

Self-Learning Efficiency in College Virtual Course of Engineering Mathematics on YouTube[†]

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Abstract: The author has provided more than 2100 engineering mathematics teaching materials on YouTube since 2014. The viewer information provided by YouTube revealed that (1) 59.16% of viewers were 18 to 24 years old while 23.18% were over 35 years old, (2) the gender ratio was 4:1 (male–female), (3) 9.19% of viewers subscribed to the educational channel, (4) 88.13% of viewers were from Taiwan and 1.97% from Hong Kong, and (5) the proportion of “External Sources” and “Playlist” was 26.91% and 25.30%, respectively. Such viewer demographics help adjust the principles of tutorial videos. For instance, nearly 60% of the viewers were college students, and their expectations aligned with the grading criteria set by instructors. The majority of college instructors arrange written examinations and present engineering mathematics content in a handwritten manner. Around 25% of the students had richer life experiences and no examination pressure. Therefore, proverbs or idioms related to life philosophy in videos better resonated with these viewers. Tutorial videos were created to assist self-learners in mastering engineering mathematics. The data over the past nine years on YouTube serve as a valuable reference in constructing instructional videos for engineering. This virtual tutorial experience provides a basis to adjust the direction of future tutorial video recordings.

Keywords: engineering mathematics; OpenCourseWare; information technology integrated into instruction; self-study tutoring



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1. Introduction

An open-course teaching model is used in engineering mathematics. Starting from 21 September 2014, a teaching community for engineering mathematics on YouTube was formed. As of 27 January 2024, this community’s instructional videos had attracted 3950 subscribers interested in engineering mathematics. Over 2100 instructional videos were posted on YouTube for engineering mathematics.

Many teachers have used YouTube for instruction and have achieved good results. Kadriu et al. [1] explored tutorial trends using available public YouTube data. This study focused on tutorials for 11 programming languages, and its methodology can be used in any other field of interest. Maziriri et al. [2] suggested that perceived usefulness impacted students’ perceptions of learning through YouTube compared to considerations of ease of use. Despite the limitations, Kibirige and Odora [3] indicated that incorporating YouTube videos enhanced students’ cognitive achievements. Rigdel et al. [4] concluded that YouTube as supplementary material significantly influenced the improvement of students’ learning achievements and their attitudes toward learning geography. Nabayra [5] observed a significant improvement in the performance of students before and after the utilization of teacher-created videos on YouTube for online mathematics learning. Jamil et al. [6] disclosed that STEM students frequently utilized YouTube tutorial videos to learn mathematics, and their performance in mathematics was improved. Pattier [7] pointed out the significant impact of YouTube channels on science with a positive trend and substantial growth in users and educational audiovisual content. Based on interviews with mathematics educators

and students, Anisa et al. [8] discovered that YouTube served as a viable platform for mathematical education.

Thus, it is crucial to recognize and assess the diverse advantages and disadvantages associated with YouTube's use. Rahmatika et al. [9] concluded that YouTube functioned as a learning medium and encouraged independent learning for students. Nacak et al. [10] determined that teachers considered YouTube to have suitable educational material for various lessons and believed that it enhanced retention and reinforced learning. Dubovi and Tabak [11] demonstrated that YouTube provided an informal space for scientific deliberation and a forum for collaborative interactions to support lifelong learning. Rachmawati and Cahyani [12] concluded that the use of YouTube videos positively impacted students' pronunciation skills, and YouTube was a significant learning medium for English pronunciation, particularly for non-English department students. Shaikh et al. [13] discovered that the number of video views was crucial in predicting citations and enhancing the popularity of research articles, as well as fostering public engagement with science. Sunday et al. [14] demonstrated that the utilization of YouTube as an online educational tool enhanced the academic achievements of undergraduate students in mathematics education. Toleuzhan et al. [15] suggested that students in secondary education held a positive attitude toward utilizing YouTube videos for learning English speaking skills. Nielsen [16] highlighted a strong negative correlation between the length of a video on YouTube and the portion of that video that students watched per viewing session.

In this study, differences in the learning of self-learners by age, gender, subscription ratio, geographical location, and search methods were explored in the YouTube engineering mathematics community. The results can be used to fine-tune the focal points of instructional videos and provide a reference for developers of similar educational channels.

2. Recorded Information on YouTube

In Taiwanese YouTube teaching channels, a channel with over 1800 subscribers is considered important. As of 27 January 2024, the studied engineering mathematics teaching channel had garnered 3950 subscribers (Figure 1). Figure 2 shows that the readers viewed newly published instructional videos every day. In the latest 7 days (20–27 January 2024), 16.12% of the viewers were subscribed. From September 2014 to January 2024, the proportion of subscribed viewers was 9.19%. During 20–27 January 2024, male students were more inclined to view newly published engineering mathematics videos on YouTube. For these 7 days, 91.58% of viewers were male students (Figure 3). From September 2014 to January 2024, the proportion of male students was 80.36%. The gender ratio of male to female viewers was 4:1.

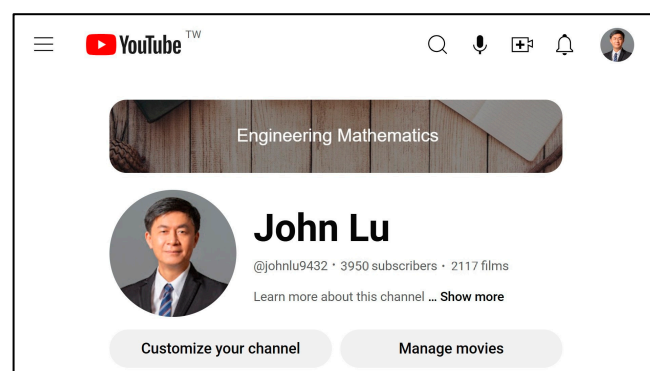


Figure 1. There were 3950 subscribers on a YouTube channel for engineering mathematics (as of 27 January 2024).

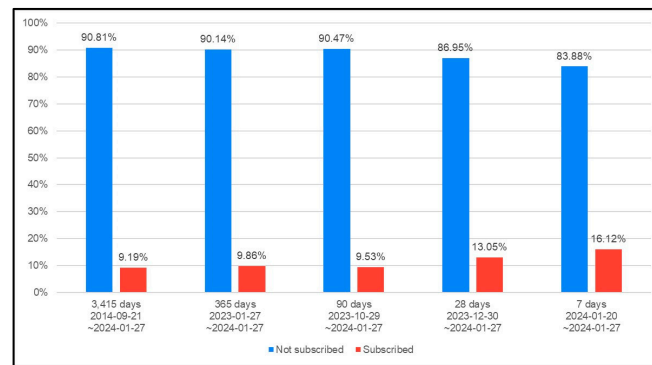


Figure 2. Ratio of subscribers for 7, 28, 90, 365, and 3415 days as of 27 January 2024.

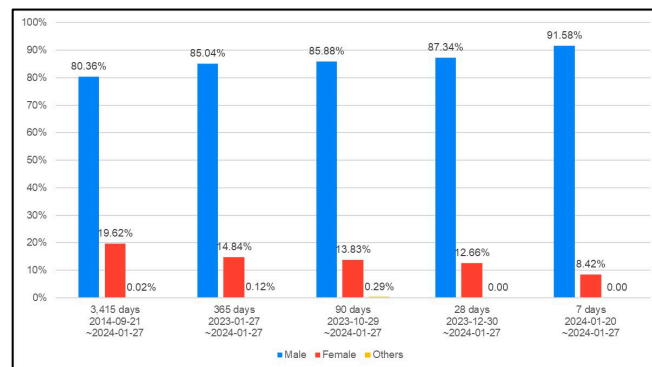


Figure 3. Gender ratio for 7, 28, 90, 365, and 3415 days as of 27 January 2024.

Figure 4 shows that the majority of viewers of the YouTube engineering mathematics channel were 18–24 years old from September 2014 to January 2024, accounting for 59.16%. The viewers were mostly college students studying engineering mathematics in this age group. Viewers over 35 years old accounted for 23.18%. During 20–27 January 2024, the dominant age group was 55–64 years old, constituting 45.70%. These results show the needs of both age groups. As engineering mathematics questions were explained for civil service exams with a proverb (Figure 5) bilingually, this addition attracted more viewers.

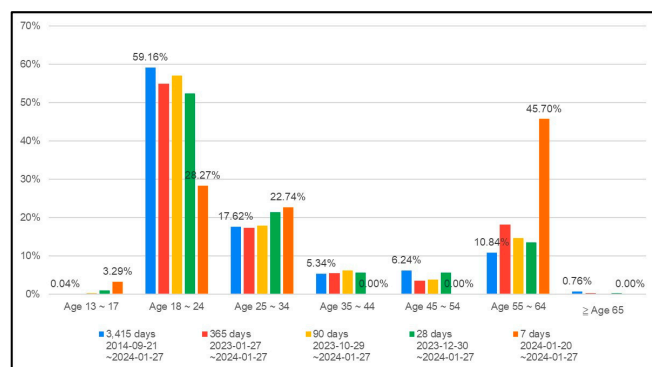


Figure 4. Composition of viewers in various 7, 28, 90, 365, and 3415 days as of 27 January 2024.

$$\begin{aligned}
 & \triangleright [s^2Y(s) - s \times 3 - (-5)] + 4[sY(s) - 3] + 3Y(s) = 0 \\
 & \triangleright (s^2 + 4s + 3)Y(s) = 3s - 5 + 12 \\
 & \triangleright Y(s) = \frac{3s}{(s+1)(s+3)} + \frac{7}{(s+1)(s+3)} \\
 & \triangleright Y(s) = \frac{3}{2} \left(\frac{1}{s+1} - \frac{3}{s+3} \right) + \frac{7}{2} \left(\frac{1}{s+1} - \frac{1}{s+3} \right) \\
 & \triangleright Y(s) = \frac{2}{s+1} + \frac{1}{s+3} \\
 & \triangleright y(x) = \frac{1}{2\pi i} \int_{\sigma-i\infty}^{\sigma+i\infty} \left(\frac{2}{s+1} + \frac{1}{s+3} \right) e^{sx} ds \\
 & \triangleright y(x) = \mathcal{L}^{-1} \left\{ \frac{2}{s+1} + \frac{1}{s+3} \right\} \\
 & \triangleright \text{Thus, we have the solution for the boundary value problem.} \\
 & \triangleright y(x) = 2e^{-x} + e^{-3x}
 \end{aligned}$$

'Honesty is the best policy.'

Figure 5. Scene of video with a proverb: “Honesty is the best policy.”

From September 2014 to January 2024, most viewers were from Taiwan (88.13%) and Hong Kong (1.97%). Thus, it was necessary to meet the needs of local students. On 20–27 January 2024, there was an increase in the proportion of self-learners from outside Taiwan. Consequently, it was needed to provide the video in a bilingual mode (Figure 6).

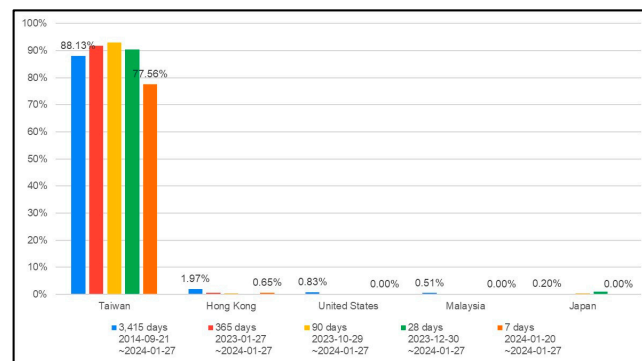


Figure 6. Countries of viewers as of 27 January 2024.

The data in Figure 7 shows that students learning engineering mathematics discover instructional videos on YouTube primarily through “External Sources” and “Playlist”, followed by “YouTube Search”, “Recommended Videos”, and “Browse Features”. The proportions of “External Sources” and “Playlist” were 26.91% and 25.30% from September 2014 to January 2024. “External Sources” were used for external websites or apps. During 20–27 January 2024, viewers browsed the videos as “Browse Features”. Traffic from “Browse Features” was generated through the homepage, subscription feed, watch later, trending, and explore sections of YouTube.

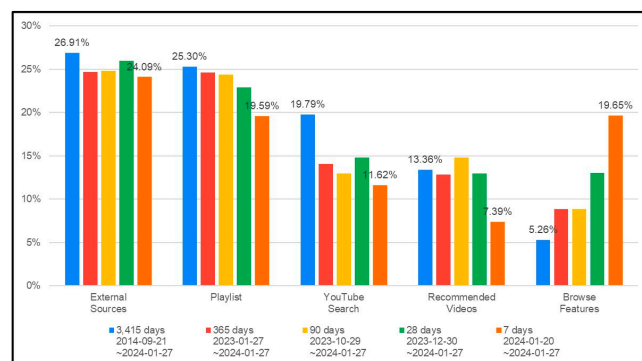


Figure 7. Traffic sources for the created YouTube teaching platform (statistical results on 27 January 2024).

3. Principles of Video

The following factors were considered in creating videos for engineering mathematics.

- **Problem-solving Approach:** In teaching engineering mathematics, examples are often used for explanation. In analyzing each engineering mathematics problem, it is essential to understand the underlying engineering significance. Appropriate mathematical methods are used for this analysis. Theorems also need to be taught for students to grasp the essence of the theorems and handle problem-solving proficiently. When applying formulas to problem-solving, students may find it less engaging. It is recommended to discard formulaic approaches for an enjoyable learning experience.
- **Design-based Teaching Method:** This teaching approach involves the planning of students' learning by themselves. For example, if students want to understand the analytical methods of "first-order ordinary differential equations," they need to review relevant instructional videos and lecture notes. By shortening the learning process, students build confidence and enhance their motivation.
- **Experimental Thinking Teaching Method:** Albert Einstein once proposed the concept of experimental thinking, which implies conducting experiments through thoughtful contemplation. In teaching engineering mathematics, students need experiments. For example, the decay rate of radioactive substances is proportional to the mass of the radioactive substance, and the rate of temperature change in an object is proportional to the temperature difference. These natural laws can be understood through experiments. Students can derive enjoyment from learning through this process.
- **Self-Learning Guidance Method:** In imparting engineering mathematics knowledge, students need to be guided to grasp learning methods and enhance their self-learning capabilities. More than 2100 videos are beneficial for students in previewing, reviewing, and referencing materials.
- **Integration of "Jigsaw" and "Pyramid" Learning:** Based on personal teaching and learning, "Pyramid"- and "Jigsaw"-style teaching are used. Learning engineering mathematics is based on the "Jigsaw" learning method, but each puzzle is a small "Pyramid." When teaching engineering mathematics, teachers need to focus on a single main topic for students to understand fundamental concepts such as calculus or high school mathematics for a specific unit.

The instructional videos on unit topics created by the author were recorded according to such principles.

4. Conclusions

To enhance the strengths and mitigate weaknesses of instructional videos, viewers were analyzed by gender, age, subscription status, and viewing methods. YouTube videos have been used to improve teaching effectiveness. More than 60% of viewers of the created videos were college students, meeting the needs for examinations and further studies. Simultaneously, the videos attracted 25% of viewers who were older than 35 years old with life experience. It is important to include elements to resonate with viewers in instructional videos. For students, detailed solutions for engineering mathematics problems need to be provided for both entrance examinations and civil service examinations. The ratio of male to female self-learners was 4:1, aligning with the common perception of fewer females in learning engineering.

The created videos were perceived as easy to understand, contributing to building learning confidence. This affirms the goal of the videos to assist students in learning engineering mathematics effectively.

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