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"Making Every Second Count": Utilizing TikTok and Systems Thinking to Facilitate Scientific Public Engagement and Contextualization of Chemistry at Home.

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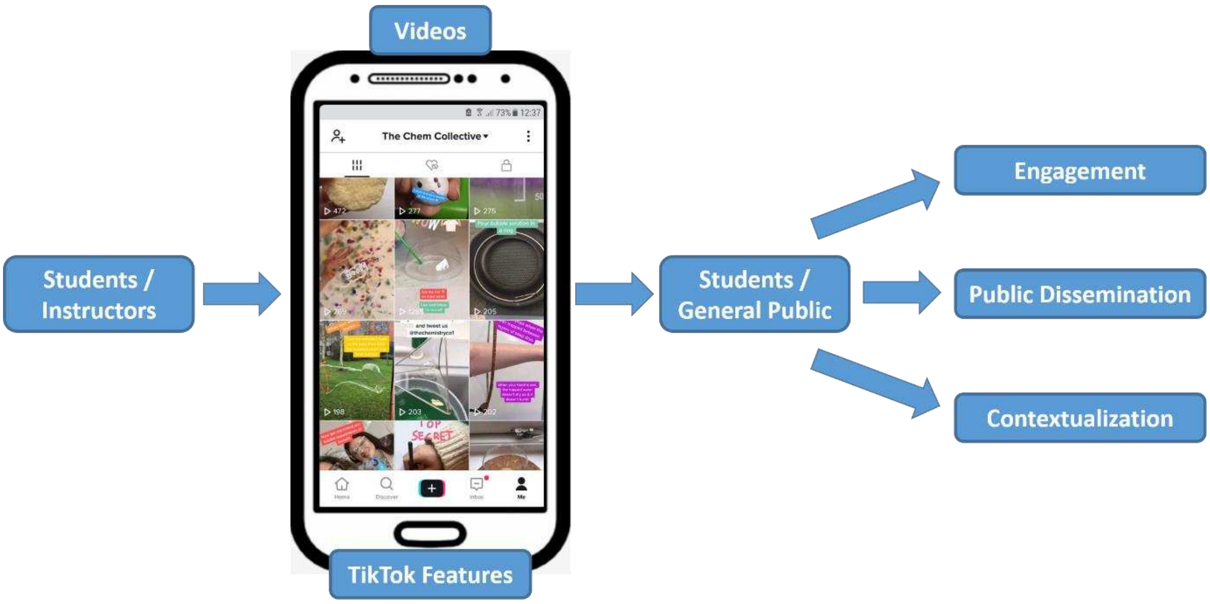
ABSTRACT

TikTok is a social media video-based phone application which enables creative and engaging videos to be shared on social media platforms worldwide. TikTok has been applied to create fun, exciting and engaging 15-60-second-long chemistry outreach educational videos, to encourage public dissemination of science with a systems thinking approach. With the creation of an online TikTok account called "The Chemistry Collective" by undergraduate students, 16 educational videos were created, with approximately 8,500 views. Upon surveying participants, viewers of these TikTok videos strongly agreed that they had learnt something new about chemistry since watching these videos (4.66/5.00) and had an increased interest in chemistry (82.7% agreed). As such, TikTok can be used to enhance public and undergraduate student engagement with chemistry and science education, together with facilitating the ability for the public to understand how chemistry can be fun, performed at home and is part of our daily lives.

GRAPHIC ABSTRACT



KEYWORDS

Internet / Web-Based Learning, Systems Thinking, Sustainability, Public Understanding / Outreach, General Public, Elementary / Middle School Science, High School / Introductory Chemistry

INTRODUCTION

Following the emergence of modern science in the late 18th century, the 'Reductionist' educational approach has dominated science education.[1,2] Reductionism can be described as "*the idea that complex systems or phenomena can be understood by the analysis of their simpler components*".[1] Reductionism also suggests that *"the world can be explained by linear cause-and-effect relationships"*.[1,2,3] There are different types of reductionism in scientific education, but in short reductionism attempts to make complex principles easier to understand by dividing the information, or complex system, into simple, individual, context-free facts.

Whilst reductionism has its advantages in many scientific fields, including molecular biology, and can be used to explain many scientific facts, such as why patients may "*exhibit enhanced susceptibility to infections*",[1] it still has limitations. The disadvantages of reductionism can be illustrated with the analogy "*If you try to take a cat apart to see how it works, the first thing you have in your hands is a nonworking cat. Life is a level of complexity that almost lies outside our vision.*".[2,4] Likewise, we cannot always truly understand a "system" by studying its individual components separately. Critics of reductionism also note that when students focus solely on individual components rather than the whole, they often fail to identify critical interconnections between course modules.[2] This can also prevent students from seeing critical interrelated and fundamental principles between different sciences and research fields.[1] This could also have long-term effects and impact their future research careers by limiting their understanding beyond the classroom. Not only can this affect chemistry education at an academic level but can also alienate students at pre-university level education, and "non-scientists" such as the general public, from engaging with chemistry.

One modern holistic approach is "systems thinking", which is an extension of a context-based method that aims to provide students with a deeper understanding of complex, real-world systems.[2,5] Over the last few years, extensive research into creating and increasing the implementation of alternative educational methods such as systems thinking has been performed, in order to advance chemistry education and to fill gaps in the reductionist approach. This led to the development of the IUPAC Systems Thinking in Chemistry Education (STICE) project,[5] which argues that a systems thinking and holistic approach must complement the reductionist methods in order for chemistry education to advance, adapt and grow.[1,2,5]

The use of systems thinking in green chemistry education has proved particularly valuable,[6-9] as the associated challenges are global and holistic in nature. In particular, achieving the United Nation's (UN) 17 Sustainable Development Goals,[10] which include tackling climate change, increasing sustainable consumption, production, cities and communities, and global partnerships in sustainable development, will require systems thinking. This approach is therefore key in green chemistry, a field of research dedicated to making chemistry safer, greener and more sustainable globally, and preserving natural and global resources for future generations.[11] Many important areas and issues of green chemistry, such as the circular economy, utilizing waste streams, creating biodegradable plastics, developing non-toxic and sustainable chemical production routes and preserving supplies of endangered chemicals, are not simple issues and will require a holistic approach. Systems thinking is essential to inspire and inform future scientists and researchers how to utilize feedstocks and develop processes that minimize the production of harmful substances.[12,6] It can also educate the general public about how to make sustainable changes to their daily lives and give them the confidence to engage with important environment-related policy and politically driven decisions and debates.

One modern teaching technique, which is seeing more and more implementation in chemistry education, is the use of mobile, web and e-learning techniques. This aligns with the theoretical framework of connectivism and its teaching approaches. Not only does this enable students and instructors to share knowledge in a timely and modern fashion, utilizing technological devices such as smartphones, tablets, laptops or computers,[13] but can also be implemented simultaneously with systems thinking. A recent survey by the Educause Center of Applied Research on exploring mobile learning practices in higher education demonstrated that students are driving the adoption of such mobile devices, with 67% of surveyed students believing that such devices are important to their academic success.[14]

Social media can be used to enhance student and staff interactions and provide an alternative learning technique from the traditional whiteboard lecture approach.[15] Such social media platforms include

(i) social networking sites, such as Facebook or Twitter;
(ii) media sharing sites, such as YouTube or Instagram;
(iii) creation and publishing tools, such as wikis and blogs;
(iv) collation and republishing through Rich Site Summary feeds;
(v) remixing of content and republishing tools; and

(vi) multi messaging applications such as Snapchat.[16]

Recent work at the University of York highlighted how the photo messaging mobile phone application Snapchat, used by an average of 158 million people every day,[17] could be used to contextualize first year undergraduate chemistry course material in the real world, whilst providing students insights into real-life research environments.[18] The global use of social media also means that teaching tools developed for use in an academic environment can easily be utilised for scientific public dissemination and engagement.

Due to the recent success of using systems thinking approaches at the University of York, and in implementing systems thinking with mobile phone applications in the classroom, this work details the investigation of using the video-based mobile phone application "TikTok", as a teaching and public outreach tool. Systems thinking methodology was utilized in TikTok by:

(i) viewing the system (or chemistry experiments) as a whole, rather than a collection of simpler components;

(ii) identifying the interconnections and feedback loops within these dynamic systems;

(iii) determining the consequences of the interconnections;

(iv) providing environmental, social and economic context to these experiments; and

(v) relating theoretical principles to everyday observations in student's lives.[2]

Undergraduate students were important contributors to this project and those involved undertook this research due to their experience in implementing systems thinking in their undergraduate degree.[19] It is therefore worth noting that all TikTok videos, resources and data generated for this work were created and obtained by undergraduate students, thus demonstrating how TikTok can easily be used by undergraduate students and implemented into academic research projects. Students can hence act as partners' in co-creators of TikTok resources to communicate chemistry.[20]

CREATING VIDEOS WITH TIKTOK

After merging with the popular musical based application "Musical.ly" in August 2018, TikTok is an application becoming increasingly popular worldwide. In late 2019, this platform reached 1.5 billion global downloads, an increase of 6% downloads compared to 2018, and was the third most downloaded application of the year, outperforming Facebook and Instagram.[21] It is also one of the all-time top ten most downloaded applications worldwide over the last decade[22] and is particularly used by a younger demographic. In the US alone, 46% of users are 18-24 years old and it is suspected that the many users are even younger than 18 years old.[23]

TikTok is a mobile phone application available on both Android and iOS devices to download for free,[24-26] which enables "creators" to make short length videos (3-60 seconds) set to audio clips, songs or pre-recorded video footage, with creative tools and effects, such as "stickers", "GIFs", "filters", "augmented reality", "split screens" and "green screens" at the creators disposal.[23] TikTok videos are created on a mobile phone, by using a phone camera to film the desired footage and then using the features within the application to add audio and visual effects. Once the created video is complete, the video can be uploaded onto a TikTok account, with added text and hashtags, prompting followers of the account to receive a notification that a new followed account video is available to watch. Creators can set videos to music in a lip synchronization feature, upload videos clips with their own audio, or even create videos using audio clips, sound bites and visual footage from other TikTok videos. This application therefore not only allows users to express their creativity, but also to engage with other platform users, with features such as "Duet" or "Stitch" (users add themselves into a video) and "React" (users film themselves reacting to a video). TikTok also offers social interaction between users and creators with the "Live Video" feature, in which users or accounts can film themselves live and have comments sent to them from fellow users during the recording. Furthermore, users of this platform can like other videos and comment on them.

One of the major advantages of using TikTok is that content can be shared on other social media platforms in a facile fashion. Videos created in this application can be shared across numerous applications and on personal media sharing platforms, such as Twitter, Instagram, Instagram Stories, Whatsapp and Facebook stories (amongst others). Not only does this sharing feature enable creators' videos to reach a wider global audience, but also with those of whom do not have a TikTok account. This is a great advantage in terms of global reach and public engagement, as some phone applications (such as Snapchat) often restrict creators to creating content that can only be accessed by, or shared with, fellow application users. TikTok videos, made by the user and other accounts, can also be directly downloaded onto online storage sites such as Google and Dropbox, saved directly to the phone, and shared via an internet link, text message or email. The number of videos creators can upload is infinite and creators can follow as many accounts as they like, as well as save as many videos to their favorites as they wish. TikTok content is also available to view indefinitely, unlike other social media applications such as SnapChat,[18] which only allows videos and images shared via the "Story" feature to be viewed for 24 hours, before then disappearing completely.

Another major advantage of TikTok compared to other social media platforms, is that videos on this platform can be viewed online on any web browser or electronic device with an internet connection. This therefore enables viewers to search for TikTok videos, accounts, videos assigned with the same hashtags or set to certain audio or music files. TikTok videos can also be uploaded on any electronic device with an internet connection, not just via a mobile phone, if desired. Although the reaction, live video, duet, like, comment and conversation features are not available online, the videos can still be shared on other media platforms. The website link to the video can also be copied and shared as desired. This provides the opportunity for those without smartphones to also engage with the application.

Potential disadvantages of TikTok include breaking through to reach a global audience in the first place, especially making videos that appear as a "For You" recommendation. Upon opening TikTok, the application immediately plays "For You" videos, which are tailored to the interest and watch history of the user's account. Whilst users of the platform can choose to follow certain accounts and receive regular updates on when these creators upload new content, TikTok uses its own algorithm twinned with artificial intelligence to tailor account personal recommendations. The content users will see upon opening up the application therefore will be videos similar to those the user has either interacted with, liked or watched.[23] Introducing new educational and chemistry based videos to viewers on the application may therefore be difficult, especially if users have never used TikTok for educational purposes before or to view chemistry or science based videos. Unless users of the platform actively use the search function to look for these videos, drawing themselves away from the "distractive swipe-up" recommended content, these videos may never reach intended audiences.

Care must be taken in terms of censorship and security when creating academic and educational TikTok accounts, as the default settings of the application mean that new accounts are not "private accounts". It is highly recommended that academic accounts and creators ensure that their use is aligned with institutional social media policies and that permission is always sought from others, if they or their work, videos, personal image or data is to be included in a TikTok video. To combat this potential issue, accounts on the application can be created representing an academic institution or school, rather than a student profile. Personal details such as age, gender, religion and race of individuals, which users of the application may wish to keep private, are therefore never shared on the platform. As TikTok is an application that keeps growing in popularity, the developers of TikTok continue to update and adapt their data policy and security regulations to ensure the safety of their creators. TikTok also enables creators to restrict user comments by blocking certain accounts from commenting on their videos and to set comment restrictions, in which comments containing certain words can be filtered and blocked from being posting on the video. Whilst ultimately creating an academic account to protect students' data may lead to some limitations in a teaching environment, this is currently the best method to use TikTok whilst protecting student's data and identities which is of the utmost importance. These limitations should not stop TikTok from being an effective social media platform to engage and enthuse students (and the public) about chemistry.

Whilst TikTok is mainly used by younger audience groups and teenagers to create fun, visually engaging, creative and often humorous online videos, we saw TikTok as an opportunity to create informative, fun and visually engaging chemistry videos, that could reach younger audiences/the general public and inspire them to learn about chemistry, encourage them to conduct their own chemistry experiments at home and to enthuse people about the beauty of chemistry, in a creative and innovative manner.

IMPLEMENTATION OF TIKTOK IN PROMOTING CHEMISTRY AT HOME

A TikTok account called "The Chemistry Collective" (or "The Chem Collective", @thechemistrycollective as shown on TikTok) was established, whereby TikTok videos could be created and uploaded for the general public to see (Figure 1). This TikTok account has 16 educational videos, illustrating scientific experiments that could be easily replicated at home by the target audience: pre-university individuals or those with little or no scientific knowledge. These videos covered different themes of chemistry experiments at home and sustainable chemistry, from using lemon juice to dissolve plastic waste to making your own pH indicator at home.

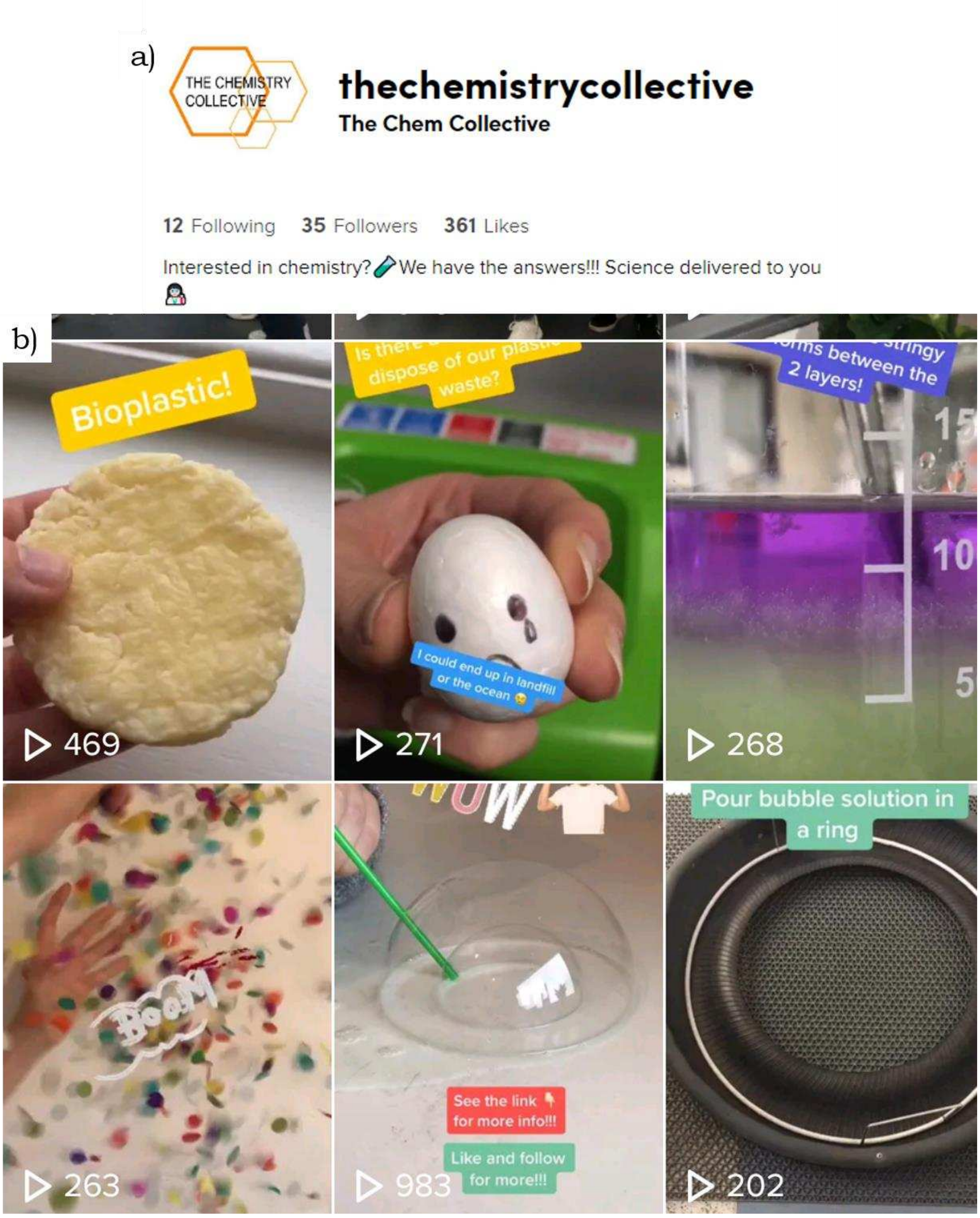


Figure 1: Representative view of "The Chemistry Collective" TikTok account homepage. (a) The Chemistry Collective TikTok account logo, and (b) view of created videos on the TikTok account homepage.

To effectively suit the target audience, no or very minimum background knowledge of chemistry and experimental technique was assumed. Scientific jargon was therefore limited, explanations were kept simple and detailed procedures (using a mixture of text and visual aids) were provided. To ensure user accessibility, experiments with minimal risk were shown in the videos, requiring tools and ingredients found in a typical household. However, it must be noted that some videos contained minor hazards, such as using a kitchen knife, boiling liquids and handling matches. Through a systems thinking approach, the videos were designed so that viewers of the video could

(i) identify the steps required to reach the desired experiment outcome;
(ii) plan and perform the experiment at home;
(iii) explain the theory behind the desired experimental observations; and
(iv) demonstrate how the theoretical principles can be applied to real-life situations.

Each TikTok video made use of sticker text and images to highlight the chemistry being shown in the video and were set to music which suited the theme of the video. Each video would also contain a link to other online references, often YouTube videos, where more information on the chemistry could be sought if desired (Figure 2).

Figure 2: Representative view of a "Chemistry Collective" TikTok video, titled *"An egg can represent the atmosphere*". Images from left to right show stills taken from the video during the video's progression. These images also exhibit the use of captions to provide both experimental instructions and scientific explanations in the video.

To reach a large viewer demographic, "click worthy" titles, thumbnails and hashtags were used (as demonstrated in Figure 3), in order to direct traffic towards these videos and to increase the likelihood of them appearing on the popular 'For You' TikTok homepage. To achieve this, we added:

(i) Titles with rhetorical questions were used when possible to entice viewers to view the video;
(ii) The most visually exciting frame was chosen for the thumbnail; and
(iii) Trending hashtags, such as #scienceexperiment, #diychallenge and #fyp ("for you" page) were incorporated.

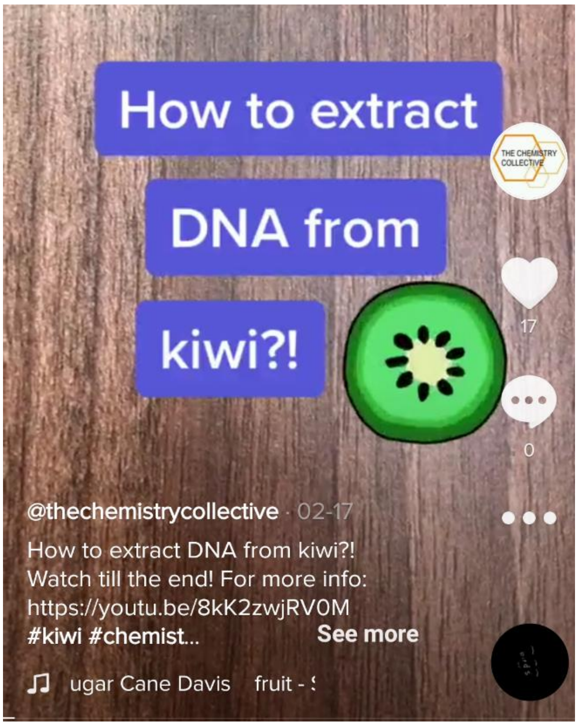


Figure 3: Screenshots from The Chemistry Collective's TikTok videos, titled "*How to extract DNA from kiwi?! Watch till the end*", displaying the use of a "click worthy" rhetorical title, engaging hashtags and links to further resources.

By contextualizing theoretical principles within experiments and specifying real-world applications, the aim to utilize a systems thinking approach was successfully addressed. This approach was most appropriate in the videos that described sustainability and green chemistry and its implementation in the real world. For example, the video titled *"Can we make this egg disappear? Wait till the end to find out!"*, explained why limonene, extracted from the zest of citrus fruits, can dissolve a polystyrene egg.[27] By stating the potential use of limonene to reduce the volume of polystyrene in landfill, its applications and environmental context were highlighted in a fun and visually engaging manner. This video also visually demonstrates to the viewer how waste valorisation of citrus fruits, including the juice and peel, ties-in with the concepts of circular economy, life-cycle analysis (LCA) and green chemistry, whilst in turn embracing the ethos of systems thinking.[28] In another one of our videos, titled "*How to make homemade bioplastic using milk and vinegar*", TikTok was also used to illustrate how waste valorisation can tie in with bioplastic production, promoting greener and safer chemical syntheses, as well as other green chemistry concepts and the circular economy.[29] These videos also detail how linking these areas of research in a holistic approach can work towards solving global issues and achieving the United Nations Sustainable Development Goals. These videos in particular therefore nicely demonstrate how our five-step approach to utilize a systems thinking approach in TikTok videos can be used effectively to teach chemistry. This also reinforces previous studies illustrating these important concepts can be taught in a classroom environment using a systems thinking approach.[28,29]

TIKTOK INTERACTIONS AND ENGAGEMENTS ON OTHER SOCIAL MEDIA PLATFORMS

Upon initial creation of the TikTok account, a separate "Chemistry Collective" Instagram (the_chemistry_collective) and Twitter account (@TheChemistryCo1) were also created, so that TikTok videos could be easily shared across numerous social media platforms and to advertise the creation of the TikTok account. Since the creation of the account in February 2020, the account as of 16th April 2020 had 35 followers, over 350 likes on the created videos and 4,946 total video views on TikTok alone. On other social media platforms, the account had 2,113 views and 40 followers on Twitter and 1,479 views and 69 followers on Instagram. Interestingly, the most viewed video varied on each social media platform. On TikTok, the most viewed video (with 983 views) was a bubble video, highlighting how and why you can blow multiple bubbles within one another. This perhaps was the most viewed video as it is one of the more visually stunning and quickly grabs the viewers' attention; qualities which make TikTok videos gain traction. On Twitter, the most viewed video (with 444 views) was a short video advertising a new set of videos on bubble experiments, showing faces and interestingly no chemistry. This may reflect the nature of Twitter being used more for people to socially interact and collaborate with one another when used in a teaching forum.[30] On Instagram, the most viewed video (156 views) was a video highlighting the effect of pressure, in when a hard-boiled egg is placed over a bottle with hot air the egg is pulled into the bottle. This was the first video created on the account, with the high views highlighting perhaps initial interest in the creation of this account.

Overall, the social media platform with the most views, out of 8,538 views, was TikTok (58%) followed by Twitter (25%) and Instagram (17%). This was promising considering the videos were created for TikTok, demonstrating this application had wide outreach potential. The viewership of these videos on other platforms must be acknowledged, as they accounted for 42% of views. In terms of account followers (out of a total 144), "The Chemistry Collective" had the majority of followers on Instagram (69 followers, 48%), followed by Twitter (40 followers, 28%) and TikTok (35 followers, 24%). This demonstrates that followers and outreach potential do not necessarily correlate with viewing figures.

FEEDBACK IN USING TIKTOK IN PUBLIC ENGAGEMENT OF CHEMISTRY

After creating and sharing TikTok videos on numerous media platforms, all followers of "The Chemistry Collective" account on Twitter were invited to complete a questionnaire administered by Google Forms, following approval from the institutional review board. The survey was conducted in March 2020 and 29 participants completed the questionnaire. The questionnaire (shown in the Supplementary Information) first involved answering some pre-video questions, about participants' chemistry education (Figure 4) and previous acquaintance with TikTok. Approximately 59% of the participants who completed the survey had an undergraduate level of chemistry understanding or higher, with 41% of participants with pre-university knowledge of chemistry. Overall, the participants who answered the questionnaire showed a spread of the highest qualifications they held in science (Figure 4). Interestingly, 74% of the participants had not viewed any TikTok videos before watching the Chemistry Collective TikTok videos, indicating this survey will gauge the opinions of participants new to this application. Those who had seen TikTok videos before had seen them across a mix of different social media platforms, with the most popular being Instagram and Twitter.

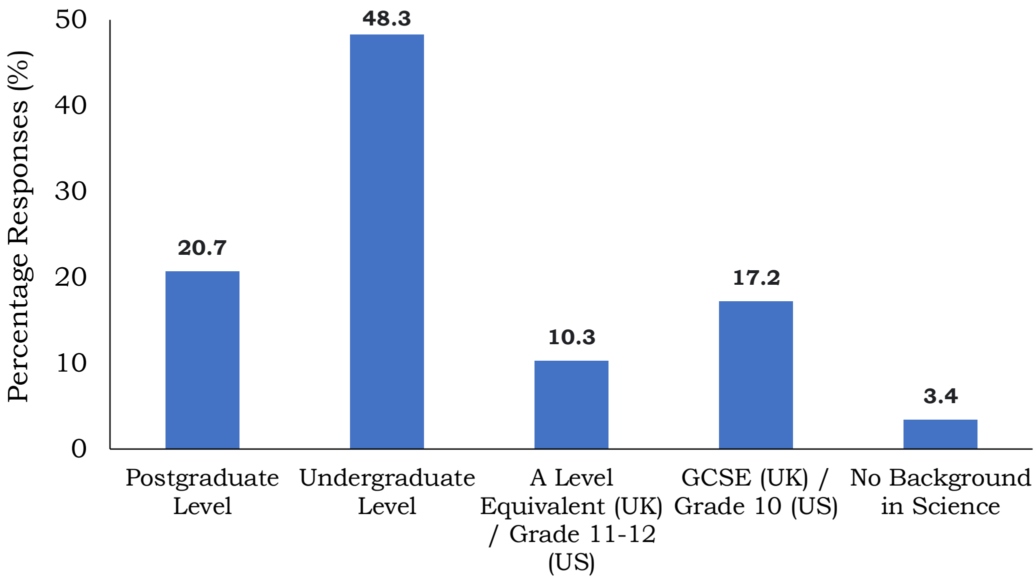


Figure 4: Percentage responses for the question "*To what level have you studied/ are you currently studying Science?*", with a total of 29 respondents.

Participants were then invited to view three of the TikTok videos created (the most viewed ones at the creation of the Google form, Figure 5) and to provide feedback on these videos, by rating their enjoyment of the video on a scale of 1 to 5 using a Likert-style response scale,[31] with 1 indicating participants "did not enjoy the video" and 5 indicating that participants "really enjoyed the video". Mean values were determined by assigning each category from 'Strongly Agree' as '5' to 'Strongly Disagree' as '1' and multiplying by the number of respondents in each category. Following this, the total sum in each category was determined and divided by the number that is 5 times the total number of respondents. This can also be expressed by Equation 1.

$$\frac{\sum_{i=1}^{n}\left(\text{Likert-scale category} * n_{\text{category respondents}}\right)_i}{5 * n_{\text{respondents}}}$$

Equation 1: Method employed to calculate mean values according to Likert-scale type responses.

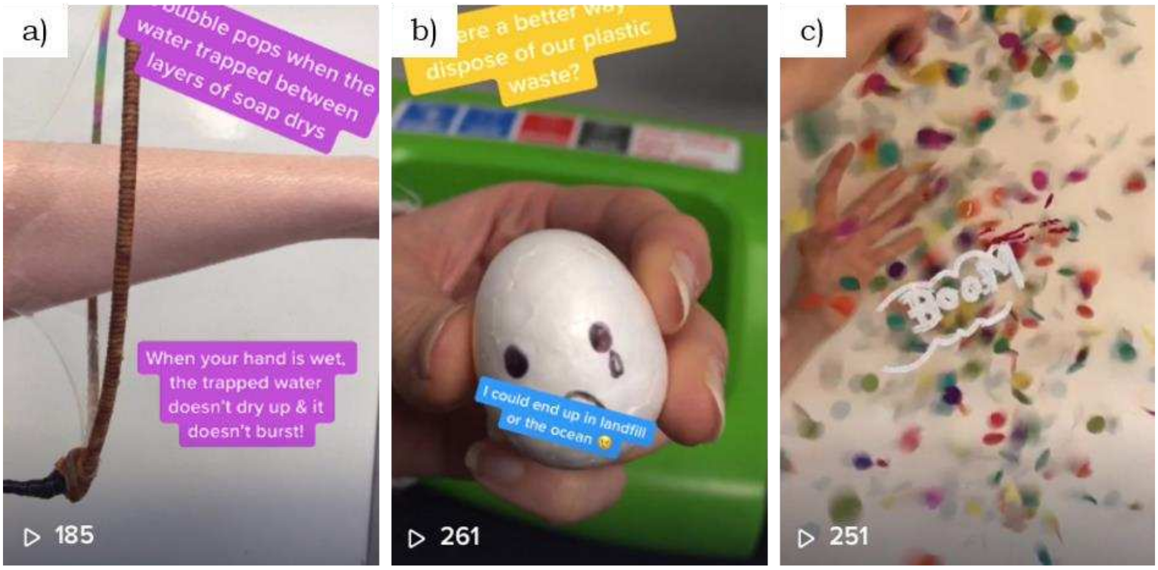


Figure 5: Thumbnails of The Chemistry Collective's TikTok videos respondents were asked to analyze in the online Google form. a) *"You can put your hand inside a bubble?! Wait till the end!"*, b) *"Can we make this egg disappear? Wait until the end to find out!"* and c) *"How powerful is a Lemon? Let's find out!"*.

All videos were well received, with all being rated 3 or higher. The first video, which explained how to insert a hand inside a bubble without popping it, scored 4.69/5.00 (Figure 5a). The second video which demonstrated that limonene can dissolve polystyrene, scored 4.59/5.00 (Figure 5b). The third video which explained why citrus zest pops balloons, scored 4.79/5.00 (Figure 5c). When asked whether the participants would recommend these videos to their friends, this again scored highly with 96.5% strongly agreeing or agreeing with this statement (Figure 6).

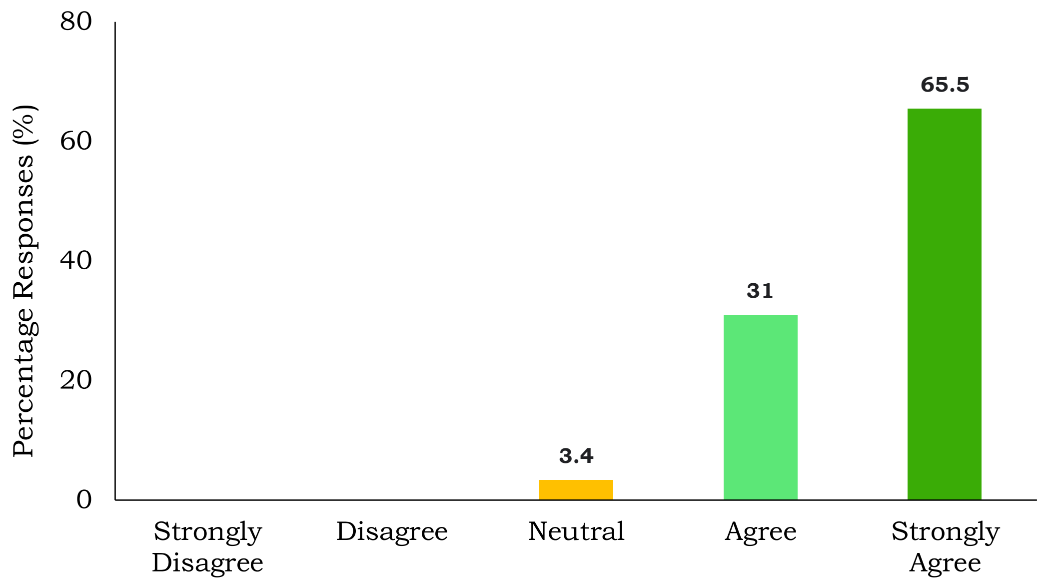


Figure 6: Responses for the question "On a scale of 1 to 5, how likely would you be to recommend these videos to a friend or peer?", with a total of 29 respondents. 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

Participants were also invited to give positive and/or negative feedback on each video. In terms of the favorite features from the videos, the use of visual demonstrations, music, and the fun, yet informative, nature of these videos were frequently noted. Only four participants (14% of respondents) thought that further explanation was needed. Graphical data for these responses, and all feedback provided by participants, is in the Supplementary Information.

After analyzing and gauging the chemistry of the three chosen Chemistry Collective TikTok videos, participants were asked a final set of post-video questions. An overwhelming majority of participants (96.5%) strongly agreed or agreed that they had learned something new from the TikTok videos, scoring 4.66/5.00 (Figure 7).

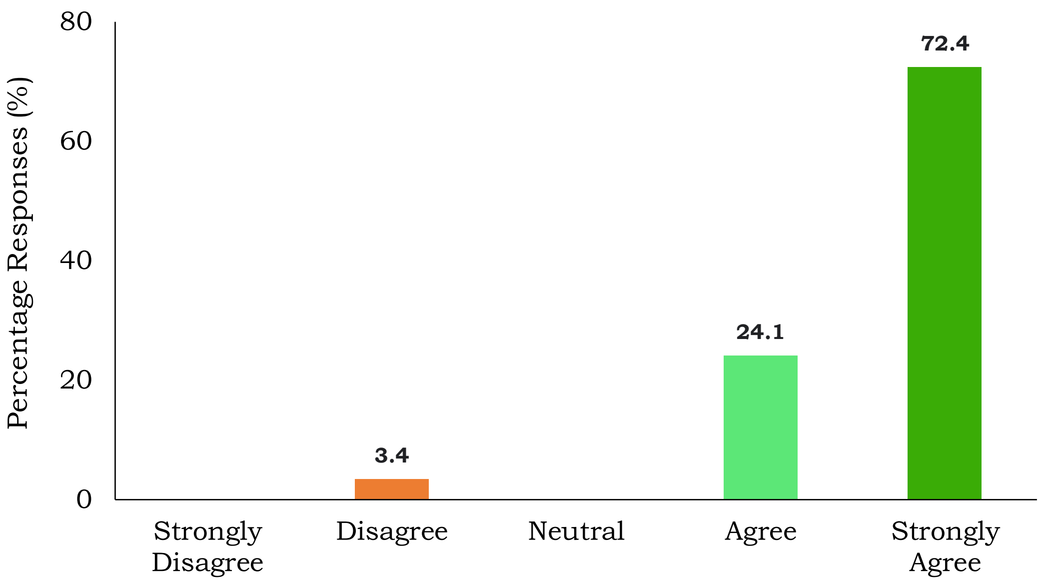


Figure 7: Percentage of participants who agreed that "*Overall, I have learnt something new about chemistry since watching The Chemistry Collective's TikTok videos*", with a total of 29 respondents.

The same majority of participants (96.5%) also felt inspired to recreate these experiments at home (4.28/5.00), with approximately 93% of participants agreeing that these experiments could be replicated at home. All participants strongly agreed or agreed that *"The Chemistry Collective's TikTok content made chemistry seem more accessible/interesting"* (Figure 8).

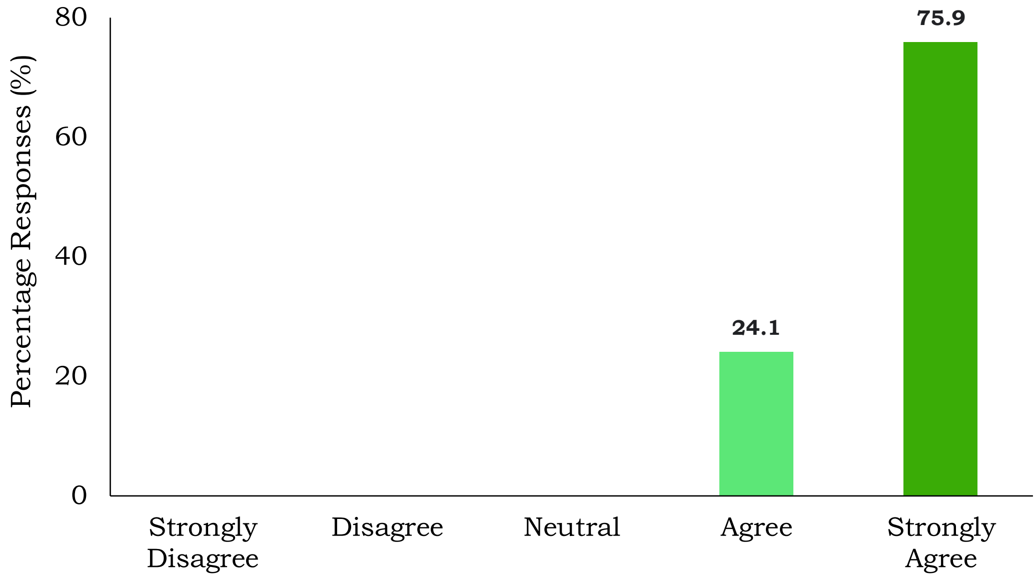


Figure 8: Percentage of participants who agree that "*The Chemistry Collective's TikTok content made chemistry seem more accessible/interesting*", with a total of 29 respondents.

The majority (82.7%) strongly agreed or agreed that their interest in Chemistry had been increased as a result of watching the Chemistry Collective TikTok videos, scoring 4.00/5.00 (Figure 9).

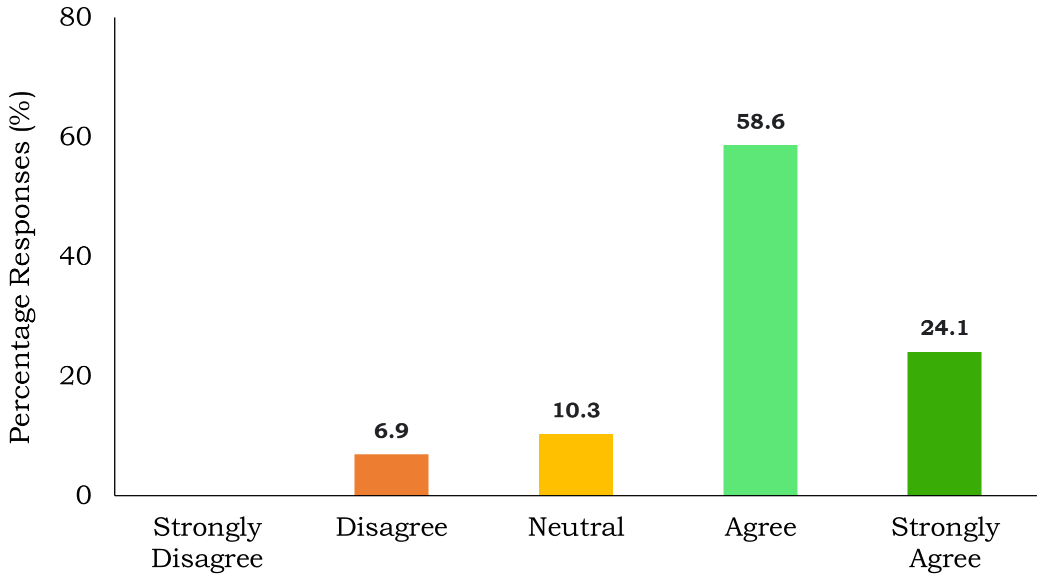


Figure 9: Responses to "*The Chemistry Collective's TikTok videos have increased my interest in chemistry*", with a total of 29 respondents.

The last question of the questionnaire asked participants which social media platform they think the videos were most suitable for, with the options to choose TikTok, Twitter, Facebook, Instagram or YouTube (Figure 10).

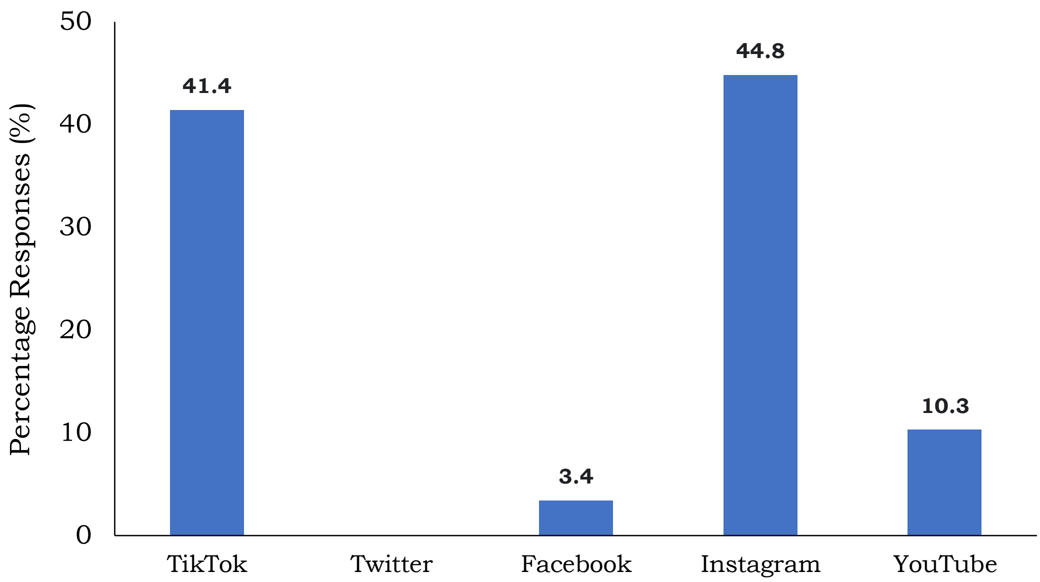


Figure 10: Responses to "*Which social media platform do you think The Chemistry Collective's content is best suited?*", with a total of 29 respondents.

Interestingly, there was a clear split between TikTok (41.4%) and Instagram (44.8%) as the chosen social media platform for communicating these educational videos. The large favourability for using Instagram may reflect the fact that Instagram was the most popular social media platform for viewing TikTok videos amongst the participants who said they had seen TikTok videos before the questionnaire. To help reinforce chemistry course content for undergraduate students, Instagram has previously been employed as an online tool to disseminate organic chemistry problems and to engage students with chemistry problems outside of the classroom.[32] The usefulness of Instagram in chemistry education therefore cannot be ignored. The age demographic of the participants may also explain why TikTok was not quite as popular as Instagram. As 59% of participants stated they had an undergraduate level of education or higher, this suggests that the majority of participants were ≥18 years old. As TikTok is a social media application used by much younger audiences (<18 years old), the split in choosing between Instagram and TikTok may reflect a lack of knowledge and familiarity with TikTok and its video creative features amongst the participants. Considering that 72.4% of participants had not seen a TikTok video before completing the questionnaire, it was promising that TikTok was seen as one of the favourite social media platforms suitable for these videos.

Feedback comments were also received about the TikTok videos outside of the Google forms questionnaire. These comments were extremely positive, with feedback such as:
"These are fab, I really enjoyed them …… and (am) now following them (Chemistry Collective) on Instagram."
"*What great fun they are and very engaging! They bring the science alive in a very memorable way. I think you have achieved your objective 'to make science more approachable and applicable to day-to-day life'.*"

CONCLUSIONS

TikTok can be used to effectively engage, educate and enthuse the general public about chemistry. By using the creativity tools employed in TikTok, chemistry can be contextualized in a fun and engaging manner and demonstrated using everyday household items. TikTok can also be used in conjunction with a systems thinking approach to highlight the importance of chemistry in research areas such as waste valorisation and the circular economy, and how this ties in with tackling global issues. This can ultimately enhance chemistry outreach, demonstrate how chemistry is a vital part of everyday life and can be done by undergraduate students. However, it is noteworthy that videos posted on TikTok can be hard to advertise to

TikTok users and to reach non-followers of the TikTok account. One solution to this issue is to repost the videos on alternative social media platforms, in order to advertise the videos to a wider audience and to encourage people to then follow the account on TikTok. We envision that TikTok, twinned with mobile learning and systems thinking, can be a great toolkit for future and modern chemistry education and outreach. Not only can TikTok be used to educate viewers of the videos and the general public, but also those who created them, as TikTok can effectively enhance teaching and creativity skills of undergraduate, or any pre-university level, students. It also enables students to act as partners in creating tools for chemistry communication, which is perhaps one of the biggest strengths of using TikTok in the classroom.

Owing to the broad usage and applicability of TikTok as a platform for teaching chemistry, instructors teaching at Middle School, High School or in higher education could use these TikTok videos, or recreate the experiments in the classroom, to contextualize principles in the curriculum. Chemistry would appear more accessible/interesting by relating the principles to real-life observations and applications. Perhaps, instructors could set homework assignments to create fun scientific TikTok videos with the aim to increase student engagement. In conclusion, this new and exciting mobile phone application can be used by educators to enhance chemistry education and promote interest in chemistry. Overall, TikTok if utilised correctly can provide educators with a valuable new tool to improve chemistry teaching, dissemination and public engagement with chemistry knowledge.

ASSOCIATED CONTENT

Supporting Information

Details of all the educational videos uploaded onto the Chemistry Collective TikTok account, online analytical data, the Google forum questionnaire and graphical results from the questionnaire are provided in the supporting information. This material is available via the Internet at *http://pubs.acs.org.*

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Notes

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