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Improving student engagement using video-enabled activity-based learning: an exploratory study of STEM preparatory education in the United Arab Emirates (UAE)

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Abstract

Student engagement is often described as ‘the holy grail of learning’ (Sinatra, Heddy and Lombardi, 2015, p.1). Higher education educators have been implementing different pedagogical approaches to promote active learning with the aim of improving student engagement. This paper proposes an activity-based learning approach with the use of educational video to promote student engagement. We evaluate whether such an approach could improve student learning and engagement with STEM subjects e.g., Chemistry and Physics, from three perspectives: motivation, engagement, and academic performance. We surveyed 136 STEM preparatory programme students to conduct qualitative and quantitative analyses. The main findings support using the video-enabled activity-based learning (ABL) approach to promote student engagement within classes and for future study. Moreover, the ANOVA tests results demonstrate the significant differences in the students’ academic performance with the use of video-enabled ABL. The P-value of the Chemistry session is 0.0016, and 0.00075 for the Physics session. This study also contributes to STEM education by providing insightful and practical guidance on how to effectively use scientific educational videos to enhance STEM education. Furthermore, this UAE-based exploratory case study has been conducted in the context of middle eastern students’ learning behavior which adds an interesting cultural dimension.

Keywords: activity-based learning; STEM preparatory education; student engagement; video-enabled.

Introduction

While STEM student enrollment and motivation have declined in many Western countries (Young et al., 2018; Freeman, Marginson and Tytler, 2019), the Emirate Youth Council prioritises the enrollment of young people in STEM disciplines and the pursual of lifelong learning and skills (Strategy and PWC, 2022). It is widely acknowledged that over the last 50 years, the economic development of the UAE has been largely achieved through its oil revenue and expatriates. To enable further economic growth outside the hydrocarbons sector and create a competitive knowledge-based economy, the UAE government is determined to transform its higher education system so that its citizens will be competitive in the global knowledge-based economy, creating over 30 institutions of higher learning in the past 15 years (WENR, 2018).

However, the UAE is facing a challenge to change from an education system where most students study non-technical majors to one with substantial science and engineering graduates (Wagie and Fox, 2006). One of the effective ways to encourage students to choose science subjects is to enrol secondary education graduates in university preparatory programmes. The preparatory programme is known as the Foundation year in the Western education system and has the same purpose, i.e., to develop academic and non-academic skills and make it easier to get started at university. It is an extra year of study that leads to a full degree programme. Students will also have the chance to improve their English language skills. More than 60% of the universities run preparatory or STEM programmes in the UAE with more than 50,000 students enrolled every year; the progression rate is 65% based on the case study university's 2021-2022 data, which matches the national level, so one of the biggest challenges is how to maintain/enhance the retention and progression rate.

Student engagement is often labelled as the 'holy grail of learning' (Sinatra, Heddy and Lombardi, 2015, p.1). However, the recent findings (as seen in Wester et al., 2021; Wu and Teets, 2021; Huang and Wang, 2022) alarmingly report a significant decrease in engagement with students after Covid-19 due to the change in learning environment, i.e., from in-person to online or blended learning. Students nowadays are always connected to screens, computers, TV, games, YouTube, etc. This motivates us to integrate multimedia teaching sources such as educational videos to develop various activities to promote student engagement with studying STEM courses. Susantini, Faizah and Suryanti (2016) claim that educational videos are one of the tools that teachers can use as to facilitate learner-teacher interactions.

Using video-enabled activities does not mean teachers are putting their classes on ‘auto-pilot’ mode. In fact, teachers still supervise the process, checking the quality of the videos and how much is serving the material of the subject through carefully designed activities. More specifically, we designed the case study STEM courses, Chemistry and Physics, where key concepts and theories are not delivered in a didactic way but through a series of activities enabled by videos. This exploratory study was undertaken at a STEM preparatory programme within a leading UAE university. The designed learning activities include acquiring knowledge, investigating and collaborating, and reflecting and evaluating learning. Educational videos are used in the whole process to facilitate various activities in the hope of promoting student engagement. The pedagogic design, therefore, focuses on transforming passive learning into active learning. This paper evaluates the effectiveness of using a video-enabled activity-based learning approach to promote students' learning and engagement in three aspects: students’ motivation, engagement and academic performance. Findings and results gained from qualitative and quantitative analysis allow us to contribute to addressing the challenges facing STEM preparatory education. The contribution of this paper is threefold:

1. It contributes specifically to the extant literature regarding the utility of activity-based learning. The use of educational video facilitates collaborative and interactive learning activities which could motivate students to engage in active learning.
2. It more generally reveals the breadth and depth of motivation and engagement that students ascend when learning STEM through video-enabled active-based learning (ABL) approach. This approach offers students flexibility and the opportunity to learn the subject knowledge in a way that appealed to them at their own pace. Consequently, students tended to become more engaged in the learning process and developed independent learning in the process.

3. The case study of the authors' own approach is discussed in detail and is designed to illustrate the activity-based learning approach. The findings may be of interest to colleagues contemplating applying video-enabled ABL to their STEM education.

This paper is organised as follows: the second section provides a theoretical and conceptual framework of the motivations for using video-enabled activity-based learning in STEM education. The third section describes the research design and methodology of this study. The analysis and findings of students' evaluation are then presented. The final section concludes the paper and outlines recommended future research opportunities emanating from this study.

Theoretical and conceptual framework

Constructive alignment and activity-based learning

In the last few decades, there have been urgent calls for active learning experiences that place the student at the centre of learning, rather than accepting students as passive listeners, to address the issue of poor student engagement (Machemer, 2007). Freeman et al. (2014) demonstrated that active learning could lead to increases in examination performance that would raise average grades. Panko et al. (2007) defined activity-based learning (ABL) as a learning process in which students are constantly engaged rather than passively receiving information. Based on the ABL, teachers should set up a series of activities which align learners' activities to learning outcomes. These activities should develop students' interest, motivation, engagement, behaviour, and intellectual capacity in the subject (Aina, 2013). Anwar (2019) highlights that the active learning method is different from the traditional method of teaching. Firstly, ABL is set up so students actively participate and become involved in the learning rather than sit as passive listeners in the classroom. Secondly, ABL provides students with an opportunity to collaborate in a positive learning environment which helps them to learn effectively. The key to achieving a successful ABL is to involve students in various interactive activities set up by the teachers in the classroom. These activities are used to connect educators and learners. Biggs's (2013) famous constructive alignment framework cleverly brings the teachers' set-up and learners' activities together:

> 'Constructive alignment' starts with the notion that the learner constructs his or her

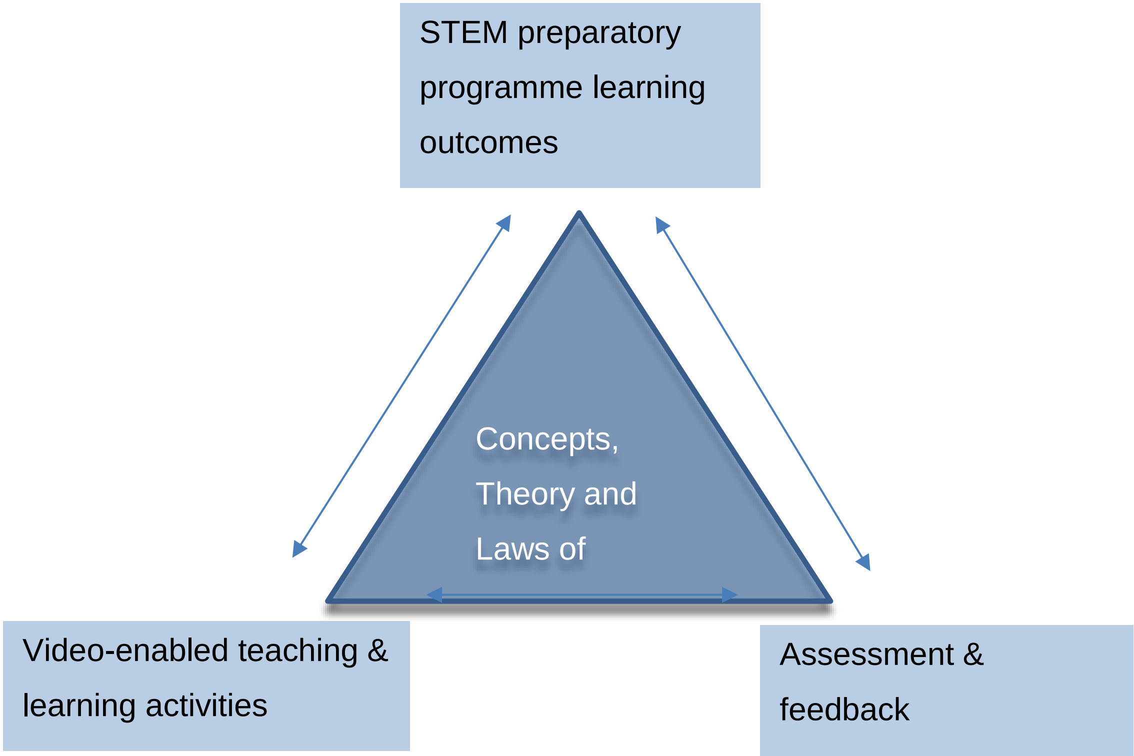
> own learning through relevant learning activities. The teacher's job is to create a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes. (Biggs, 2013, p.1).

According to constructive alignment, a good teaching system aligns teaching methods and assessments to learning activities so that all aspects of the system are supporting students' learning. Since all learning activities are designed to meet the desired learning outcomes, the learners find it difficult to escape from learning appropriately. Figure 1 illustrates the teaching system that we have designed based on constructive alignment.

The case study university's STEM preparatory programme equips students with both academic and non-academic life-long learning skills to successfully embark on undergraduate courses. The main learning outcome of the combined Physics, Mathematics, and Chemistry courses is for students to develop a good understanding of the Physics and Chemistry concepts, theory, and law to prepare them to undertake and excel in the Sciences and Engineering subject upon completion of the preparatory programme. The Physics and Chemistry courses in this case study use lectures, laboratories, and a common project as an introduction to the material, with active learning and problem solving to emphasise subject knowledge.

From the students' perspective, 'constructive' refers to the idea that students construct knowledge and skills through relevant learning activities themselves. Teachers cannot impart knowledge to students, but are simply catalysts for learning (Biggs, 2013). This idea perfectly aligns to the constructivist learning theory which underpins the ABL.

Figure 1. Application of constructive alignment in STEM preparatory programme.



Pedagogic consideration of blended-learning: using audio-video teaching materials

A blended learning approach has been adopted by most universities across the world in response to the Covid-19 pandemic. This approach has no doubt reshaped traditional pedagogic approaches to mitigate the impact of Covid-19. However, the blended and/or online learning approach has been criticised for its possible adverse impact on student engagement. For example, Wester et al. (2021) examined how the shift in the learning environment from in-person to online, because of Covid-19, has impacted undergraduate STEM student engagement. They reported a drastic decline in student engagement and their positive attitudes toward science. Wu and Teets (2021) focus on examining undergraduate student engagement in Chemistry. They concluded that the decreases in motivation and self-regulation occurred in part because the historic pandemic event made it more difficult to focus on studies in a self-regulated environment. It is crucial for us to review and introduce innovative pedagogy in order to enhance student engagement.

The traditional passive lectures using materials such as whiteboards and notes have been repeatedly proven to fail to retain students' interest (Zhao, 2019; Deslauriers et, al., 2019).

In recent years, the science classroom has been revolutionised by new educational media such as hands-on experimental tools, multimedia teaching and learning materials, computer simulation of chemical and physical processes, and adaptive learning software catering to students' learning abilities. In general, learners prefer to engage with exercises and activities in which they feel more confident. Challenging activities can lead a high percentage of learners thinking that they are not able to learn or understand and could result in them losing interest in the subject (Sawyer, 2014). For learning science subjects such as Physics and Chemistry, the question is how can we create a supportive environment to support those who are not engaged with the subject and at the same time continue to deepen engaged students' interest in the subject? For learning to take place in Physics/Chemistry teaching, two things are imperative: subject knowledge and learners' interactions. Subject knowledge consists of theory, principles, and laws of Physics and Chemistry. These are pre-determined by the learning outcomes when the courses are designed.

Using audio-video materials in the classroom is nothing new. Audio-videos were used in World War II as a training tool for soldiers, and since that time educators have recognised the power of such tools in capturing learners' attention and using it to increase their motivation and enhance their learning experience. The development of digital technology has opened new ways for education to develop, such as online education, with the flexibility to learn at a time that suits the learner and the place. With such changes academics are compelled to change their way to approach their students and ways of delivering their subjects, Rebecca Battes from Minnesota State University says: 'if we think about our students not being like us, not learning like us, not having the same motivations like us, then we start to imagine where they could be, and we can actually reach them more easily' (Kober, 2015, p.53).

In a face-to-face environment, students have better chances to actively engage with the content by interacting with their fellow peers, their teaching assistant, or the instructor. Creating the same active learning experience beyond class becomes a challenge. With the technology, we can now reimagine the same online learner, but with a twist: the student is now actively engaging with the video lecture through prompted questions. The interactive video keeps the students' attention and supports them in their learning endeavours.

The ability to use teaching technology beyond the classroom means that learning can occur anywhere, and at any time. Educators are purposeful about establishing online locations and forums for their students to share ideas and concepts with each other. Providing public spaces on the Internet, like a class blog and videos, offers a focused area where students can gather thoughts and ideas around a single subject. These spaces and education tools can engage students outside the classroom. Also, students show the ability to use new vocabulary because of education video usage; such things are considered an advantage for students when English is their second language (Sawyer, 2014), which is the case in this study.

Video-enabled activity-based learning framework

Based on the above theoretical framework and pedagogy consideration, we designed the following video-enabled activity-based learning framework. In summary, learning is divided into four activities for each topic.

a) Knowledge acquiring activity (in-class or/and online)

Students *acquire* knowledge through lecture videos - typically there will be one bitesize video introducing the main concepts and other videos explaining the main issues of the topic. Videos are curated via an online-platform, PlayPosit (formerly known as EduCanon). PlayPosit is a web and Chrome-based platform which helps instructors to create or modify video content from popular sites such as YouTube and Vimeo, among several others. Using this platform, students can attempt real-time questions such as multiple-choice questions which have been pre-loaded to the video to make the learning more interactive.

b) Collaborative activity (in-class)

Students *collaborat*e on given tasks. Teachers provide clear instructions and an overview of the task for learners. The tasks could include discussing the main concepts, theory and laws involved in the topic; numerical calculation practice; investigating an in-depth issue of the topic. This process is student-led and teachers act as facilitators. Students could access relevant videos which may help them to develop collaborative work.

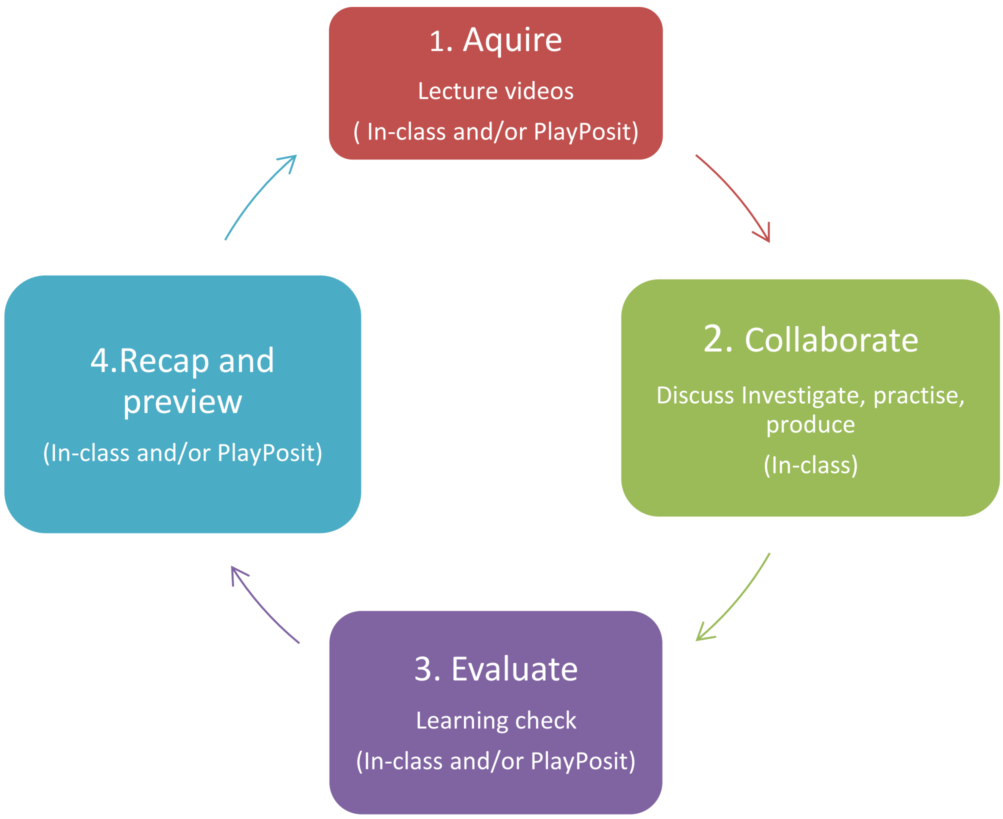
c) Evaluation and learning check activities (after-class):

Students will be given a brief such as homework, and a laboratory report to work on after the class to consolidate their understanding. This is to *evaluate* if students have achieved learning outcomes. Some of the tasks are set up in the video so that students can revisit the educational videos to accomplish the assigned tasks. Through the dashboard of the video platform PlayPosit teachers can get data about students' performance on the embedded assessment items.

d) Reflection and feedback activities (in-class and/or online)

Recap and review what has been learned and relate it to the next topic. Teachers provide oral feedback to students in class and summative feedback is given through a PowerPoint added to videos at the appropriate section. This will help students to understand what they have done well and what to improve in the future.

Figure 2. Video-enabled activity-based learning framework.



Methodology and research design

Methodology

The participants of this study were a group of foundation programme students at one of the top-rated Universities in UAE. They are mainly enrolled in science, technology, engineering, and mathematics (STEM) courses. The case study university offers STEM courses including Physics, Chemistry, and Mathematics which are delivered to students via different sessions by various lecturers. The focus of this study is to examine the effectiveness of the use of bite-size, i.e., 10-15 minutes, of educational video-enabled activity-based learning in terms of improving student learning engagement and performance. The video-enabled activities are designed to be completed during the course contact hours, i.e., in-class and/or as part of students' independent learning hours, i.e., after class. Students are not expected to invest extra time beyond the course study time, although some students may decide to consolidate their learning by spending more time revisiting the video-enabled activities.

The chosen videos have been modified to be fitted into the courses, i.e., Chemistry and Physics, in this study according to their syllabus and learning outcomes. Each video has a group of questions related to a specific concept, theory, or law of Physics and Chemistry. We add real-time questions, such as multiple-choice questions, to help students to pause and progress. The students can always rewind to find the answer they need. Adding pauses at regular intervals is a great way to break up a long session of narration. It also helps to prevent students from zoning out, encouraging them to watch and listen more actively. The questions have been embedded at different intervals during the video; they have been given a 10-point score each but are not summative assessments for the courses. These formative assessments can encourage students to apply subject knowledge acquired from the videos and promote an active learning experience for students in an online environment. Furthermore, within the PlayPosit platform instructors can obtain analytical information related to students' scores, attending/watching the video, and whether they watched the video completely or stopped somewhere (students cannot fast-forward any of the videos). The final product, the interactive video, is what PlayPosit calls a 'bulb'. Through a dashboard, teachers can get data about students' usage and performance within the embedded assessment items. These data then could be used to further develop discussion and investigation during classes.

Research design

This study uses a simple version of blended learning, which combined digital content such as video clips or educational activities with face-to-face classroom learning. Blended learning typically still requires the physical presence of the instructor and students in a classroom but gives the student some control over their time and space of learning, via e-learning teaching. The idea of using this version of blended learning is not to curtail the importance of the instructor, but to provide other ways for instructors to use digital technologies to support learning. This study conducts qualitative and quantitative analyses based on the survey and questionnaire results. First, a paper-based questionnaire was constructed to explore the perceptions of students using scientific-educational video to develop ABL. Secondly, this study applies the analysis of variance (ANOVA) test to examine the statistical significance of the difference in students' performance. The student performance was measured by the end-of-term test results. Tests were carried out at the end of the semester, and we compared the test results between the groups of students who accessed the video and the groups who did not have access to the video depends on the instructors' choice.

Ethical approval to undertake the research was granted by the faculty's Ethics Committee. The questionnaire was distributed to, and collected from, students by a member of staff unrelated to the module and students were informed that their participation in the research was voluntary, their responses and comments would be anonymous, and that they could withdraw from the study at any time. Students were encouraged to be honest in their answers. Consent was received from all 126 students.

Results and discussion

Questionnaire and survey results

We surveyed 136 STEM preparatory programme students and received 126 valid responses (where 52 were from the Chemistry course and 74 were from Physics). We assessed the perception of using educational video by asking the ten questions (5-point scale where 5=strongly agree and 1=strongly disagree) seen in Appendix 1. Table 1 and 2 presents the students' perceptions of Chemistry and Physics, respectively. The tables show the questions asked in the survey in this study about using the educational video to facilitate learning activities.

Table 1. Questionnaire data of Chemistry teaching first semester-2020 (total sample size: 52).

The survey questions at the end of the semester	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
Compared to traditional teaching	11	26	12	3	0
Motivation	10	25	11	6	0
Connecting outside classroom	11	27	8	4	2
Review lecture material	17	27	4	2	2
Take notes	5	7	14	17	9
Scientific language	11	20	15	6	0
Practise solving problem	17	26	6	1	2
Concentration	10	25	12	5	0
Replace the book	7	9	16	12	8
Video length	16	29	4	3	0
Total voting	115	221	102	59	23

Table 2. Questionnaire data of Physics teaching first semester-2020 (total sample size 74).

The survey questions at the end of the semester	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
Compared to traditional teaching	41	22	8	1	2
Motivation	31	32	10	0	1
Connecting outside classroom	41	28	4	1	0
Review lecture material	48	20	4	1	0
Take notes	5	7	24	24	14
Scientific language	16	42	16	0	0
Practise solving problem	41	29	4	0	0

Concentration	26	43	3	2	0
Replace the book	14	9	25	20	6
Video length	35	29	9	1	0
Total voting	298	261	107	50	23

Figure 3. Survey data of Chemistry teaching 1st semester 2020.

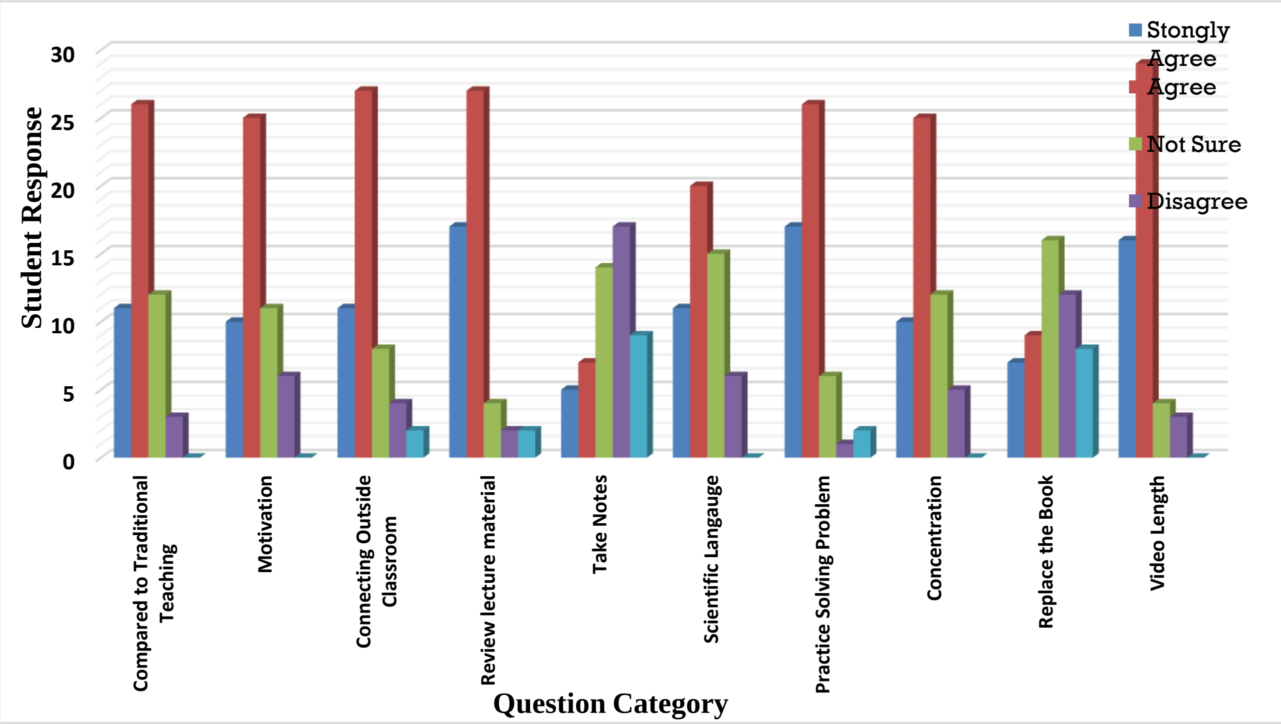
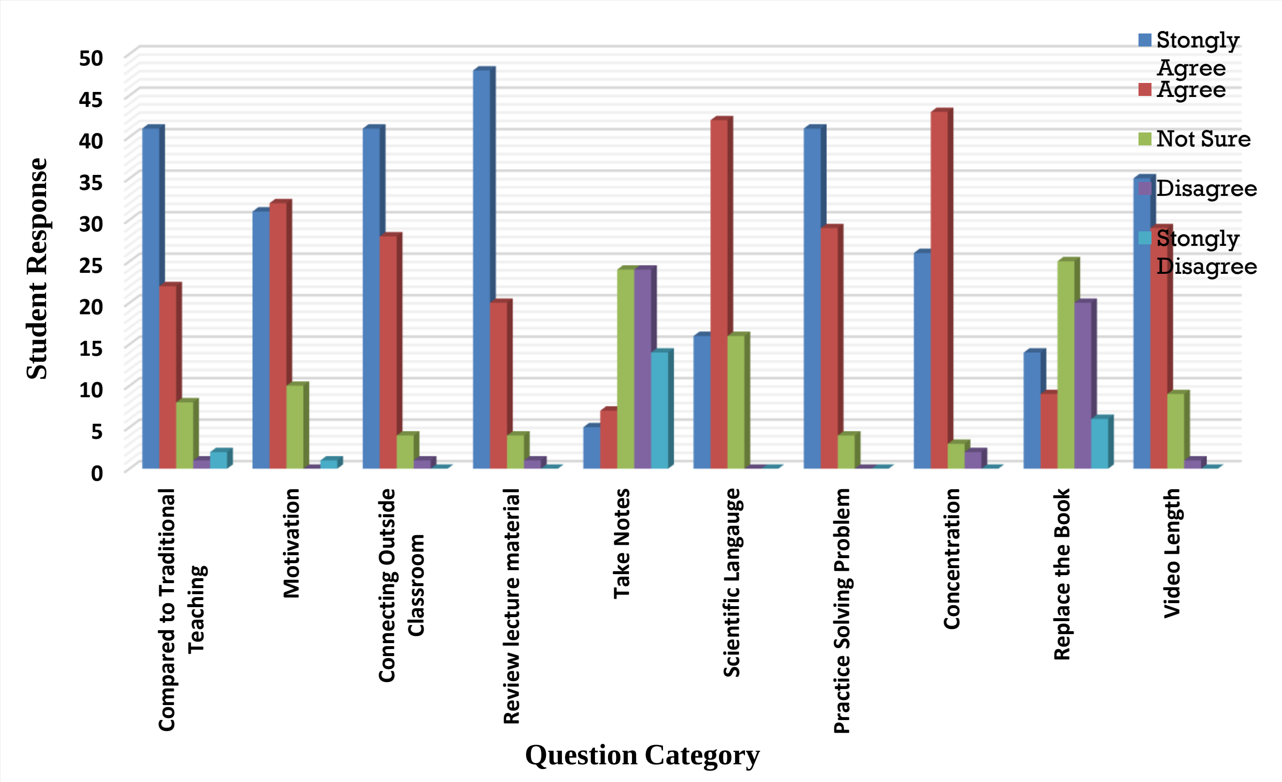


Figure 4. Survey data of Physics teaching 1st semester 2020.



In summary, Tables 1 and 2 and Figures 3 and 4 evidence that the students are in favour of the scientific videos involved in teaching Chemistry and Physics subjects. Physics classes in particular found the scientific videos prepared by the instructors were a great help to their engagement. Detailed discussion is presented in the subsequent sub-section.

Analysis and discussions of survey and questionnaire results

Malina, Nørreklit and Selto (2011) claim that students' motivation for learning activities determines their level of engagement. When students pursue an activity because they want to learn and understand (self-oriented), rather than solely wanting to obtain a good grade or satisfy their parents, their engagement is more likely to be full and thorough. Table 1 shows that compared to traditional didactic teaching using only a whiteboard, the video-enabled ABL significantly increased students' motivation, i.e., 85% of the Physics students strongly agreed or agreed, and 71% of the Chemistry session agreed. In addition, the use of videos also improved the student engagement with the subject study outside the classroom, i.e., 93% of Physics students strongly agreed or agreed, and 73% Chemistry session agreed. One student commented that ‘the interactive videos helped me to recall the course material more distinctly, the videos were like private tutorial sessions can be accessed when it needed repeatedly [sic]’. In addition, ‘the conversational style of the video is closer to personalise the conversation rather than using formal language’. This comment echoes the findings of Brame (2016) which suggests that the use of language in learning has a great impact on developing a relationship with the presenter and increases student engagement with the subject.

Fredricks’ (2004, with Blumenfeld and Paris; 2014) studies have shown that if students do not consider a learning activity worthy of their time and effort, they might not be motivated, or engaged in a satisfactory way. Hence, it is essential that students perceive activities as being meaningful and relevant. Table 1’s results (strongly agree and agree combined in each percentage) show 93% of Physic students and 85% of Chemistry students found using educational videos helpful for reviewing lecture material. Furthermore, 93% of Physics and 70% of Chemistry students strongly agreed or agreed that video-enabled ABL helped them to focus on the main concepts. One of the merits of using video-enabled learning is that students could have more autonomy with controlling their learning pace, i.e., they could freely move backwards or skip and select important sections to review. This allows students to revisit the key concepts at any time and stay focused. Using PlayPosit in this study provided many of these options, such as, trimming any extra or unrelated parts of the video and adding questions to alert learners to certain parts of the material. This helps the learner focus on the main contents of the subject, and makes it easier for them to revise the material.

Problem-solving is one of the most important skills for STEM students as they construct knowledge through solving problems. Students often find solving complex problems that require multiple steps a challenge. Nevertheless, problem-solving skills do not develop spontaneously. As educators, it is important that we create a classroom environment in which students are problem solvers. Using the supporting educational videos when discussing solving problems will provide students with the guidelines to analyse the question and use it as a reference while they are trying to practise solving more problems without the teacher present. Learning activities, i.e., a) knowledge acquiring and b) collaborative activities as described above are designed to encourage students’ problem-solving. This study finds that video-enabled ABL is supportive in terms of developing students' problem-solving skills. As seen in Table 1 and Figure 3, the majority of students strongly agree and agree (94% and 83% in Physics and Chemistry sessions respectively), that educational videos are as effective tools for practising solving problems. This could build students' confidence and improve their performance in comparison to other students who were not exposed to the same videos for the same subjects.

As instructors our primary goal is to deliver syllabus, and we could not always accommodate each student's need during scheduled class time. There is always a need to create opportunity for students to discuss the materials in more depth outside class time. Hence, the video-enabled ABL also could promote deep-learning and address the needs of weaker students who could not fully grasp the subject knowledge within the limited class time. The learning activities c) evaluation and self-check and d) reflection as described above are designed to support and/or stretch students. The evaluation of students' academic performance provides further evidence of whether the video-enabled ABL enhances their test results. This will be presented and discussed in the next section using statistical tests.

ANOVA test of students' performance

We examined and compared students' performance in Chemistry and Physics tests. There were 20 class groups across the STEM programme and different tutors made their personal choices regarding usage of videos.

ANOVA test results in Chemistry

Whether learning truly takes place will be reflected in students' academic achievement (Kola, 2013; Aravind, 2016). We compared the results of students' test results between the groups with access to videos (n=57) and without videos (n=63). The full mark for the Chemistry test was 33%. The average of classes without the video was 24.0397 and the number of classes with videos was 27.4298, as shown in Table 3. ANOVA testing was conducted to determine if the mean difference is significant. The statistics show there was a significant effect of scientific videos on students in the test performance. The value of $F(1,119) = 10.50$ and p value= 0.0016 indicates that the null hypothesis (i.e., that there is no difference) is rejected.

Table 3. ANOVA: single factor test on Chemistry session.

SUMMARY						
Groups	Count	Sum	Average	Variance		
Without	63	1514.5	24.0397	38.7202		
With	57	1563.5	27.4298	26.1736		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	343.9299	1	343.9299	10.4966	0.0016	3.9215
Within Groups	3866.37	118	32.76585			
Total	4210.3	119				

ANOVA test results in Physics

We examined students' test results between the groups with videos access to videos-enabled learning n= 79) and without access to videos (n=104). The results are presented in Table 4: the average for classes without the video was 17.9952 and for classes with videos was 22.0823. Similarly with the Chemistry classes, the statistics show the scientific videos had a significant effect on students in the test performance. The value of $F(1,182) = 11.7483$ and value of $p = 0.00075$ indicates the null hypothesis is rejected.

Table 4. ANOVA single factor test on Physics session.

SUMMARY						
Groups	Count	Sum	Average	Variance		
Without	104	1871.5	17.9952	72.099		
With	79	1744.5	22.0823	53.0476		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	749.958	1	749.958	11.7384	0.00075	3.8933
Within Groups	11563.96	181	63.8893			

Total	12313.92	182	

In summary, ANOVA results showed that the mean test results for both the Chemistry and Physics students were higher with the use of scientific videos. The ANOVA results indicated that the integration of scientific videos improved students' performance in learning regardless of the specific subject. ANOVA testing was carried out on data from both STEM1 and 2 sections, (Physics in STEM1 and Chemistry in STEM2). The average score of the session with video-enabled ABL implemented is higher than the other sections in both Chemistry and Physics regardless of course levels. The P-value was calculated as less than 0.05 (5%), so the null hypothesis is rejected which suggests the difference in students' performance is statistically significant.

Conclusion

The shift from in-person to online and/or blended-learning due to the pandemic has brought more challenges in terms of keeping students engaged in a different learning environment. To improve the learning and progression of science subjects such as Physics and Chemistry, instructors need to complement not replace traditional (in-class) learning. We should also appreciate and value students' desire to use digital technologies and help them to embrace the new learning methods. The findings of this study suggest that video-enabled ABL could provide significant improvements in student engagement and academic performance. However, the sole use of educational videos itself will not have magical results. The key is to use these videos to develop activities to foster better interaction and self-directed learning. The framework proposed in this study facilitates STEM educators to implement video-enabled ABL.

However, this exploratory study relates to only one cohort of students at one institution and so is limited in scope. The authors plan to extend the level of tuition required for scientific videos and further research will be carried out to develop the student's perceptions questionnaire and repeat the survey to make the results more generalisable. Additionally, focus groups or interviews could be undertaken to obtain a deeper understanding of students' views on this novel approach. Students' performance comparison was undertaken on two types of classes, with or without videos. Therefore, there might be other factors to explain the difference in their test results. Notwithstanding the limitations of this work, the findings suggest that students do perceive using scientific video-enabled ABL is effective to promote engagement in learning STEM. Hence, the findings of this paper will be of relevance to academics involved in STEM education and those interested in the application of scientific videos to engage students with STEM curriculum.

Disclosure of potential conflicts of interest

The authors certify that they have no affiliations with or involvement in any organisation or entity with any financial, non-financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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Appendix

Questionnaire: student's feedback survey/Chemistry

1. I enjoy learning STEM02 Chemistry using educational videos compared to the traditional method with just white board

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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2. I find learning STEM02-Chemistry (Stoichiometry & Precipitation Reaction) more motivating with Chemistry educational videos

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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3. I find STEM02-Chemistry educational videos are enough for me that I do not need to take notes during lecture time

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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4. Educational STEM02-Chemistry videos help me concentrated on the main concepts of the subject

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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5. I find STEM02-Chemistry educational videos keep me engaged with the course outside the classroom

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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6. I find educational videos a useful way to review the course material

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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7. I find educational videos improve my scientific English language because of the captions provided and clear audio

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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8. Problem solving STEM02-Chemistry educational videos very helpful solving problem practise with guidance

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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9. The length of the STEM02-Chemistry videos was acceptable

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

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10. Educational videos could be a good tool to replace books

1. Strongly Disagree 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

Any further comments you may have:

Selected example Chemistry learning videos:
https://www.youtube.com/watch?v=ZxQp80Fvhjo&t=288s (Balancing Chemical Equations).
https://www.youtube.com/watch?v=K5vsiJzGnsc (Chemical Reactions Types).
https://www.youtube.com/watch?v=bltnuzbs2JA&t=329s(Chemical Reactions Stoichiometry).
https://www.youtube.com/watch?v=ZiXtpuDZlP8 (Empirical and Molecular Formula from Percent Composition).

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