VIDEO-BASED LEARNING IN CHEMISTRY EDUCATION: EXEMPLARS, ISSUES AND CHALLENGES

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Abstract

In learning chemistry, a teacher's approach has an impact on student's understanding of content and their motivation for learning. Many studies suggested integrating technology that includes video in teaching and learning may increase students' understanding, attention and interest in exploring scientific ideas. It is a worldwide demand for integrating technology in science teaching. This paper presents an analysis of the types of educational video that were used in the field of chemistry education as well as identification of exemplars, the advantages and disadvantage of each educational video, particularly in the field of chemistry. This review was done by a meta-analysis or systematic reviews of 260 studies published in peer reviewed journals in the year 2003 to 2017, as well as indexed in the Educational Resources Information Centre (ERIC), Taylor and Francis, Science Direct, Journal of Computer Assisted learning and Springer. From the analysis, there are five types of videos that were widely used in chemistry classroom teaching such as demonstration video, instructional video, simulation video, tutorial video and video games. In one hand, several advantages are identified: first, the use of educational video is self-accessible; second, interesting; third, safety for students to conduct the hazardous experiment. On the other hand, several barriers are identified: first, using educational video should be aligned with educational standards; second, limited hours of school; third, accessibility at school. The implications of these findings are explored and suggestion for future research are raised.

Keywords: Chemistry education; Educational video-based learning; Exemplars; Challenges

Introduction

Background and Overview

The Ministry of Education introduced the National Science Education Philosophy which emphasizes the outcomes needed to include producing universally accomplished students with knowledge and skills related to technology. This statement presents a task that should also be recognized by all teachers whose responsibilities are not just to deliver content information, but also understand its use.

> *Science education in Malaysia nurtures a science and technology culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific and technological competency.*
> (Malaysia National Science Education Philosophy, 2016, p.4).

Chemistry is an experimental science and cannot be separated from laboratory work. For students to have a meaningful learning coupled with in-depth understanding of chemistry, they need to be able to conduct experiments and be familiar with a range of laboratory skills. It is therefore necessary to give them supplementary experience in laboratory work.

But, devoid or lacking of knowing the concept behind the experiment, what has happened is that many students struggle collecting data and analyzing the experimental results. They are busy creating and developing their own understanding of the principles associated with that data. This sort of problem happens at the secondary school level where students struggle with the preparation of numerous types of laboratory reports as their necessary responsibilities (Barbara, Gary, & Lyubov, 2003).

In addition, compared to the formal teaching in the classroom, laboratory work consumes more time to organize and handle, as well as leads to exposure to hazards. When it comes to handling hazardous chemicals, teachers have to pay closer attention to students and the concerns are that without close supervision, students may have fun with the lab activities as well as may think that chemicals and equipment are toys to be played with. The inherent nature of some aspects of chemistry (like radioactivity or nuclei and physical chemistry) cannot provide a safe laboratory experience due to equipment, materials and time constraints.

Compared to the secondary level, in a higher learning institution, students themselves start handling instruments or tools. The teacher and/or lab assistant are prepared and available to give help. At this stage, students are faced with something entirely new, the apparatus. A shortage of individuals who are specialists in operating a particular equipment or machine reduces the opportunity for students to acquire skills to handle an instrument. Without these individuals, there is no laboratory. It is also essential that equipment like an FT-IR spectrometer (used to confirm the presence of certain bonds in a certain sample, and is something stimulating to students to explore at the higher institution level) is fully mastered before students face real-life experience in industry.

Focus of Study

This article discusses meta-analysis or systematic reviews of studies conducted between 2003 to 2017 on the five types of educational video and educational videos in the field of chemistry education with elaboration of exemplars as well as identification of the advantages and barriers of using educational video, particularly in the field of chemistry. It is expected that the analysis of data from literature research could form the basis for the development of a conceptual framework for further studies on the integration of educational video in the teaching of chemistry.

Statements of the Problem

It is a worldwide demands for integrating technology in science teaching. The paper review was done by a meta-analysis or systematic reviews of 260 studies published in peer reviewed journals in the year 2003 to 2017, and index in the Educational Resources Information Centre (ERIC), Taylor and Francis, Science Direct, Journal of Computer Assisted learning and Springer. The analysis then narrowed the articles to chemistry as instructional subject which only use observation and interviews as instrument among students and teachers. This paper proposed to develop a conceptual framework for further studies on the integration of educational video in the teaching of chemistry.

Literature review

The Use of Technology. Considering today's development and advancement of technology, a technological tool used as a teaching aid is necessary. Technology is a means to make things easier. Technology can be used in entertainment, for problem-solving and completing tasks that would never have been possible to accomplish without that specific tool. Computer and multimedia, gadgets, as well as phones are samples of technology that are widely used. Such technologies are explicitly designed for various functions and for a specific purpose.

Technology in education aims to improve educational practices. The latest generations are critical technology users and have become highly technologically based, so that the educational field could better take this opportunity to utilize it as an attractive approach for learning and teaching (Benedict & Pence, 2012). Traditional teaching styles, like chalk and talk, as well as lecture, are no longer interesting and appealing to students who do not pay full attention during the learning period. Schneider, Krajcik, and Blumenfeld (2005) indicate that students have a tendency to simply become bored with something plain in style and they really do not get involved or participate in a learning session.

Integrating Technology in Chemistry Teaching and Learning. Besides biology and physics, chemistry is one of the strands in science. Chemistry deals with materials and concepts that are not possible to be seen in real life; they are more abstract than real. It requires for both teachers and students to use their imaginations and visualizations of things. For example, electrochemistry, one topic in the chemistry of Form 4, deals with inter-conversion of chemical energy and electrical energy, taking place in electrolysis and in voltaic cells. In this case, studies by Kamisah and Lee (2014) and Roziah (2005) exhibited that the topic is tough to learn since the concepts are abstract.

Moreover, it's vital for students to actually comprehend the concept in advance of entering college or university because an information-deprived concept or misconception developed in secondary school may have a greater influence on their understanding during the tertiary stage of education. Therefore, acquisition of the basic concept in secondary school is imperative, leading to an improved understanding of chemistry at the tertiary level (Bulte, Westbroek, de Jong, & Pilot, 2006). Peterson (1990) stresses that educational materials had better be lively, dynamic, and as stimulating (motivating), such as television, music, video, movies and computer games. Humor and sound effect, precisely, contribute momentously in stimulating the students' imagination.

Therefore, with the improvement of technology, chemistry learning has to be more attractive and interactive to provide meaningful learning to the student (Pryor & Bitter, 2008). Technology, as a teaching aid, can provide the picture of the concept behind the process that is applied. Innovative and interactive approaches to teaching and learning of chemistry engage students more intimately as compared with the customary classroom method (Lerman, 2003). Students of this new age, possess noteworthy information and communication technology skills. It would then be advantageous to utilize these cultivated or enhanced skills in the classroom for the educational benefit. For instance videos add the advantage in classroom learning because they reflect and recognize the intensely diverse learning style of the present-day generation of students (Jeremy et al., 2016).

Methodology

Surveying all that have been published on educational video in education was not a possible task within the time constraint of this project. Therefore, the study looked for the most systematic way to sample the research conducted in the field. The researcher decided to conduct meta-analysis of research studies by focusing on peer-reviewed journal articles that were indexed in the ERIC, Taylor and Francis, Science Direct, Journal of Computer Assisted Learning and Springer database. This decision was done, by considering the database that was subscribed by the researchers' university library. The analysis then narrowed the articles to research on various types of video-based learning in chemistry as instructional subject involving observation and interviews as methodology of studies among students and teachers who were involved in video-based chemistry learning.

Data Analysis and Discussion of Findings

This section presents the analysis of data based on literature review of empirical studies that were conducted to extract findings from observation and interviews among students and teachers in schools/institutions using various types of video-based learning in chemistry.

Meta-Analysis of Research Studies Based on Chronological Order and Types of Videos

Table 1 is the meta-analysis based on the studies conducted on various types of educational videos in chemistry teaching and summary is given in terms of types of videos, research techniques and samples involved in these studies. By narrowing the studies from over 260 articles to those only involving chemistry as an instructional subject between the years 2003 to 2017, the number of articles were reduced to 21 papers specific to our study.

Table 1
Summary of the Selected Studies Conducted (Arranged According to Chronological Order with The Most Recent First) on Various Types of Educational Videos in Chemistry Teaching

No.	Research Studies Conducted		Methodology	
	Researchers (Year of Publication)	**Types of Educational Videos in Chemistry**	**Research Techniques**	**Samples Involved**
1	Fujioka (2017)	Instructional video	Observation	Students
2	Roggenkämper and Waitz (2017)	Tutorial video	Observation	Students
3	Galloway and Bretz (2016)	Demonstration video	Observation	Students
4	Ominowa and Bamidele (2016)	Demonstration video	Observation	Students
5	Jordan et al. (2015)	Demonstration video	Observation	Students
6	Key and Paskevicius (2015)	Tutorial video	Interview	Students
7	Timberlake (2015)	Tutorial video	Interview	Students
8	Erdmann and March (2014)	Instructional video	Observation	Students
9	Guo, Kim and Rubin (2014)	Instructional video	Interview	Students
10	Smith (2014)	Instructional video	Observation	Students
11	Tierney, Bodek, Fredricks, Dudkin and Kistler (2014)	Instructional video	Observation	Students
12	Björkman and Tiemann (2013)	Instructional video	Observation	Students
13	Tatli and Ayas (2013)	Simulation video	Observation	students
14	Tomas and Seidel (2013)	Instructional video	Observation	Students
15	Benedict and Pence (2012)	Instructional video	Observation	Students
16	Chee, Tan, Tan and Jan (2012)	Video game	Interview	Students
17	He, Swenson and Lents (2012)	Tutorial video	Interview	Students
18	Sasaki, Silva, Fortes, Feres and Zagatto (2011)	Demonstration video	Observation	Students
19	Jyun and Hong (2010)	Instructional video	Observation	Students
20	McClean and Hagan (2010)	Demonstration video	Interview	Students
21	Barbara, Gary and Lyubov (2003)	Demonstration video	Observation	Students

Table 2 illustrates another meta-analysis with classification of research studies conducted based on five types of videos, number of research and methodology used in the studies.

Table 2
Literature Research on Types of Videos and Empirical Studies via Observation & Interviews

No.	Types of Videos Identified in Research Studies	Number of Research and Methodology Used in the Studies Involving Observation Techniques	Number of Research and Methodology Used in the Studies Involving Interviews Techniques	Total Number
1.	Demonstration video	4 [Barbara et al. (2003); Ominowa and Bamidele (2016); Sasaki et al. (2011); Galloway and Bretz (2016)]	1 [McClean and Hagan (2010)]	5
2.	Instructional video	8 [Fujioka, (2017); Jyun and Hong (2010); Björkman and Tiemann (2013); Erdmann and March (2014); Tomas and Seidel (2013); Smith (2014); Tierney et al. (2014); and Benedict and Pence (2012)]	1 [Guo et al. (2014)]	9
3.	Simulation video	1 [Tatli and Ayas (2013)]	-	1
4.	Tutorial video	2 [Roggenkämper and Waitz (2017); He et al. (2012)]	2 [Timberlake (2015); Key and Paskevicius (2015)]	4
5.	Video games	-	1 [Chee et al. (2012)]	1

Table 2 above indicates that the great majority of researchers focused on instructional videos rather than any other form of educational video. This could be as a result of the effectiveness and enjoyment in developing student engagement in a classroom, enhance creativity and presentation skills (Smith, 2014). It is clearly understood from the typical observation that students who received classroom instruction via instructional videos tended to be more confident and acquired a deeper understanding of the material than those who received similar instruction in a traditional format (Jyun & Hong, 2010).

Due to their flexibility, other video forms, including demonstration and tutorial were also preferably used to specify instructions in secondary school, value and cost-effective nature in providing meaningful learning in the chemistry classroom (He et al., 2012).

Elaboration on Exemplars According to Types of Educational Video

Utilization of videos as instructional tools is no longer out of the picture when we think of science or chemistry studies, ever since it has become the necessary tools which offer a sophisticated and imaginative picture that best describes a certain topic. There is a proportion of studies that try to create and design educational videos to aid the students' imagination as well as gain a deeper understanding of complex and abstract subject matter. Videos can be developed to convey information in numerous forms and incorporate with various content, e.g. demonstration video, instructional video, simulation video, tutorial video and video games.

Demonstration Video. A demonstration video illustrates an intended instructional area of chemistry to the classroom. Besides students practising their laboratory skills, several topics in chemistry (e.g. the determination of melting points, acetamide, reported cancer cause, and also 1 to 6 molar acetic acid causing serious eye and skin irritation during stoichiometry) need a visual practical laboratory demonstration. Then again, very few practical examples can be conducted in the laboratory because of the hazardous chemicals and/or the inherent danger of the reaction itself resulting in health and/or safety concerns. For that reason, teachers can use a video that illustrates the topic to provide at least a visual experience for students even if they can't personally perform the experiment.

Moreover, the demonstration video helps the teacher to show an early picture of exactly how the experiment will look like (Galloway & Bretz, 2016). Occasionally students can't picture how the experiment will be conducted by just reading the instructions given in a handbook or manual. Thus, a demonstration video provides assistance to students and teacher to imagine as well as get the picture how the actual experiments ought to be conducted in advance to their experience of the activities themselves. It also offers precautionary advice if there are risky and dangerous reactions happening, furthermore, videos can even demonstrate which might happen.

Instructional Video. An instructional video shows step-by-step procedures or instructions of how to use or control or handle some equipment. As an example, Figure 1 illustrates a teacher is describing how to use an FT-IR or UV-Visible spectroscope or any related apparatus that needs extra precaution to handle in a university course called "spectroscopy". The instructions given in video form include steps or procedures to prepare samples, type of sample that is suitable to run on the precise apparatus and what result to expect.

Figure 1. FTIR Analysis (FTIR Spectroscopy) (Labtesting, 2013).

To accommodate the requirement of the user who wants to know by running a sample on the equipment, essentially, each tool or machine that is able to run the sample has its own objective. Each machine has its own manual that needs to be learned, and it also addresses different types of expected outcomes. Therefore, by watching the instructional video, it is expected that those students who have no prior idea or experience in dealing with that particular equipment, will develop reasonable skills that will enable them to become active members of the classroom. This will also enable them to read the result acquired from the specific equipment during the laboratory experiment and/or classroom activity.

Smith (2014) stressed assigning students to utilise instructional videos as well as develop one of their own will automatically enhance creativity and the skills of the students in public engagement and presentation. These students can even become empowered as worldwide educators in their own right. Instructional videos can be made precisely for one specific type of equipment, like the spectrophotometers used in universities. Essentially students need to watch the video required to handle or perform experiments using different equipments. Studies have indicated that many instructors have stopped doing demonstrations because of time limitations and welcome the utilization of instructional videos as an alternative to provide and ensure effective classroom instruction thus enhancing deeper understanding.

For example, Jordan et al. (2015) conducted a study to determine the effectiveness of a demonstration video in comparison with a traditional laboratory experiment that involved identification of organic compounds in a laboratory. Students were divided into two: the first group of students received regular mode for laboratory instruction for organic compounds identification; while the second group of students watched a video demonstration on how to identify the organic compound in an experiment. They found that students who watched the demonstration video were able to better repeat the experiment than those who received traditional laboratory instruction.

Simulation Video. A simulation video is a typical video that expresses how a concept or process occurs. Essentially, it provides a simulated picture of exactly how the process works when it can't be seen. For instance, how electrons share or pairing of electrons is imagined to occur, the movement of particles during boiling, what happens to particles during freezing, where the electron moves during electrolysis or why oxygen gas is needed in combustion, as shown in Figure 2.

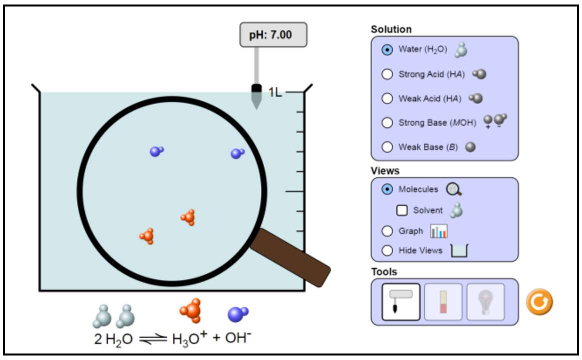

Figure 2. Acid and base interactive simulation (PhET Interactive Simulation, 2017).

Therefore, through graphics and action, a simulation video helps students to imagine how the process is thought to occur in a particular science/chemistry topic. Usually, this form of video is short and brief. This video focuses on certain chemistry topics (like the concentration of substances) that need to be augmented because an explanation with words or pictures may not be enough. We need some simulation to boost the student's understanding by providing a clear and real representation of the concept to enhance a deeper understanding by the students. A few short notes or supplementary notes will provide additional explanation. This kind of video typically acts as an additional teaching method supported by digital tools for the teacher to consolidate students' understanding of the formal teaching in the classroom.

Tutorial Video. The tutorial video is a type of video that comprises steps and procedures in searching the answer for a certain chemistry or problem-based questions. It provides a question on various topics and subtopics, like organic chemistry and alkenes. A student can search out the question that specifically relates to the topic, and it will show step-by-step how to get to the answer.

This form of video also focuses on other chemistry areas that may require mathematical computations, for example, finding the molarity, the volume, the concentration and how to balance an equation. Basically, teachers use this video as bank questions and student uses these questions as their references. Because some of the questions like balancing equations in reduction-oxidation need explanations, and depending on the question asked, this type of video can last for more than 30 minutes. The video could be used to provide written notes or audio recording in which the narrator could elucidate why certain steps are used.

Video Games. This kind of video is extensively used. The games played provide content that includes chemistry elements. Video games can offer diverse types of digital games at various levels, such as novice, intermediate or expert. This form of video is also specific in terms of the topic or educational level. Usually, a teacher uses this video to attract student's attention in learning and to polish their understanding of certain topics.

Among the types include games or quizzes, video games for exploration or even video games that include a virtual laboratory. Video game design typically provides numerous choices of topic for students to play.

Elaboration on Exemplars According to Educational Videos in Chemistry

Table 3 presents a sample representation of the summary of types of Educational Videos in Chemistry and the methodologies used in the studies involving observation and interviews.

Table 3
Types of Educational Videos Related to Chemistry Education *and Methodology of Studies Involving Observation and Interviews*

No.	**Types of Educational Videos in Chemistry Identified from Research Studies**	**Methodology of Studies Involving**	
		Observation	**Interviews**
1.	Dance video	Predominantly used	
2.	iTube	Normally used	Normally used
3.	WeTube	Normally used	Normally used
4.	YouTube	Normally used	Normally used
5.	Video Game	Predominantly Used	

Demonstration Video. Multimedia laboratory instruction has largely been observed to increase students' skill thereby lessening the time spent in learning the skills (Isman, Abanmy, Hussein, & Al Saadany, 2012). An example for such finding was demonstrated in a classroom instruction under chemistry subtopics which included size, charge, electronegativity, and ion energies of the elements in the periodic table. Two videos-based lessons illustrated the step-by-step procedures of an experiment demonstrating the reactivity of elements were used for the classroom instruction.

This classroom instruction was designed to convey three activities to be performed by the students during the lesson. At the beginning of the instruction, students were systematically grouped and a worksheet was distributed among the groups. The worksheet required students to identify their hypotheses based on their previous knowledge, experiences and information about chemical reactivity of groups 1, 2 and 3 metals of the periodic table (Barbara et al., 2003).

After stating their hypotheses, a video clip that illustrated the activity-series of chemical reactivity and non-reactivity of some eleven metals was played. At this time, the second activity of the students was to conclude what kind of periodicity had been exhibited.

After logical conclusions were turned in by each student, the second video clip was played to demonstrate another set of chemical reactions. Based upon the hypotheses made before, students and instructor engaged in discussion. The acceptable and non-acceptable hypotheses were discussed and a suitable conclusion reached. Finally, the third activity of the students was to design an experiment to examine the effect of electronegativity on cation acidity, using suggested halides. Some compounds of halide combinations are reasonable, while others are not. Students should have been able to come up with their suggested elements, with a reason given for their choice.

This activity engaged students in moving between utilization of video and their scientific understanding in learning science or chemistry. It led students to concentrate and pay full attention to the video played to comprehend the concept, thereby forming the best conclusion along with a strong explanation. Results from the interviews after finishing the activity indicated that about 50% of students preferred the video method while another 50% favoured the live demonstration.

Dance Video. Gidget and Kimberly (2015) conducted studies using dance in a video to learn chemistry. DanceChemistry, as shown in Figure 3 presents the concept of thin-layer chromatography. In the video clip, there were dancers and all were individually representing a specific character. The group of dancers in a white dress made a Thin Layer Chromatography (TLC) plate and wore a black armband on their left arm to represent the plates' hydrogen bonding abilities. While dancers in orange dresses were 'spotted' onto the plate also wore a black armband to represent a set of hydrogen bonds. Dancers in blue represented the solvent moving up the plate and pushed upwards two dancers in orange together with them. The orange dancers with the black armband (the polar analyte) interacted with the white TLC plate dancers through dance lifts, lowering the movement of the plate and in due course lowered the retention factor (Rf).

Figure 3. Thin Layer Chromatography-Dancer Version (DanceChemistry, 2013).

This activity implements the pedagogical approach through chemistry learning incorporating art in dance in order to facilitate student's visualization of an abstract concept. For those involved in the dance activity, it assisted the students to extensively discover the role of the characters they embodied in the process. They also learned about another character performed by their friend, how to react, when to react and why to react. They are able to be exposed to and learn deeply about the concept illustrated in the video. Those who are watching the video clip will also be helped to visualize (or develop strong meaning to) the concept and get a picture of how the process occurs. It shows that both participants in this activity get advantages. It is challenging for its developer to design an interesting storyboard that attracts students' attention and focus. Hence this type of video should add notes and provide a narrator to facilitate real understanding and achievement of effective learning.

From the study indicated in Figure 3 above, pre- and post- surveys to test the effectiveness of DanceChemistry (2013) on learners' understanding were given. Learners reported that the video helped them visualize chemistry ideas in a new and memorable way. About 75% of the learners interviewed reported wanting in the future to use these videos to learn additional chemistry topics.

iTube, WeTube and YouTube. A widely used channel to post a video is YouTube. Without any limitation and regulation, where anyone having his/her own account, one can post any video one wants, either created or taken from other sources with consideration of ethical issues through proper acknowledgement.

Students generally accept natural resources, but some, in particular, demonstrated a degree of fear and dislike (chemophobia) for attending a chemistry class in secondary schools. YouTube offers a rich learning environment through which students of chemistry and members of the general public can be engaged, as well as chemophobia can be addressed (Smith, 2014). Other benefits of such videos include the development of learning activities in which students are optimally engaged with acquisition of mostly presentation skills; enhanced creativity and are empowered to become global educators (Anderson & Kratwohl, 2001).

An example of a video which can be posted in iTune, WeTube and YouTube is shown in Figure 4 below. This is a YouTube video developed by a group of chemistry postgraduate students from the Faculty of Education, Universiti Teknologi Malaysia for an edutainment competition. The video provides basic information about oxygen and the uses of oxygen by human beings through the Claymation technique (Sandaram et al., 2016).

Figure 4. Oxygen (Sandaram et al., 2016).

By making and creating the learners' own video, publishing and sharing it with the public, this activity also helps members of the general public to feel closer to science as well as to make science easier to learn and apply. It is evident from a study that video making is a means of engaging students in the propagation and explanation of science. They enjoy themselves and become creative. It can increase open appreciation of chemistry as an important instrument or mechanism to satisfy the needs of a society, to develop young people's keen interest in studying science, and to breed passion for its creative future (Burke, Snyder, & Rager, 2009).

Advantages and Barriers to Using Educational Video and Suggestions for Implementing

Using qualitative data analysis approach, the summary of the 'advantages and barriers to using educational video' is presented in Table 4 which were extracted from literature research, as well as studies through observation and interview conducted earlier.

Table 4
Summary of Advantages and Barriers Based on Review of Literature on Research Studies

No.	Advantages	Barriers
1.	Self-accessible	Alignment with educational standards
2.	Interesting	Limited hours of school
3.	Safety	Accessibility at school

The following are further elaborations made.

Advantages

Self-Accessible. This supplementary aid consists of easily accessible features and abilities for students and teachers. These educational videos consist of the play and the pause buttons, enabling students and teachers to run the clip, repeat or anytime, to control the volume, as well as to regulate the size displayed on screen and speed of motion. All these features lead students and teachers to be comfortable with the ease of use in their learning and teaching sessions.

Moreover, these abilities encourage students to use and reconsider the material on demand when needed. Zhang, Jin, and Li, (2010) indicated that even when they are not in a teaching period in school, students are able to have access on their tablet anytime and anywhere. Students are also capable of sharing to some extent with teachers and their friends any video-relatable resource they found as well as watched (Ruiji, 2012).

Interesting. With the development of technologies, the present generation faces a bundle of entertainment forms. For that reason, video in classroom instruction containing interesting and exciting elements that are capable of capturing student's attention. Usually, students learn science in the class, with pen and paper, teacher's use of chalk and whiteboard. By using video, students now have the opportunity to watch instructional content with animation that can make their learning become alive (Turkoguz, 2012).

The video that is made up of graphics, animation and even sound as well as the visual effect stimulates students and motivates them to stay focused on learning. They are able to interact and share with friends as well as teaching others what catches their interest and excites them. It promotes informal learning in a relaxed environment.

Safety. Again, chemistry deals with a variety of types of chemicals and apparatus. Many students believe that chemicals and equipment used in the laboratories required a well-trained person to handle and explain. Students just need to watch and listen to the instructions from the educational video. Therefore, a video can help students to watch some real experiments or demonstrations that they would not be able to do in the laboratory.

Video helps to reduce the risk of injuries and accidents. After an explanation from the teacher about the hazards, a video can help students to watch the impact when they are dealing with hazardous chemicals in the classroom. Therefore, it provides students with meaningful learning despite not being directly involved in the experiment.

Barriers to Implementing Educational Video

Alignment with Educational Standards. A study conducted by Mayer (2001) indicated that the content as provided in an educational video is crucial in the part it plays; either it aligns with standard curriculum or otherwise. Studies indicated that most of the videos used in education are developed for marketing purposes and the contents do not attract major attention. If the developers are not in the educational field, it leads to not being cognizant of the standard curriculum content.

Hence, it has become obligatory for the makers of the video and experts in education to be involved with each other in designing and planning the video used for education. This collaboration will help society in selecting videos that align with the standards of education.

Limited Hours in School. Teachers in Malaysia are challenged by the target curriculum content within specific hours given. Thang et al. (2010), reported that most of the teachers interviewed expressed deep concern about the limited time assigned for classroom instruction in secondary schools. Teachers must strictly trail the framework they prearranged earlier on in the term. It is also an obligation for them to finish certain topics in certain weeks.

For that reason, teachers have inadequate time to show students additional materials. Basically, a teacher may have to give formal learning before giving extra material. For certain topics (like stoichiometry, thermodynamic, and so forth) or certain classes, as required, there is extra attention and a brief clarification from the teacher. He/she has to find time to provide the additional material to students. Darling-Hammond and McLaughlin (2011) offered a discussion about curriculum content and the workload assumed for teachers to be changed and re-designed. During the next curriculum review, Malaysia's Ministry of Education could consider the daily period (including duration for instruction), time given to each subject and curriculum content provided to teach.

Accessibility at School. The lack of infrastructure and facilities available in the school are still causing the many administrators to be undecided whether educational videos should be used or not. Schools in rural areas have limited access to technologies or even basic facilities. Although teachers are provided with extra material for teaching, the school facilities are still not in good condition to support the materials given to them.

To have access to the resources that are required in integrating educational video in chemistry classroom instruction (i) a projector needs to be installed in all classrooms where chemistry instruction may be scheduled; (ii) teachers should possess personal computing devices for educational video development; (iii) facilities must be well-managed by both teachers and the students; and (iv) there should be regular maintenance of classroom facilities.

Conclusion and the Way Forward

From all the advantages explained above and taking into consideration the barriers to implementation of the educational video, it can be concluded that educational videos play critical roles in promoting students' understanding. Primarily because educational videos have the important elements that capture and attract students' attention.

The analysis of data from literature research, as well as findings from observation and interview form the basis for the development of the conceptual framework for further studies on the integration of educational video in the teaching of chemistry. In addition, the development of science and technology that are at a peak stage in this digital era suggests that the optimal use of educational video should be adopted and instituted in the educational system.

Society and educational technologists should work hand-in-hand to assist teachers and parents through developing quality video or providing any sort of moral assistance that suggests educational video can help future education. All stakeholders must take the risk to produce something that can have a bigger impact on our educational system.

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