

Proceeding Paper

Using YouTube as an Effective Educational Tool to Improve Engineering Mathematics Teaching during the COVID-19 Pandemic [†]

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[†] Presented at the 3rd IEEE International Conference on Electronic Communications, Internet of Things and Big Data Conference 2023, Taichung, Taiwan, 14–16 April 2023.

Abstract: An investigation and assessment of virtual learning in engineering mathematics during the COVID-19 pandemic were explored in this study. The result showed that the media platform was an especially useful technology for students to create, share, learn, and interact with others. YouTube, a free media-sharing website, has proved to be an effective educational tool to add a new dimension to education in increasing student engagement, motivation, understanding, and achievement. Thus, students' learning models on the OpenCourseWare YouTube channel were researched to investigate how virtual activities in e-learning of engineering mathematics during coronavirus confinement were implemented and describe how YouTube was used for teaching engineering mathematics by engaging students in mathematical problem-solving.

Keywords: COVID-19; engineering mathematics; YouTube channel; online learning

1. Introduction

Improving teaching effectiveness has been tried continuously to help students engage more in learning. Therefore, a series of research related to engineering mathematics has been carried out with continuous funding from the Ministry of Education in Taiwan. The above efforts are aimed at attracting students to study engineering mathematics, and this also helps the author to improve teaching. The efforts include (1) integrating key points of engineering mathematics into multimedia teaching materials, (2) creating an appropriate environment for self-learning, (3) providing learning opportunities for students and enhancing comprehension ability by analogy, (4) constructing unit-themed learning materials, and (5) making an environment suitable for action learning. These efforts are especially critical for the conversion of in-person courses into virtual courses during the COVID-19 pandemic.

Paschal, Pacho, and Adewoyin [1] found effective teaching methods for higher educational institutions during the COVID-19 pandemic in Africa through empirical research. Simamora et al. [2] displayed the lecturer's perspectives during the COVID-19 pandemic in higher education and concluded that there was a need to continue exploring alternative learning environments to ensure learning with an effective, efficient, easy-to-access, and high-quality knowledge dissemination process. Marsudi, Lestari, and Hidayati [3] investigated the improvement in mathematics learning achievements of students after using YouTube as a learning media during the COVID-19 pandemic. They observed the impact of the interactive learning model and orientation of mathematics material on conceptual comprehension ability. Antón-Sancho and Sánchez-Calvo [4] recommended increasing the specific training for professors in the pedagogical usage of information and communication technologies addressing the specific knowledge in each area. Kanetaki et al. [5] identified variables that impacted student performance in the educational process disorientation due to the COVID-19 pandemic and concluded that innovative teaching improved students'



Citation: Lu, J.C.-C. Using YouTube as an Effective Educational Tool to Improve Engineering Mathematics Teaching during the COVID-19 Pandemic. *Eng. Proc.* **2023**, *38*, 24. <https://doi.org/10.3390/engproc2023038024>

Academic Editors: Teen-Hang Meen, Hsin-Hung Lin and Cheng-Fu Yang

Published: 21 June 2023



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spatial conceptions. DeCoito and Estaiteyeh [6] revealed that online teaching was viewed negatively by most teachers in terms of student engagement and outcomes. Febrianto, Mas'udah, and Megasari [7] focused on determining the online learning process and the associated obstacles experienced by students. Their investigation showed the importance of the availability of supporting facilities, infrastructure, and facilitated internet access. Shahroury [8] demonstrated that the use of the flipped classroom strategy helped overcome the challenges associated with e-learning and maintain overall performance. The investigation of Beruin [9] revealed a generally unfavorable and unenthusiastic view of online learning during the COVID-19 pandemic. George [10] presented effective teaching and examination strategies that can be utilized for undergraduate learning courses during COVID-19 restrictions. Karasneh et al. [11] recommended that training programs and inter-departmental communication strategies be implemented and use fewer platforms to provide an efficient online learning experience. Libasin et al. [12] concluded that students and lecturers worked together to ensure similar learning outcomes before the pandemic. The work of Patalinghug and Patalinghug [13] displayed that using YouTube as a web-based instructional tool improved students' sociability, grades, learning motivation, and curriculum delivery through utilizing technology-enabled learning. Revelo-Rosero et al. [14] highlighted digital tools and resources available on the web to improve the teaching-learning process inside and outside the classroom. Abubakar and Muhammed [15] provided a rational literature investigation and analysis of the education teachers' pedagogy and YouTube video technology. There have been many related investigations about effective educational tools to improve teaching during the COVID-19 pandemic.

The series of videos on engineering mathematics on YouTube recorded by the author has helped many students learn well on engineering mathematics. Three representative students sent the appreciated messages from 2020 to 2022 on YouTube as follows.

- "Thank you so much, Teacher. You have helped me a lot. I cannot express how grateful I am right now. Thank you so much. Please stay safe and take care."
- "Thank you for your contribution, since mathematics is a universal language, I will always understand. Good video! Greetings from Mexico."
- "You may not believe me but I'm a Spanish speaker and I only know around 7 words in Chinese but it was so clear that I understand what you explain. Thank you so much!"

In this study, the ideas and keys are suggested to establishing a YouTube engineering mathematics teaching channel for readers' reference.

2. Creating Teaching Materials

There have been 39 teaching research projects implemented by the author since 2003, who had a strong interest in multimedia teaching and the integration of digital technology into teaching. Each project was focused on the research and development of innovative teaching materials. The research projects supported by the Ministry of Education in the past five years are shown in Table 1. All teaching materials have been uploaded on YouTube for interested students to use for free. The established OpenCourseWare on YouTube was applied to teaching and learning engineering mathematics during the COVID-19 pandemic. The goals of the projects are as follows.

- Studying according to their own pace
- Making teaching materials more interesting
- Helping students pass various exams
- Improving students' concentration on the study

- Triggering learning motivation
- Solidifying abstract ideas
- Enhancing memory and impression
- Shortening learning time
- Making teaching activities lively and funny
- Expanding information content can satisfy students' thirst for knowledge

Table 1. Projects supported by the Ministry of Education in 2018–2022.

Year	Project Title
2018	Study on the Establishment and Application of Teaching and Problem-Solving Handouts/Videos of the OpenCourseWare “Engineering Mathematics”
2019	Study on Case Study of the Application of OpenCourseWare “Engineering Mathematics”
2020	Study on the Design of Adding Interactive Tests to the Online Video of the OpenCourseWare “Engineering Mathematics”
2021	Study on the Frequently Asked Questions and Its Answers of OpenCourseWare “Engineering Mathematics”
2022	Evaluation of Key Points of OpenCourseWare “Engineering Mathematics” Using Animation Methods

The current research is focused on the animation presentation of the key knowledge of engineering mathematics. All the efforts are conducive to the implementation of student-centered pedagogy, question-and-answer pedagogy, technology-integrated pedagogy, problem-based pedagogy, design thinking pedagogy, and self-study tutoring. There is much interesting information displayed on YouTube. Instructors can improve teaching based on feedback in the detailed message. Figure 1 presents the welcome page of instructional YouTube developed by the author. Figure 2 shows that there were currently 3627 students subscribed to the educational channel. In 28 days, the YouTube channel had 12,899 accumulated views with 3619 non-repetitive audiences (Figures 3 and 4). Figure 5 presents the ordinary differential equation problem-solving process on YouTube, and the application of ordinary differential equations to structural mechanics is presented in Figure 6. Students could self-assess their learning effectiveness through online quizzes in H5P as displayed in Figure 7. The key points of engineering mathematics are presented by animation as shown in Figure 8. The project facilitated online learning of engineering mathematics while maintaining the quality of teaching.



Figure 1. Welcome page for browsing and Q&A (感謝瀏覽, 歡迎提問): YouTube instructional videos developed by the author at Chung Hua University (中華大學).



Figure 2. Channel dashboard (頻道資訊主頁): 3627 students subscribed to the engineering mathematics YouTube channel.



Figure 3. Channel data analysis (頻道數據分析): 12,899 views in the latest 28 days.



Figure 4. Channel data analysis (頻道數據分析): 3619 non-repetitive audiences in the latest 28 days.

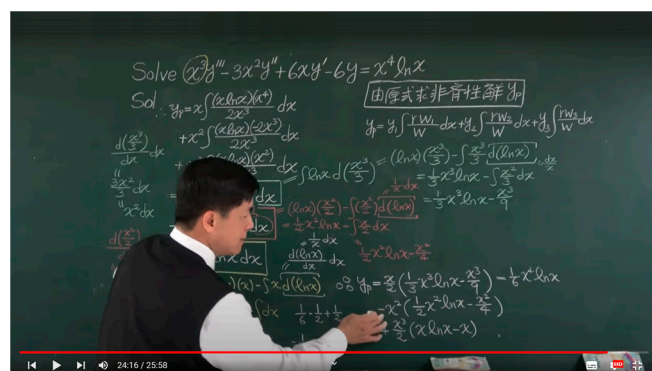


Figure 5. Problem-solving process of ordinary differential equation displaced on YouTube.

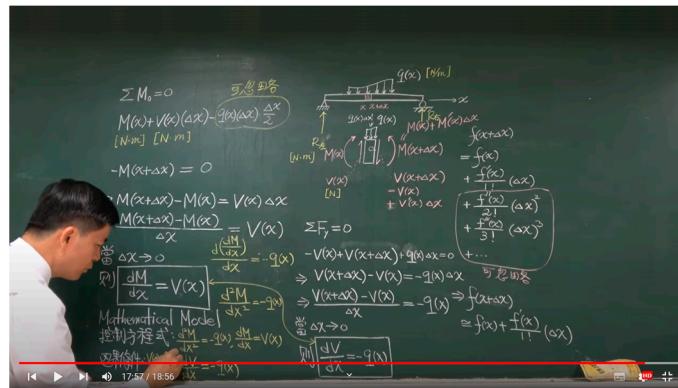


Figure 6. Application of ordinary differential equation on structural mechanics.

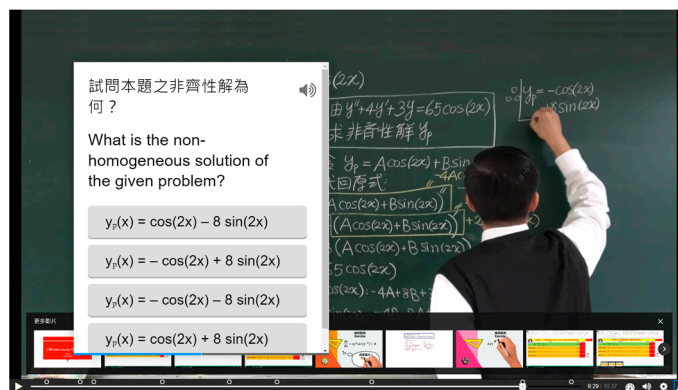


Figure 7. Self-assessment of learning effectiveness through online quizzes.



Figure 8. Key points of engineering mathematics are presented by animation.

3. Questionnaire Survey

An online questionnaire survey was conducted on the effectiveness of teaching videos with Google Forms. In total, 77 students from the courses of engineering mathematics in 2020–2022 participated in the survey. The descriptive analysis result showed that planning of learning scored 4.62 on a scale of 5. Thus, the recorded teaching videos on YouTube were effective during the COVID-19 pandemic (Table 2). The scores obtained for each indicator were interpreted based on the criteria of Table 3. The students’ responses to the teaching videos are displayed in Table 4. The average score was 4.62, which showed student satisfaction. Most students liked the quality of the engineering mathematics materials in the educational videos, which implies that the quality of the learning videos was satisfactory, and the videos were helpful in online learning during the epidemic.

Table 2. Score on the Likert scale of the questionnaire.

Option	Score
Strongly Disagree	1
Disagree	2
Neither Agree nor Disagree	3
Agree	4
Strongly Agree	5

Table 3. Interpreted students' responses based on scores.

Interval	Students Responses
$1.00 \leq x < 1.80$ ^a	Very Bad
$1.80 \leq x < 2.60$	Bad
$2.60 \leq x < 3.40$	Neutral
$3.40 \leq x < 4.20$	Good
$4.20 \leq x \leq 5.00$	Very Good

^a x = Scores of each indicator.

Table 4. Students' responses to the developed teaching videos in 2020–2022.

Indicator	Score	Response Category
The teaching materials developed by the teacher can inspire my interest in learning	4.59	Very Good
The recorded digital video provided by the teacher helps me adjust my learning progress	4.65	Very Good
Average	4.62	Very Good

4. Conclusions

Based on the findings in this research, the following conclusions are drawn.

There were 39 teaching research projects implemented by the author since 2003. Each project focused on the development of innovative teaching materials. All of the teaching materials have been uploaded on YouTube for students to use for free. The results of the online survey with 77 students in 2020–2022 showed that students' responses to the developed teaching videos scored 4.62 on a scale of 5, which was very good. Students studied according to their own pace on YouTube. Furthermore, teaching materials made the course more interesting and maintained the quality of instruction. The developed teaching videos integrated the key points of engineering mathematics into multimedia teaching materials and built a suitable environment for active learning. All the efforts were conducive to the implementation of student-centered pedagogy, question-and-answer pedagogy, technology-integrated pedagogy, problem-based pedagogy, design thinking pedagogy, and self-study tutoring.

Funding: This work is supported by the Ministry of Education of Taiwan, Republic of China, through grants PEE1101210 and PEE1110397.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not available.

Conflicts of Interest: The author declares no conflict of interest.

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