



Effect of YouTube Math Tutorials on the Proficiency in Engineering Mathematics

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Abstract

Digital learning platforms have significantly transformed mathematics education for engineering students worldwide. The integration of video-based learning technologies, particularly YouTube tutorials, has emerged as a crucial supplementary tool in STEM education (Freeman et al., 2014; Khan et al., 2024). This study, conducted from May to June 2025, investigated the Effect of YouTube Math Tutorials on the Proficiency in Engineering Mathematics among Aerospace Engineering students. Using a concurrent embedded mixed-methods approach, 112 Aerospace Engineering students selected through stratified random sampling engaged with curated YouTube tutorials covering Calculus, Differential Equations, Thermodynamics, Physics, and Chemistry. The research employed a five-point Likert-scale survey to assess student perceptions across three dimensions: professional growth, advanced engineering mathematics skills, and understanding of aerospace engineering concepts. Quantitative analysis utilized weighted mean calculations and ranking formulas to interpret the data. Findings indicated that students agreed on the positive impact of YouTube tutorials in enhancing professional growth ($M = 4.1$), advancing engineering mathematics skills ($M = 4.1$), and improving understanding of aerospace engineering concepts ($M = 4.1$). However, students reported challenges in applying tutorial knowledge to real-world engineering problems ($n = 44$, 39.3%). The study recommends integrating application-based activities and real-world case studies with YouTube-based learning to bridge the gap between theoretical understanding and practical application.

Keywords: *professional growth, advanced engineering math, understanding aerospace engineering*

Introduction

The digital revolution has fundamentally reshaped global education by introducing powerful tools and platforms that enhance teaching and learning. Active learning methods, including digital video tutorials, have been proven to significantly improve student performance in science, engineering, and mathematics compared to traditional lectures (Freeman et al., 2014). Students engaged in active learning show higher exam scores and lower failure rates. In the United States, educational institutions have been leaders in integrating technology such as augmented reality, tablets, and video conferencing to create interactive, flexible, and collaborative learning environments (EdTech Magazine, 2019). According to the National Center for Education Statistics, over 90% of US schools now employ digital or blended learning approaches, with platforms like YouTube, Khan Academy, and Coursera becoming vital resources for mastering complex subjects like mathematics and engineering.

YouTube, launched in 2005, is a free video-sharing platform widely used worldwide for self-directed learning, offering educational tutorials, lectures, and demonstrations (Google, n.d.). Research during the COVID-19 pandemic highlighted YouTube's role in sustaining education when traditional classrooms were disrupted. Studies in engineering mathematics revealed that YouTube fosters student engagement, motivation, understanding, and achievement by enabling learners to create, share, and interact with content, especially benefiting complex topics through step-by-step visual explanations (Rahayu et al., 2023). This digital learning shift is global. In Asia, countries like Singapore, South Korea, and Japan have prioritized technology integration in education, achieving high digital literacy and improved STEM outcomes (UNESCO, 2022; Teo et al., 2020). In the Philippines, digital learning adoption accelerated during the pandemic, with over 80% of students accessing online resources and

YouTube emerging as a key platform for STEM subjects (DepEd, 2021). Despite progress, Filipino students face challenges such as inconsistent internet access and dependence on self-directed learning, especially in technical fields like engineering and mathematics,

driving increased use of YouTube tutorials.

While platforms like YouTube offer unprecedented access to educational content, they lack standardized quality assurance, requiring users to discern suitable materials. This underscores the need for curated, faculty-guided integration of digital resources in formal education (Castellanos-Reyes, 2024). The study is grounded in theoretical frameworks supporting digital learning in engineering education. Social Cognitive Career Theory explains how digital self-efficacy and online resources enhance professional development and confidence (Lent, 2021). The Professional Learning Community Model highlights the value of collaborative digital spaces for peer learning and connecting theory to practice (Li et al., 2021). The Digital Competence Framework stresses the importance of digital literacy for STEM career success, especially in specialized fields like aerospace engineering (Redecker, 2023). Additionally, Interest-Driven Creator theory shows that student engagement and mathematical problem-solving improve when learning is motivated by personal interest in video content (Hsiao et al., 2021).

In light of these insights, this study investigates the Effect of YouTube Math Tutorials on Proficiency in Engineering Mathematics, focusing on three key variables: professional growth, advanced engineering mathematics skills, and understanding of aerospace engineering concepts.

Research Question/ Objectives

This study aimed to determine the Effect of YouTube Math Tutorials on the Proficiency in Engineering Mathematics at Indiana Aerospace University for the A.Y. 2024–2025. Specifically, this study sought to answer the following sub-problems:

1. Assess the Effect of YouTube Math Tutorials on the Proficiency in Engineering Mathematics in terms of:
 - 1.1. professional growth;
 - 1.2. advanced engineering math; and
 - 1.3. understanding aerospace engineering?
2. Rank the problems encountered by Aerospace Engineering students.

Methodology

Research Design

This study employs a concurrent embedded mixed-methods design (also known as a nested design), where quantitative and qualitative data are collected simultaneously to investigate the Effect of YouTube Math Tutorials on the Proficiency in Engineering Mathematics among Aerospace Engineering students at Indiana Aerospace University (IAU). This methodological approach aligns with established practices in educational research, particularly in studies examining the effectiveness of digital learning tools in STEM education (Creswell & Plano Clark, 2017).

Participants/Respondents

The study involved 112 Aerospace Engineering students from various year levels, including First Year ($n = 15$), Second Year ($n = 47$), Third Year ($n = 32$), and Fourth Year ($n = 18$). Participants were selected through stratified random sampling, a method that divides the population into distinct subgroups or strata based on year level, and then randomly selects participants from each stratum proportionally. This approach ensures that the sample accurately reflects the diversity within the Aerospace Engineering student population, thereby enhancing the representativeness and validity of the study's findings. The sample size of 112 participants exceeds the minimum recommended sample size for educational research studies of this type, providing adequate statistical power for detecting meaningful differences in student perceptions and outcomes (Cohen, 1988). The stratified sampling approach ensures representation across different levels of academic experience, which is crucial for understanding how YouTube tutorials affect students at different stages of their engineering education.

Instrument

A mixed-method research instrument was administered to the stratified, randomly selected Aerospace Engineering students. The instrument included a quantitative questionnaire using a five-point Likert scale (1 – Strongly Disagree to 5 – Strongly Agree) to assess perceptions across three dimensions: professional growth, advanced engineering mathematics skills, and understanding of Aerospace Engineering concepts. The instrument design was informed by validated scales used in previous research on digital learning effectiveness in STEM education (Means et al., 2014). The three-dimensional framework (professional growth, advanced engineering mathematics, and understanding aerospace engineering) was developed based on established competency frameworks in engineering education and aligned with learning outcomes identified in aerospace engineering curricula. The survey was conducted online via Google Forms to facilitate efficient data collection and ensure participant anonymity. This digital approach to data collection is consistent with current best practices in educational research, particularly when studying digital learning phenomena (Bethlehem, 2010). The study adhered to ethical guidelines, ensuring participants were fully informed about their rights and the confidentiality of their information.

Data Analysis

The statistical treatment of data involves analyzing and interpreting both quantitative and qualitative results gathered from the research instruments. For the quantitative component, responses to the Likert-scale statements were analyzed using descriptive statistics,

including weighted mean calculations, frequency counts, percentages, and ranking formulas to summarize students' perceptions and familiarity with YouTube tutorials.

The weighted mean calculation follows the formula: $\text{Weighted Mean} = \frac{\sum(\text{Scale} \times \text{Frequency})}{\text{Total Frequency}}$

For the qualitative component, open-ended responses were analyzed using thematic analysis to identify common patterns and themes in students' experiences with YouTube tutorials. This approach allowed for a deeper understanding of the factors that contribute to the effectiveness or challenges of using YouTube for engineering mathematics learning.

Ethical Considerations

This study strictly adhered to ethical guidelines established for educational research involving human subjects. All participants provided informed consent after being fully briefed on the study's purpose, procedures, and their rights, including the voluntary nature of participation and the option to withdraw at any time without penalty. Confidentiality was ensured by anonymizing all data with unique codes, and only authorized members of the research team had access to the raw data, which was securely stored and will be destroyed after the completion of the analysis.

The research instruments, consent forms, and study design underwent review and approval by the appropriate institutional review board. All incentives offered were modest and non-coercive, intended solely to acknowledge participation. Throughout the study, participants were reminded of their rights, including the option to skip any question and the assurance that all information collected would be used exclusively for academic purposes related to this research.

Results and Discussion

Professional Growth

Professional growth refers to the continuous process of acquiring new knowledge, skills, and experiences that contribute to an individual's development within their profession. In the context of aerospace engineering education, professional growth encompasses the development of technical competencies, problem-solving abilities, and career readiness skills that prepare students for success in the aerospace industry (Lent, 2021). Contemporary research on digital learning in engineering education has shown that self-directed learning through online platforms can significantly contribute to professional development when properly integrated with formal educational structures (Li et al., 2021). The ability to access diverse learning resources and engage with content at one's own pace has been identified as a key factor in developing the self-efficacy necessary for engineering practice.

Table 1 presents the perceptions of Aerospace Engineering students regarding their professional growth, arranged from highest to lowest average weighted mean.

Table 1. *Professional Growth*

<i>Indicator</i>	<i>Weighted Mean</i>	<i>Description</i>
1. YouTube tutorials help me connect classroom learning to real-world applications.	4.3	Strongly Agree
2. I feel more prepared for professional tasks after using YouTube math tutorials.	4.2	Agree
3. YouTube tutorials motivate me to pursue further learning in my field.	4.2	Agree
4. YouTube math tutorials help me develop skills relevant to my future career in aerospace.	4.2	Agree
5. Using YouTube tutorials increases my confidence in tackling engineering problems.	4.0	Agree
Average Mean	4.1	Agree

Legend: 4.21-5.00 = Strongly Agree, 3.41-4.20 = Agree, 2.61-3.40 = Neutral, 1.81-2.60 = Disagree, 1.00-1.80 = Strongly Disagree

Advanced Engineering Math

Advanced Engineering Mathematics involves the application of higher-level mathematical concepts and techniques essential for solving complex problems in Aerospace Engineering. Research has consistently shown that engineering students often struggle with the abstract nature of advanced mathematics and benefit significantly from visual and step-by-step explanations (Hsiao et al., 2021). The use of video tutorials has been particularly effective in helping students understand complex mathematical procedures and their applications in engineering contexts.

Table 2 presents the perceptions of Aerospace Engineering students regarding Advanced Engineering Math, arranged from highest to lowest average weighted mean.

Table 2. *Advanced Engineering Math*

<i>Indicator</i>	<i>Weighted Mean</i>	<i>Description</i>
1. I rely on YouTube tutorials when I struggle with advanced math subjects.	4.2	Agree
2. YouTube tutorials make advanced engineering math topics easier to understand.	4.2	Agree
3. I can solve more complex math problems after using YouTube tutorials.	4.2	Agree
4. YouTube tutorials help clarify concepts in calculus and differential equations.	4.1	Agree
5. YouTube tutorials provide clear step-by-step solutions for engineering math problems.	4.1	Agree
Average Mean	4.1	Agree

Legend: 4.21-5.00 = Strongly Agree, 3.41-4.20 = Agree, 2.61-3.40 = Neutral, 1.81-2.60 = Disagree, 1.00-1.80 = Strongly Disagree

Understanding Aerospace Engineering

Understanding Aerospace Engineering reflects students' comprehension of core aerospace concepts and their ability to relate engineering mathematics to practical aerospace applications. Research in STEM education has shown that students learn most effectively when they can see clear connections between abstract concepts and real-world applications (Teo et al., 2020). The visual nature of YouTube tutorials, combined with their ability to demonstrate practical applications, makes them particularly suitable for helping students understand complex aerospace engineering concepts.

Table 3 presents the perceptions of Aerospace Engineering students regarding their understanding of Aerospace Engineering, arranged from highest to lowest average weighted mean.

Table 3. *Understanding Aerospace Engineering*

<i>Indicator</i>	<i>Weighted Mean</i>	<i>Description</i>
1. I find YouTube tutorials essential for grasping complex topics in aerospace engineering.	4.2	Agree
2. YouTube tutorials support my learning in thermodynamics, physics, and chemistry.	4.2	Agree
3. I can better relate theoretical knowledge to practical aerospace applications using YouTube.	4.1	Agree
4. Visual demonstrations on YouTube make aerospace principles clearer.	4.1	Agree
5. YouTube tutorials help me understand key aerospace engineering concepts.	4.1	Agree
Average Mean	4.1	Agree

Legend: 4.21-5.00 = Strongly Agree, 3.41-4.20 = Agree, 2.61-3.40 = Neutral, 1.81-2.60 = Disagree, 1.00-1.80 = Strongly Disagree

Problems Encountered

Despite the positive perceptions of YouTube tutorials, students reported several challenges that highlight important considerations for integrating these resources into formal engineering education. The identification and ranking of these challenges provide crucial insights for educators seeking to maximize the benefits of digital learning tools while addressing their limitations.

Table 4 contains the problems encountered by Aerospace Engineering students in utilizing YouTube math tutorials.

Table 4. *Problems Encountered*

<i>Indicators</i>	<i>Frequency</i>	<i>Rank</i>
I lack confidence in applying what I learn from YouTube tutorials to real-world engineering problems.	44	1
I struggle to understand key aerospace engineering concepts despite using YouTube tutorials.	31	2
I do not feel prepared for professional tasks even after using YouTube math tutorials.	30	3
Visual demonstrations on YouTube do not make aerospace principles clearer for me.	22	5
YouTube tutorials do not clarify concepts in calculus and differential equations for me.	22	5
I am still unable to solve complex math problems even after using YouTube tutorials.	22	5
YouTube tutorials do not help me connect classroom learning to real-world applications.	15	7
YouTube tutorials do not motivate me to pursue further learning in my field.	14	8.5
YouTube tutorials do not make advanced engineering math topics easier to understand.	14	8.5
I do not feel that YouTube tutorials contribute to my professional growth.	12	10

The most significant challenge identified was the lack of confidence in applying tutorial knowledge to practical, real-world engineering problems. This finding is consistent with research showing that while online learning can effectively convey theoretical concepts, the transfer to practical application often requires additional scaffolding and structured practice opportunities (Castellanos-Reyes, 2024). This challenge highlights a fundamental limitation of passive video consumption: while students may understand concepts when presented in tutorial format, they may struggle to apply this knowledge independently in novel situations. This finding aligns with research on the "illusion of knowing" phenomenon, where students believe they understand material after watching explanations but struggle when required to apply the knowledge independently (Bjork et al., 2013). The second most common challenge was difficulty understanding key aerospace engineering concepts despite using YouTube tutorials. This finding suggests that while YouTube tutorials are helpful for many students, they may not be sufficient for all learners, particularly those who require more personalized instruction or have different learning style preferences. The third-ranked challenge was insufficient preparedness for professional tasks, indicating that while students find YouTube tutorials helpful for academic learning, they may not feel these resources adequately prepare them for the practical demands of engineering practice. This finding underscores the importance of integrating digital learning with hands-on experiences and professional development opportunities.

Conclusion

The study demonstrated that Aerospace Engineering students at Indiana Aerospace University perceive YouTube math tutorials as highly beneficial in supporting professional growth, advancing their understanding of engineering mathematics, and strengthening their grasp of aerospace concepts. Students consistently valued the tutorials for their accessibility, clarity, and ability to connect classroom lessons with real-world applications, particularly in complex subjects such as calculus, differential equations, and aerospace engineering practices. However, despite these advantages, the findings also revealed a significant limitation: many students struggled with

transferring tutorial-based learning into practical applications. This suggests that while YouTube tutorials are effective for conceptual understanding and independent learning, they must be complemented with active, practice-oriented instruction to fully prepare students for professional engineering challenges.

To address the challenges identified, the study recommends integrating YouTube tutorials into a structured, faculty-guided framework that bridges conceptual knowledge with practical application. This can be achieved through project-based assignments, case study workshops, and industry-linked activities that encourage active learning and professional preparedness. Faculty are encouraged to curate high-quality video content, supplement it with guided materials, and facilitate peer discussions to enhance comprehension. Furthermore, creating institutional capacity for producing context-specific videos, establishing peer tutoring systems, and developing diagnostic assessments can ensure stronger support for foundational mathematics concepts. By combining digital resources with active, applied, and collaborative learning strategies, YouTube tutorials can be transformed into powerful tools that not only clarify complex topics but also strengthen problem-solving skills, career readiness, and overall competence in aerospace engineering.

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