The Potential and Pitfalls of Using the Video-conferencing Technology to Enhance Student Learning

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Video-conferencing permits two or more people in different geographical locations to engage in face-to-face communication. Although this technology has already been around for some time, its use has yet to become widespread because of the high costs of equipment and call charges. However, recent technological developments have reduced the costs drastically and video-conferencing is now more affordable to implement. Recently, two groups of secondary school students in Singapore had an opportunity to participate in a video-conferencing programme conducted by an overseas university. The students had to attend a lesson taught by an expert first, then made short presentations to an audience whom they had never met before in another session. This article discusses the potential benefits and shortcomings of using such a technology at the secondary level, with the aim of raising awareness of its capabilities so that teachers can harness its potential to support and enhance teaching and learning.

Introduction

Those who have watched earlier sci-fi movies would have come across scenes that show people from one planet sitting in front of a screen and communicating with others from another planet. The technology enabling that communication to take place is often merely regarded as the sci-fi writer's creative imagination. That such technology would one day become reality was a remote possibility. However, such technology, known as video-conferencing, is now available and more accessible than ever, all because of recent technological developments.

Video-conferencing is a two-way real-time technology that enables individuals or groups of people in different geographic locations to engage in face-to-face communication. In this live interaction, all the parties involved in a video-conference can see, hear and even talk to each other concurrently. Although this technology has been available for many years, the high costs of equipment and maintenance services plus the lack of flexibility have limited its use in education. In recent years, there appears to be a rising number of schools that are using video-conferencing to enhance teaching and learning. In many countries ranging from the US (Kollie, 2005) to the UK (Martin, 2005), the video-conferencing technology is making its way into the classrooms because of recent advancements in technology which make it more affordable than ever to be acquired.

In Singapore, students from two secondary schools, on separate occasions, recently had an opportunity to participate in video-conferencing lessons on mathematics-related topics conducted

by a British university. This article discusses the potential and pitfalls of conducting lessons through the use of video-conferencing technology, which arise from the students' participation in this programme. It begins with a rationale for conducting this study and follows with a discussion of the methods. The results and discussion of the benefits and shortcomings of video-conferencing are presented as a way of helping teachers who intend to use this technology.

Rationale for this study

Research literature on the use of video-conferencing technology in education has tended to focus mainly on higher education (see Canning, 1999; Hu, *et al.*, 2001; Peterson, 2004; Wang & Yuen, 2004), but rarely at primary and secondary levels (see Arnold, Cayley & Griffith, 2002; Martin, 2005). There is evidence in the research literature that using video-conferencing can enhance learning outcomes for students. For instance, Year 8 British students showed improvement in their mathematical communication skills, both oral and written, after participating in video-conferences (Gage, 2003). In another case study, which involved A-level students from a British school receiving distance lessons from the Liberty Science Centre in the USA, the teacher noted some benefits of learning through video-conferencing such as enhanced pupil motivation, improved problem solving skills as well as a meaningful use of IT skills (Martin, 2005). Even so, the potential of video-conferencing still remains largely unexamined in the research literature. Thus, the purpose of this study is to mainly gather students' feedback about their learning experiences in the video-conferencing programme so as to examine the potential and pitfalls of conducting lessons through the use of video-conferencing technology. With using video-conferencing as a means for teaching and learning in local schools being a relatively new initiative, the findings of this study will, therefore, not only be important and valuable, but also helpful in creating an awareness of its capabilities in offering a new dimension to teaching and learning.

Methods

The video-conferencing programme in which the Singapore students took part was called the *MOTIVATE* project (**M**athematics **O**pportunities **T**hrough **I**nternet, **V**ideo-conferencing **A**nd in**T**eractive **E**ducation). This real-time video-conferencing programme, managed by University of Cambridge, provides a platform for school-going children of ages 5 to 18 years to be engaged in direct interaction with expert users of mathematics, from whom they get to solve problems and learn about the applications of mathematics in the real world. Using multipoint video-conferencing to connect participants from different locations around the world, the programme aims to enrich the children's mathematical experience, broaden their mathematical horizons, as well as provide them with opportunities to work collaboratively on mathematical tasks and present their work to an outside audience.

A *MOTIVATE* video-conference is typically conducted over two sessions. The first session is an interactive discussion between a particular expert in mathematics and the participating students from different schools on a specific topic, normally lasting an hour and a half. In the interim between the two sessions, students work on suggested project work under their teachers' guidance. Then at the second session, some students from each participating school are encouraged to make

short presentations on their project work. After each presentation, they are also expected to field questions from the expert and other schools' students.

The Participants
The two Singapore secondary schools, which participated in this study, are labelled A and B. Established almost thirty years ago, School A is a mixed-gender government school with a student population of about 1300 and caters to the needs of a wide range of students from Secondary 1 to 5 (13 to 17 year olds). School B is a very established independent girls' secondary school whose students, from Secondary 1 to 4 (13 to 16 year olds), are all academically talented.

In 2004, twenty six Secondary 3 students, aged 15 years, from School A participated in a *MOTIVATE* video-conference on *Mathematics and Music*. Another group of twenty six students, also aged 15 years from School B, attended one on *Codes and the Quantum Computer* this year. All the students were studying in the upper secondary level when they took part in the respective video-conferences. The *Mathematics and Music* video-conference was held at the National Institute of Education because video-conferencing facilities were not yet available in their school whereas students from School B attended the video-conference in their own school. All the video-conferences started in the evening at 6 pm (Singapore time) for School A and 5.30 pm (Singapore time) for School B.

The Video-conferences
The first session of the *Mathematics and Music* video-conference, presented by Dr Jenny Gage, dealt with the role of mathematics in music. Ideas such as the interesting relationship between the length of a string and the note it produced when plucked and how the anomaly in the Just Scale had led to the development of the Well-tempered Scale presently used were discussed. She also demonstrated how the basic concept of symmetry in mathematics could be used as a fundamental principle for folk dancing. In between the explanation and demonstration, students were given short tasks to do and later asked to share their results. For instance, one of the tasks, which aims to give students a sense of the idea of symmetry in folk dancing, required four students, each holding a letter A, B, C or D and all standing in a line, to act out a set of moves by following Jenny's instructions. In the second session, two groups of students from Singapore presented their project to Jenny and participating British students. One group explored the ordinary guitar and found that the frets of a guitar were spaced out according to a certain ratio. The other group discovered that the inverse relationship between the frequency of a note and the length of the string was valid for the case of a Chinese musical instrument known as the *erhu*, a two-string bowed fiddle with a sound box.

The second video-conference on *Codes and the Quantum Computer* was conducted by Prof Artur Ekert, an expert in the field of quantum physics. He shared with the students some methods used in ancient times to encrypt and decipher messages from the caesar shift cipher to frequency analysis, as well as those used in modern history such as the binary one-time pads during the First World War and the famous Enigma machine in World War 2. Students also learned about the concept of quantum computers, which are said to have the potential of revolutionising codes and code-breaking all over again (see Figure 1).

Figure 1: Prof Ekert delivering the lesson

Aside from listening to the presenter, students also had hands-on experience in decoding a message only given out during the video-conference. As a follow-up activity, they were first encouraged to use any of the methods discussed during the session to code a message, then mail it to the video-conference facilitator to be sent to the other participating students for them to have a try at cracking. Next, they were challenged to create an "unbreakable" code for other students to break. In the second session, three different pieces of project work ranging from topics like the history of cryptography to public-key ciphers were presented by the Singapore students to Prof Ekert and participating British students.

Instruments and Data Analysis
A qualitative approach was adopted as it was deemed most appropriate for a small-scale study. Two instruments were mainly used to collect data of such nature: a student questionnaire and video-recordings of the video-conferences. A questionnaire consisting of open-ended questions was distributed to every participating student immediately after the video-conferences. But because it was very late at night when the video-conferences ended, the students were allowed to fill in the questionnaires at home and instructed to return the completed questionnaires to their teachers within the next few days. The questionnaires were then analysed to find out about their viewpoints on video-conferencing. Video-recording was used to document all the video-conferences. All video-recordings were reviewed to look for visual evidence that would shed lights on the possible benefits and shortcomings of using video-conferencing. Data were also collected through another method: personal communication with the teachers involved in this programme. The teachers provided some useful feedback on their viewpoints of using such technology in teaching and learning.

Results and Discussion

The results of this analysis yielded some interesting information about the affordances of the video-conferencing technology, which will inevitably influence the school's decision to implement it. Therefore, it is important for prospective users of this technology, such as teachers, to know the kind of learning outcomes it can help to achieve and be convinced that it can enhance and enrich

teaching and learning before making any decision to use it in the classrooms. So, in order to create an awareness of what such technology can offer for teaching and learning, this section discusses some of its benefits, as well as shortcomings, based on the two *MOTIVATE* video-conferences described previously.

The Benefits
Learning from experts Video-conferencing can be used as a means of bringing an expert, who may otherwise be inaccessible due to distance and time, to the students (Gage, 2005). Indeed, in the two *MOTIVATE* video-conferences, the Singapore students had never met the presenters before. However, owing to the technology available, they had a chance to learn and interact with them. The resulting interaction between them offered a new learning experience for the students. Not only were they enthused by this opportunity to learn and interact with an expert, they also appeared to cherish such a privilege. Additionally, some students even found the experience of learning from the experts, whom they regarded as a figure of authority in their respective fields, fruitful and meaningful. Table 1 shows four students' remarks about their experience in interacting with the experts.

Table 1
Learning from experts

	Remarks
Student 1	… it's a once in a lifetime experience when we are communicating via video-conferencing to an expert mathematics lecturer from the prestigious Cambridge university
Student 2	It isn't often we get to listen to lecture by such experts in school.
Student 3	…it was interesting to communicate with a professor and listen to his explanations and analogies as an expert in the field
Student 4	Here we have an expert giving a lecture rather than a school teacher so insights, analogies and general communication of the subject is better.

Other than these benefits, what is fascinating about video-conferencing is the fact that travelling time and costs in bringing an expert to the students are significantly trimmed. This is indeed a remarkable characteristic of the video-conferencing technology.

Interaction with live audience Similarly, bringing students in different parts of the world together for collaborative learning via the use of video-conferencing also exposes them to a refreshing and enriching learning experience. During the conference, students had to share ideas, make short presentations of their project work and even face the daunting challenge of fielding questions from the others regarding their project. Yet students seemed to enjoy the exchange of ideas that took place during the video-conferences (see Table 2).

Table 2
Exchange of ideas between students

	Remarks
Student 5	It is very interesting. We can share our opinions or ideas with the friends from other countries.
Student 6	Exposed to more ideas & learn from questions asked by overseas students. It's more interesting being able to compare how they work outside usual classroom situation.

According to Gage (2005), the presence of a live audience generates a motivating force for students to treat their presentations more seriously, as well as value and take pride in their own work even more. In addition, there is also evidence, as presented in Table 3, pointing to the fact that speaking to a live audience during a video-conference can help to breed and enhance students' confidence.

Table 3
Improvement in Confidence

	Remarks
Student 7	It improves my confidence of speaking up in front of a mass.
Student 8	I gain confidence in talking to a group of outside people.

Improvement in presentation skills In a similar vein, video-conferencing can also help students to improve their presentation skills. Video-conferences with a presentation component can offer a good training ground for students to practise how to report their work effectively to a target audience. This is because the audience may not necessarily have the same background knowledge as those making the presentation. Therefore, it is important to clearly convey ideas across to them if they are to understand what is being delivered. Apart from this perceived benefit, students can also gain from learning the different presentation styles shown by the rest. While the use of PowerPoint presentation remains common amongst many students, both locally and in the UK, some actually came up with other methods of presentation, a couple of which are thought to be quite innovative. For instance, in one of the video-conferences, a group of British students clearly conveyed their responses to a student task to the audience by writing the answers on a flipchart. On the contrary, the other groups merely read out theirs. The use of a flipchart produces an effective presentation by allowing the audience to follow the responses easily. In another video-conferencing session, an innovative presentation was observed when a British student sang a self-composed song to deliver a mathematical idea across to the audience.

Information exchange across the globe Video-conferencing can also serve as a vehicle for information exchange across a wide range of topics amongst the participating students of different nationalities. In fact, one student perceived video-conferencing as "a much advanced method for sharing knowledge". Like the two cases of exposing Singapore students to piped organ, folk dancing and Irish music, and of introducing the *erhu* to the British students in the *Mathematics and Music* video-conference, students were initially unfamiliar with the arts in each other's culture and many were probably hearing some of these for the first time. However, the sharing of these ideas amongst themselves broadens and deepens their understanding of the different cultures by the end of the video-conference. Likewise in the *Codes and the Quantum Computer* video-conference,

where there was a sharing of history, Singapore students discovered how a code-breaking technique caused the downfall of Mary, Queen of Scots when it was used to crack one of her messages. On the other hand, British students learned from their Singapore counterparts about the cryptography used by the Japanese during World War 2. Such exchanges of information augur well for all and, hopefully, can continue further once the barriers between students are dissolved and the gap narrowed.

The Shortcomings
Different Time Zones The geographical locations, from which the participating students come, can become a limitation of using video-conferencing technology. In this study, the UK and Singapore are thousands of miles apart, with Singapore seven hours ahead of the UK in winter and eight hours in summer. Consequently, a suitable local time to convene a video-conference between the two countries would seem to be in the late evening. However, having to start the video-conferences late in the evening was a common concern amongst the local teachers-in-charge of the programme. They were worried that their students would be too tired to concentrate during the sessions after having spent an entire day in schools. Their concerns were genuine and understandable, but, owing to the time difference of at least seven hours, this schedule, although not an ideal one for Singapore students, was deemed the most appropriate with all the participants' best interests in mind. Now, imagine the conference starts, say, at 10 am (Singapore time) for the welfare of Singapore students. Those in the UK will have to attend the sessions in the early hours of the morning. Obviously, it is not a reasonable arrangement for them! Therefore, it was inevitable that the sessions had to be held late in the evening. At this juncture, it must be highlighted that this problem can be reconciled when the participating countries share proximate time zones.

Technical Glitches Technical problems can strike any time during a video-conference. So it was not surprising at all that the two video-conferences encountered some technical problems. During a video-conference, the kind of technical glitches that can possibly happen include having freeze frames (see Figure 2), getting disconnected from the rest and receiving no audio outputs.

Figure 2: A freeze frame

All these technical problems can impinge on the students' learning, depending on the severity of the problem. The technical problems in the *Mathematics and Music* video-conference were relatively minor and did not really cause much disruption. For instance, in its second session where students made presentations of their project, Singapore students were only able to hear what a group of British students delivered very faintly because of faulty audio speakers in the local conference venue even despite having to turn on the volume to the highest. On the contrary, the situation was apparently much worst in the other video-conference on *Codes and The Quantum Computer*. Its entire first session was marred throughout by freeze frames and the occasional disconnection, thus disrupting the flow of the session. It also caused many students to lose track of what was being said. Evidence such as those given in Table 4 seems to reveal the students' disappointment with the video-conferencing technology as a result of these technical problems.

Table 4
Disappointment due to technical glitches

	Remarks
Student 9	It's quite a novel experience, but there were some technical faults that made the progression of the video-conference a little unsmooth, as in there were some interruptions as we kept getting disconnected.
Student 10	The quality of facilities causes inconvenience & impeded the fluency of the lesson a bit.
Student 11	An interesting and different way of approaching learning and definitely an experience all students should have, though sometimes technical difficulties may reduce its effectiveness.

Student reticence Finding students not wanting to speak up during the lesson is not uncommon in traditional classroom teaching. But would they feel more at ease and hence be more responsive during a video-conference when the presenters were total strangers to them? Well, it seemed that there was no difference in student behaviour. The same phenomenon, which happened during normal classroom teaching, was also observed in both video-conferences despite all the encouragement from the presenters and the coaxing from their own teachers. In general, most local students appeared to be rather hesitant when it came to asking questions or delivering their work. It usually took quite a long while before someone responded, unlike their British counterparts, who were more spontaneous. On a couple of occasions, the local students had to miss their turns of asking questions because nobody wanted to speak up. To save time and maintain the flow of the session, the presenter had to skip their turns. In one of the video-conferences, teachers had to resort to calling specific students to answer, but even then, some still felt uncomfortable and procrastinated in participating in the discussion. Unlike traditional classroom teaching, the presenters did not know the participating students well enough to call individuals by their names to answer questions. As a result, the interaction did not appear to be quite student-centred enough. Therefore, students had to take ownership of their personal learning because it was quite difficult for the presenters to monitor the progress of everybody during a video-conference. Perhaps, this is one area where a lesson delivered in a traditional classroom is thought to be seemingly more effective than it is by video-conference.

Conclusion

This article has highlighted some benefits and shortcomings of using video-conferencing in education, in particular, at the secondary level. The aim was to raise awareness of its educational value in offering a new dimension to teaching and learning. The benefits are simply impossible to be disregarded because students can gain and achieve so much more when they are engaged in video-conferencing. Furthermore, the feedback received from the local students regarding their general perception of video-conferencing has been very positive and encouraging so far. Many remarked that video-conferencing offers them an interesting and novel learning experience, and some appeared to have enjoyed it so much that they even proposed extending such an experience to other students as well.

The outlook for video-conferencing then seems to be promising. The recent introduction of 3G technologies in telecommunication gadgets such as the videophones familiarises the public to this technology. Additionally, the rapid development in broadband technology and the drastic drop in equipment costs and call charges make it even more accessible. In time to come, the use of video-conferencing will be more widespread than ever in institutions of higher education and the workplace. Therefore, if we do not harness its potential to help deliver, support and enrich student learning now, we will deprive students of the opportunities to be exposed to alternative learning approaches and to get involved in collaborative learning at international level. And when this happens, we will be doing students an injustice by putting them at a disadvantage in today's technological and globalised society.

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