A Study of Collaborative Tool Use in Collaborative Learning Processes

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ABSTRACT

Student collaboration has been shown to be beneficial in many contexts in computer science education. However, little research has been performed on the factors that affect collaboration processes either negatively or positively. In this study a partial grounded theory analysis was performed on three engineering education courses, investigating the collaborative tool selection and collaboration processes. The presence of internal team motivation and tools that had clearly perceived benefits were important to students. Some tools affected the collaborative processes positively by increasing the range, speed and information content of communication, automating goal tracking processes and providing additional avenues for information distribution.

Categories and Subject Descriptors

K.3.1 [**Computers and Education**]: Computer Uses in Education – *collaborative learning.*

K.3.2 [**Computers and Education**]: Computer and Information Science Education – *computer science education.*

General Terms

Measurement, Documentation, Experimentation, Human Factors.

Keywords

Collaborative learning, computer-supported collaborative learning, collaborative tools, grounded theory

1. INTRODUCTION

Collaborative learning, or students cooperating towards a specific learning goal with the teacher as a facilitator [1], has become an increasingly important topic in education [2]. The collaborative approach to education has been shown to develop critical thinking, deepen the level of understanding, and increase shared understanding of the material [3]. Computer-supported collaborative learning (CSCL) facilitates collaboration by using computer-mediated communication tools to either enable new communication methods between students or to extend the range of communication beyond a single classroom [4].

The extension of collaboration with CSCL allows increased knowledge building between a wider range of participants, more flexible teaching structures independent of place or time and improved student productivity and satisfaction [4]. However, the nature of CSCL has to be taken into account from the first planning stages when designing courses or it can be a drawback instead of a benefit.

While there has been extensive research on the benefits and drawbacks of collaborative learning approaches in higher education [4], there has been less research on how the choice of collaborative tools affects cooperative processes and collaborative outcomes. More specifically, we want to investigate which kind of effect the students' chosen tools and the course's collaboration arrangements have on the collaborative learning processes.

Our research questions in this study are:

1. Which kind of processes lead to students' choices of collaborative tools?
2. How did the collaborative tools affect student teams' collaborative processes?

In this international study we followed three engineering courses. The main data source for the study was team interviews, which were analyzed using the Grounded Theory [5] research methodology.

In this paper we present the research setup and results of the first two steps of the Grounded Theory analysis along with initial conclusions.

2. RESEARCH IN STUDENT COLLABORATIVE PROCESSES

Three collaborative courses were studied as a part of the research. All of the three courses were teamwork-based courses, with an emphasis on independent teamwork, collaboration and problem-based learning. The two longer courses (A, B) were major events in their curriculum, or so-called capstone courses, and had multidisciplinary problems with a wide variety of student skills. The course A was 28 weeks long with 64 students participating and concentrated on an industrial product lifecycle from design to marketing. Courses B and C were both programming courses with 14 students that differed in duration and location. Course B was arranged in Italy over 13 weeks and course C was arranged in Finland over one intensive week. While all the courses had some tutoring at the beginning, the students were expected to

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independently form their teams, regulate the teamwork and solve the problems independently.

2.1 Data Collection

After the courses student teams participating in the study were interviewed. In the programming courses full teams were interviewed and in the multidisciplinary course only team leaders were interviewed because of the large group size and other team members were sent an online survey. Both the survey questions and the interviews concerned the students' collaboration, collaboration tools used and how the students thought their collaboration processes worked. Because of the nature of online surveys, the surveys had specific questions and numerical replies. Themes and topics covered in each interview include:

- Group structure and group dynamics
- Collaboration management and teamwork processes
- Collaboration in practice (discussing the members' experiences and examples from practice)
- Collaboration tools, utilization, planning and experiences
- Roles and people (including mentoring and external support)

The interviews were semi-structured theme interviews, in order to allow the interviewees to bring up issues and phenomenon that occurred in their team without preconceptions. The interviewer guided the conversation to a new theme after a previous one was exhausted and occasionally prompted the interviewees to go deeper into a topic. For example: "What do you think that went well in your collaboration?" and "Why do you think that (an issue previously mentioned by interviewee) happened?" All interviews were performed by the same researcher, who also participated in the course activities as an observer and performed the majority of data analysis.

The interviews and other material gathered from the courses were analyzed using Strauss-Corbin's [6] Grounded Theory [5] research methodology using additional guidelines for computer science education research by Kinnunen and Simon [7]. Grounded Theory is a method which has been said to be well-suited for analysis work into phenomenon, which involve multiple human interaction factors, especially if the phenomenon is not well-known or strictly definable [6].

2.2 Analysis Results

In open coding we analyzed sixteen interviews with a total of 26 interviewees participating. Initially we did not make a distinction between courses while performing open coding in order to get as wide view of issues and possible categories present in collaboration as possible. After the first round of open coding we started to build a table of individual team narratives for identifying paradigm models for different major categories. This table with data about tools, collaboration methods, challenges and assignments each team faced was also used in comparative analysis of collaboration approaches in later research steps. These materials were used in constant comparison, refinement of categories and discovery of causal relationship in the axial coding phase. The codification process resulted in 59 interconnected codes in a total 201 quotations. In open and axial coding four categories related to the phenomenon were discovered: *Collaboration tools*, *collaboration (success) factors*, *collaboration (preventing) issues* and *collaboration processes*.

Collaboration tools used by the teams can be divided to four groups according to their purpose: Communication, goal tracking, information distribution (e.g. document sharing and management) and change management. The major benefits provided by the tools were increasing the range, speed and information content of communication, automating tracking processes and providing additional avenues for information distribution. The amount of tool use and perceived benefits varied between teams. Communication tools were most used and goal tracking tools were least used. *Convenience*, *mentors* and *clearly perceived benefits* were the largest affecting factors in tool selection process.

The student teams' collaboration processes encountered *issues that prevented collaboration* and had several *factors that assisted collaboration*. The main issues were related to *team commitment*, *efficient communication* and *goal mismatches*. The main beneficial factors were related to *member initiative*, *shared goals* that led to *cooperation* and *cooperative goal setting*. *Cooperative goal setting* and *initiative* were also often associated with *effective communication*s, which contributed to working *task assignment* and *member responsibility* for *team progress*.

The three other categories interact with the teams' *collaboration processes*. Depending on team structure, member backgrounds and goals, the teams approached the assignments diversely and adopted different working methods. *External support*, *effective communications* and *shared goals* were the major aspects of collaboration that were mentioned to contribute to *team success*.

3. CONCLUSION

In this paper we presented the first two phases of a grounded theory analysis of student collaborative tool use in collaborative higher education courses. In open and axial coding four categories were identified that relate to the phenomenon. Three categories affect the collaboration process and the processes in turn play a role in the choice of tools and the issues teams face.

The teams can be divided into groups according to their method of tool use, challenges, and collaborative outcomes. Many of the teams faced similar challenges in tool use and collaboration, and these critical points led to different outcomes depending on the adopted collaboration process and supporting factors. The next step for the study is to use the selective coding process to define the core category and the causal conditions, context and strategies that are behind common narratives. An expected outcome for selective coding is an analytic model of student collaboration cycle with emphasis on where and how tool choice occurs in the cycle and how the chosen tools affect the collaboration process.

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