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Investigating TikTok as A Learning Tool for Learning Chemistry: A Study Among Secondary School Students in Malaysia

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ABSTRACT
TikTok is a social media, video-based phone application, which enables creative and engaging videos that are rapidly growing in popularity. TikTok has been used to create fun, exciting, and engaging 15-60 second duration educational chemistry and science outreach videos. This study aims i.e., (i) to investigate the effectiveness of TikTok as a learning tool for learning chemistry among secondary school students in Malaysia, and (ii) to compare the effectiveness of TikTok and traditional mind-map technique in facilitating secondary school students' learning chemistry and determine which approach is preferred by students. Non-random purposive sampling was used to select 40 participants from two different secondary schools, namely Sekolah Menengah Integrasi Sains Tahfiz, Cheras, Kuala Lumpur, and Sekolah Menengah Tinggi Sultan Salahuddin Abdul Aziz Shah, Sabak Bernam, Selangor. The instruments used were document and interview sessions. The results showed that the overall response to the survey was promising as most of the

respondents gave positive feedback on the use of the TikTok application in their chemistry learning process. In this respect, the potential of TikTok to be used as a learning tool should be further explored since it enables the designing and delivering of creative and high-quality e-learning content.

Keywords: TikTok; learning tool; chemistry; secondary school students

INTRODUCTION

TikTok is a social network launched in the Chinese market in 2016 (initially known as Douyin) and internationally in 2017; when it was rebranded as TikTok). The TikTok application has surpassed Facebook and WhatsApp as the most popular mobile phone app, with more than 45 million downloads globally during a three-month period (Adnan, Ramli, & Ismail, 2021). In 2018, TikTok videos were the most downloaded mobile app in the United States and are currently available in more than 150 countries with 800 million monthly active users (Fiallos, Fiallos, & Figueroa, 2021). TikTok allows users to create and share short videos (15 to 60 seconds in duration) that are quick and uncomplicated to edit using various filters, effects, and sounds. In 2020, TikTok launched the 'LearnOnTikTok' program which consists of educational videos to assist learning during the COVID-19 pandemic (Hutchinson, 2020). The educational videos were created by professionals from various disciplines, educators, and students who shared their knowledge to this social network's audience (Fiallos et al., 2021).

The educational videos were linked to the hashtag of #learnontiktok with various topics i.e., chemistry experiments, health tips, learning languages, cooking recipes, education tips, and others. TikTok has an ideal format and tools for creators to create short educational videos. The 'LearnOnTikTok' videos have achieved 72 billion views with hundreds of uploaded videos per day (Fiallos et al., 2021).

The educational system in Malaysia is moving towards implementing the latest technological innovations, in line with the Fourth Industrial Revolution (IR 4.0). Therefore, the education sector is currently adapting to new technologies to generate new types of teaching and learning media. This change is required to provide up to date knowledge, and inculcate students with all the essential skills needed for the machine age (Schwab, 2017). The teaching and learning methods are now being integrated with both face-to-face interaction and technology-facilitated instructional approaches in the form of online class sessions. In the 21st century, mobile phone technology with the integration of interactive Web 2.0 Internet, also known as online social media (including TikTok – the world's most popular application) is becoming an important and integral part of our lifestyles (Azlan, Zakaria, & Yunus, 2019).

Social media has the potential to have both positive and negative impacts on the education system (Akram & Kumar, 2017). With the evolution of the education system, students have increasingly turned to social media as a source of information. In today's world, schools and

colleges are prioritizing the use of artificial intelligence tools to educate millennial students (Limna, Jakwatanatham, Siripipattanakul, Kaewpuang, & Sriboonruang, 2022). Despite numerous studies on the impact of social media, very few have specifically focused on TikTok and its effect

on academic performance. Although there are many factors that can influence academic performance, this study seeks to determine whether TikTok has any impact on students' academic performance. TikTok is primarily used by young people and teenagers to create entertaining, visually appealing, creative, and humorous videos. Educators and professionals can utilize this opportunity to create informative, enjoyable, and visually engaging videos on chemistry to attract younger audiences and encourage them to learn about chemistry in a creative and innovative way.

Previous research in the field of science education has highlighted the benefits of using social media to enhance teaching and learning. Studies have shown that social media platforms like Facebook, Twitter, and YouTube encourage students to engage in social interactions, which helps to develop their creative and logical skills. However, there has been limited research conducted on the use of TikTok, a multimedia platform that combines various technological aspects such as dance, jokes, and videos, particularly in chemistry education in Brunei (Yunus, Zakaria, & Suliman, 2019). Despite the increased use of social media in Brunei, TikTok has not gained much attention in the context of chemistry education (Hayes, Stott, Lamb, & Hurst, 2020). TikTok has the potential to improve teaching and learning due to its global reach, ease of accessibility, ability to sustain student interests, and capacity to develop IT soft skills. It also fosters student interest in chemistry or science and creates an environment for spontaneous learning both inside and outside the classroom. The use of social media tools has been shown to improve student post-test scores by enabling them to apply their prior knowledge to different contexts and build correct mental models (Abdullah & Chan, 2016). Therefore, this study aims to investigate the use of TikTok to facilitate learning of chemistry and scientific concepts, with a focus on addressing the following research questions:

i. To what extent the engagement of TikTok as a learning tool for learning chemistry among secondary school students in Malaysia?
ii. How does the effectivess of TikTok compare to traditional mind-map technique in facilitating secondary school students' learning chemistry?

LITERATURE REVIEW

Previous Study of TikTok in Education

In 2018, Tabassum Khan and Ahmed conducted a study titled "Impact of Facebook Addiction on Students Academic Performance" which aimed to investigate the correlation between Facebook addiction and academic performance among undergraduate students. Using the Bergen scale, data was collected from a sample of 100 randomly selected undergraduates. The results of the study revealed that students who had a strong addiction to Facebook had lower GPAs, indicating a negative impact on their academic performance. In the present study, the authors utilized descriptive statistics tools to test hypotheses and found significant variations in performance, further supporting the conclusion that Facebook has a negative impact on student performance (Khan & Ahmed, 2018).

In 2016, a study entitled "Effects of Social Media on Youth: A Case Study in University of Sargodha" was conducted to analyze the impact of social media on various aspects of youth, including education, entertainment, health, communication, interaction, job opportunities, and skill enhancement. The study included popular social media platforms such as WhatsApp, Twitter,

Facebook, LinkedIn, YouTube, and other websites. The researchers collected data through a questionnaire distributed among 380 students at the University of Sargodha and used bivariate analysis to analyze the results. The study found that social media provides various job opportunities and enhances the learning capacity of students (Ali, Iqbal, & Iqbal, 2016).

Abigail Radin and Caitlin Light conducted a study in 2022 titled "TikTok: An Emergent Opportunity for Teaching and Learning Science Communication Online," which aimed to incorporate social media platforms like TikTok into higher education and develop science communication skills for the 21st century. The study found that using TikTok activities helped students to think about communicating their research to a broader, non-scientific audience using the information systems of their generation. Additionally, it required them to be creative and consider science communication principles as they relate to social media (Radin & Light, 2022).

According to Komljenovic (2019), social media has not only been embraced by students in higher education, but it also offers opportunities for academics and university administrators. Academics use social media platforms to advertise their research, establish their reputation as researchers, and gain access to sources in various academic fields. Similarly, university administrations use social media to brand their institution's name and increase its appeal to the general public. While there is a considerable amount of research on social media in higher education, most of it is quantitative and focuses on social media as an educational tool. The researcher suggests that social media studies should be expanded, particularly in the early stages of education (Komljenovic, 2019).

In a study by Kennedy, M. (2020), it was found that digital technology, particularly social media, is a significant issue in higher education that affects all aspects of the student experience. Social media's relevance in adolescent culture has led to research exploring its impact on academic institutions and faculty, leading to practical guidance on its proper use in education. New research on social media in higher education can help all academic fields and individuals to gain and share experiences in education (Kennedy, 2020).

Implementation of TikTok in learning chemistry

The existing TikTok accounts called “NileRed” was chosen for this study (Figure 1). As of 14th June 2022, this TikTok account has uploaded 117 educational videos. Generally, these videos demonstrate scientific experiments for the targeted audience who consist of secondary school and pre-university individuals with or without some background knowledge of chemistry, thus, the use of scientific jargon was limited. The explanations were kept simple and detailed procedure were provided using both text and visual aids. The TikTok educational videos could be used in conjunction with a system thinking approach to ensure the viewers could: (i) identify the steps required to reach the desired outcomes, (ii) explain the theory based on the observations, and (iii) demonstrate how the theoretical principles could be implemented to real life situations (Hayes et al., 2020).

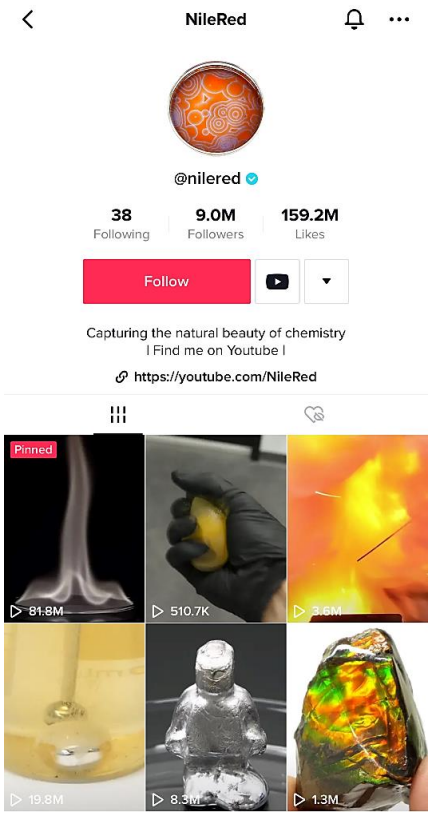

Figure 1: Screenshots of TikTok Accounts' Homepages for Learning Chemistry from "NileRed" (the photo has been screenshotted on 7th June 2022)

Theoretical framework

The theoretical framework of Richard Mayer's 12 principles of using multimedia for learning could provide insights into the usefulness of the TikTok application in teaching and learning chemistry among secondary school students. The core of the 12 principles is that students learn the most from words and graphical images due to the meaningful connections between them, rather than from words only (Mayer, 2014). According to the 12 principles, the human information processing system has three memory stores, i.e., sensory memory, working memory, and long term memory (Mayer, 2002). The Mayer's principles are coherence, signalling, redundancy, spatial contiguity, temporal contiguity, segmenting, pre-training, modality, multimedia, personalization, voice, and image principles (Figure 2).

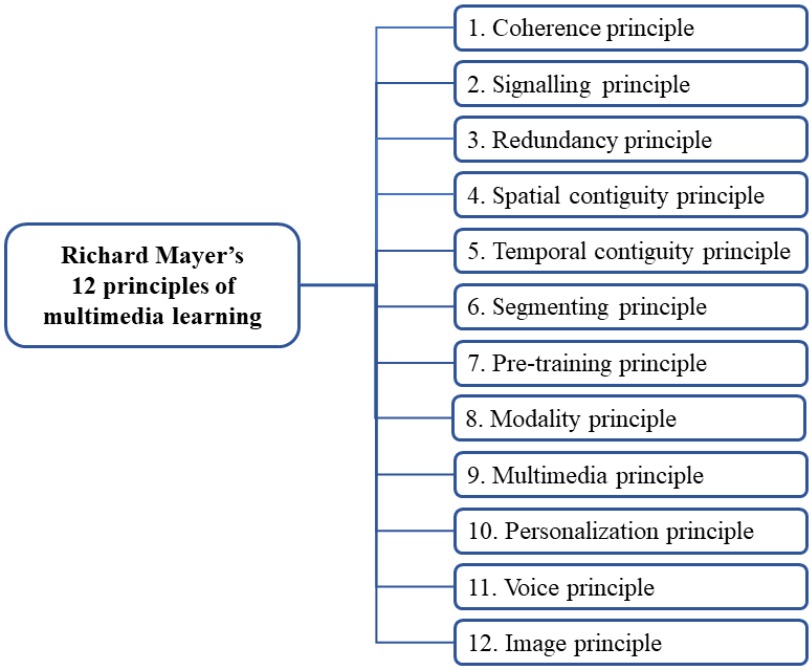

Figure 2: Richard Mayer's Principles of Multimedia Learning (Mayer, 2002)

Looking at the 12 principles, there are five principles that are applicable with the TikTok application, i.e., (i) spatial contiguity principle, (ii) temporal contiguity principle, (iii) pre-training principle, (iv) multimedia principle, and (v) image principle. The spatial contiguity principle refers to the space in between the text and visuals on the screen, which states that users learn best due to the relevant text and visuals being physically near to one another (Mayer, 2005). The temporal contiguity principle states that individuals acquire new information at the highest level when corresponding words and visuals are presented simultaneously, instead of in consecutive order (Mayer, 2002). The pre-training principle states that individuals learn more efficiently when they have some prior background knowledge on certain things (Moreno & Mayer, 1999). The individuals could be more easily motivated when complex visuals and definitions are thrown in their way if they started a learning course on TikTok to gain some background knowledge. The multimedia principle states that individuals would learn better from both words and images, rather than using words only. Finally, the image principle states that relevant visuals on the screen would be more effective than only showing a video of an educator's or instructor's talking head (Adnan et al., 2021; Mayer, 2002).

METHOD

Research design

In this research, a qualitative methodology was employed to investigate the area of chemistry education on social media platforms, specifically TikTok, from the perspective of secondary school students. Prior to commencing the study, an extensive literature review was conducted, which revealed that most of the existing research in this field used a quantitative approach and relied heavily on surveys to collect data (Ali et al., 2016; Kennedy, 2020; Khan & Ahmed, 2018; Komljenovic, 2019; Radin & Light, 2022). In contrast, by employing a qualitative methodology, this study was able to focus more specifically on targeted groups and key aspects of the topic,

resulting in more meaningful data collection (Hayes et al., 2020). This approach also helped to expedite the data collection process and reduce associated costs.

For data analysis, researchers employed an inductive thematic analysis as described by Braun and Clarke in 2006. The analysis yielded two main themes, which covered broad thematic areas. The initial theme pertained to the advantages and benefits of social media as educational tools, while the second theme focused on the difficulties, obstacles, and constraints related to the integration of social media as educational tools. The process of analysis involved six stages: becoming acquainted with the data, coding the data, recognizing themes, scrutinizing themes, defining and naming themes, and ultimately presenting the results (Braun & Clarke, 2006).

Participants

The participants of this study were 40 secondary school students who were non-randomly selected from science stream classes from two different schools, i.e., Sekolah Menengah Integrasi Sains Tahfiz in Cheras, Kuala Lumpur and Sekolah Agama Menengah Tinggi Sultan Salahuddin Abdul Aziz Shah in Sabak Bernam, Selangor. Purposive sampling was used by selecting 20 form 4 students who own a TikTok account from each of the two schools. The purposive sampling is an appropriate type of qualitative sampling due to adequate data collection and to avoid redundancy (Babbie, 2010; Creswell & Tashakkori, 2007; Merriam, 1998; Skulmoski, Hartman, & Krahn, 2007).

Instrumentation

The instruments used were document and interview sessions. The document consisted of videos that were used to support the interview data (Creswell & Tashakkori, 2007). The research procedures were carried out as follows: (i) The students were required to watch a TikTok video (url: https://vt.tiktok.com/ZSdrf3vVR/) from an account i.e., @NileRed (Figure 3b). This TikTok account has 117 educational videos (highest view: 81.7 million views), illustrating scientific experiments that could be easily understood by the target audience who are secondary school individuals with little to no scientific knowledge.

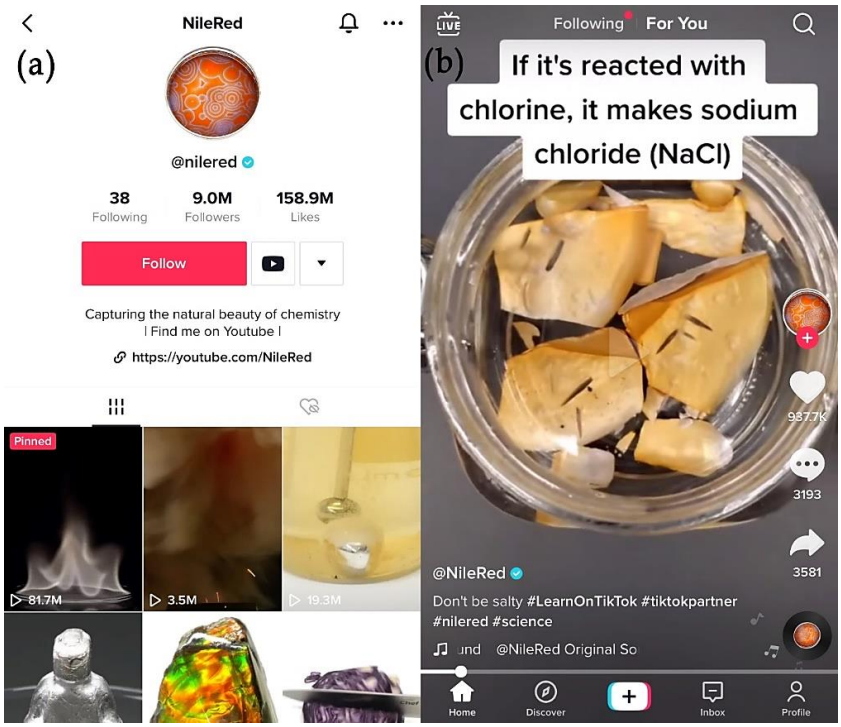

Figure 3: (a) View of Created Videos on the @NileRed TikTok Account Homepage, and (b) Screenshot from the @NileRed TikTok Video, titled "Don't be salty" (the photos have been screenshotted on 7th June 2022)

The students were then asked to write down their observations based on the TikTok video in order to investigate their understanding in the learning process. (ii) The students were then required to watch a 5 minutes video clip on a chemistry lesson on the topic of chemical bonds (url: https://www.youtube.com/watch?v=g-tE6MN-wrE) as shown in Figure 4. Chemical bonds is a difficult topic for secondary school students to understand as it involves many abstract concepts (Abd Halim, 2012).

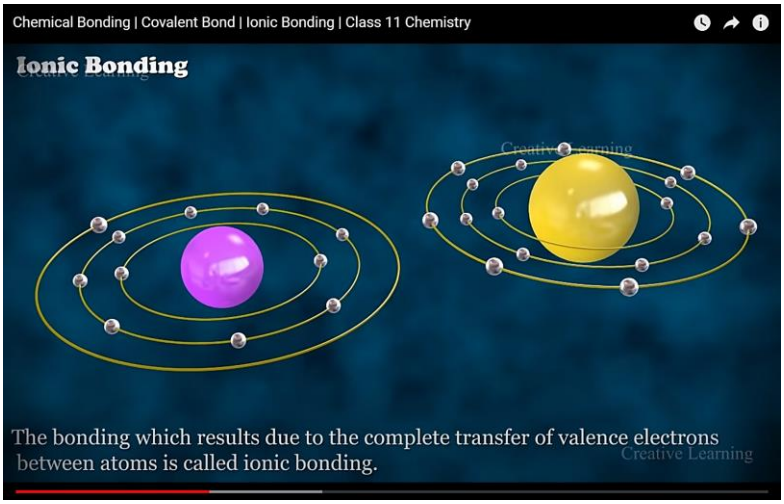

Figure 4: YouTube Video titled "Chemical Bonding | Covalent Bond | Ionic Bonding | Class 11 Chemistry" (url: https://www.youtube.com/watch?v=g-tE6MN-wrE)

They were then asked to transfer the information from the video clip to a graphic representation using the TikTok application. (iii) After watching the similar 5 minutes YouTube video clip on the chemical bond topic, they were required to proceed with the same task, though this time using the traditional mind-mapping technique. They were given one week to complete the tasks. Upon submission of the tasks, i.e., notes from the TikTok educational video, the recorded TikTok video made by the students, and the mind-map, the students were interviewed to give feedback on those two methods. Two questions were asked as follows:

i. Can you share your experience using TikTok as a learning tool?
ii. Which is better for you? TikTok or traditional mind-map technique? Why?

RESULTS AND DISCUSSION

Analysis of respondents' feedback

In this part, the demographic information was analysed which are gender and daily usage of TikTok application among the respondents. From figure 5(a), out of 40 respondents, there were 12 male students (30%) and 28 female students (70%) altogether. Figure 5(b) shows the percentage of daily usage of TikTok application among the respondents i.e., 35 respondents reported active participation (87.5%) while only 5 respondents reported inactive participation (12.5%).

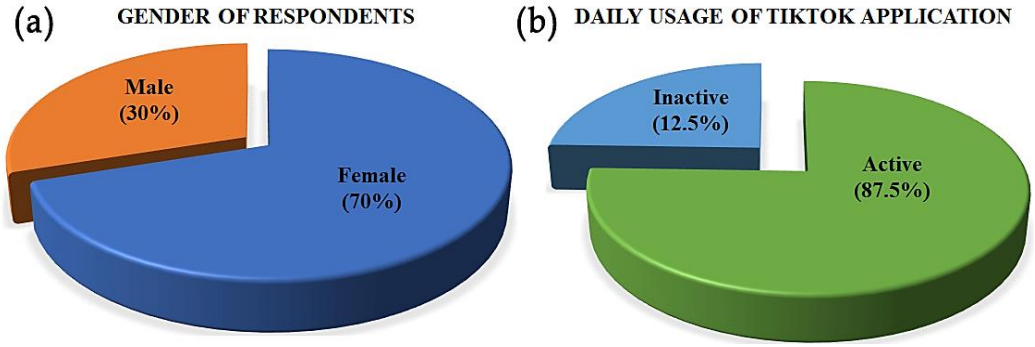

Figure 5: (a) Gender of respondents i.e., male (30%) and female (70%), and (b) daily usage of TikTok application among respondents i.e., active participation (87.5%) and inactive participation (12.5%)

The responses from the respondents were recorded and analysed to acquire an in-depth understanding of their opinions on this activity. The use of the TikTok application for knowledge and information transfer was analysed by employing Mayer's principles of multimedia learning as the analytical framework.

Based on the respondents' feedback, it was found that, out of 40 respondents, 13 students preferred using TikTok as a learning tool to transfer the information from video to graphic representation. The respondents stated that TikTok was highly interesting due to the musical and entertainment elements compared to the traditional mind-mapping technique. One of the respondents mentioned that TikTok has challenged him to be more critical and creative by exploring new methods. In terms of content, the majority of the respondents agreed that TikTok could assist them to understand and memorize the content better due to the increased time spent in

looking at the information to create their own TikTok video compared to that of the traditional mind-mapping technique. Social media applications, especially TikTok could be used as effective learning tools in designing, scaffolding, and interacting between students during the learning process whenever necessary (Al-Naibi, Al-Jabri, & Al-Kalbani, 2018).

In order to effectively suit the target audience, a minimum background knowledge of chemistry and experimental technique were expected. Based on the respondents' feedback, the majority highlighted on the simple and understandable of information conveyed from the TikTok videos, which indicated that the use of scientific jargon was limited and avoided to ensure audience's engagement.

Whilst TikTok was mainly used by respondents of younger groups and teenagers to create fun, visually engaging, creative, and humorous contents, we observe that TikTok could also be an opportunity for them to create informative, fun, and visually engaging chemistry videos, that could reach this audience. This would therefore encourage them to conduct their own study of chemistry i.e., taking notes, and conduct their own chemistry experiments at home in a creative and innovative manner.

Nevertheless, 4 out of 40 of the respondents pointed out that using TikTok was a challenge for them to keep up with the advancing technology and was time-consuming due to requirement of editing. As a result, they felt less motivated to use TikTok as a learning tool. Other than that, a lack of knowledge and familiarity using the creative video features in the TikTok application could be hypothesized as factors of interest inhibition. Thus, 4 students seem to prefer to learn using the traditional mind-mapping technique rather than TikTok videos. These findings were supported by the five principles that are applicable with the TikTok application, i.e., (i) spatial contiguity principle, (ii) temporal contiguity principle, (iii) pre-training principle, (iv) multimedia principle, and (v) image principle (Mayer, 2005). The respondents' experience using TikTok as a learning tool were summarized in Table 1 and 2 below.

Can you share your experience using TikTok as a learning tool?
To answer the first research question, several themes emerged after analyzing the students' responses to the interview. The summary of the themes after the thematic analysis was presented in Table 1.

Table 1
Summary of themes after the thematic analysis

Themes	Scripts
Musical and entertainment elements	*"…easy to understand, and TikTok application provides interactive and creative videos which grab students' interest…"* (Respondent 2)
	"…TikTok helps us as a learning tool, for instance, creating ideas for our additional notes…" (Respondent 5)

	"...I think it is difficult to get used to the TikTok application in the beginning, however, I could eventually catch up with the information given in TikTok videos because it is catchy and entertain..." (Respondent 10)
	"...I used to learn on how liquid could transform into ice, and why coco is insoluble in water at the first place and getting soluble in the end, from TikTok videos..." (Respondent 11)
	"...I like the music in TikTok while learning chemistry..." (Respondent 12)
	"...Chemistry information in TikTok is very fun and engaging to students..." (Respondent 4)
	"...TikTok is way better than mind-mapping because it consists of visual, audio, and physical movement which could help us to understand easily..." (Respondent 21)
Challenge to be more critical and creative by exploring new method	*"...I can challenge myself to be creative using TikTok..."* (Respondent 36)
Promote a good understanding and memorization	*"...I can remember better when learning using TikTok..."* (Respondent 37)
	"...I would prefer the TikTok application because it is clear and direct information, it helps us to memorize better..." (Respondent 40)
Avoid usage of scientific jargons to promote students' engagement	*"...Learning chemistry using TikTok is very interesting and easy to understand..."* (Respondent 1)

Based on the study's findings, using TikTok as a tool for teaching and learning has the potential to be engaged in learning chemistry. This result aligned with the previous research that found social media applications, such as Facebook and Twitter, to have a positive impact on students' understanding of scientific concepts (Akgunduz & Akinoglu, 2016; Junco, 2012). The outcome is not unexpected, considering the feedback provided by students who learned through TikTok. They found the lessons fun, informative, and engaging, with various musical and entertainment elements, which were consistent with prior studies (Ivala & Gachago, 2012; Tess, 2013).

Syah et al. (2020) emphasized that in today's digital era, students tend to gravitate towards social media platforms like TikTok, primarily because of its creative, and engaging features. Utilizing diverse multimedia content, such as videos and photos from different cultures, could fully immerse users and challenge them to be more critical and creative by exploring new method (Aranego Jr, 2020; Zhou, 2019). Research has also linked students' critical thinking skills to their eagerness to gain knowledge and their expectations of what a teacher could offer in a classroom environment (Escamilla-Fajardo, Alguacil, & López-Carril, 2021). For example, collaborative projects were be initiated, where students worked together to create chemistry-related challenges or experiments and share their results on TikTok (Belova & Krause, 2023). Studies by Mitra et al. (2010) indicated that video-based learning promotes creative, active and profound learning, while research by Hight et al. (2021) found that using chemistry-themed videos assists in retaining innovative instructional concepts (Hight, Nguyen, & Su, 2021; Roy, Kihoza, Suhonen, Vesisenaho, & Tukiainen, 2014).

The fact that TikTok promotes students' participation in this study comes as no surprise. This was due to TikTok has the potential to promote good understanding and memorization in a variety of ways (Barta & Andalibi, 2021). By leveraging its multimedia platform, TikTok could present information in a way that was both entertaining and educational, helping learners to better understand and retain the material. The bite-sized format of TikTok videos also makes it easier for learners to digest and remember information (Kaye, Zeng, & Wikstrom, 2022). Additionally, the creative expression and social learning features of TikTok could be powerful tools for learners to deepen their understanding of the material and reinforce their memory of it.

Using social media platforms such as TikTok could be an effective way to promote learning and engagement among students, especially when it comes to complex scientific topics that often require the use of technical jargon. One way TikTok helped promote the avoidance of scientific jargon was by encouraging educators to present complex topics in a more simplified and relatable manner (Sun, Liu, Zhai, & Wang, 2022). TikTok's short-form video format allowed for quick and easy consumption of information, and this could be leveraged by educators to break down complicated scientific concepts into smaller, more digestible pieces of information. In addition, TikTok's unique features such as filters, stickers, and music can be used to create engaging and entertaining content that appeals to students. This type of content could help students remember scientific concepts better by creating a memorable and fun learning experience. Another way TikTok helped avoid the use of scientific jargon was by promoting the use of visual aids such as diagrams, animations, and infographics (Sleigh, Amann, Schneider, & Vayena, 2021). These visual aids helped illustrate complex concepts in a more accessible and understandable way, allowing students to engage with the material more effectively.

Which is better for you? TikTok or traditional mind-map technique? Why?
To answer the second research question, several themes emerged after analyzing the students' responses to the interview. The summary of the themes after the thematic analysis was presented in Table 2.

Table 2
Summary of themes after the thematic analysis

Themes	Scripts
TikTok	*"...I think TikTok is more enjoyable and interactive to inspire the learning process..."* (Respondent 13) *"...TikTok application is good to attract us for the learning process because it is trendy with our generation..."* (Respondent 15) *"...TikTok is way better than mind-mapping because it consists of visual, audio, and physical movement which could help us to understand easily..."* (Respondent 21) *"...TikTok videos are way better than traditional mind-map because every procedure in chemistry experiments could be visually taught in videos rather than lame drawing skills..."* (Respondent 34) *"...I can learn using my own time and my own style using TikTok..."* (Respondent 2) *"...TikTok is better because I can interact with other user with the same interest in the application, and also we can share our thoughts and opinion..."* (Respondent 1) *"....Learning chemistry using TikTok is giving me motivation because I am easily bored and distracted when it comes to learning chemistry without interaction with others..."* (Respondent 40)
Both TikTok and mind-map (traditional technique)	*"...I would choose both TikTok and traditional mind-map techniques. TikTok promotes fun-learning, meanwhile mind-mapping promotes simplified and good information..."* (Respondent 20)
Mind-map (traditional technique)	*"...Using TikTok application is less preferable for my studies because it is hard to catch up with the technology..."* (Respondent 22) *"...TikTok is fun, but it is time consuming to edit the learning videos..."* (Respondent 3) *"...Mind-mapping technique is way better than learning from TikTok videos because I could permanently memorize all the information that I*

wrote…"

(Respondent 31)

"…Mind-mapping technique is preferable because it is easy to learn, more information, and time-efficient..."

(Respondent 32)

"…Using mind-mapping technique helps me to learn in systematic way and a lot more structured. I can not understand in detail using TikTok…"

(Respondent 4)

"…I can directly and actively ask teacher when learning chemistry using mind-mapping technique. If I use TikTok, I do not have guidance from teacher…"

(Respondent 11)

TikTok was not typically considered a formal learning tool in the traditional sense (Jerasa & Boffone, 2021). However, it was true that some secondary school students were using TikTok as a means of learning and retaining information. The reason was that TikTok provides an engaging and interactive way of learning, which could be more appealing to students than traditional methods. TikTok videos were often short and visually appealing, and they could be set to music or other sound effects that make them more memorable. This could help students retain information better than if they were just reading or writing notes. Another reason why students prefered TikTok was that it allowed them to learn at their own pace and on their own schedule. With traditional mind-mapping learning, students were required to attend lectures or complete assignments at specific times, which could be difficult for some students who have other commitments or learning styles. TikTok, on the other hand, allowed students to access information whenever and wherever they want, making it more flexible and convenient. Additionally, TikTok provides a sense of community and social interaction that could be lacking in traditional learning environments. Students could follow other users who share similar interests or topics, and they could engage with each other through comments and reactions. This helped students feel more connected to their peers and more motivated to learn. However, it was important to note that while TikTok could be a useful supplement to traditional learning methods, it should not be relied on as the sole source of education. Students still need to develop critical thinking skills, read and write effectively, and engage in meaningful discussions with their teachers and classmates. TikTok might be a helpful tool for learning, but it should not replace the fundamentals of a solid formal education (Brame, 2016; Guangmei, 2022).

Four secondary school students prefered traditional mind-mapping learning over using TikTok as a learning tool. Traditional mind-mapping learning provided a more structured and systematic approach to learning (Abd Karim, Abu, & Khaja, 2016). It allowed students to organize their thoughts and ideas in a clear and logical manner, which could be helpful for retaining information and understanding complex concepts. In contrast, TikTok videos were often short and might lack the depth and detail necessary for in-depth learning and understanding. Traditional mind-mapping learning typically involved active engagement and participation, such as asking questions and engaging in discussions with teachers and classmates (Guzey & Roehrig, 2009).

This type of interaction was beneficial for learning and helped students develop critical thinking and problem-solving skills. In contrast, TikTok was more passive and did not offer the same level of interaction and engagement. Traditional mind-mapping learning was more effective for certain types of learning, such as memorization and recall (Adodo, 2013). This was because mind-mapping allowed students to visualize information and make connections between different ideas and concepts, which could aid in memory retention. TikTok, on the other hand, was more useful for learning creative or artistic skills, such as dance or music, but may not be as effective for academic learning. Traditional mind-mapping learning was often more widely recognized and accepted as a legitimate educational tool (Gavens, Doignon-Camus, Chaillou, Zeitler, & Popa-Roch, 2020). While TikTok might have some value as a supplement to traditional learning methods, it was not yet widely accepted as a formal educational tool by schools and universities.

TikTok as a learning tool in learning chemistry

Referring to the Mayer's multimedia principles, five principles are in line with the use of TikTok as a learning tool for chemistry e-learning in this research, i.e., spatial contiguity, temporal contiguity, pre-training, multimedia, and image principles (see Figure 6-13) (Mayer, 2002; Mayer, 2017).

The spatial contiguity principle

The spatial contiguity principle refers to the space in between text and visuals on the screen. It states that the users would learn better when the relevant text and visuals are physically close to each other. In the context of the current research, the TikTok application would allow the students to choose their own visuals and text. Therefore, the learning process in chemistry would be easier for the secondary school students. Using the spatial contiguity principle, TikTok creators could improve the learning experience of their viewers by placing the relevant visual elements near the corresponding text or narration. For example, if a creator is explaining a chemical reaction, they could show an animation of the reaction happening simultaneously while explaining it in the voiceover. By following the spatial contiguity principle, TikTok creators helped their viewers better understand the concepts they are discussing, which could ultimately lead to a more effective learning experience. In summary, the spatial contiguity principle can be applied in the context of TikTok to enhance the learning experience of viewers, particularly in the domain of chemistry.

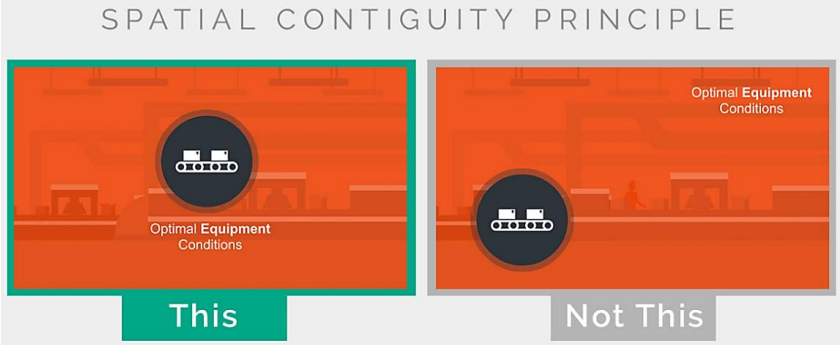

Figure 6: Spatial Contiguity Principle (Mayer, 2014)

Figure 7: Spatial Contiguity Principle – A sample of a respondent's TikTok video

The temporal contiguity principle

The temporal contiguity principle refers to the individuals acquiring new information at the highest level when corresponding visuals and text are presented at the same time, rather than in consecutive order. In the current research, the students were allowed to be creative in arranging their visuals and text. Most of the students preferred to present their visuals and text that are related to each other at the same time in TikTok to enhance the comprehension of viewers. When making TikTok videos about ionic bonds, creators used visual elements such as animations and diagrams to illustrate the concepts they are discussing. They used voiceovers to provide explanations of the concepts. Using the temporal contiguity principle, TikTok creators could improve the learning experience of their viewers by presenting the visual and auditory elements at the same time. For example, when explaining how an ionic bond was formed, a TikTok creator could show an animation of two atoms coming together to form the bond, while simultaneously providing a voiceover explanation of what is happening. By synchronizing the visual and auditory elements, the TikTok creator could help their viewers better understand the concept of ionic bonding. By following the temporal contiguity principle, viewers would be provided with a more effective and engaging learning experience when it comes to understanding ionic bonds.

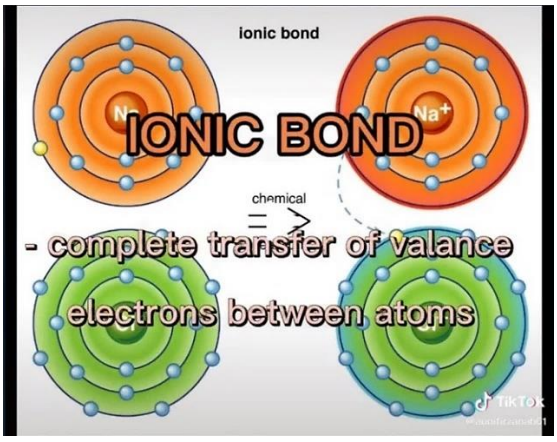

Figure 8: Temporal Contiguity Principle – A sample of a respondent's TikTok video

The pre-training principle

The pre-training principle states that the individuals would learn efficiently based on their prior knowledge on a particular matter. This means that their comprehension of basic definitions, terms, and concepts is highly significant for the pre-learning experience. The learners would be highly motivated to deal with complex visuals and definitions if the learning process begins with a background knowledge. In this research, 35 of the respondents have been actively using TikTok application for pleasure and entertainment before being introduced to using it as an educational platform. Therefore, the students possess some prior basic knowledge of TikTok, which results in an easier and more engaging learning experience.

The multimedia principle

The multimedia principle refers to individuals learning better from both visuals and text, rather than from text only. TikTok allows users to think out of the box due to the ability to insert images and words, and more engaging elements, such as animations, voiceovers, songs, sound effects, filters, and the users' own videos. These elements would ensure that the TikTok presentation becomes livelier, entertaining, engaging, fun, and informative. Using the multimedia principle, TikTok creators could improve the learning experience of their viewers by presenting information about covalent bonds in both visual and auditory formats. For example, when explaining how a covalent bond was formed between two atoms, a TikTok creator could show an animation of the two atoms sharing electrons to form the bond, while simultaneously providing a voiceover explanation of what was happening. By engaging multiple modalities, the TikTok creator could help their viewers better understand the concept of covalent bonding.

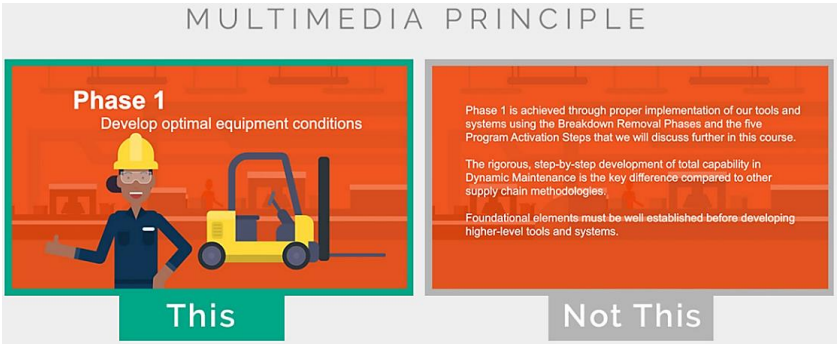

Figure 9: Multimedia Principle (Mayer, 2014)

Figure 10: Temporal Contiguity Principle (Mayer & Fiorella, 2014)

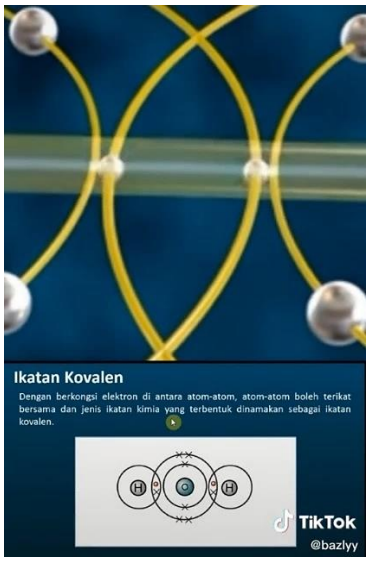

Figure 11: Multimedia Principle – A sample of a respondent's TikTok video

The image principle

The image principle stated that the relevant visuals on the screen would be more effective for learning information compared to only showing a video of the instructor's talking head. The features element in the TikTok application allows users to be visible in the video. They could convey their information with special effects without any spoken words. TikTok has been used to explain the concepts of ionic and covalent bonds using images and animations. Creators have used visual elements such as diagrams, chemical structures, and animations to illustrate the concepts they are discussing. For example, to explain how an ionic bond is formed, a creator could show an animation of two atoms coming together and transferring electrons to form an ion. This visual representation of the concept can make it easier for learners to understand the process. Similarly, to explain how a covalent bond is formed, creators have used images of atoms sharing electrons to illustrate the concept. This visual representation can make it easier for learners to understand the process of covalent bonding. By using the image principle, TikTok creators have been able to make the concepts of ionic and covalent bonding more accessible and easier to understand for learners. By presenting the concepts as images, rather than just text, the creators have engaged learners' visual processing systems, making it easier for them to understand and retain the information.

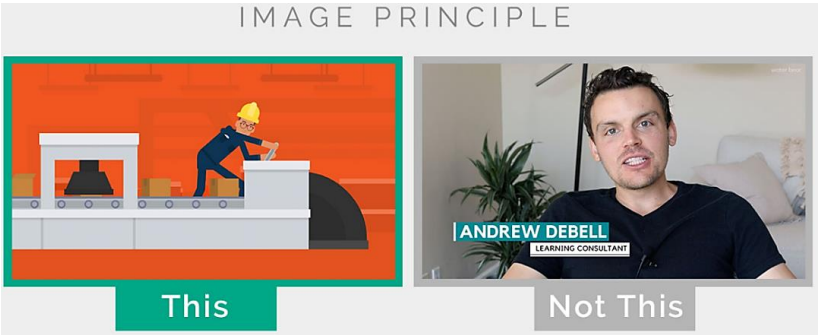

Figure 12: Image Principle (Mayer, 2011)

Figure 13: Image Principle – A sample of a respondent's TikTok video

CONCLUSION

TikTok was not typically considered a formal learning tool in the traditional sense. However, it was true that TikTok could be used to effectively engage, educate, and stimulate the general public about chemistry. Chemistry could be contextualized in a fun and engaging manner using the creativity tools employed in TikTok. It enables students to act as partners in creating tools for chemistry education, which would be the biggest strengths of using TikTok in the classroom. The use of TikTok corresponds to five out of 12 of the of the Mayer's principles in multimedia learning. This demonstrates its effectiveness as a learning tool that is manifested as a better learning experience. However, there are positive and negative implications from the use of TikTok in educational environments. It is crucial to harness the positive aspects and adapt them for the modern approaches in teaching and learning. We suggest further work to assess the usefulness of the TikTok application as a learning tool for other subjects based on the components of critical thinking, problem solving, and experimental skills enrichment. Overall, it was highlighted that TikTok could be a useful supplement to traditional learning methods, it should not be relied on as the sole source of education. Students still need to develop critical thinking skills, read and write effectively, and engage in meaningful discussions with their teachers and classmates. TikTok might be a helpful tool for learning, but it should not replace the fundamentals of a formal chemistry education.

RECOMMENDATIONS

In order to further explore the potential benefits and limitations of using TikTok as a teaching and learning tool, future research could investigate the specific teaching strategies employed when using this platform. By analyzing these strategies, researchers could gain insights into the most effective ways to incorporate TikTok into the classroom and optimize its impact on student learning outcomes. This research could involve detailed observation and analysis of TikTok-based lesson plans, as well as surveys or interviews with both teachers and students to gather their perspectives on the effectiveness of different strategies. Ultimately, a deeper understanding of the teaching strategies that work best with TikTok could help educators to more effectively integrate this platform into their pedagogical practice and enhance the learning experiences of their students.

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Conflict of Interest

No conflict of interest have been declared.

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