Volume 1, No.1, March – April 2012
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at www.warse.ijatcse.current

Prototypical implementation and empirical evaluation of a combined communication and collaboration system, in the context of classroom teaching - Educator Collaborator (EC)

Hobert Sasa
Computing department.Faculty of Science
National University of Samoa
Apia.Samoa
h.sasa@nus.edu.ws

ABSTRACT

For the past decades, many academic institutions avoided, or tried to avoid physical travel in favour of Video Conferencing Systems (VCS). With VCS, the real-time two-way visual and verbal interaction of the traditional classroom could be simulated by technology – creating a virtual classroom whose boundaries are limited only by the extent of the video conferencing network. However, compared with real face-to-face conversation, research suggests that communication through conventional video conferencing tools is an artificial experience. VCS filter out and distort many of the often unconscious signals that are used in face-to-face interaction. These signals, such as body expression, posture, gaze, and eye contact are used to regulate, maintain and progress verbal and social interactions among participants. In addition, VCS generally support the communication aspects of the interactions only, neglecting the collaboration aspect. Collaboration in an educational context is determined by the teaching and learning material used in an interactive way. What is needed is an integration or convergence of the communication and collaboration aspects into one integrated system. The Educator Collaborator (EC) approach, proposed in this paper, addresses this issue. With the use of questionnaires as instruments of measure, this project intends to explore and compare the degree of students' perceived interaction and satisfaction in three different VCS settings, in favour of our proposed system.

Keywords : Programming Errors, VCS, Educator Collaborator, Virtual Classrooms

1. INTRODUCTION

Constructivism learning theory states that learning is an active, social process whereby students must be active discoverers and constructors of new knowledge. Students develop competency and become critical thinkers in a classroom that "provides opportunities for intensive, structured interaction and collaboration among students" [9]. Studies confirm that learning can be effective when strategies of collaborative learning are built into the design of classroom interaction. Classroom interaction involves active communication and collaboration among students. With regards to remote and distance learning, the biggest challenge for educational institutions lies in creating greater opportunity for dialogue, through the establishment of interactive technological approaches that support and maintain students' "interaction" within "virtual classrooms". Remote or distance learning occurs when knowledge is transferred between two or more geographically situated persons or parties through the use of information and communication technologies.

One potential communication technology which is currently in use and shows significant promise in the future of synchronous distance education is Video Conferencing (VC). A Video Conferencing System (VCS) is a set of interactive telecommunication technologies which allows two or more geographically separated nodes to interact simultaneously via two-way video and audio transmissions. The rapid emergence and development of the Internet made video conferencing an ideal mode of communication that fosters spontaneous "interaction". With videoconferencing, the real-time, two-way visual and verbal interaction of the "traditional classroom" could be simulated by technology – creating "virtual classrooms" whose boundaries are limited only by the extent of the videoconferencing network [2]. For the past few decades, many educational institutions avoided or tried to avoid physical travel in favour of these technologies. However, compared with real face-to-face conversation, research suggests that communication through videoconferencing tools is still an artificial experience [3]. Videoconferencing filters out and distorts many of the often unconscious signals that are used in face-to-face interaction. These signals such as facial expression, posture, gaze, and eye contact are used to regulate, maintain and progress verbal and social interactions among participants. In addition to these visual cues, the current VCS settings generally support the communication aspects of the interactions only, neglecting the collaboration aspect.

Collaboration in an educational context is determined by the teaching and learning material used in an interactive way. With this notion, it is proposed that if the two aspects of the interaction are integrated, it will promote a joint focus of attention, eradicating the need to look at your partner every time you talk. Achieving a joint focus of attention is critical for successful communication and collaboration. Karsenty [5] corroborates that for a physical task, particularly one with a visuo-spatial component, being able to see what the other person is doing makes communication much more efficient than not seeing such information.

When collaborators communicate at a distance, the most useful kind of visual information appears to be a shared task artefact. [9] also argues that, "being able to view a document that a conversational partner is looking at during a joint task is more useful than being able to see the partner's face". "What is needed is an integration or convergence of the communication and collaboration aspects into one integrated system" [7]. The integration of the two aspects of the interaction simulates a real world classroom scenario - in which students communicate and collaborate through a rich and interactive learning environment. In a classroom scenario, students communicate through eye-to-eye contact, through verbal and non-verbal signals. The collaboration aspect of the interaction happens through discussions of the content or learning material. This form and nature of collaborative learning brings into play the use of video conferencing as an effective medium for classroom teaching in distributed setting (i.e. distributed teaching or co-located teaching). Within this frame of reference, our study proposes a prototypical implementation and empirical evaluation of a combined communication and collaboration system in the context of classroom teaching – the Educator Collaborator (EC). To anticipate that the proposed system will minimise the problem of visual cues mentioned earlier. Our proposed system incorporates both elements of the interaction in its prototypical design endorsing a high degree of interaction and satisfaction of the participants in the learning experience. Consequently, it is this perspective that instigates the main objectives and motivation of this study. The main objective of the study experiment was to determine the extent to which students' perceived level of interaction and satisfaction towards task performance changed over different levels of classroom VCS setups. In doing so, the study aims to accomplish the following objectives:

i. Conceptually design a real-world use case scenario

ii. Implement a prototypical EC-VS setup

iii. Identify and evaluate the critical factors that influence "interactivity" in the EC-VCS

iv. In the classroom context.Evaluate the degree of interactivity achieved

v. Explore students' level of interaction and satisfaction towards learning in the EC-VCS

vi. Develop guidelines for future scenarios

The study aims to test the following two hypotheses:

Hypothesis One: It is hypothesised that the level of students' interaction with learning increases when the level of collaboration integration increases in video conferencing settings.

Hypothesis Two: It is hypothesised that the level of students' satisfaction with learning increases when the level of collaboration integration increases in video conferencing settings.

2. METHODOLOGY

2.1 Equipment Setup

In the Educator Collaborator approach setup, two screens were used and placed slightly perpendicular to each other. The top screen was used for communication with the full-screen view of the remote participant's video image, while the bottom screen was used for collaboration with a full screen view. Two desktop computers with the same specifications were set up in two separate rooms. Both computers were connected to the University Local Area Network using CATEGORY 5 Ethernet cables. Skype was used for the communication aspect of the interaction. Skype was chosen because it is free and runs relatively smoothly on the current Local Area Network capacity. Real VNC (Virtual Network Computing) is remote control software which allows one to view and fully interact with one computer desktop (the "VNC server") using a simple program (the "VNC viewer") on another computer desktop anywhere on the Internet. In the case of the experiment, it allows the two participants to view the same window and take turns to edit from their perspective locations.

Two identical Apple iSight cameras were used. One camera connected to each desktop computer mounted on top of the screens. The specifications of the cameras are given below:
i)¼ inch CCD image sensor with 640-by-480-pixel (VGA) resolution; ii)Full-motion video at up to 30 frames per second and 24-bit color; iii) Autofocus from 50 millimeters to infinity and iv) Single FireWire connection for audio, video, and power. Two identical Genius earphones with volume control and microphone with microphone mute

2.2 Environment / Room Setup

Two acoustically and visually separated rooms were prepared with identical standard desktop PCs, monitors (TFT LCD, 17", 1280x1024), head-sets (stereo with mono microphone), and Apple iSight cameras (Firewire, 640-by-480-pixel (VGA) resolution @ 30fps). The twp PCs were connected using a standard 1000 MBit/sec. network.

2.3 Participants

Forty four subjects (25 female and 19 male) participated in the experiment. In 22 sessions each of two participants took part in three trials which gave a total of 66 trials. The age of the participants ranged from 18 to 36 years. 30 participants were in the age range of (16 –22), 12 participants were in the age range of (23 – 29), and 2 in the age range of (30 – 36). Out of the 44 participants, 32 subjects reported to have used videoconferencing (specifically Skype) to some extent, mainly to communicate with friends and families. 10 subjects had never used video conferencing tools before, and 2 subjects were not sure if they had used such systems before. The

participants were recruited by personal invitation mainly from Information Science staff members and through the Pacific Island Center. The assignment of participants to groups and time slots was based on self selection and availability of the participants. A chocolate bar was given to each participant at the end of experiment as a reward.

2.4 The Experiment Tasks

There were three different tasks performed during the experiment. Tasks were randomly selected, with one task allocated to each setup. All tasks were designed to be collaborative and interactive, so that both participants would be involved and would contribute to solving the problem tasks.

2.4.1Task One

In the first task, the two participants were involved in a negotiation activity in order to come into a collective agreement in the end. Given that the two participants just won a NZ$5 Million LOTTO, they decided to buy a house in Queenstown. They decided to spend no more than NZ$20,000 on the house, with certain criteria. The amount to spend on the house is not realistic according to the actual price for a house in NZ. It was randomly allocated just for the sake of the negotiation task in-hand. They were given a number of choices to select from. They were aiming for a nice, simple, but big enough house to accommodate their family members and friends when they are visiting. The house must have a big garage to accommodate up to 5 cars. As flower lovers, they also need enough space for a garden and a playground for kids. The house must be secure and have a fence around.

2.4.2 Task Two

The second task is an activity related to a computer programming task, specifically using Object Oriented Programming (OOP) concept. Although this concept may be unfamiliar to many of the participants, the task has been designed to be general enough for them to grasp the idea easily. An example is also given at the beginning so they can always refer to it throughout the task. They were given a description of an object in real life using one paragraph. Their task is to identify the object's name and as many attributes of the object they can identify from the passage.

2.4.3 Task Three

The final task is a logical one. It contains three logical questions from the popular game of GBrainy[1]. Gbrainy is a brain teaser game designed for use in education. It contains logic puzzles, mental calculation, memory trainers, and verbal analogies. Each question has one or more correct answers. The questions require participants to analyse figures and logical patterns, hence it requires personal intuitive thinking.

2.5 Measurement Instruments

The experiment used a quantitative approach. Three questionnaires are used. The first one was used to assess students' perceived level of satisfaction; it contained 5 questions on a Likert-Scale from 1 (satisfactory) to 7 (unsatisfactory). The second one was used to assess students' perceived level of interaction; it contained 4 questions on a Likert-Scale from 1
(satisfactory) to 7 (unsatisfactory). The last questionnaire was used to assess students' preferences of the systems; it contained 9 questions with a Likert-Scale from 1 (best) to 3
(worst). All questionnaires were manually constructed. The questionnaires were developed to gather data measuring the dependent variables of students' perceived level of interaction and satisfaction in relation to the independent variable of level of collaboration Integration. Specifically, student satisfaction is measured with the learning experience in the condition where there is only one screen for communication only as a channel of interactivity; one screen divided for communication and collaboration as a channel of interactivity; and two screens as a channel of interactivity -one for communication and one for collaboration. A within-subjects design was used because each participant is wanted to participate in all three environments (setups).

2.6 Procedures

The experiments were conducted at the University of Otago, at the Information Science Annex Research building. Two participants took part in each session that lasted for about 40 minutes. Upon arrival, participants were welcomed and formal introductions were made. Then they were asked to read a Participant Information sheet that explained the goal of the experiment (evaluating different VCS settings), the general procedure and the anonymity of the experiment. The participants then signed a Consent Form, and were asked to fill in the General Demographics Survey.

The participants were then escorted to their designated rooms. There was no formal method of assigning the rooms to the participants; they were randomly assigned by the experimenter. Within the forty minute session, the participants were exposed to three different VCS setups (conditions); they were asked to spend eight minutes to work on each task in each condition. Upon completion of each task within each setup, they were given two questionnaires (Interaction & Satisfaction) to complete before the next task. The distributed questionnaires were identical for each session and were approximately estimated to be filled within 2 minutes' time. The questionnaires were constructed to measure students' perceived interaction and satisfaction – the dependent variables. While the participants were filling in the questionnaires between each session, the experimenter changed the VCS settings for the next task. The order of VCS setups and tasks were randomly assigned. After each condition the participants were brought back into the original room and filled in the Participant's Systems Preference Questionnaire. After that, the participants were given a bar of chocolate, thanked, and then released.

2.7 Data Collection

The data collected in this study is in the form of answered questionnaire items, falling into the interval scale of

measurement. The questionnaires for satisfaction and interaction were on a 7-point Likert scale, so the raw data will be one marked on the scale that corresponds to how the participant felt about certain aspects of their interactions in the specific VCS setup. The questionnaire for systems preference used a 3-point Likert scale. A 3-point scale for accurate and precise results is used.

3.ANALYSIS

The experiment raw data were stored in an Excel spreadsheet (Microsoft Excel 2007 ©Microsoft Corporation), while all of the statistical analysis and testing was done using Predictive Analytics SoftWare (PASW) Statistics Release 18 [6]. This experiment measures two social qualities -interaction and satisfaction. In addition, it is also looked at students' preferences of systems. Reliability analysis refers to the consistency of a measure. It is a test to confirm the fact that a scale should consistently reflect the construct it is measuring. In statistical terms, it is based on the idea that individual items (or set of items) should produce results consistent with the overall questionnaire. The Cronbach's alpha is the most common measure of scale reliability. It is a useful method for examining reliability, with the calculation being based on the number of items and the average inter-item correlations [9].
The alpha value ranges from 0 (indicating a completely unreliable test) to 1, (for a completely reliable one). There is debate on an acceptable alpha value to conclude a questionnaire is reliable, but values over 0.70 would be considered acceptable in this study [4]. Cronbach's alpha was calculated for every social factor using the questionnaires from all 44 participants.

From the reliability analysis test done in SPSS, both satisfaction and interaction questionnaires produced high alpha scores, indicating that the items (from the questionnaires) within each factor in each of the three conditions were measuring a consistent underlying construct (internal consistency) (See Table 1).

Table 1: Reliability Test - Cronbach's Alpha values for each questionnaire on the twosocial factors, Interaction and Satisfaction

	Condition 1	Condition 2	Condition 3
Interaction (n = 4)	0.842	0.856	0.783
Satisfaction (n = 5)	0.843	0.835	0.771

n = number of items

The significance testing is a statistical measure to test if the data from an experiment support a given hypothesis. That is, in the case of our study, it is a test to show if there is a significant difference between the means of interaction or the means of satisfaction among the three setups (conditions).

Repeated-Measures Analysis of Variance with conditions as a repeated measure (within-subjects factor) is used since all participants were tested in all three conditions. This tests for any difference among the three conditions. To determine which means among conditions were different, a Sidak test was conducted.

The Mauchly Test was not significant (p=0.485), so the assumption of the correlations are equal among pairs of conditions (eg 1 vs 2, 2 vs 3, 1 vs 3) is not violated. Therefore "sphericity assumed" tests can be used.

The factor condition is significant (F 2, 86, = 34.398, p < 0.001), so there is difference among the three conditions. The Sidak's Test shows that all means for each condition differed. Condition3 had the highest level of interaction (mean=1.6080, Table 2).

Table 2: Descriptive Statistics for Interaction

Descriptive Statistics

	Mean	Std. Deviation	N
Condition1	2.7500	.90380	44
Condition2	2.0625	.85271	44
Condition3	1.6080	.61804	44

The last questionnaire was constructed to gauge participants' preferences of the three system setups. The questionnaire included nine items with a Likert-Scale from 1 (best) to 3 (worst). The results showed that the majority of the participants favoured the two screens setup (See Figures 3– 5).

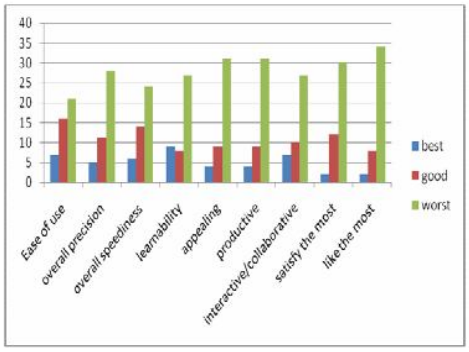

Figure 1: Setup1 Results of Students' Systems Preference

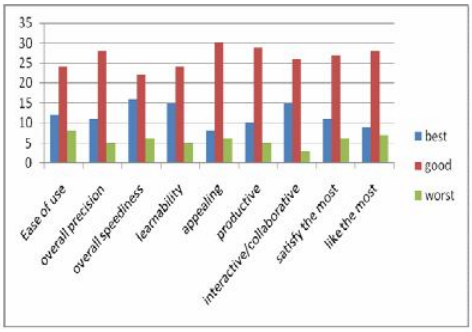

Figure 2: Setup 2 Results of Students' Preference to Systems

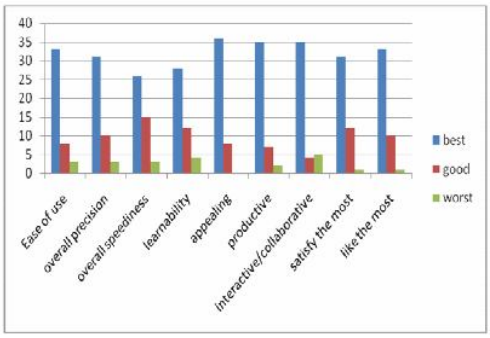

Figure 3: Setup3 Results of Students' Preference to Systems

The findings clearly support our two hypotheses. It is shown that there is significant difference in students' perceived level of interaction and satisfaction between the three conditions. That is, the level of students' interaction and satisfaction was higher in the conditions where there was higher integration of collaboration. The level of the two social factors being measured increased in the conditions in the order:

Condition 3 (two screens) > Condition 2 (one screen divided) > Condition 1 (one screen)

Students' level of perceived interaction and satisfaction was higher in the EC-VCS condition compared to the other two conditions, indicating that their learning experience in task performances improves when more collaboration is built into the VCS settings.

The level of interaction and satisfaction is also compared between genders in every condition. For satisfaction, it is found that there is no difference between genders, either in the mean response averaged over conditions ($F1, 42 = 0.446$, $p = 0.508$) or in the relative response of gender with condition ($F2, 84 = 1.940$, $p=0.150$). For interaction, it is found that there is no difference between genders, in the mean response averaged over conditions ($F1, 42 = 0.210$, $p = 0.649$), but there was a difference in the relative response of gender with condition ($F2, 84 = 3.680$, $p=0.029$).

3.1 Issues

Although the results from this study seem promising enough to draw some conclusions, there are still some issues that is needed to address carefully when doing future work. These factors may have a huge impact on our findings and results. These issues include participants' affiliation, previous experience, gender pairing, and age grouping.

3.1.1 Participants' affiliation

Participants' affiliation refers to how well a participant knows the other participant. They could be related, friends, know them a little or be a total stranger. In the experiment, a control on this issue is not provided because most of the participants were Pacific Island students and they know each other very well or to some extent. Knowing the other participant might have an effect on our results particularly in terms of trust and confidence towards each other.

3.1.2 Previous experience

Previous experience with using VCS is another factor to be considered. A comparison between those with previous experience and those without can be done. In the case of our experiment, the setups and interface were easy enough to use, even non-experienced users could easily acquaint themselves to use such system setups.

3.1.3 Gender Pairing (same gender pair, mixed-gender pair)

Gender is one of the most important factors when it comes to evaluating social factors in video conferencing systems. No control has not had on this issue, the pairing of the participants was randomly done and in accordance with their availability. This is one area that could be further investigated in future research.

3.1.4 Age Grouping

Age grouping refers to the grouping of participants according to their age. Also no control is had on this factor; this was due to the availability of the participants. Randomly, participants have paired up with first come first serve basis.

4. CONCLUSION

Learning theories state that learning can be effective when strategies of collaborative learning are built into the design of classroom interaction. Collaborative learning involves two or more students working together or engaging in a common task to achieve or fulfil a common goal. This characteristic of collaborative learning brings into play the use of video conferencing as an effective medium for distance and remote classroom teaching. This study focused on the use of video conferencing in higher education, particularly the use of Desktop VCSs in supporting remote and co-located classroom teaching. It focussed particularly on the concept of incorporating communication and collaboration aspects into a single integrated unit, in order to maximise interaction between learners.

In the experiment, in which the achieved levels of students' interaction and satisfaction are compared in three different VCS settings, the proposed system (EC) is discovered has the highest level of the two mentioned social factors. In other words, it establishes our concept that the more collaboration aspects integrated into the VCS settings, the better the interaction among students towards learning in general.

5. LIMITATIONS AND FUTURE WORK

Although our experiment shows strong results to support our concept, there are still some factors that need to be carefully considered when conducting future work in this area.

The first is turn taking. In the experiment it is included some control in the task design but mainly this was to do with mutual respect among the participants on who was to do what at specific times. The tasks allowed only one person to type or have control of the mouse at a given time, but this was impossible to control as some participants liked to experiment with multi-control of the mouse. Another important factor to be considered is the instruments of measurement used. Measuring social factors such as interaction, satisfaction, trust, social presence, and others within computer mediated learning environments such as video conferencing systems requires established instruments.

Various studies use a quantitative approach in which they measure interaction by the number of dialogues or words spoken, for example. Using this approach is avoided as it is interested in the participants' perceived level of interaction towards learning. For future work, it would be useful to investigate and examine more closely the relationship between students' perceived level of Interaction, Satisfaction, and Task Performance.

Lastly, when dealing with measuring social factors in computer mediated environments, it is important to clearly identify the scope, definition, and specific aspects of the factor being measured. For example in the study, it is looked at interaction as a general concept without considering its individual constructs such as verbal, non-verbal, cognitive elements, psychomotor elements, and others which usually have an influence on the overall interaction and learning experience.

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APPENDIX 1: INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing your interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to participate there will not be any disadvantage to you of any kind and we thank you for considering our request.

What is the aim of this project?

The aim of this project is to determine the degree of interaction between participants in video conferencing systems using three different setups. Therefore, we are comparing three different technological conditions.

What will the participants ask for?

Should you agree to take part in this experiment, you will be asked to perform topic discussion task with another person through a video link. You will be asked to participate in three sessions.
The whole process should take no more than 40 minutes. At the end of the each session, you will be asked to fill in a brief questionnaire about your experience with the experiment.

Can participants change their minds and withdraw from the project?

You may withdraw from participation in the project without any disadvantage to yourself of any kind.

What data or information will be collected and what use will be made of it?

The participant's responses to the questionnaires will be recorded. Only Hobert Sasa and his Supervisor (Associate Professor Holger Regenbrecht) will have access to the data. Results of this project may be published but any data included will in no way be linked to any specific participant. Anonymity is maintained.

What if participants have any questions?

If you have any questions about this project, either now or in the future, please feel free to contact

Hobert Sasa
Master of Science Candidate
Department of Information Science
E-mail: hsasa@infoscience.otago.ac.nz

Associate Professor Holger Regenbrecht
Department of Information Science
E-mail: holger@infoscience.otago.nz
University Telephone Number: 479 8322

