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The videoconferencing learning environment: Technology, interaction and learning intersect

K. G. Saw, Omar Majid, N. Abdul Ghani, H. Atan, R. M. Idrus, Z. A. Rahman and K. E. Tan

K. G. Saw teaches physics at the School of Distance Education, Universiti Sains Malaysia. His research interests include delivery and support systems for distance learners in Malaysia and Physics Education. Omar Majid, N. Abdul Ghani, H. Atan, R. M. Idrus and Z. A. Rahman are also from the School of Distance Education while K. E. Tan is based at the School of Educational Studies, Universiti Sains Malaysia. Address for correspondence: K. G. Saw, School of Distance Education, Universiti Sains Malaysia, Minden, 11800 Penang, Malaysia. Tel: ++604 6534570; email: kgsaw@usm.my

Abstract

This paper is a study on the interaction patterns of distance learners enrolled in the Mathematics and Physics programmes of Universiti Sains Malaysia in the videoconferencing learning environment (VCLE). Interaction patterns are analysed in six randomly chosen videoconferencing sessions within one academic year. The findings show there are more interactions in the graphics display mode than the video display mode. The graphics display mode, which involves the simultaneous interaction of the teacher, students and course materials, shows greater student engagement in the VCLE. The focus on a three-component interaction in distance learning differs from previous studies which looked at distinct types of two-component interactions. The types of communicative interaction, in particular the explanatory and cognitive types which are dominant in the graphics display mode, are discussed within the construct of learning. The higher number of teacher-initiated interactions may also imply that the teacher plays a crucial role in creating and maintaining a community of inquiry focused on exploring and developing content as well as giving feedback on concepts, ideas or solutions.

Introduction

With the advent of advanced technology, distance education practices have evolved from didactic conversation utilising a simple dedicated telephone line for two-way communication and a self-instructional package to providing a learning experience almost as real as that found in a face-to-face traditional learning environment. While guided didactic conversation is no longer the pervasive characteristic of distance education, Chen and Willits (1998) found that dialogue in the form of in-class discussion remains

as the only factor to lessen the teacher–student transactional distance in spite of a technologically advanced learning environment. Therefore, a question of interest is how dialogue in a virtual environment can improve interaction between teacher and students (as well as between students themselves) and sustain a community of inquiry.

Expanding on the dialogue variable, Moore (1989) proposed the instructor–learner interaction, learner–learner interaction and learner–content interaction as the three main types of interaction that can be supported by synchronous interactive technology. The term 'interaction' generally involves interpersonal activities but could also mean an event or a process or situation in which two or more people are engaged in order to respond to one another (Shin, 2002). Studies on interaction in the videoconferencing learning environment (VCLE) have been few and it is not clear how much each of the three types of interaction proposed by Moore contributes to meaningful learning. A recent study on the effectiveness of dialogue in distance learning suggested that students initially chose individual study characterised by intra-personal dialogue, and only when individual study failed did students opt for interpersonal dialogue (Gorsky, Caspi & Trumper, 2004). Equating dialogue as a form of interaction, Gorsky *et al* suggested that the assumed importance often ascribed to interpersonal dialogue is not always true in practice. Moreover, unlike instructor–learner and learner–learner interactions, learner–content interaction is difficult to determine, and its frequency difficult to measure. For instance, Zhang (2005) defines learner–content interaction as any interactive activity between learner and instructional content in an online learning environment while Gorsky *et al* (2004) assume that learner–content interaction has taken place when learners read self-instruction texts, listen to lectures or audio tapes, view educational films, solve problems and manipulate computer simulations with the intent to learn.

For the study of interaction to be meaningful, it should be viewed from the domains of learning and instructional theories. It is important for distance educators to bring the discussion of interaction into finding ways to improve learning outcomes in a distance-learning environment. In general, learning theories describe the changes experienced by the learners and how they respond to a particular situation while instructional theories describe how instruction can be adapted to maximise learned capabilities. The purpose of this study is to analyse the pattern of interaction of distance learners in the VCLE environment and to describe the function of interaction within the constructs of learning and instruction.

Background of the study

The School of Distance Education in Universiti Sains Malaysia (USM) has been utilising the VCLE as the main delivery mechanism for its degree programmes since 1996. The VCLE is an improvement from the earlier audio graphics teletutorial system as it allows real time interaction between teacher and student(s), as well as student and student with the capability of presenting teaching materials using software such as Microsoft PowerPoint, simulation packages or video clips. An LCD projector and an electronic board are interconnected with the computer for this purpose. In addition, there is a

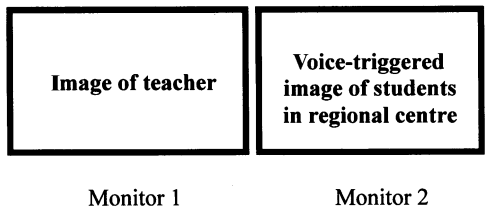

Figure 1: The video display mode

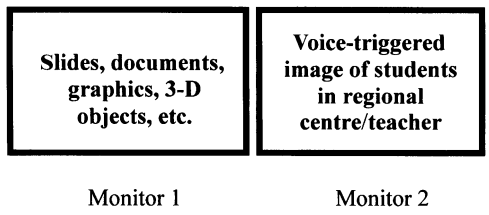

Figure 2: The graphics display mode

camera to record the teacher in real time and another to capture the images of any documents or 3-D objects that the teacher may refer to during the videoconferencing session. The teacher has control over these two cameras and can decide whether to enable the students to see him in real time or to see the images of teaching materials, 3-D objects or software graphics. These two display modes are used in this present study. The first type, which is the video display mode, involves the teacher and the students interacting with one another with the help of the voice-triggered monitor, but without the display of teaching materials, software packages or graphics. In this environment, one monitor will display the image of the teacher while another monitor is voice-triggered and displays the students at a particular regional centre. The second type, which is the graphic display mode, involves the display of documents, 3-D objects or software graphics, with the possibility of the teacher and students discussing the material being displayed. In the graphics display mode, one monitor is used to display the graphics while another is voice-triggered and displays the images of either the teacher or the students at a particular regional centre. Thus students from all the regional centres can interact with the teacher at any time during the video conferencing session. Figures 1 and 2 show the two monitors that face the students in the video display and graphic display modes respectively at the regional centres.

For the past decade, the two delivery modes have been found to be practical and easy to manage for the teachers, students, administrators and technical staff. While Internet-based approaches have formed part of the delivery mode in many distance-learning systems, these approaches cannot be used for students who do not have Internet access. Because a significant number of our students are mainly from the rural areas with limited Internet access, Internet-based approaches may not be suitable.

The VCLE system interconnects the main studio at the Minden campus in the state of Penang to the other videoconferencing sites at the regional centres throughout Peninsular Malaysia (West Malaysia). As a result of the high cost of telecommunication to connect East Malaysia to this system, students there are provided with a recorded version of the videoconferencing sessions. At the videoconferencing sites, one video monitor is used to display either the image of the teacher or the graphics used (PowerPoint slides, text, handwritten materials, 3-D objects, etc) while another is a voice-triggered monitor that displays the images of the students at a particular regional centre. The whole infrastructure uses dedicated telecommunication lines according to the specified bandwidth requirement to avoid technical problems associated with the use of normal lines. Good quality audio signals and video images are obtained using 64 kbps and 786 kbps respectively.

Most of the teachers are content experts with PhD qualifications and are familiar with the VCLE system. The teachers are also the course managers responsible for the entire administration of their courses, assessing the work of their students as well as building a close rapport with them. In this sense, they interact directly with the students without the assistance of intermediaries in the form of instructors, tutors or other learner supporters. While the materials in the instructional packages form the basis of the videoconferencing session, the teachers have considerable autonomy to determine the detailed contents of the course. For comparison with existing models of interaction, the term 'teacher' in our study is synonymous with the term 'instructor'.

The students aged between the late 20s to late 30s were fairly homogeneous in terms of educational background. Most of them possessed the *Sijil Tinggi Persekolahan Malaysia*, which is equivalent to the 'A'-level qualification. At the time of the present study, they were pursuing their first degree while keeping a full-time job.

The main sources of academic support for the successful completion of their studies would be the self-study course materials and the VCLE sessions. At the start of their candidature as distance learners, these students are required to undergo a formal course on the concepts of distance education and communications technologies in distance learning such as the VCLE.

Methodology

The study was undertaken to explore the question, 'What were the interaction patterns of distance learners and their teachers in the VCLE in the School of Distance Education, Universiti Sains Malaysia?' The undergraduate courses identified for this study were Mathematics and Physics, as a high degree of interaction was anticipated because of the nature of these courses, which requires inquiry and problem solving. This richer source of data would make it possible for us to analyse interaction patterns. Six courses managed by different teachers were chosen randomly from various levels. Each course was normally allocated five videoconferencing sessions for the whole academic year. The duration of each session was 1 hour. One session was randomly chosen from each course to provide data for this study. The Mathematics and Physics sessions were identified as

Table 1: Types of communicative interactions (Oliver & McLoughlin, 1997, p. 40)

Type of communicative interaction	*Description*
Social	Teacher–student talk, establishing and developing rapport
Procedural	Teacher–student dialogue involving information exchange on course requirements and procedures
Expository	Student or teacher demonstrating knowledge or skill in response to a direct request from one another
Explanatory	Teacher using student responses to explain knowledge and develop content
Cognitive	Teacher providing constructive feedback to a student to reflect and to reconsider an alternative perspective/reality

Table 2: Categories of interactions (Oliver & McLoughlin, 1997, p. 41)

Category of interaction	*Description*
T–C	Teacher initiated and directed to the whole class
T–S	Teacher initiated and directed to a specified student(s)
S–T	Student initiated and directed to the teacher
S–S	Student initiated and directed to other students

M1–M3 and P1–P3 respectively. Interactions that occurred throughout the lesson were generally divided into the video display mode and the graphics display mode.

The analysis of interaction is based on the framework suggested by Oliver and McLoughlin (1997), which consists of five types of communicative interactions, namely, social, procedural, expository, explanatory and cognitive interactions. Table 1 describes each of these interactions. The six recorded sessions (M1–M3 and P1–P3) were transcribed and the interaction pattern was analysed according to Oliver and McLoughlin's classification. In addition, each type of interaction is further broken down into categories of interactions, according to the initiator–respondent relationship. The initiator and the respondent could either be a teacher, student or the class (or group). Refer to Table 2 for a fuller description. In this study, a single interaction was considered to have occurred when an individual stopped conveying a message while a new interaction commenced when the communication moved to another individual or when the communication from the same individual shifted to a new topic or to a new instructional intent. To ensure that the transcribing scheme was valid, the services of an independent analyst were used (Miles & Huberman, 1984). Because the comparison of the independent analyst's results showed an agreement of more than 80%, the transcribing of the interaction pattern into its appropriate categories in our study was considered valid.

The Oliver and McLoughlin (1997) analytic framework is useful in providing a more comprehensive and multi-level understanding of the relationship between the interaction, engagement and learning process taking place in the VCLE.

Table 3: Interaction pattern in the six sessions

		Category of interaction							
		Video display mode				*Graphics display mode*			
Type of interaction	*MS & PS*	*T–C*	*T–S*	*S–T*	*S–S*	*T–C*	*T–S*	*S–T*	*S–S*
Social	M1								
	M2	1				1	2	7	
	M3		2	15			2	2	
	P1	3	1	1	1				
	P2	3	2	2					
	P3	1							
Procedural	M1	29		8		2	1	1	
	M2	10	22	22		4	2	5	
	M3	6	21			3		2	
	P1	4	11	12					
	P2								
	P3		2	3					
Expository	M1	1				17	1	2	
	M2	2	3	2			20	27	
	M3	1	2	2		1	10	7	
	P1					2		1	
	P2	1				7	15	14	
	P3	1	1						
Explanatory	M1					21	3	3	
	M2	2	1	1		35	41	5	
	M3	2	1			22	33	20	
	P1					9	7	10	
	P2	7	5	6		7	8	6	
	P3	3	12	13		15	18	27	
Cognitive	M1	1				10	3	9	
	M2	6	14	6		19	115	84	
	M3					6	128	80	
	P1					1	3	3	
	P2		15	16		1	23	26	
	P3		4	6		1	6	6	
Total		84	119	115	1	184	441	347	0

MS, mathematics session; PS, physics session.

Results and discussion

Table 3 shows the patterns of interaction in three Mathematics and three Physics sessions. The interactions are presented as frequencies of occurrence. A total of 1291 interactions were recorded. Tables 4 and 5 are further summaries of Table 3. The presentation of data in the three tables is followed by the discussion of three major findings of the study stated as follows:

1. There were more interactions in the graphics display mode compared to the video display mode.

Table 4: Number of interactions in the video display mode

	Number of interactions							
Type of interaction	*M1*	*M2*	*M3*	*Total*	*P1*	*P2*	*P3*	*Total*
Social	0	1	17	18	6	7	1	14
Procedural	37	54	27	118	27	0	5	32
Expository	1	7	5	13	0	1	2	3
Explanatory	0	4	3	7	0	18	28	46
Cognitive	1	26	0	27	0	31	10	41
Total	39	92	52	183	33	57	46	136

M, mathematics session; P, physics session.

Table 5: Number of interactions in the graphics display mode

	Number of interactions							
Type of interaction	*M1*	*M2*	*M3*	*Total*	*P1*	*P2*	*P3*	*Total*
Social	0	10	4	14	0	0	0	0
Procedural	4	11	5	20	0	0	0	0
Expository	20	47	18	85	3	36	0	39
Explanatory	27	81	75	183	26	21	60	107
Cognitive	22	218	214	454	7	50	13	70
Total	73	367	316	756	36	107	73	216

2. In the graphics display mode, the predominant forms of interaction were the cognitive and explanatory types.
3. There were more teacher-initiated interactions compared to student-initiated interactions.

Major finding 1: there were more interactions in the graphics display mode compared to the video display mode

As can be seen in Tables 4 and 5, the total number of interactions in each session varied from 69 (P1) to 459 (M2), that is to say the frequency of interactions ranged from about one interaction per minute to about eight per minute. Within each session, the graphics display mode recorded a higher number of interactions compared to the video display mode. The greatest difference was found in M3, where the number of interactions in the graphics display mode was 6.1 times than in the video display mode. The ability of the graphics display mode to generate more interactions suggests that the three-component mode involving the teacher, student and course materials produced greater participation and engagement in learning.

For these students, visibility of the course materials to both teachers and students in the graphics display mode enables a more focused and detailed discussion of lesson content

and is thus likely to support learning. Therefore, pedagogical design of the VCLE should facilitate this three-component interaction to ensure that both teachers and students can interact with the course materials. This finding may seem obvious but it does not apply to all students (distance learners) in their different contexts. For other types of learners engaged in a different subject, the video display mode may be preferred. For example, a video conferencing session on History or Political Science may be able to generate a high number of interactions in the video display mode without the need to display course materials. Even a session on Quantum Physics can be lively if all the participants are knowledgeable and are keen to discuss why classical physics fails in certain physical phenomena without resorting to the use of computer software, 3-D objects or course materials. The number of such sessions may be small, but it shows that the video display mode need not be inferior. While our study finds that there are more interactions in the graphics display mode for students taking Mathematics and Physics, this trend cannot be generalised to all students in their different subject matter, learner characteristics and learning styles, as these do affect the effectiveness of the display mode.

Major finding 2: in the graphics display mode, the predominant forms of interaction were the cognitive and explanatory types

When analysed in terms of the type of interaction, it was found that there was an unequal distribution of the five types of interaction. For example, Table 5 shows that in all six sessions, the social and procedural types of interaction are less in the graphics display mode while the expository, explanatory and cognitive types are more.

In Table 5, both the cognitive and explanatory types of communicative interaction together constituted 83.7% of the total number of interactions in the graphics display mode (that is, 814 out of 972). In P3, only these two types of communicative interaction were observed.

These two types of communicative interactions contribute significantly to learning from the cognitivist, behaviourist and constructivist perspectives. Elaboration and the development of lesson content using the students' responses, from a cognitive point of view, could increase the recall of information and make the information more meaningful. Cross-content development in particular facilitates the recall of information by providing additional paths for encoding information in memory. The provision of these additional paths for information recall through skilful questioning and building on the students' responses demonstrates the potential value of interaction in improving information encoding and retrieval. In this study it was observed that feedback was given to incorrect as well as correct responses. Because feedback provides students with information about the 'correctness' of a response and allows students to modify responses before encoding them in memory, it is more essential to give feedback to incorrect responses. Students use such information in the teacher's feedback to generate further responses. To the behaviourists, feedback is reinforcement to response and concept learning. Moreover, the frequency of feedback can influence the rate and efficiency of

shaping behaviour. It follows that the more interaction there is on teacher–student feedback-response, the higher the probability for learning to take place.

Constructivists, however, view knowledge construction as a social process and maintain that knowledge cannot be simply transmitted from the teacher to the student, because the student has not undergone all the experiences of the teacher. The student's interpretation of a particular experience would be different from the teacher's because the teacher is relating it to a different set of prior experiences (Choi & Johnson, 2005). In this context, the teacher facilitates the discovery and construction of knowledge by interacting with the students to help them reflect on their responses as well as alternative ways of solving problems. The VCLE provides a place for activities to occur in a cultural context with different levels of interactions, values, shared beliefs, knowledge and skills. Properly designed strategies could encourage students and teacher to communicate and construct personal meaning while being exposed to the views of others.

In contrast to the pattern in the graphics display mode, the video display mode had more interactions of the social and procedural types. In Table 4, with the exception of P2 and P3, the procedural type of interaction was dominant whereas the social, expository, explanatory and cognitive types of interaction were less extensively deployed. In P1, only the social and procedural types of interaction were found. Matters relating to course requirements such as assignment deadlines and examination format were the focus of interaction. Interactions in the social category occurred where participants exchanged pleasantries and got to know those who had just joined the group. Except for the isolated case of M1 where there were no interactions of the social type, the teachers first directed interaction efforts to establish a social presence, which would help reduce the transactional distance.

Major finding 3: There were more teacher-initiated interactions compared to student-initiated interactions

Table 3 shows that the number of interactions in the T–C and T–S categories was 828 (that is, 84 + 119 + 184 + 441). This represents 64.1% of the overall 1291 interactions observed.

For the graphics display mode, where the types of interaction were mainly the cognitive and explanatory types, as explained previously, the significant number of T–S and T–C interactions that occurred in the VCLE could be seen as communication with the intent to influence thinking in a critical and reflective manner. The higher number of teacher-initiated interaction also implies that the teacher plays a crucial role in maintaining a community of inquiry focused on exploring and developing content as well as giving feedback on concepts, ideas or solutions. Although the teacher facilitated the direction and flow of the discussion, the students could respond in any way appropriate and meaningful to them.

The number of student-initiated interactions (S–T and S–S) was 463 (that is, 115 + 1 + 347 + 0). This is significantly less than teacher-initiated interactions.

Furthermore, the number of interactions in the S–S category was almost absent. Only one S–S interaction was observed in P1 in the video display mode. The S–T interaction in the graphics display mode was higher compared to the video display mode, suggesting that the inclusion of course materials had greatly enriched interactions in the VCLE.

It is not surprising to find that most of the interactions involving students are S–T and not S–S interactions, because the course structure is basically designed to be self-sufficient. Upon registration each student is given a self-instructional package that contains learning materials that include questions within the text itself, self-assessment questions as well as suggested answers. Because the VCLE provides real time communication similar to the conventional face-to-face learning environment, students naturally prefer to interact with the teacher whom they consider as a content expert rather than to interact with their own peers. However, this does not necessarily mean that students do not interact with their peers outside the confines of the VCLE. In our previous study, we reported that students found peer assessment to be a significant contribution to their efforts to improve their understanding of subject matter (Saw *et al*, 1999a). Some students also formed discussion groups on their own initiative. They were willing to bear the financial costs incurred as a result of travelling and accommodation to meet at a predetermined place for discussion (Saw *et al*, 1999b).

Conclusion

Using the framework of Oliver and McLoughlin (1997), the analysis of the interaction in the VCLE environment for distance learning in USM has yielded a few interesting patterns. There were more interactions in the graphics display mode in the VCLE compared to the video display mode, suggesting that interaction which involves the teacher, student and course materials simultaneously is likely to support learning. Within the graphics display mode, the explanatory and cognitive types of communicative interaction were dominant. From the perspectives of cognitivism, behaviourism and constructivism on learning, the use of these two forms of interaction indicates active engagement and learning. Finally, the higher number of teacher-initiated interaction also implies that the teacher's instructional input and strategic use of feedback promote inquiry learning.

Based on the findings of the study, the graphics display mode is the better delivery mode to promote learning and participation in the VCLE for Mathematics and Physics. However, to obtain a better understanding of the effectiveness of this three-component mode, there is a need to analyse more sessions as well as include qualitative data on teachers' and learners' perceptions of this mode of interaction. This study could also be duplicated across a range of VCLE settings and disciplines. Clearly more research on the intersection of technology, interaction and learning is justified in the effort to improve distance learning.

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