Available online at www.joac.info

ISSN: 2278-1862

Journal of Applicable Chemistry

2015, 4 (4): 1017-1023

(International Peer Reviewed Journal)

Chemical Education Article

An Experiment in Technological Pedagogical Content Knowledge: Effect of Online Video Support on Student Comprehension And Critical Thinking in Chemistry

Kotwal Marazban

Department of Chemistry, St. Xavier's College, 5, Mahapalika Marg, MUMBAI – 400 001, **INDIA**

Email: marazban.kotwal@xaviers.edu

Accepted on 20th July 2015

ABSTRACT

The goal of this research was to comparatively examine the effect of online support through chemistry videos, created by the author, on the student performance for a group of students and its comparison with those students who did not have the support. The study was carried out on two groups of students belonging to 2 different divisions of First year Bachelor of Science with 135 students in each of them such that one of the division students were provided with video support on YouTube in accordance with the fundamental premise of Technological, Pedagogical and Content Knowledge (TPCK) which takes into account effective technological integration of teaching specific content with pedagogical skills. Chemical Kinetics unit of the Physical Chemistry syllabus was chosen about which the students had some fundamental knowledge from their earlier studies. A knowledge based diagnostic test was administered before starting with the topic and an internal assessment was administered after the completion of the unit for both the groups. The internal assessment was designed on the basis of Bloom's Taxonomy. In the internal assessments both the groups performed better than that in diagnostic tests however the performance of the group with the online video support far exceeded compared to those without the online support in understanding and application oriented questions. This study in Chemistry education, unlike many similar studies, is quantitative in nature rather than based on student perceptions and can be useful to chemistry educators.

Keywords: Chemical Education Research, Technological Pedagogical Content Knowledge, ICT, Educational videos, Bloom's Taxonomy.

INTRODUCTION

The technological advancement in the recent years has affected our life in every possible aspect, including the environment in a classroom and the way teachers can teach. This technological advancement holds a huge potential to improve teaching and how it can make academic content accessible to students for its optimum use [1].

The advent of Web 2.0 represents a conceptual change in the way contents are built in the internet and the way people utilise these contents, the major features include user created web sites, self-publishing platforms and the Web 2.0 offers all its users the same freedom to contribute and collaborate, in contrast with the old modelled websites where people were limited to the passive viewing of the contents. Experts have argued since its inception that the activities of users generating content (in the form of ideas, text, videos, or pictures) could be "harnessed" to create value. Web 2.0 technologies hence have opened up for Educators new ways to engage students and methods to facilitate learning of concepts [2]. Social networking sites have started playing a great role in education in many parts of the World [3]. YouTube is a social network that was launched in 2005, in which users share videos, and therefore will be considered in our study. According to YouTube statistics over 850 million unique users visit YouTube each month, over 4.2 billion h of video are watched each month on YouTube, 72 h of video are uploaded to YouTube every minute. In other words, YouTube is a dynamic endless source of videos that can also be used by chemistry students. Technology is increasingly being accepted to be an integral part of chemistry education, with the use of videos, simulations, and student response systems well reported. It is becoming increasingly more common to find videos of chemistry experiments, animations, and simulations that explain abstract chemistry concepts on YouTube, thus making students' conceptual learning of chemistry much easier [4].

Teachers rely on two elements in their teaching: content knowledge and pedagogical skills which are integrated. The term Pedagogical Content Knowledge (PCK) is used to describe the interdependence between the two elements and the merging of content and pedagogy into a complete understanding of how the different aspects of a specific subject are organized, coordinated, and represented for instruction [5]. Incorporation of technology as a part of the instructional process has become an almost a compulsion and hence a modified term Technological Pedagogical Content Knowledge (TPCK) is used to describe the intersection between the above-mentioned content knowledge and pedagogical skills relevant and technology [6]. TPCK is a framework describing how content, pedagogy, and technology influence and complement one another. The TPCK framework allows teachers to design pedagogical strategies and to examine the changes needed in the teacher's knowledge to create effective technology-based teaching. The TPCK method requires a good understanding of how to represent educational ideas, pedagogical techniques, and content knowledge in the curriculum, all with the use of technology [7]. One major application of TPCK is the use of Information and Communication Technology (ICT). This kind of learning provides a better clarification, explanation, and emphasis on the added value of subject matter that students usually find difficult to understand or teachers find difficult to teach [8-10].

There are several pedagogic reasons for change to be brought about by educators' which include attempts to enhance student-centred activity, harness technology to provide rapid feedback, facilitate student group work, provide student support to large groups. This can be facilitated by using technology optimally to teach effectively rather than using it to act as a repository for academic content. This is specially so as ICT is used by many teachers as a tool for passing on the educational content rather than using the technology to improve teaching.

One method of using technology to improve teaching and support classroom teaching would be using videos as they facilitate learning by allowing students to animate abstract chemical concepts in their minds [11-17] and make it easier for students to remember the important points of the content [18]. It has been mentioned that videos have a positive impact on acquiring knowledge [19-20] and contribute to the development of a student's cognitive capabilities, including interpreting, critical thinking, and problem-solving skills [21]. The use of videos as teaching material also has a positive impact on a student's motivation. Making use of videos in support classroom teaching changes the style of teaching to shift from teacher-centred to student-centred instruction.

Though a large number of teachers are employing the tenets of TPCK, it is needed to evaluate its impact in the form of educational research as evaluation of the methods should be considered to be a fundamental part of educational advance. The study was carried out on 2 groups of about 135 students each, one group was provided with online support in the form of videos on YouTube after the traditional classroom teaching to understand the concepts at their own pace and as a review whereas the second group was only exposed to traditional classroom teaching. Two tests were carried out for both the groups, to evaluate the impact before and after the completion of the unit.

MATERIALS AND METHODS

Imbibing the ethos of TPCK and with an objective of carrying chemical education research for evaluating the impact of the strategy, several videos in the form of screencasts were created by the author in order to support the students in their understanding of a unit involving Chemical Kinetics which was part of their physical chemistry syllabus. The videos were created and edited using Camtasia Studio 7 ® which is a screen casting programme by www.Techsmith.com and catered to various facets of the unit namely the concepts, derivations and the word problems. For the concept based videos which did not demand a large amount of writing, PowerPoint was used whereas for derivations and problems which required several mathematical equations to be written step-by-step, Windows Journal was used. The functionality of Camtasia was found to be more suited to all the requirements as one can record anything on the computer screen and the audio simultaneously, edit out mistakes, add callouts or arrows to highlight important information, zoom in or out at appropriate times and then upload the file directly to YouTube. The PC Tablet allowed the use of stylus for annotating on PowerPoint (which is known to improve attention) and writing the derivations and solutions to problems step-by-step. For recording the videos with high quality of audio it was preferred to use an external microphone connected with the help of a USB to the PC Tablet as the sound obtained from the microphone in-built in the PC Tablet was quite poor. The requirement for high quality of audio was my expectation that many students will view the videos on their smartphones or Tablets some of which have a poor output volume.

To evaluate the impact of the support, the study was carried out on 2 groups of students belonging to 2 different divisions, one of which was given the support of the online videos and the other was not and hence used as a control in the study. This was achieved by privately sharing the videos with the students of one of the divisions on YouTube. A diagnostic test was carried out for both the divisions before starting with the unit as some fundamental knowledge of chemical kinetics was already taught to the students in the lower classes. The diagnostic test questions were knowledge based and was administered to both the classes unannounced. At the end of the unit an identical test was administered to both the groups on the basis of Bloom's Taxonomy with the test paper being balanced with knowledge based, understanding based and application based questions. Bloom's Taxonomy encompasses skills in the cognitive domain that revolve around knowledge, comprehension (understanding), and critical thinking (application) on a particular topic and refers to a classification of the different objectives that educators set for students (learning objectives). The students were made aware of the methodology of conduction of test being based on Bloom's Taxonomy in the beginning sessions of the course so as enable them to prepare accordingly.

RESULTS AND DISCUSSION

The data of the marks obtained in the diagnostic test indicated the two groups being homogeneous had almost similar performance with the simple arithmetic mean of the marks obtained out of 20 being 9.73 and 9.82 respectively which was almost the same. However in the test conducted after the unit was completely taught, the students supported by online videos performed better in the questions based on understanding and applications. Whereas the performance in knowledge based question was the same like the results obtained from the diagnostic test. For example as can be seen from the graphs given below 12 % of the students got more than 18 marks and less than equal to 20 marks in the group supported by online videos as against 5 % in the group not supported. Similarly, 21 % of the students got more than 16 marks and less than or equal to 18 marks in the group supported by online videos as against 10 % in the group not supported. The supported group had more than double the number of students successfully solving application based successfully questions and about 20 % more students solving the understanding based questions efficaciously. The arithmetic mean of the marks obtained are out of 20 by the students were 12.87 and 15.33 for the groups without online support and with online support respectively.

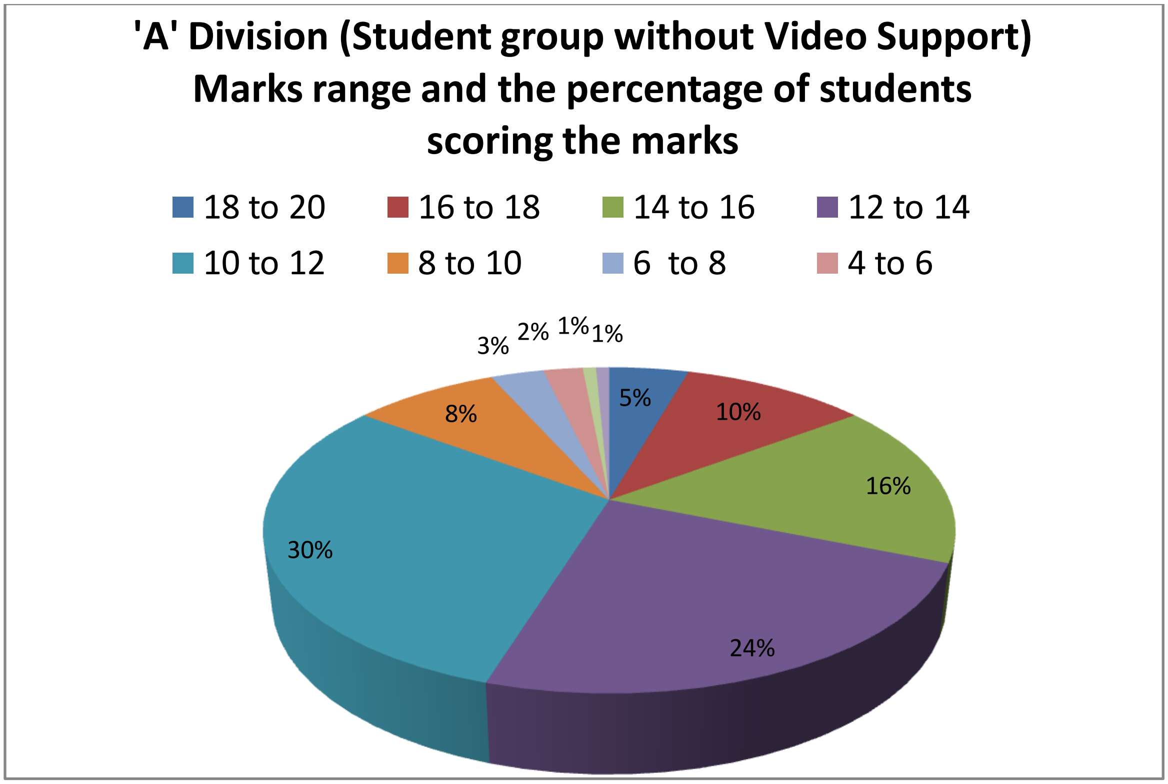

Figure 1: Performance of students not supported by Online Videos in the marks range from zero to 20 (Marks range 18 to 20 represents marks more than 18 and equal to or less than 20; Marks range 16 to 18 represents marks more than 16 and equal to or less than 18)

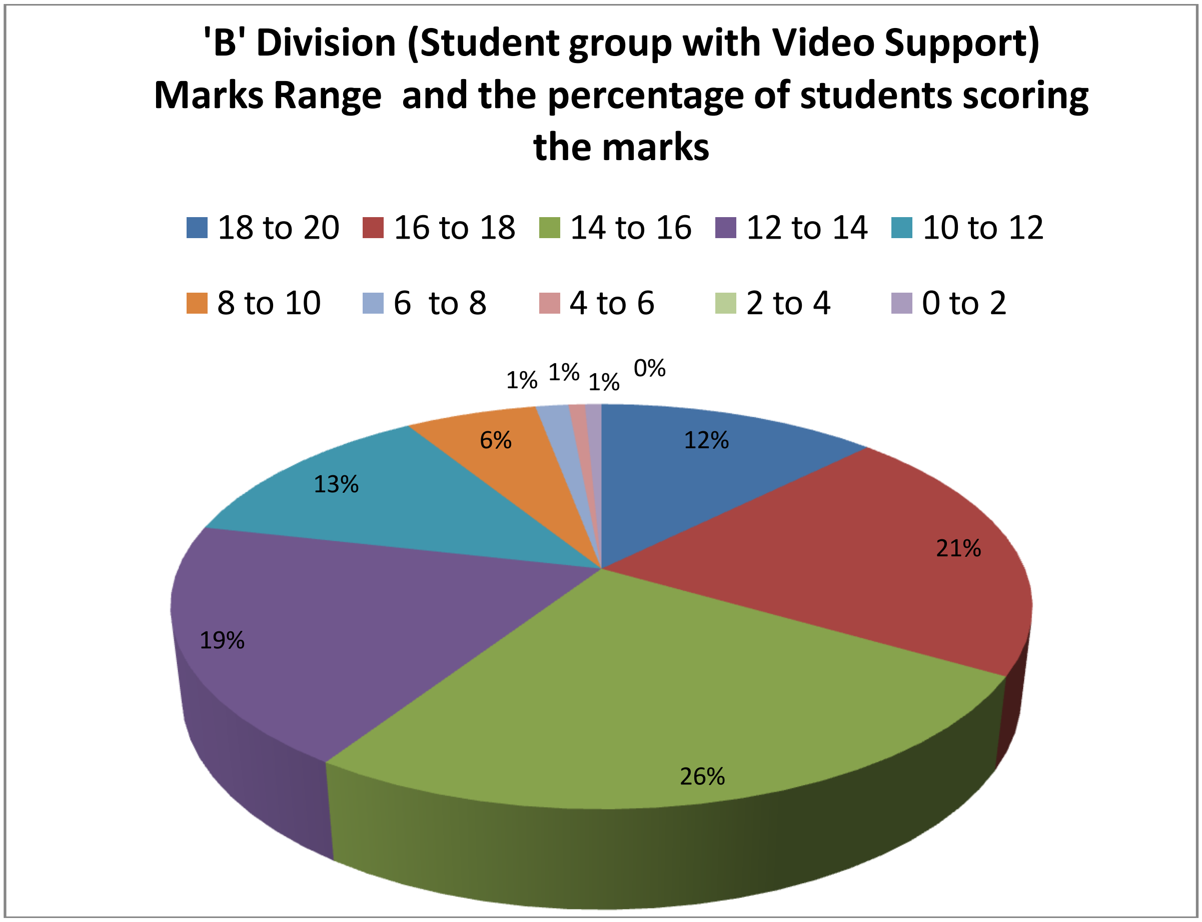

Figure 2: Performance of students supported by Online Videos in the marks range from zero to 20. (Marks range 18 to 20 represents marks more than 18 and equal to or less than 20; Marks range 16 to 18 represents marks more than 16 and equal to or less than 18)

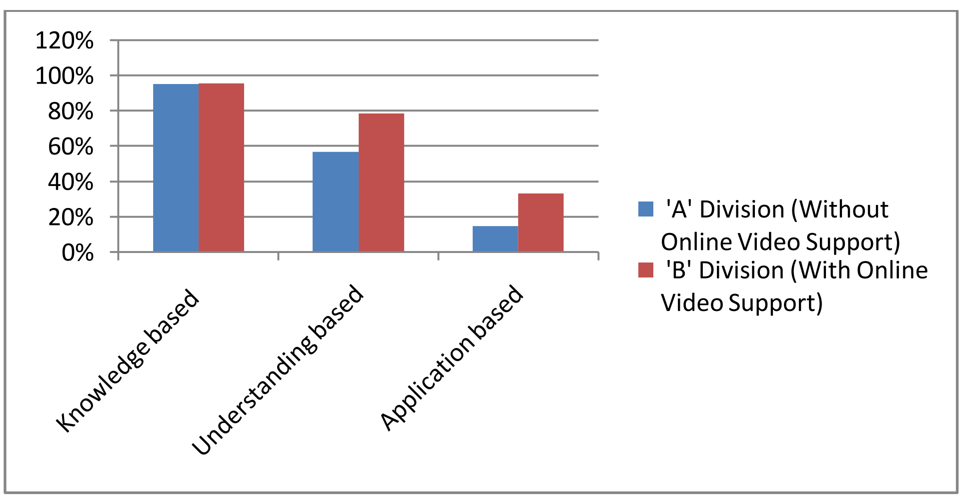

Figure 3: Comparative performances of students in knowledge based , Understanding based and Application based.

This can definitely be attributed to the fact that the students with online support had the edge of being able to catch up with the events in the classroom in case they inadvertently missed the class or had a lapse of concentration. Also students who were gradual in their uptake of the concepts could understand them at their own pace. Apart from this the students with anxieties towards mathematical aspects of the unit could gain confidence by repeatedly going through the videos and the several numerical problems solved.

CONCLUSIONS

The student performances indicate that the video support enhances the understanding of the concepts and provides a tool to the students to tackle application questions and helps them solve mathematical problems with relative ease. Ease of access to YouTube increases the availability of the videos at their preferred time, place as well as on the type of gadget (computer, Tablets or smart phones) they prefer and the ability to replay them helps them learn and assimilate concepts at their own pace. The inherent excitation brought about by the prospect of online learning surely contributed to motivate the students to make the extra effect and dedicate more time. This very much conforms with the tenets of TPCK which propounds the idea of using technology to enhance teaching pedagogy and improve cognitive abilities of the students and involves framework that highlights complex relationships that exist between content, pedagogy and technology knowledge areas and may be a useful organizational structure for defining what it is that teachers need to know to integrate technology effectively.

ACKNOWLEDGMENTS

Special thanks to the Head, Department of Chemistry, St. Xavier's College, Mumbai, for supporting this endeavour.

REFERENCES

[1] J. Voogt, P. Fisser, N. Pareja Roblin, J. Tondeur and J. van Braak, Technological pedagogical content knowledge – a review of the literature, *J. Comput. Assist. Learn,* **2013**, 29(2), 109–121, DOI: 10.1111/j.1365-2729.2012.00487.x.

[2] A. Collins and R. Halverson, Rethinking education in the age of technology: the digital revolution and the schools, New York: Teachers College Press, **2009**.

[3] J. Garcia-Martinez, Chemistry 2.0: creating online communities, *Chem. Int.*, **2010**, 32(4), 4–7.

[4] B. Pekdag and J. F. Le Mare´chal, An explanatory frame-work for chemistry education: the two-world model, *Educ. Sci.,* **2010**, 35(157), 84–99.

[5] L. S. Shulman, Those who understand: knowledge growth in teaching. *Educ. Res.,* **1986**, 15(5), 414.

[6] P. Mishra and M. J. Koehler, Technological pedagogical content knowledge: a framework for integrating technology in teacher knowledge, *Teach. Coll. Rec.*, **2006**, 108(6), 1017–1054.

[7] J. T. Abbitt, Measuring Technological Pedagogical Con-tent Knowledge in Preservice Teacher Education: A Review of Current Methods and Instruments. *J. Res. Technol. Educ.,* **2011**, 43(4), 281–300.

[8] C. Angeli and N. Valanides, Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: advances in technology and pedagogical content knowledge (TPCK), *Comput. Educ.,* **2009**, 52, 154–168.

[9] A. Jimoyiannis, Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers professional development, *Comput. Educ.,* **2010**, 55(3), 1259–1269.

[10] M. H. Lee and C. C. Tsai, Exploring teachers' perceived self efficacy and technological

pedagogical content knowledge with respect to educational use of the World Wide Web, *Instr. Sci.*, **2010**, 38, 1–21.

[11] V. M. Williamson and M. R. Abraham, The effects of computer animation on the particulate mental models of college chemistry students, *J. Res. Sci. Teach.*, **1995**, 32(5), 521–534.

[12] T. Cavanaugh and C. Cavanaugh, Learning science with science fiction films. Paper presented at the annual meeting of Florida Association of Science Teachers, Key West, FL. Retrieved from the ERIC database. (ED411157) computer-driven laser videodiscs. *J. Chem. Educ.*, **1996**, 62, 514–515.

[13] J. G. Goll and B. J. Woods, Teaching chemistry using the movie Apollo 13, *J. Chem. Educ.*, **1999**, 76(4), 506–508.

[14] L. H. Laroche, G. Wulfsberg and B. Young, Discovery videos: a safe, tested, time-efficient way to incorporate discovery-laboratory experiments into the classroom, *J. Chem. Educ.*, **2003**, 80(8), 962 -966.

[15] E. Yang, T. Andre, T. J. Greenbowe and L. Tibell, Spatial ability and the impact of visualization/animation on learning electrochemistry, *Int. J. Sci. Educ.*, **2003**,25(3), 329–349.

[16] A. V. Marcano, V. M. Williamson, G. Ashkenazi, R. Tasker and K. C. Williamson, The use of video demonstrations and particulate animation in general chemistry, *J. Sci. Educ. Technol.*, **2004**, 13(3), 315–323.

[17] M. J. Sanger, E. Campbell, J. Fekler and C. Spencer, Concept learning versus problem solving: does particle motion have an effect? *J. Chem. Educ.*, **2007**,84 (5), 875.

[18] D. D. Kumar, Hypermedia: a tool for STS education? *Bull. Sci. Technol. Soc.*, **1991**, 11, 331–332.

[19] C. Zahn, B. Barquero and S. Schwan, Learning with hyperlinked videos – design criteria and efficient strategies for using audiovisual hypermedia, *Learn. Instr.*, **2004**, 14(3), 275–291.

[20] E. Michel, C. M. Roebers and W. Schneider, Educational films in the classroom: increasing the benefit, *Learn. Instr.*, **2007**, 17, 172–183.

[21] B. J. Hagen, Lights, camera, interaction: presentation programs and the interactive visual experience, Paper presented at the Society for Information Technology and Teacher Education International Conference, Nashville, TN. Retrieved from the ERIC database, **2002**.

AUTHORS' ADDRESS

1. **Marazban Kotwal**
Assistant Professor, Department of Chemistry
St. Xavier's College,5, Mahapalika Marg, MUMBAI – 400 001
marazban.kotwal@xaviers.edu, Phone No: 91-9821086871