills than students. Academic performance among students varies, with the majority having a CGPA between 2.01 and 2.99, while only a small percentage achieve a CGPA above 3.50.

Table 3 highlighted key elements needed for the interactive multimedia weblog courseware. From the students' perspective, several key elements are deemed essential. The highest priority is given to the availability of content notes for every topic and sub-topic in electronic form (Mean: 3.88, SD: 0.89), underscoring the importance of easy access to comprehensive study materials. Students value interactive presentations and online tutorials, which facilitate a dynamic and engaging learning environment. Regular online assessments for tests and quizzes are also favoured, allowing for continuous evaluation and immediate feedback. The need for monitoring student attendance and transparency in academic records indicates a preference for structured and accountable learning. The value placed on interaction between lecturers and peers highlights the importance of communication and collaboration in the educational process.

Table 3
The content materials for the learning of Hydrology Engineering needed by the students to be included in the Hydrology Engineering Interactive Multimedia Weblog Courseware

No	Item	Mean	SD
1	Interaction between lecturers and students of the Hydrology Engineering course	3.81	1.11
2	Content of notes for every topic and sub-topic in electronic form	3.88	0.89
3	Interactive presentation	3.63	0.96
4	Online tutorial	3.81	1.28
5	Online assessment for test and quizzes in the classroom	3.75	0.77
6	Monitoring of students' attendance	3.75	1.18
7	The students' record book should be shown to the students and lecturers	3.56	1.21
8	Online interaction such as open forum, emails, and video conference between students.	3.63	1.09

The results suggest that students place a high value on direct interaction with lecturers and online tutorials, as well as having access of detailed electronic notes. While the visibility of students' records is deemed less critical, it remains a significant aspect of the courseware. The development of the interactive multimedia weblog courseware should be guided by these insights in order to meet the needs of students effectively.

The analysis of the learning problems faced by students in the Hydrology Engineering course, as indicated in Table 4, reveals several critical challenges that impede the educational process. The highest-rated issues highlight significant gaps in both traditional and modern learning methodologies, underscoring the need for comprehensive reforms to enhance student understanding and engagement.

Table 4
The learning problems faced by students in the Hydrology Engineering

No	Item	Mean	SD
1	Traditional learning using chalk and talk is not enough to understand the content of the Hydrology Engineering course	3.94	0.73
2	No complete notes as reference	3.89	1.08
3	Limited time to master the topic and sub-topic during the lecture	3.78	0.81
4	Difficulty in getting electronic notes with the learning module	3.89	0.96
5	Difficulty in understanding the examples of sketches and diagrams	3.83	0.79
6	Students were not told in exact terms about the topic planning, schedule and the quiz and tutorial assessment	3.83	1.04
7	The real attendance percentage could not be determined	3.56	1.11
8	Difficulty in interacting with lecturers and fellow students due to the limited meeting time	3.83	0.51
9	Difficulty in knowing about the assessment record such as marks, test, quiz, and tutorials conducted by the lecturer	3.78	0.69
10	High learning costs in doing the assignment	3.94	1.00
11	Difficulty in contacting the lecturer and fellow students outside of the lectures if there is a study-related problem	3.94	0.67
12	Not knowing the quiz answers, test and tutorials as the assessment were rarely returned by the lecturers	3.56	0.73

*N=201

One of the most prominent challenges identified is the inadequacy of traditional "chalk and talk" methods, with a mean score of 3.94 (SD: 0.73). This suggests that conventional teaching techniques are insufficient for effectively conveying the complex content of Hydrology Engineering.

Similarly, the high learning costs associated with assignments and the difficulty in contacting lecturers and fellow students outside of lecture hours further complicate the learning experience, indicating a need for more accessible and affordable learning resources and communication channels. The lack of complete notes as references and difficulty in obtaining electronic notes with the learning module (Mean: 3.89, SD: 0.96) highlight the necessity for comprehensive and readily available study materials. These issues point to a critical gap in resource provision that needs to be addressed to facilitate better student preparation and understanding. Moreover, students face challenges in understanding examples of sketches and diagrams suggesting a need for clearer visual aids and more interactive teaching tools.

Meanwhile, studies among the lecturers revealed in Tables 5 and 6 shows that the most popular materials used by lecturers were course modules (100%) and materials created by themselves (76.9%). The most popular electronic media was the Powerpoint presentation (88.5%). For instance, only 30.8% of lecturers use reference books available in the market, and 38.5% use teaching and learning materials supplied by private firms in the form of CD-ROMs. This suggests that while these resources are not the primary choice for most lecturers.

Materials from the internet, such as portals, websites, and blogs, are used by only 11.5% of the lecturers. This indicates a potential area for improvement, as integrating more internet-based resources could provide diverse and current content, enhancing the learning experience. Similarly, materials from the resource centre/library (19.2%) and courses (26.9%) are underutilized, which could otherwise serve as valuable supplementary resources.

Table 5
The materials utilized by the lecturers of the Hydrology Engineering course

No	Item	%
1	Modules produced by the institution	100.0
2	Reference books in the market	30.8
3	Materials from resource centre/library	19.2
4	Teaching and learning materials in the form of CD-ROM supplied by private firms	38.5
5	Materials produced by other polytechnics or other colleagues	30.8
6	Internet materials from the portal, website, and blog	11.5
7	Materials from courses	26.9
8	Self-created materials	76.9
9	Magazines and newspapers	7.7
10	Others	19.2

*N=26

Table 6
The types of electronic media utilized by the Hydrology Engineering lecturers

No	Item	%
1	The teaching and learning materials were produced by the lecturers (Power Point, Prezi.com etc)	88.5
2	The electronic materials produced by the institution	38.5
3	Materials in CD ROM form produced by private firms	34.6
4	Internet materials from the portal, website, and blog	15.4
5	Materials from colleagues via the social media	11.5
6	Did not utilize any resources from the internet	76.9
7	Did not utilize CD-ROM for teaching and learning	96.2
8	Did not utilize the electronic materials	34.6
9	Others	30.8

*N=26

Similar to discoveries on students' need, Table 7 revealed that the lecturers agreed on the content required by them, such as notes, interactive presentations, online tutorials, assessments, attendance records, and online interactions.

Table 7
Content materials for the teaching of the Hydrology Engineering course needed by the lectures to be included in the Hydrology Engineering Interactive Multimedia Weblog Courseware

No	Item	Number	Percentage (%)
1	Teaching plan in electronic form	18	69.2
2	Interaction between lecturers and students of the Hydrology Engineering department	17	65.4
3	Calendar as a reference	20	76.9
4	Reference notes in electronic form	25	96.2
5	Monitoring of student attendance	26	100.0
6	Content of notes of each topic and sub-topic in multimedia form	24	92.3
7	Interactive presentation	25	96.2
8	Online tutorial	21	80.8
9	Online assessment for the test and quizzes in the classroom	22	84.6
10	The students' record book should be shown to the students and lecturers	25	96.2
11	Online interaction such as open forum, emails, and video conference between students.	20	76.9

*N=26

All lecturers unanimously agree that it is crucial to monitor student attendance. This highlights the importance of keeping track of student participation and engagement. Additionally, the vast majority of lecturers (96.2%) emphasized the necessity of reference notes in electronic form, interactive presentations, and the visibility of students' record books to both students and lecturers. This underscores the value placed on accessibility, transparency, and interactive teaching tools in the learning process.

Table 8
Component of the Hydrology Engineering Interactive Multimedia Weblog Courseware

No	Main component of the Hydrology Engineering Interactive Multimedia Weblog Courseware	Percent (%)	Median	Mod	Inter-quartile Range	Experts' Consensus Value	Z	No sig. diff. P2 & P3
1	The content of notes in every chapter and sub-topic in multimedia	100	3.0	3	0	High	-1.000	Yes
2	All the topics learnt in semester	100	3.0	3	1	High	-1.000	Yes
3	Two-way collaborative online interaction	80	3.0	3	2	Low	-1.414	Yes
4	Reference notes in electronic form	100	3.0	3	1	High	-1.000	Yes
5	Sources which fulfilled the course requirements	90	3.0	3	1	High	-1.414	Yes
6	Students' information such as record of marks and classroom management	80	4.0	4	0	High	0.000	Yes
7	Resources in multimedia, graphic charts, and graph form	90	4.0	4	1	High	-1.000	Yes
8	Interactive online tutorial	100	4.0	4	1	High	-1.732	Yes
9	Resources in electronic and CD ROM form	90	3.0	3	1	High	-1.000	Yes
10	Online self-learning	100	4.0	3	1	High	-0.447	Yes
11	Online marking of quizzes and tests in class as well as outside the class in interactive way.	80	3.5	3	1	High	-1.000	Yes
12	Questions in subjective form or essay	100	4.0	4	1	High	0.000	Yes
13	Final semester exam questions and answers (cloned)	90	3.5	4	1	High	-1.000	Yes
14	Monitoring of lecturers' and students' attendance	80	4.0	4	1	High	0.000	Yes
15	*With a search engine	70	3.0	3	1	High	-2.000	No
16	*e-hidrologi.com hyperlink	60	4.0	4	0	High	-2.236	No
17	*Interactive presentation	90	3.7	4	1	High	-0.378	Yes
18	*Instant marking	100	3.7	4	1	High	-0.577	Yes
19	*Examples of final exam questions	80	3.0	3	1	High	-1.633	Yes

The findings from the analysis of the required content materials for the Hydrology Engineering Interactive Multimedia Weblog Courseware highlight the critical components necessary for both

students and lecturers to enhance the learning and teaching experience in the Hydrology Engineering course.

Table 8 showed that all items tested had an interquartile range of 0.0 to 1.0 (high consensus). The Wilcoxon test result ranged from 0.000 to 1.732, indicating no significant difference between for the 14 items studied. The experts also agreed that all of the main components were appropriate for inclusion in the developed Hydrology Engineering Interactive Multimedia Weblog courseware. Approximately 98% of experts believed that the teaching and learning techniques were appropriate for inclusion in the weblog courseware. Furthermore, 95 percent of the experts thought the items were problematic for teaching and learning Hydrology Engineering.

The findings revealed that students were more engaged when using hypermedia compared to hypertext. The learning increased the students' understanding, confidence, and happiness with constructivist learning. The multimedia presentation helped them understand and remember the course material, allowing them to achieve high grades. Students' motivation and interest would also increase if the learning process was realistic and included a description of the actual event [19]. The study also suggested that the internet was an electronic media that provided numerous advantages for students in acquiring information and resources during the teaching and learning process. According to Moreno and Mayer [20] that explore the benefits of interactive multimodal learning environments, the emphasize the role of multimedia in improving students' understanding and knowledge retention. Research also indicates that integrating blogs into teaching practices can indeed enhance learner satisfaction and improve learning achievement [21].

Furthermore, the needs analysis revealed that students agreed that online tutorials, tests, and quizzes were more effective and could reduce paper usage, and that electronic technology could manage, store, and distribute information in shaping the curriculum in a wired, digital, and paperless environment. This finding was supported by other studies that states the need for systematic planning with clear objectives, self-testing instruments, learning activities, and feedback may meet the requirements of e-lectures, e-learning, and lecture-centred learning [22]. Interactive multimedia also has been shown to be valid in terms of material substance, learning design, visual communication display, and software utilization [23]. The results of this need analysis also aligned finding by Indriyani and Mufit, the integration of cognitive conflict elements into the design of interactive multimedia has been found to enhance learning outcomes [24].

5. Conclusion

In conclusion, the requirements for the Hydrology Engineering Interactive Multimedia weblog courseware were unanimously agreed upon by lecturers, students, and experts**.** The integration of electronic learning enabled students to improve and conduct extensive interaction and information research, as well as manage effective teaching and learning.

The research presents some suggestions for the development and implementation of interactive multimedia courseware. The identified learning problems reflect significant gaps in both traditional and modern educational practices within the Hydrology Engineering course. Addressing these challenges requires a multifaceted approach, including the adoption of interactive and multimedia teaching tools, better communication and feedback mechanisms, and more accessible learning resources. By tackling these issues, the course can better support student learning, engagement, and overall educational outcomes. These insights are also intended to serve as a guide for future development efforts and to provide educators and developers with information that will assist them in the creation of robust and effective educational tools in Malaysian polytechnics.

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