12 USER CENTERED DESIGN OF A COMPUTER SUPPORTED COLLABORATIVE WORK ENVIRONMENT IN AN EDUCATIONAL SCENARIO USING MULTIPLE MOUSE INPUTS: A CASE STUDY

P. Vamshi Reddy[*,a], **Kshitiz Singh**[†,b] **and Pradeep Yammiyavar**[*,c]

*Indian Institute of Technology Guwahati, Guwahati. *+91-9008887492,† +91-9008719430.*
E-mail: [a] vamshi@iitg.ernet.in, [b] ksh.designer@gmail.com, [c] pradeep@iitg.ernet.in

Collaborative Education is a concept which is very uncommon to Indian School Education and not much content is developed in order for it to be implemented in classrooms. In this paper we present a User Centered Design methodology that led to the development of a Multi User educational software aimed at fostering collaboration among students in primary classrooms.

Our study depicts various aspects that are to be considered while developing products that help in fostering collaboration among students. We conducted an initial pilot test to find out the factors that exist in collaborative task solving using multiple mice. Certain merits and demerits of using multiple mice were also recorded and are presented in this paper. We then compiled our findings from these pilot tests into educational software for 3rd standard students. We tested our product in Kendriya Vidyalaya — IIT Guwahati and in this paper we present the findings of our test and how the product which we developed using Microsoft Multipoint Technology (a technology which enables several mice to be connected to a single computer) helps in collaboration among students.

Keywords: Computer Supported Collaborative Education, Learning, Psychology of learning, Collaboration, Cognitive Load.

1. INTRODUCTION

The concept of collaboration is very uncommon to Indian School Education. In India most of the government schools suffer from deficiency of computers for students, so even in schools with computer infrastructure available, we find situations where a single PC is used by multiple students. The notion of Computer supported collaborative learning (CSCL) is even more remote concept due to lack of computer infrastructure in schools and also due to lack of proper content developed to implement and assess students in terms of collaboration.

Microsoft Multipoint is a technology that enables multiple users to interact with a single computer simultaneously with a mouse. This technology enables as many as 50 mice to connect to a single computer i.e. as many as 50 users can interact with a single computer. This technology would help build applications which would help students to involve in controlled collaborative environment as well as address the economic factors involving in setting up a computer infrastructure.

In the following paper we present you a case study of our product "LETUS" which fosters collaboration among students of primary school i.e. 3rd standard students. LETUS was developed keeping in mind the social and the economic factors. The content for our product was developed keeping in mind the current knowledge of the target group i.e. 3rd standard students and also its acceptance level in schools.

2. LITERATURE STUDY

2.1. Learning

Learning is the acquisition and development of memories and behaviors including skills, knowledge, understanding, values and wisdom.

"Learning is the process that depends on experience and leads to long term changes in behavioral potential."[4]

The general notion of learning is something which occurs in schools. Learning can takes place not only at school but outside it also.

When teachers speak of learning, they tend to emphasize on things taught in schools, which includes both the official curriculum and the various behaviors and routines that make classrooms run smoothly. Learning is often measured in academic achievement especially language and mathematics and to a lesser extent musical skill, physical coordination or social sensitivity.

Indian Education system is dominated by the rote learning system where a lot of stress is given to retaining and reproduction of knowledge. The other parts of learning are undermined.

2.2. Collaboration

"Collaboration is a structured, recursive process where two or more people work together towards a common goal, typically an intellectual endeavor that is creative in nature by sharing knowledge, learning and building consensus."[4]

Collaboration takes place at every situation where two or more individuals come together in groups; it suggests a way where one respects each individual and his contribution. The underlying principle is that of consensus building rather than competition.

The objective of collaboration is "co-construction of ideas and resolution of conflicts". Collaborative learning stresses the social nature of learning and the need to train students how to work collaboratively in order to resolve conflicts, interact appropriately and actively involve all group members.

There are several reasons for not implementing collaborative learning in schools, but the main reason is due to lack of any proper material to follow.

3. PILOT TEST

For collaboration to take place on a computer screen, we should have a task to be completed by the group. This could be done by sharing the task among the users. In order to understand the user behavior during collaboration on the screen, an initial pilot test was done. For this a pattern build up application was made using Microsoft Multipoint in .net environment. The basic goal of this experiment was to identify factors that one should pay attention while designing an interface for a collaborative application.

The pattern build up application consisted of creating a given pattern using circles, rectangles and squares. The patterns that were asked to create were of various difficulty levels depending upon the cognitive load each pattern posed.

The experiment was conducted in Kendriya Vidyalaya high school, IIT Guwahati. The students who participated in this experiment were of class 3. Three groups of 3 students each were asked to perform the task.

Three different experiments were setup:

3.1. Single User

In this case the task was performed by a single user and he was asked to create the given patterns. The user was in control of all the elements i.e. circle, square and triangle. Total of nine students were asked to perform the task.

3.1.1. Observations

1. The student completed the task with few instructions from the guide
2. No student to student interaction took place even though they sat beside each other
3. A sort of competition between students even though the tasks each person performed were different as to who completes first

3.2. Three User Working Simultaneously Through Multiple Mice

In this case each user was given a mouse and he/she was able to control only 1 element of the pattern i.e. first mouse can only control square, second mouse only circle and third mouse only triangle i.e. the task has to be completed by three users working together.

3.2.1. Observations

1. Student completed the task with even more less interactions from the guide
2. Student to student interactions has increased. These can be further classified as the following
   (a) Argument
   (b) Agrement
   (c) Assertion
   (d) Cooperation
   (e) Consent
   (f) Disagreement
   (g) Irritation
3. Few Students complained that they could do the task much faster if done single.
4. Dominating Child: In certain groups a single student trying to bully the others was also observed, the dominating child has taken control of the rest of the team member's actions by doing the thinking for them and taking the responsibility of everybody. The dominating child had almost made others obey him even if he was wrong in taking decision and forcing others to follow him.

3.3. Three User but Only Single Mouse Allotted for Them to Share

In this case the task was given to a group of three but the control was given to only one student. The students were asked to help while the other person is completing the task

3.3.1. Observations

1. Snatching of mouse from each other was observed
2. Each user trying to do his mental model of the problem with a single user led to chaos
3. The other user was pointing to the screen to explain the user with mouse to what to do next.

3.4. Three User but Only Single Mouse Allotted for them to Share

On comparing the two scenarios of working together and working single, we have observed that few students had said that they preferred working alone as the task can be completed more quickly and without much interference.

It was clear that students were not used to working together and got irritated while the other person was not complying. The design implication that could be inferred is that the interface should enable at least one of the observed collaborative interactions such as decision making, affirmation, granting permission and should leave scope for discussion, argument, consulting among the students.

Guiding: In order to help the other student, the one helping usually points to the screen and gestures as to what to do and explains him/her. At an interface level this can be avoided by creating within the interface some helping mechanisms like clicking on the other mouse and help drag that mouse to that specified position.

3.5. Analysis of Pilot Test

The idea of collaboration is to pose students with an situation which would enable the sort of interactions observed in test setup 2 and help the students learn to deal with the differences and be productive at the same time learn from each other.

The goal here is to enable this sort of interaction and help students figure out to work collaboratively to achieve a collective goal. The interface developed should facilitate at least few of the above said interaction methods among students. The interface should itself provide methods where students could express their emotions (interaction types) within the interface itself.

The interface should provide a method to express collaboration especially when there is lot of students involved in collaboration.

1. Physical proximity among students will give more scope for collaboration then collaboration enabled through the screen.
2. Driving force for Collaboration is traditional competition among groups, each group member can collaborate to perform the task and compete with other groups, and the role of group leadership is introduced in such interfaces
3. Giving positive feedback to work together.
4. Content

The content on which collaboration has to take place is very important. It should not require special knowledge and should be within the domain of student's knowledge. But at the same time there should be some inequalities in the expertise of the content so that one could observe the learning curve of the students. Hence the content which was decided was the NCERT syllabus of students.

Another reason being such content would be easily acceptable by students and teachers. Instead of thinking it as a separate game application as such students can themselves learn the regular syllabus and have an advantage of learning daily syllabus along with concepts of collaboration.

Apart from this in order to gain relevance of collaboration in a school environment it is preferable if the content of the application also concentrates around the syllabus that is being taught in the school or something which the students already are familiar with like mathematics, so we have based our content on 3rd class NCERT mathematics syllabus and use the content to create a situation where collaboration is made possible. Several concepts of mathematics as prescribed in 3rd class mathematics were converted to computer interfaces with the goal of making students collaborate and at the same time learn effectively.

So each concept and exercise was coupled with a particular collaboration scheme.

3.6. Several Collaboration Schemes

The product LETUS consists of several segments with each segment concentrating on a particular collaborative scheme. The goal here is to enable this sort of interaction and help students figure out to work collaboratively to achieve a collective goal. The interface developed should facilitate at least few of the above said interaction methods among students. The interface should itself provide methods where students could express their emotions (interaction types) within the interface itself.

3.6.1. Segment 1

Working simultaneously without having to deal with other player was the major goal of segment1. The primary purpose was to enable the student to identify themselves and to identify public space.

3.6.2. Segment 2

In this segment the concept of collaboration was introduced where two of the user has to be passive and let the other work before making any difference. Visual feedbacks were necessary to help the students know that they have granted the other player permission to do his task. This segment is more effective to students who already are familiar with addition of numbers.

3.6.3. Segment 3

In this segment the ideas of team were introduced as groups of three have to move the train with each player movement being restricted by the player in front. The idea was that each of them cooperates and moves forward.

3.6.4. Segment 4

The objective of this particular exercise was to let the students perform individually but the result was given to the entire team in the sense positive feedback was given for getting the answer right for the entire group by awarding them marks to the group as a whole.
The point to study was how the students take up the responsibility of contributing to the group marks, do they identify with the group after the first 3 sessions and try to avoid mistakes, but it was observed that they had no regard for the group marks they still maintained their identity and did not care much as long as they could perform the task. There was no pressure if a mistake is done.

3.6.5. Segment 5

Forced collaboration was introduced and we have observed that the inherent nature of competitiveness was the motivation to collaborate and help the student who is lacking behind.
There was public space and personal space. The public space was the 100, 10 and 1 circles where everybody could click and the private space was the progress indicator and the question area.

3.6.6. Segment 6

This segment was similar to segment 4 except that this time the marking scheme was removed and concentrated more on the content part. Conflicts in screen sharing were to be observed in this segment. Visual feedback was used to teach students the concepts of addition.

3.6.7. Segment 7

The collaborative scheme that was used in this segment was agreement and decision making. The interface was so designed that the students were forced to make a decision and agree upon it before moving further. Visual feedback was used to show their agreement behavior. In this both the concepts of math's curriculum as well as concepts of collaboration was enforced.

Later we found that each of these collaboration schemes were helpful in developing the psychological behavior of children with a different social outlook. Hence using different collaboration schemes is necessary for children as they are helpful in adapting them to different types of social interactions.

Broadly the collaborative schemes in these segments can be briefly described as

1. Collective Agreement
2. Screen Sharing
3. Group Progressing
4. Role Playing
5. Collective assessment vs Individual assessment
6. Sequential Tasks
7. Interface facilitating collaboration

4. TESTING

The product which was built with the above discussed schemes was tested in Kendriya Vidyala –IIT Guwahati. Class 3 and class 4 students participated in this test.

The experimental setup consisted of

1. Providing each student with a mouse.
2. Three students were sitting at each desk forming a group of 3.
3. All these mice were connected to a single CPU using USB extension cables.
4. A projector was used to project the application on the screen.

4.1. Observations

4.1.1. Chaotic

It was expected while a single team performs the tasks the other teams would pay attention to the first team but it was observed the rest of the students were busy playing with their mouse. So explaining the task to the students became a very difficult task. The rest of the class did not concentrate while 1 team was performing. This chaotic nature was observed with class 3 as the concepts on the screen were new to class 3 compared to class 4.

4.1.2. Adaptability

The students were very quick in coping up with the technology, they had no problem in identifying their mouse and using their mouse and for most of them it is their first time they have played with a mouse.

4.1.3. Attention level

As expected the attentively and involvement in the class has increased.

4.1.4. Competitive nature

Even though collaboration was observed among team members there was considerable competitive nature between teams.

4.1.5. Motivation

The competitive nature of students to complete the task was the motivation to help and get the entire team together to the top.

5. ANALYSIS

5.1. Cognitive Load

While developing collaborative applications, one has to consider the cognitive load of the collaborative scheme. Even while performing the simplest task the cognitive load increases when he/she has to work with another individual so he has to consider the other user before performing his task. This is the reason why as the number of people involved in collaboration increases the cognitive load on the user increases hence the tasks have to be kept to a minimum complexity. Even the task of just selecting the visual instances has considerable cognitive load on the user.

5.2. Working space - Personal and Shared

Children tend to possess a psychological ownership. They like to have their personal space in addition with the social spaces. When the personal spaces were not present they were less motivated rather confused in accomplishing the give task. Also as the concept of collaboration is relatively new in school education, while designing collaborative spaces the designer should take appropriate measures that the screen is well divided where children could easily identify their personal and shared space. These distinctions can be done by using strong visual schemes.

5.3. Teacher as a User

In all the segments of the final product we have considered as the teacher as the user too. Considering the class management problem that the teacher would face while conducting a lecture we kept the key controls of the segments with the teacher by providing him/her with a keyboard. Keyboard controls can be used for navigation between the segments, controlling the working of teams and closing of application.

5.4. Motivation

The motivation to be involved in the tasks can be provided at three levels:

5.4.1. Individual Motivation

Here the user is motivated to compete with everyone present in the classroom. These can be done by providing personal scores. Also this motivation would also help to develop a feeling of competitiveness within the team.

5.4.2. Team Motivation

The user is motivated to move forward as a team. As we found out in the literature survey that realistically achieving this situation is difficult as any bully character would ruin the team motivation for other users. This was particularly found in examples where the aim was to provide a screen sharing module. In the earlier case studies, it was assumed that the screen sharing would result in task sharing but in the exp 1 we found out that such thing does not happen. Hence, to prevent the bully character from influencing other children's learning task the task needs to be appropriately shared amongst team members and along with the motivation there should also be restriction on directly influencing other member's work.

5.4.3. Game Motivation

This concept was used particularly in segment 4 where the condition was kept that the movement of one train would only begin when other team crosses a fixed distance. Hence the team kept motivating their previous team to play fast so that they could get their turn.

5.5. Awarding and Dis-awarding

In the team motivation we discussed about the restriction of task sharing. However the influence of a bully child present in the team can also be reduced to some extent by appropriate awarding and dis-awarding of actions. The dis-awarding again can be done to both individual actions that led him to bully others & team so that other student realize the reason for they are being dis-awarded so that they themselves can stop the influence of bully child.

5.5.1. Cognitive Load

While developing collaborative applications, one has to consider the cognitive load of the collaborative scheme. Even while performing the simplest task the cognitive load increases when he/she has to work with another individual so he has to consider the other user before performing his task. This is the reason why as the number of people involved in collaboration increases the cognitive load on the user increases hence the tasks have to be kept to a minimum complexity. Even the task of just selecting the visual instances has considerable cognitive load on the user.

6. CONCLUSION

The product enables collaboration among its users and its content is very relevant to the current curriculum that is being taught in schools. The product in broader sense transfer static textbook based content to dynamic content which is more enjoyable and has increased attention level. In this process we have also changed the traditional single user interaction with the computer to a multi-user interaction. The product shows how the current school content can be modified and developed using Microsoft Multipoint technology to support collaboration.

The potential content that could be developed using a similar approach is very vast, we have only covered mathematics for class 3, and content could be developed in the other areas of education like science which will give a wider scope of its application once the content is developed.

REFERENCES

[1] Multiple mice for retention task in disabled school — Uday Singh Pawar, Rahul Gupta, Kentaro, Jayajeet Pal.
[2] Multiple Mice for computers in education in developing countries — Uday Singh Pawar, Rahul Gupta, Kentaro, Jayajeet Pal.
[3] Modelling Chinese classrooms for low cost ubiquitous interactionin the classroom — Neema Moraveji, Udai Singh Pawar, Taemie Kim.
[4] Psychology of learning — http://www. wikipedia.com
[5] Encouraging the use of collaborative learning in higher education — Dr. Theodore Paintz, EdD and Patricia Panitz.
[6] Collaborative learning of computer applications in the contexts of work, learning and play — D. Michelle Hinn University of Ilinois, X. Cchristine Wang M, Michael B. Twidale.
[7] Regulation in groupware: The example of a collaborative drawing tool for young children — Christine Ferraris and Christian Martel Syscom Universitc de Savaie.
[8] Understanding computers and cognition: a new foundation — E. Winograd, T. Flores. Toyama
[9] Active learning creating excitement in the classroom eric digest — Bonwell Charles C Eison, James A.
[10] Online collaborative drawing boward for real time student instructor interaction and lecture creation — Mohammad Alramahi and Kurt Gramoll.
[11] Cooperative learning methods: a meta analysis — Johnoson D. W. R. T. Hohnson and M. B. Stanne.