The Design and Investigation of a Web-based Synchronous and Asynchronous Peer Feedback Mechanism

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Abstract: Peer feedback has received increased attention as a mechanism for promoting learning. Our experiences with peer feedback indicate that students face challenges in providing and utilizing peer feedback. We report on the design and empirical investigation of a web-based tool with the intent to support students' collaborative inquiry by helping contextualize students' feedback. The effectiveness of the tool was tested with two classes of 6th grade students (n=39) at an elementary school in Cyprus. Students worked in small groups to solve a topical, socio-scientific problem. Each group in one class was paired with a group in the other class and was asked to peer review each other's work in progress on two occasions. Several types of data relating to the peer review processes were collected and analyzed qualitatively. Findings suggest that synchronous and asynchronous web-based tools can serve different roles in supporting peer feedback. Implications for design are discussed.

Introduction

Peer interactions can be powerful motivators for learning, as they provide opportunities for peers to exchange and critique ideas, allow for productive cognitive conflict, during which peers can either argue, negotiate meanings, or even restructure their own understanding, and can enhance social interaction, leading to a collaborative development of ideas (Damon, 1984; Hartup, 2008). Students' reactions to peer feedback are distinct from students' reactions to adults (such as teachers) questioning their ideas (Cole, 1991); in the latter case children most often succumb to the adult view, because of the asymmetrical nature of the adult-child relationship, in terms of the commonly accepted knowledge that each one holds, and also because of the power relations in the teacher-student relationship. Students may perceive peer feedback as less threatening and more understandable, than feedback provided by adults (Damon, 1984). Under certain conditions, peer feedback appears to be an effective mechanism for helping students learn (Kollar & Fischer, 2010; Phielix, Prins, & Kirschner, 2010; van Zundert, Sluijsmans, & van Merrienboer, 2010), even at the elementary school level (Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003). Most often, the arguments put forth in support of peer feedback processes are cognitive; however, researchers have also stressed the importance of the peer as a motivating factor and of social interaction in achieving better learning, pointing out that the socio-emotional aspect of collaboration can impact on the quality of the collaborative processes (Kreijns, Kirschner, & Jochems, 2003).

Peer feedback can be defined as the process of reviewing the work of an individual or of a group of students, with the goal of providing comments that can help peer(s) identify strengths and shortcomings, and help plan their future learning activities. Peer feedback is not about providing a grade or a score of achievement, nor does it concern feedback provided once a task is completed, unless the task is connected with another ongoing activity. Thus, we distinguish peer feedback from peer assessment, the latter focusing on a summative evaluation of students' work. As a construct, peer assessment has received more attention in the literature and has sometimes been used to include peer assessment both as learning and evaluative tool (van Zundert, Sluijsmans, & van Merrienboer, 2010). Most of these studies focused on higher education with little work conducted in secondary or primary settings –yet our experiences with students, as young as 6th grade, indicate that younger students are also able to participate in peer feedback sessions, but require guidance. Most work on peer feedback in CSCL situations involves providing peer feedback within a group. Phielix et al. (2010) investigated technology-based methods for supporting individual awareness of high school students' within-the-group behavior, seeking to enhance the group's social interaction, metacognition, and productivity. In contrast, this work explores a web-based tool for providing peer feedback between-groups of 6th grade students, as a mechanism for helping students look at their work critically. In this paper, we report on an exploratory, qualitative study, examining students' collaborative use of synchronous and asynchronous tools to provide peer feedback using a web-based mechanism during inquiry-based science learning.

Methodology

Participants

Two intact 6th grade classes (n1=20, n2=19), working in pairs or triads (7 groups in each class), from a public school in Cyprus participated in this study. Students had not participated in any extended inquiry-based project in the past. During the peer review phases, a group from one class collaborated with a group from the second class. The researchers decided how to pair up students in each phase according to the objectives of the task. For example, since the first peer review aimed at engaging students in discussing the subjective nature of scientific claims, groups with opposing claims were paired up; on the other hand, groups arguing in favor of the same opinion collaborated during the second peer review session to help each other improve their final claims. Two teachers participated in the classroom implementation. The first teacher had three years of teaching experience while the second teacher (the second author of this paper) had no in-service experience.

Data Collection and Analysis

Several forms of data were collected. Six groups' interactions (three from each class) with the learning environment, their peers and with their teachers were videotaped during the whole enactment. In addition, the synchronized computer logs of the feedback provided by all 7 pairs of groups using the WorkSpace sharing, logs of their chat exchange history, as well as the groups' work on the computer were collected. The data were analyzed using the activity theory framework (Engestrom, Miettinen, & Punamaki, 1999). In this paper, we use all groups' written work and the videotaped interactions of one group of three boys (Group 1 consisting of Mark, Anthony and Peter). During the analysis, all episodes involving Group 1 were identified and labelled according to the phase of peer review activity: 1) Preparing for peer review, 2) Selecting WorkSpace pages to share, 3) Peer Reviewing process, and 4) Examining and acting upon feedback received. The videos were transcribed verbatim from Greek and transcripts were coded for metacognitive comments (planning, monitoring, evaluating inquiry work). All comments provided in the groups' pages were analyzed in order to create a typology of students' comments while assessing the content of their peers' page. A similar analysis was performed with the chat log exchanges between groups. All the chat logs from both peer review sessions were coded so as to identify the nature of discussions that took place. More specifically, we tried to identify 1) categories of criteria students used to assess the content of their peers' page, 2) other issues they were concerned with, and, 3) whether they used design features such as the sentence openers.

Instructional Context

The learning environment "Meles-Meles", which was used in this study, was hosted on the STOCHASMOS (Kyza & Constantinou, 2007) web-based platform. The context of the investigation was a socio-scientific issue on the bovine tuberculosis problem in cattle in the U.K. Each group of students assumed the role of scientists who represented relevant organizations, charged with the goal of studying the data and constructing evidence-based scientific claims on how the problem could be best solved. The implementation lasted for 10 weeks (24 40-minute sessions) and was kept similar in the two classrooms in relation to the duration, the activity sequence and the teachers. The activity sequence included two peer review sessions (PRS1 and PRS2). The first session lasted for three 40-minute periods, whereas the second session lasted one 40-minute lesson, including the time needed for providing task-related instructions. The activity sequence provided students with multiple opportunities to construct and evaluate scientific claims and it systematically engaged them in explicit reflective discourse on the subjective and uncertain nature of scientific claims (Khishfe & Abd-El Khalick, 2002). Firstly, students were introduced to the problem and were assigned the role of scientists who need to construct scientific claims as to whether badgers should be culled. This led to the development of an operational definition for scientific claims through the use of specific WorkSpace templates on the STOCHASMOS platform. Then students were expected to study the available data and construct their own scientific claims. After students had constructed at least two claims, they were asked to evaluate the scientific merit of another group's claim. This was the *first peer review session* which served as an opportunity for students to apply specific criteria. Feedback was given between groups with different roles and this led to discussions about the subjectivity of data. Next, students were given time to improve their claims based on their paired group's comments. Then, in a whole class discussion, two claims were compared in order to choose the most convincing one. Since all claims were scientific, evaluating only the scientific merit of the claims was not enough, leading to the development of criteria for evaluating the validity and reliability of scientific claims. This activity was accompanied by discussions on the role of emerging evidence in determining the trustworthiness of a claim (e.g., the accumulation of supporting evidence enhances its reliability while the emergence of conflicting evidence puts its validity into question). Following this activity, the second peer review session took place. Feedback between groups with the same roles was given in order to help each other get prepared for the final conference and, thus, have an opportunity to apply all criteria. Finally, a conference took place where groups of students presented their claims and evaluated other groups' claims.

Synchronous and Asynchronous Peer Feedback Tools

The activity sequence included two peer reviewing sessions using the STOCHASMOS collaboration tools. STOCHASMOS is a web-based platform designed to host problem-based investigations and to scaffold students' collaborative reflective inquiry. The learning environments developed using this platform consist of the *Inquiry Environment*, where the scenario of the investigation is described and the relevant data are presented, and the reflective *WorkSpaces*. The Inquiry Environment represents data to students using multi-modal formats, such as text, graphs, pictures and videos. The *data capture tool* enables students to automatically record data as evidence. The selected data are automatically transferred to the *WorkSpace*, where students can organize and interpret them using *templates* designed for each learning environment. Each template contains teacher-designed prompts for scaffolding students' reflective inquiry.

The platform also consists of tools supporting synchronous and asynchronous communication between groups of students. The *Workspace Sharing area* was designed to scaffold the asynchronous feedback provided between peers in relation to their work in the WorkSpace. The WorkSpace Sharing area offers students the opportunity to collaborate with other groups in their classroom or in other schools, by allowing them to select and share their WorkSpace pages (e.g. data pages, explanation pages) in order to receive and provide peer feedback. Each group can identify the WorkSpace pages they would like to share with their collaborating group, and can activate or de-activate sharing as they wish. They can view the collaborating group's review of their work by visiting the WorkSpace sharing tab of STOCHASMOS. Students can also access a log of previously saved peer comments. Figure 1 shows the WorkSpace Page Sharing tool. Workspace Sharing provides students with tools to facilitate the review process, such as the ability to add comments to their peers' data pages. The comments are added in the form of annotation notes. Students' work is saved as a new version of the original page, while the original page is maintained. This gives students the opportunity to continue their work and selectively apply the changes proposed by their peers. Groups who share a WorkSpace page can access the original page as well as the page with the comments from the group's WorkSpace. When a group adds comments to a page, the other group is automatically notified. Selecting the corresponding icon, students can view their partner's group comments. The between-groups collaboration tools build upon students' work with the WorkSpace templates.

Another collaboration tool in STOCHASMOS is the *chat tool* (Figure 1) which can be used for synchronous communication between two paired groups in order to support the process of seeking and providing comments and clarifications. This tool appears as a separate, movable window above the main platform in order to give students the possibility to have visual contact with the Inquiry Environment or WorkSpace pages. Designers of learning environments can add prompts in the form of customizable sentence starters or questions in order to help students focus on the objectives of the communication but without eliminating their autonomy. When a group sends a message to their partner group, the other group is automatically notified. The same happens when the teachers, who can remotely monitor and participate in students' discourse, send an instant message for facilitating students' discourse.

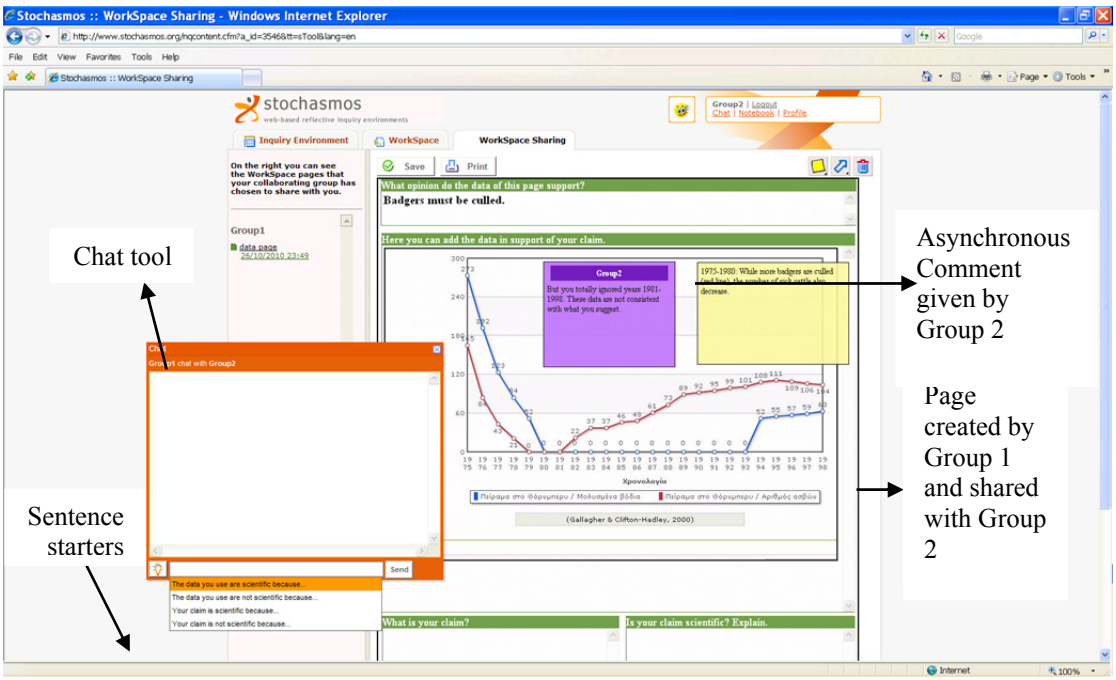

Figure 1. The STOCHASMOS Collaboration Tools.

Findings

We report on findings relating to the nature of the web-based asynchronous and synchronous peer feedback by examining the annotations provided by each group using the WorkSpace Page Sharing tool, the comments exchanged via the chat tool, and the videos of Group 1 discourse and interaction during the Peer Review sessions. Based on the Activity Theory framework (Engestrom, et al., 1999), three different states of activities were identified, all situated within the community of the classroom: (a) page sharing and students' written peer-review comments, (b) students' discourse and activity around these comments, and (c) intergroup communication using the chat tool. The examination of the groups' asynchronous peer review comments indicated that the paired groups reviewed a total of 34 WorkSpace pages during PRS1 and 13 pages during PRS2. A content analysis of the feedback indicated that most of the comments during both peer review sessions (n_1=21, 67%, n_2=8, 61%) were relevant to the task and related to the content of the pages. Some comments concentrated on whether their partners responded to all the questions of the template (n_1=7, 23%, n_2=4, 31%). The analysis of the feedback provided by the groups indicated that the written feedback, even though brief, was contextualized, specific and relevant to the peer review task students were asked to perform, with only three comments during PRS1 (10%) and one (8%) during PRS2 not directly relevant to the task. In addition, the comments provided addressed issues which were not explicitly setup by the task, focusing on the reviewed group's interpretations, indicating agreement, or disagreement, and asking for more complete articulations of students' interpretations. An analysis of the chat conversations indicated that students used the chat tool mostly for phatic communication and for coordinating the sharing of data in the WorkSpace Sharing space. Whenever students argued about claims in the chat tool, these discussions lacked the contextualization and the support of data. The analysis of the videotaped discourse of Group 1 during the peer review sessions illustrated the relationship and timing between each of the activities (page sharing, providing comments, chatting) and mapped the interdependencies between offline and online activities. This analysis provided evidence that the page sharing activity engaged students in reflective practices, such as monitoring their process, evaluating their work and proposing a course of action prior to sharing their pages.

Specifying the time periods in which the peer review should take place influenced the within-the-group discourse, as students were primarily concerned with making contact with the other group and receiving comments. Group 1 students were facile with using the collaboration tools but technical, network-related problems and the task setup delayed the process of exchanging comments. Technical difficulties, which were related to the school's network infrastructure, also influenced the nature of the student conversations and their interactions with the teacher, placing emphasis on procedural and logistical issues. As shown in Table 1, this behavior, however, did not preclude students from giving relevant, written comments, even though a different task setup might have improved the peer review process.

Based on the analysis of the discourse of Group 1 and the analysis of all chat logs, students were eager to receive their peers' feedback, something that strengthens the belief that peer feedback may increase students' motivation to engage with the task. The analysis of the interactions between peers and the software tools also indicated that socio-technical and task structuring decisions delayed the process of providing feedback and limited the time devoted to discussions. This analysis suggested that a more efficient activity structure could address socio-technical and task structuring problems in future enactments. Finally, the teacher also played a role in coordinating the activity, by regularly visiting the groups and monitoring their work.

Discussion and Implications

This exploratory study contributes to knowledge about peer feedback processes in collaborative, inquiry based learning in elementary school, a topic currently understudied. The study explored the role of synchronous and asynchronous representational web-based tools in providing and receiving peer feedback. Findings indicate that a) collaborative peer feedback is feasible even at the elementary school level, and b) asynchronous and synchronous representational and communication tools can support different aspects of the peer feedback process. The data presented support a broader function of the communication tools than the one originally intended. For instance, students did not adhere only to the task of employing epistemological criteria to asynchronously assess the other group's claims but spontaneously engaged in exchanges which were desirable but not explicitly requested by their teacher. Such observations indicate that the students appropriated the tool and that such peer review sessions can serve for providing peer feedback on varied aspects of the students' work. We believe that the visual representations of students' work contextualized and helped focus the WorkSpace sharing comments on task-related issues.

The findings of this study have implications for the re-design of the collaborative, peer feedback tools and the context within which they can be used. For example, we found that most of the chat exchanges were consumed by socio-emotional and procedural interactions. It appears that the use of group names, instead of the students' real names in the chat tool, was an obstacle to focusing the communication on the cognitive task, as each group wanted to identify which school mates participating in their paired group. We hypothesize that this type of phatic communication will continue to exist even in the cases when student groups do not attend the

same school. Possible design modifications to address this could be to explore ways in which paired groups can become acquainted through other means (e.g. initial video conference sessions, development and exchange of WorkSpace profile pages, visual cues embedded in the chat tool). It is also possible that the observed behavior may be due to the novelty of this type of computer-mediated interaction between the students and that this behavior may change in future similar experiences. Furthermore, it maybe that this type of synchronous communication serves the need for socio-emotional communication, as identified by researchers (Kreijns, Kirschner, & Jochems, 2003) chat exchanges may played a complimentary role to the more cognitively-oriented processes supported by the WorkSpace sharing space. Findings about a differentiated role of software tools to support collaborative learning have been suggested elsewhere in the literature (Stahl, 2009). Our own findings provided us with context into how these tools work in early years' science education peer feedback sessions. Findings also indicate that the groups did not use the scaffolding represented in the chat tool in the form of sentence starters or questions. This maybe a usability or a cognitive support issue that should be explored in future studies.

A second design implication concerns the task activity structures, involving the use of the collaborative peer review tools. By design, the Peer Review Sessions were constrained in two sessions, instead of freely allowing groups to exchange comments at any point during their investigation, to avoid an excessive amount of non-task focused communication and to respond to time constraints imposed by the school schedule. Our findings have led us to reconsider this task setup, as it precluded us from observing students' spontaneous patterns of interaction during such sessions. Future studies will address this issue and other limitations of the present study, such as the need for gaining more insight about the tools and feedback processes through extended interviews of the students using the tools, and analyzing the discourse and interaction for a larger number groups.

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