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Learning Introductory Level Physics with Phys-TikToks

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Abstract

This paper discusses the advantages of integrating TikTok videos into introductory physics education, leveraging the popularity of this social media platform among teens and college students. TikTok's concise, attention-grabbing, and engaging video format is demonstrated to enhance information retention compared to conventional platforms like YouTube. Our experimentation involved introducing videos, known as "Phys-TikToks", into an introductory-level physics course focused on the mechanics of the human body. We empowered students to create these informative TikToks, supported by a dedicated Google page, "Phys-TikTok-com", housing crucial topics, chapter summaries, TikTok-friendly problems, and the corresponding videos. Sharing this resource across the class and other sections ignited collaborative physics discussions and significantly bolstered students' knowledge. This approach not only injected enjoyment into learning physics but also proved invaluable in addressing educational disruptions caused by the COVID-19 pandemic. Ultimately, we aim to harness TikTok's addictive allure to enrich students' learning experiences, cultivate their enthusiasm for physics, and extend this innovative pedagogical strategy to diverse academic domains.

Keywords

TikTok, Phys-TikTok, Physics Pedagogy, Physics Education

1. Introduction

During the pandemic, most higher education institutes and even high schools heavily depended on pre-recorded lectures (Guraya, 2020; Le, 2022; Azlan et al., 2020; Liguori et al., 2021). We found that students preferred pre-recorded

lectures to synchronous meetings. Pre-recorded videos helped the students to watch the lecture at their convenience. However, it was time-consuming for the instructors to upload a 50 min lecture into YouTube or the school's video-sharing platform. On the other hand, only a few students used pre-recorded videos effectively, even though the instructors have invested enormous effort in them. Research shows videos are more effective when they are exciting and engaging (Brame, 2015; Lin et al., 2017). However, producing exciting and engaging videos when teaching specific physics topics is challenging. The theory is as critical as the application side; as a result, avoiding theory is not an option when recording videos. Later, instructors came up with shorter videos, generally lasting 10 minutes. The instructors used trackers to gather statistical data on those who watched the videos, and the data showed that many students only watched up to 4 - 5 minutes of the video. Some studies showed that the optimal video length is 6 minutes or shorter (Guo, 2013; Lagerstrom, 2015).

On the other hand, TikTok is a social media platform that allows users to create and share short-form videos, typically lasting between 15 and 60 seconds. The platform has gained a significant following, particularly among younger users, and has several benefits. One benefit of TikTok is its ability to foster creativity and self-expression. The platform provides users various tools and features to edit and enhance their videos, such as filters, special effects, and music. These features allow users to express themselves uniquely and creatively and showcase their talents and interests. Another benefit of TikTok is its ability to connect people with similar interests. The platform's robust algorithm suggests content to users based on their interests and interactions. Its "For You Page" (FYP) gives content tailored to the users' likes and hobbies, giving them an enjoyable experience on the forum, which allows users to discover and engage with a diverse community of like-minded individuals and build relationships with others who share their passions. The short-form nature of the videos makes it easy for users to consume a large amount of content quickly, which can be very useful in education (Khlaif & Salha, 2021; Herlisya & Wiratno, 2022). Additionally, TikTok has become a powerful tool for businesses and brands to reach new consumers. The platform's massive user base and highly engaged audience make it an ideal place to market products (Zhang, 2021; Haenlein et al., 2020), promote campaigns (Gesmundo et al., 2022), and increase brand awareness (Wahid et al., 2022; Barger et al., 2016). In conclusion, if handled effectively, TikTok videos can be used to teach students and make the classroom an engaging learning environment.

In this paper, we report using TikTok in a physics class. The course we picked was Mechanics and the Human Body. Many students in this class were new to learning physics. Enrolled students in the class were primarily physical therapy and sports medicine majors. We surveyed four sections with 86 students, and **Figure 1** shows the distribution of fundamental physics and algebra knowledge

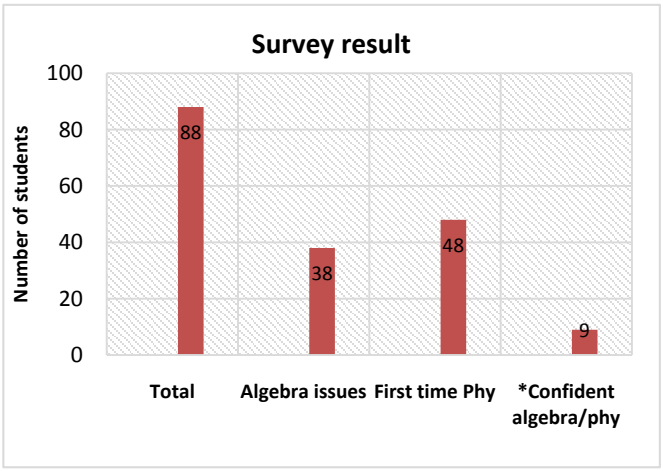

Figure 1. Shows a survey we did in four sections of the same class. Total number of students in all sections was 88. More than 50% of the students have not taken physics in high school. Close to 40% of the students were not confident on algebra. About 10% of the students in the group have taken AP physics and AP calculus in high school.

in the class. Only a small fraction (~10%) of the class exhibited a substantial understanding of math and the fundamentals of physics, while the rest had only moderate knowledge. We discovered that due to the global pandemic, many students still needed to complete high school algebra and science curricula. Teaching a group of inhomogeneous students with a wide range of understanding in math and physics was challenging. We used several innovative teaching tools to connect with the students, such as demonstrations, videos, and animations in all four sections. We quickly noticed that most students were visual learners who instantly bonded with videos and animations. Unfortunately, there were only a few visual aids designed for a course like Mechanics and the Human Body. Thus, in one of the sections, we decided to test a new teaching-learning approach using TikTok.

2. Methodology

Upon discovering that approximately 95% of our students were active TikTok users following a brief survey, we enlisted the participation of willing volunteers from our class who were well-versed in the TikTok sphere. This initiative commenced with a small, dedicated group of students eagerly embracing the project. As the initial step, we established a Google webpage for the project, accessible at https://sites.google.com/view/phys-tiktok-com, designating a web administrator to oversee its development and maintenance. Subsequently, all team members were granted editing privileges, facilitating collaborative content creation. The web administrator's principal role encompassed crafting and curating distinct pages for each topic covered in our coursework. These pages featured comprehensive summaries of class content, incorporating equations, external video resources, and illustrative animations.

Moreover, the Phys-TikTok webmaster administered biweekly problem post-

ings tailored to the relevant subject matter. The team's collective expertise was characterized by a shared passion for TikTok, with several members possessing prior experience in video creation. However, it is worth noting that crafting educational content was an entirely novel undertaking for each participant, presenting a unique learning opportunity for all involved.

Phys-TikTok Videos and Students' Experience

As is customary in any introductory-level physics class, we commenced the course with an emphasis on the significance of units and unit conversions, recognizing their pivotal role across scientific disciplines, particularly in physics. Proficiency in utilizing SI units and mastering unit conversions is a fundamental skill set for problem-solving in this field. Our maiden TikTok conundrum revolved around the conversion from miles per hour (mph) to kilometers per hour (kph). The scenario entailed a motorist navigating Canadian roads subject to speed limits ranging from a minimum of 50 km/hr to a maximum of 120 km/hr. The team collectively brainstormed to deduce the equivalent mph limits and ingeniously crafted a concise, one-minute TikTok video illustrating an individual facing the consequences of exceeding the speed limit, as depicted in **Figure 2**. Reflecting on this endeavor, one team member aptly remarked, "*For the unit conversion TikTok video we did, our group was able to think outside the box and come up with a creative situation and skit. We brainstormed together and thought of some ways to get people's attention and make the video as entertaining as possible. We came up with the idea of somebody getting arrested because not many things will catch your eye more than a cop car flashing lights*". Notably, within the video's narrative, the students presented the step-by-step process of unit conversions on a whiteboard, facilitating a comprehensive understanding of the concept. The video effectively conveyed the importance of units and imparted a lasting lesson on their essential role in physics problem-solving.

Figure 2. The image is captured from the Phys-TikTok video clip https://youtu.be/ohd98cUbC4c. That shows an individual facing the consequences of exceeding the speed limit, getting stopped for speeding by a trooper.

At another time, when discussing one-dimensional motion involving kinematic equations, we posted a problem from a Jackie Chan movie. The question was whether a fugitive on one end of a railway platform could safely cross a rail track as a train approached a railway station. The objective of the question was to show the use of kinetic equations in a real-time scenario and help students practice kinematics equations. Once again, the TikTok team created a video. They made an extra effort to make a train with a nose attached to its engine as shown in **Figure 3** and took turns explaining the problem on a whiteboard. It was obvious that students enjoyed what they were doing. One team member commented, "*In the class, I didn't fully understand how to use the table and the kinematic equations, but after making this video, I am* 100% *confident*." Students from the class, in their evaluations, said, *it is a great idea to have TikTok videos in Physics classrooms*.

Another student commented,

"*To present this information to an audience in a short video was seen as a challenge, especially because we didn't have access to a video of a real train, meaning we had to get creative. We decided that even though we couldn't get a real-life train, we would still make that visual and draw the screen on the whiteboard. We drew a picture of a train station. To add a sense of comedy, we pasted a picture of a nose at the tip of the front of the train to symbolize the 'nose' of the train passing through the station. Although it wasn't as action-packed as Jackie Chan in an action movie, we were able to provide the information to solve the problem, while providing creative visuals and comedy.*"

Introducing 1-D equations marked our students' initial foray into integrating physics equations with algebra, presenting a unique educational challenge for some. A sense of apprehension and hesitation loomed among specific individuals who were wary of venturing into unfamiliar territory, driven by the fear of

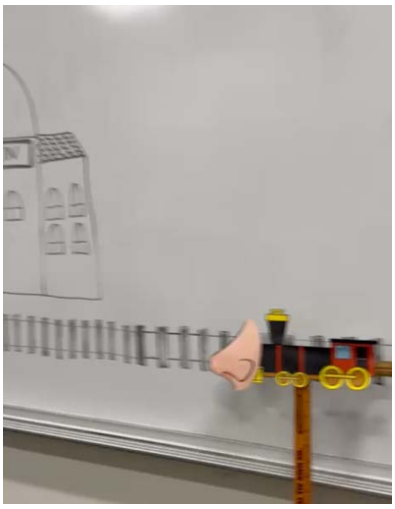

Figure 3. The above image is captured from the video https://youtu.be/dZNfuwf4j_4, shows the nose of the train approaching the station. Students were very creative to actually make a small train and do a small demo in the video they were filming.

potential errors. The TikTok video, however, served as a transformative catalyst, shedding light on the profound realization that their acquired knowledge extended far beyond the confines of the classroom, ultimately proving instrumental in addressing real-world challenges. Furthermore, it instilled in students the invaluable skill of breaking down complex problems into manageable steps, empowering them to confidently approach formidable challenges rather than feeling overwhelmed by the sheer volume of information at hand.

In our pedagogical experience, we have consistently observed that the concept of centripetal force poses a considerable challenge for most students enrolled in introductory-level physics courses. This intricate concept often leads students to seemingly conjure this force out of thin air in their attempts to grasp it. To illuminate this subject, we employed a multifaceted teaching approach, employing tools such as animations, the instructive "Fifth Gear Loop the Loop" video, and an interactive in-class demonstration, all aimed at elucidating the intricacies of centripetal force. Despite these concerted efforts, many students still grappled with this concept, leading us to assign a tangible real-world centripetal force problem, specifically the "Fifth Gear Loop-the-loop" scenario from 2010, to our team of Phys-TikTok creators. Remarkably, these students adeptly distilled the intricacy of the challenge into a concise video presentation, unraveling the forces at play and their associated physics principles. Upon completing this project, one student commented,

"*The loop de-loop was another Phys-TikTok that was quite helpful to me. After filming, I constructed a swing from an amusement park that demonstrated centripetal force. I was able to relate the physics in the film to the real-world object; I recognized that as all things traveling uniformly in a circle accelerate toward the center.*"

Another student added,

"*The loop-de-loop was a video that challenged us the most. How would we provide a demonstration of a car going in a loop-de-loop motion without a stunt devil and trained professionals on our university campus*?! *That is where intensive editing came in. We used one of the cars we had on campus and, with the power of editing, were able to make the car look like it was really a* 2009 *stuntman Steve Truglia driving it*!"

The below figure (**Figure 4**) shows two frames from the TikTok video they produced and the students' innovative method of going around the Loop-de-Loop.

To allow readers to explore the complete array of videos available on the webpage, we will now delve into one more illustrative example about the human body. Following discussions on vectors and Newton's Laws, we ventured to apply this knowledge within the context of human anatomy. Students were presented with a complex problem related to the tension generated by the erector spinae muscle, which induced a distinctive force resulting in spinal column rotation. Drawing from their backgrounds in physical therapy, the students fully

understood human anatomy and the real-life forces at play in the musculature. However, the challenge lay in navigating the intricacies of this problem, which involved rotations and force components in typical directions, departing from the conventional x and y axes. Once the instructor clarified the question's expectations, the students created a Phys-TikTok video, melding physics concepts with dance and music. Figure 5 provides a snapshot of the video crafted to address this question. A member of the Phys-TikTok team shared his insights, saying,

Figure 4. The figure presented delivers two distinct frames extracted from the TikTok video crafted by the students, showcasing their inventive approach to conquering the Loop-de-Loop challenge. https://youtu.be/RYQp6kTzSBc.

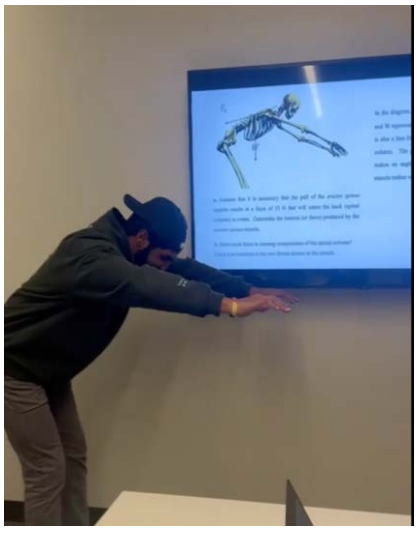

Figure 5. The figure is captured from the Phys-TikTok video students did for the spinae column problem https://youtu.be/rvwdIebZTAI.

"*For the Force on the Spinae muscle video, I saw the picture of the Skelton and instantly thought of the dance move 'The Giddy'. I knew it would be a good catch to the eye of the millennial target we were trying to reach with our videos. Throughout that video, we incorporated the dance move and tied it to the physics of the video. This was often my favorite part of being on the team. Designing and creating the video to be fun and exciting.*"

Another student added,

"*By connecting this popular song and dance to both physics and physical therapy, it allowed the entire group to gain a better understanding of the muscles of the Body and how the world, along with how physics, connects to physical therapy, which is the goal of the majority of the individuals in the group. Because many of us in the group had this realization, it was the goal to share this content with many more students who may be questioning the importance of physics to their major, along with an overall better understanding of Newton's law in a funny way.*"

3. Findings/Discussion

All most all the videos lasted between one to two minutes; therefore, the students were never bored watching them. These videos grabbed the audience's attention. Students with disabilities (for example, ADHD) find short videos more attractive than long ones. In the end, the students in the TikTok team managed to get extra credit points for the work they did and earn good grades in their exams. While many thought that Phys-TikToks were incredibly useful and made learning physics fun and engaging, one member in the team said, "*Personally, I often find my greatest success learning in solitary. At times, we did have questions that we could bounce off of each other, but in the end, I think I would have been more successful working alone.*" No matter what, any teaching-learning technique would face its challenges; some students prefer working alone, with no interference from others, and making TikTok videos may not be ideal for them.

Nevertheless, majority of the students had an excellent time learning, teaching, and collaborating while making the videos. They all seemingly enjoyed making the Phys-TikTok videos. The other TikTok users who watched the videos also enjoyed them and followed its handle. Influenced by the TikTok videos, many students got involved in hands-on projects. About 30% of the students in the class built various prototypes, including mechanics, and combining mechanics and the Human Body.

We evaluated students in all four sections the same way and gave the same set of problems in the exams and quizzes. We picked five problems directly related to the Phys-TikTok videos and found out that the section with TikTok answered the questions with more confidence and with high accuracy. The group of students involved in making videos did an excellent job, and the errors were negligible. Table 1 shows a summary of how students answered the five selected problems. There is no significant difference in the kinematic problem in all sections,

Table 1. Table shows the comparisons of how students answered five selected problems. Except in one case (*), in all other areas students who had exposure to Phys-TikTok did better than their peers.

Problem	*Section with Phys-TikTok*	*Sections without Phys-TikTok*
Centripetal force	95%	82%
Force associated with the Human Body	89%	72%
** 1-D motion with const. acceleration*	96%	92%
Impulse and momentum	88%	80%
Torque and Human Body	91%	83%

but the problems associated with centripetal forces and the human Body had the most significant improvements.

4. Conclusion

As a versatile social media platform, TikTok offers many advantages, encompassing the cultivation of creativity and self-expression, the facilitation of connections among like-minded individuals, the provision of entertainment, and the potential for business and marketing endeavors. Its inherently captivating nature has solidified its status as an addictive medium, as previously mentioned, with a significant proportion of our students being frequent users. Our observations in the sections where we integrated Phys-TikTok into the curriculum revealed remarkable transformations distinct from our past teaching experiences. Students who participated in video creation exhibited commendable dedication beyond the classroom, collaborating to grapple with complex physics problems, nurturing engaging physics dialogues outside of scheduled class hours, and acquiring substantial expertise in video editing. Most importantly, these endeavors fostered an atmosphere where learning physics became enjoyable, both within the confines of the classroom and in the students' independent explorations. Our overarching objective was to harness this inherent addictiveness for the students' benefit, channeling their interests toward physics education and extending its application into diverse academic domains.

Note

For the users' convenience, we uploaded all TikTok videos to YouTube.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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