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Introducing synchronous e-discussion tools in co-located classrooms: A study on the experiences of 'active' and 'silent' secondary school students.

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Abstract

Even though the advantages of online discussions over face-to-face discussion formats have been extensively discussed and investigated, the blending of synchronous online discussion tools in co-located classroom settings has been considered with far less intensity. In this paper, we report on secondary school students' experiences and preferences concerning two different discussion formats for critical debate in co-located classroom settings: face-to-face and synchronous, computer-mediated communication (CMC). Data was collected with the help of self-report questionnaires (N = 70) and structured interviews (N = 4). A differentiation was made between students that define themselves as active participants in face-to-face classroom discussions and those who usually remain silent in these settings. The findings highlight several potential advantages of the computer-mediated discussion format, especially in terms of the social-interactive and managerial aspects of classroom discussions. Comparisons between the two groups show that 'silent' students welcome the introduction of CMC with enthusiasm, whereas 'active' students do not show a clear preference. Practical implications as well as new directions for further research are discussed.

Research highlights:

- We explore the (dis)advantages of conducting online discussions in co-located classrooms**.**
- 70 secondary school students participated in F2F and synchronous discussions during the school year
- The online format was found to have advantages with regard to social-interactive and managerial, but not academic aspects
- Differences were found between students that are active vs. silent F2F participants

Many theories of learning and development emphasize the importance of children's guided participation in structured, intellectual dialogue, both in classroom as well as out-of-school settings (e.g., Resnick, Michaels & O'Connor, 2010; Rogoff, 1990; Sfard, 2008; Webb, 2009). Among others, the role of structured academic dialogue has been studied with regard to its benefits for the learning of academic content (e.g., Asterhan & Schwarz, 2007; 2009; Chi, Roy, & Hausmann, 2008; Chin & Osborne 2010; Webb, 2009), the development of individual intellectual skills (Mercer, Dawes & Wegerif, 2004; Kuhn, Shaw & Felton, 1997), and the appropriation of certain forms of discourse that are highly valued by society (Michaels, O'Connor & Resnick 2007). Unfortunately, however, most children are offered only few opportunities to actively participate and engage in dialogic classroom activities, especially in secondary education (e.g., Adger, 2001; Nystrand & Gamoran, 1991). In the next section, we will consider the two more common forms of face-to-face (F2F) discussion formats in secondary school classrooms (teacher-led discussions with the entire classroom and peer-to-peer small-group discussions) and show how these formats provide limited opportunities for each student to actively participate in dialogical activities. Based on theory and findings from the literature, we will then argue that the integration of synchronous, computer-mediated communication tools in classroom activities could address some of these difficulties and offer additional advantages. Finally, we will present empirical findings from an exploratory study that sought to document secondary students' experiences with and preferences for face-to-face and computer-mediated discussions in co-located classrooms.

Face-to-face discussions in the classroom

Teacher-led classroom discourse is typically characterized by Initiation-Response-Evaluation, or IRE, sequences (Cazden, 2001), where the teacher asks a quiz-like question, a student answers, the teacher evaluates the answer and then moves on to the next student. Several interventional programs, such as for example Accountable Talk (Michaels,

O'Connor, Hall & Resnick, 2002; Michaels, O'Connor & Resnick, 2007) and Dialogic teaching (Alexander, 2008), have been initiated to improve the quality of teacher-led classroom discussions, so that teacher communication is aimed more at eliciting students to actively and deeply engage in the content matter. Still, it is inherent to whole-class discussions that at any given moment only few students can actively participate in the conversation. In fact, many students do not or rarely ever participate in classroom discussion activities (e.g., Caspi, Chajut, Saporta, & Beyth-Marom, 2006; Crombie, Pyke, Silverthorn, Jones, & Piccinin, 2003). Moreover, conversational content and procedures (e.g., turn-taking) are predominantly guided by and channeled through the teacher. Research has shown that pupils tend to be more explorative and generate more explanations and ideas of themselves in peer-guided dialogue, than they do in teacher-guided dialogue (Hogan, Nastasi & Pressley, 2000). Thus, whereas high quality teacher-led discussions may play an important role in classroom instruction, and not in the least for modeling good discussion practices, it does not maximize student opportunities to actively engage in and practice them themselves.

Small-group, peer-guided discussions offer more opportunities for students to be active participants in the discussion. However, such discussions may quickly become incoherent, superficial and/or off-task when unmonitored or inadequately structured (Gillies, 2004; Webb, 2009). Moreover, student differences in social status, verbal abilities and personality traits cannot guarantee equal participation rates (Chinn, Anderson & Waggoner, 2001). High-status, high-ability and extrovert peers may often dominate the discussion and group decision making (Barron, 2003; Caspi et al, 2006) while leaving their other peer discussants passive throughout the discussion. In the next section, we will discuss how some of these challenges may be overcome by blending computer-mediated communication (CMC) for small-group discussion activities in co-located classrooms.

On-line discussions in educational settings

Research into the use of discussion boards in educational settings suggests that textual computer-mediated communication (CMC) formats offer several advantages over face-to-face (F2F) formats of peer-to-peer discussions: First of all, a great deal of the non-verbal cues that are present in F2F communication is unavailable in CMC (Kiesler, Siegel & McGuire, 1984). Since these non-verbal cues are used to assess among others social status, CMC has the potential of being more democratic (Harasim, 1987, Herring, 2004). It has been found that people become less inhibited, self-disclose more frequently, and are more inclined to express personal, individual standpoints (Hamburger, & Ben-Artzi, 2000; Hamburger, Wainapel, & Fox, 2002; Suler, 2004) and to take academic risks (Blau & Caspi, 2008). In addition, students do not need to compete for speaking rights in most online communication environments. They can post contributions simultaneously which often leads to increased and more egalitarian participation (Hampel, 2006; Weasenforth, Biesenbach-Lucas & Meloni, 2002).

It has also been argued that the ability to re-read and revise contributions - both before as well as after posting contributions - encourages reflection (Guiller, Durndell, & Ross, 2008; Kim, Anderson, Nguyen-Yahiel, & Archodidou, 2007). In addition, the absence of non-verbal communication cues, such as facial expressions, body language and intonation, requires more effort to sustain, comprehend and engage in conversation. This has not been found to deter students (Tiene, 2000). In fact, it may have certain pedagogical benefits, such as the need for student to more clear, specific and explicit in their communication. Indeed, several studies have found that compared to F2F settings, participants in asynchronous CMC contributed were more explicit and showed higher rates of substantive and reasoned contributions (Jonassen & Kwon, 2001; Kim et al, 2007; Newman, Webb, & Cochrane, 1995).

Alongside reports on the advantages of the online over the F2F format for group discussions, studies on students' self-reported comparisons and evaluations of both formats have shown a somewhat different pattern: Some studies reported on higher self-reported satisfaction and motivation in F2F settings, but did not find differences in self-reported learning gains (Blau & Barak, 2009; Blau & Caspi, 2008; Marcus, 1994). Others have found that undergraduate students reported on positive attitudes towards asynchronous online discussions when these are blended with F2F classroom formats, but that they did not want them to replace F2F discussions (Tiene, 2000).

It is striking, however, that the above-mentioned body of comparative research has almost solely focuses on text-based, asynchronous communication between individuals that are physically distributed. Moreover, they have almost exclusively focused on college student and other adult populations in post-secondary education (Ellis, Goodyear, Calvo & Prosser, 2008). Typical settings that have been studied are, for example, e-courses, Open University education, homework assignments, and after-school social communication. Little is known about the use of synchronous e-discussion tools in educational settings, and even less so about its use in co-located, secondary school classrooms (Cuban, 2002), even though several recent studies have started to explore this topic (Asterhan, 2010; Asterhan & Schwarz, 2010; Asterhan, Schwarz & Gil, in press; Janssen, Erkens, Kirschner & Kanselaar, 2010; Sins, Savelsbergh, van Joolingen & Elshout-Wolters, in press; Schwarz & Asterhan, 2011). The present study aims to further our understanding of this particular practice by focusing on the students' perspective and how they experience the difference between F2F and online, synchronous discussions in the classroom.

Before turning to a description of the empirical study, we will elaborate on the practical and pedagogical reasons for preferring a synchronous, co-located format, instead of a asynchronous, distributed format of CMC for this study.

Synchronous discussions in co-located classroom settings

For many it may appear counterintuitive to communicate through a computer while sharing a room. Why not simply talk to each other? There are several reasons for preferring a synchronous, co-located discussion format over the asynchronous and distributed alternative. First of all, many of the aforementioned features of a-synchronous, distributed CMC are identical to synchronous CMC formats: Both are textual, lack non-verbal cues, provide the ability to revisit and revise contributions, and do not require turn-taking. The potential advantages that have been associated with these features, such as more reflection, explicitness, interactivity and egalitarian participation, are then expected to replicate for synchronous CMC.

Secondly, synchronous, co-located CMC also differs in several ways from its asynchronous, distributed counterpart which potentially make it a better fit for blending online discussions with regular F2F classroom activities: In typical secondary school settings, student discussants share a physical space, they personally know their discussion partners and the teacher is physically present. This co-location is likely to avoid some of the drawbacks of distributed, anonymous discussion settings for educational purposes, such as 'flaming' or other social disturbances and lack of accountability for communication content. Teachers are physically present to sustain engagement and motivation, to monitor and support group functioning, and to provide individual help when needed. In addition, there are *practical* reasons to consider: For example, if students were to participate in an after-school discussion assignment from their home computers, teachers would not be able to verify whether a certain task was actually completed by the student him/herself, or by another person in the household. Moreover, not all students can be considered to have convenient out-of-school computer access.

The *synchronous* mode of these co-located computer-mediated discussions has also several potential advantages. Communication in synchronous discussion environment is closer to spoken conversation and therefore likely to be more engaging and animating than asynchronous conferencing (McAllister et al, 2004). Students have also been found to be more active and produce more contributions in synchronous, than in asynchronous environments (Cress, Kimmerle & Hesse, in press).

On the other hand, however, the rapid pace of simultaneously posted messages may also pose several problems. This is particularly true for the most commonly used discussion software, where turn adjacency is based on chronological precedence (such as in instant messaging or threaded discussion boards). Conversational overlap can prove to be quite problematic in these environments, especially when used synchronously and in groups that have more than two participants: Unrelated messages from other participants often intervene between an initiating message and its response (Condon & Cech, 1996; Marvin, 1995; Murray, 1989) and discussants tend to focus mainly on recently posted messages (Hewitt, 2003). As mentioned by McAlister, Ravenscroft and Scanlon (2004), the result is "(…) like a noisy party in which replies get lost in the hubbub of conversations" (p. 196). This sequential incoherence poses a substantial cognitive load for participants and causes rapid topic decay (Herring, 2001). It also makes it difficult for participants to find relevant contributions, to place one's own contribution in the relevant context, or to quickly assess the outcome of the discourse (Suthers, Vatrapu, Medina, Joseph & Dwyer, 2008).

Software design is capable of providing solutions for these difficulties, however. Instead of limiting communication sequencing to a vertically organized, chronological order, environments can be designed to allow discussants to organize and interlink postings in a more flexible way. For example, in discussion environments such as Digalo (Asterhan et al., in press, 2010; Schwarz & de Groot, 2007), jigaDREW (Lund et al 2007) and Knowledge

Forum (Scardamalia & Bereiter, 2006) participants are free to post their contributions anywhere in a two-dimensional discussion map and link it to any posting of their choice. With several different, but interconnected discussion threads developing simultaneously and students moving from one to the other, this flexibility is much needed. Moreover, software such as Digalo also provides representational support to increase visibility and overview, by offering different link colorations and tagged geometrical shapes to highlight dialogue moves of different types, such as disagreements, questions, arguments and so on.

In summary, there are several practical and pedagogical reasons for preferring a synchronous, co-located format over an asynchronous, distributed format of CMC for online discussions in secondary school settings. In order to avoid some of the problems of sequential incoherence that is characteristic of regular instant messaging software, the discussion environment employed in the present study allows for flexible posting of contributions in a two-dimensional discussion phase (i.e., communication sequencing is not limited to a vertically organized, chronological order).

The present research

The purpose of the present study was to explore the different affordances of F2F and synchronous, computer-mediated discussion formats in secondary, co-located classrooms. Following studies by Goodyear and colleagues (e.g., Ellis, Goodyear, Calvo & Prosser, 2008) a phenomenographic approach was adopted. We explored how secondary school students experienced and compared F2F and synchronous CMC discussion formats in the classroom. The study was conducted in an in-vivo school environment, in which students experienced several sessions of both F2F as well as computer-mediated critical debates throughout the school year. Since both F2F discussions as well as CMC are still the exception to the norm in most classrooms, this study accompanied students whose teachers participated in a professional development program to increase and improve F2F discussion activities and to

introduce computer-mediated discussions in their classrooms. It then included only students that had experience with both formats and were in a position to compare these experiences.

The design of this first exploratory study involved a combination of interviews and self-report surveys. The surveys focused on aspects of the social-interactive dimension (participation, interactivity, classroom management) and of the academic dimension (learning experience, motivation, clarity) of classroom-based discussions. Based on the aforementioned rationale and literature, we expected that with regard to the social-interactive aspects of the interaction (participation, interactivity, classroom management) students will report on an overall preference for the synchronous CMC format. With regard to the academic aspects of the discussion activity (motivation, learning experience, clarity), they are not expected to report on clear preferences for either format.

In addition to these hypotheses on the general student population, we also hypothesized that different students are likely to experience the introduction of online discussion activities differently. Given that this study focuses on students' experiences of a more common (F2F) versus a novel (CMC) form of classroom communication, their existing discussion habits should be taken into account. For this reason, we differentiate between students that are active and frequent participants in F2F classroom discussions, and those who hardly ever participate in them (from here on referred to as 'active' and 'silent' students, respectively). It is expected that they differ in the extent to which they will welcome the introduction of new communication formats

in the classroom: 'Silent' students are expected to benefit most from the aforementioned affordances of CMC environments more and will therefore report on a stronger preference for the online formatthan 'active' discussants, who already posses effective discussion habits in F2F classroom discussions. This difference is expected to be reflected in an overall

preference difference, as well on the more particular aspects of the discussion experience, such as participation, interaction, motivation, perceived learning and clarity.

Method

Participants

Seventy students from a public secondary school in the Jerusalem metropolitan area participated in this study (61 9th graders from three different classrooms, and 9 11th graders). All students filled out a questionnaire on their experience of F2Fand online discussions in the classroom (see Tools section). In addition, four students of one 9th grade classroom (two 'active' and two 'silent' classroom discussion participants) participated in individual, short structured interviews on this experience.

Tools

The discussion environment. The discussions were conducted within the Digalo environment (available at http://www.argunaut.org; see also Asterhan, et al, 2010; Schwarz & Asterhan, in press; Schwarz & de Groot, 2007, for additional descriptions). It enables synchronous, textual talk through mediation of geometrical shapes and links that represent different dialogical moves (such as, argument, explanation, claim, and so forth). Group discussions in Digalo consists of co-creating maps built of textual contributions inside geometrical shapes and different arrows (supporting, opposing, and linking) representing different relations between the contribution shapes. The output from this activity is then a collaboratively constructed dialogue map (see Figure 1).

Insert Figure 1 About Here

Each discussant works on a personal computer and sees the display of the on-going argumentative map while constructing his/her own contribution. The different geometrical shapes constitute the ontology that specifies and constrains the kinds of dialogue moves discussants choose during their discussions. The tags for the different shapes may be

specified by the teacher and typically include (a selection of) the following: "idea", "claim", "explanation", "argument", "comment", and "question". Together with the three different types of arrows, this ontology covers various kinds of argumentative moves. As is shown in Figure 1, the upper bar displays the pallet of tagged shapes to be chosen from. The lower left window displays the icons of the discussants that are attached to each shape in the map. Discussants may write the title of their contribution in the title rubric (visible at all times). The content of their contribution is visible when hovering over a shape with the cursor or by opening a shape by double-clicking it.

Survey. A questionnaire was developed in which students were asked to report on their personal experiences with on-line Digalo and face-to-face classroom discussions in a comparative manner. It included twelve statements that described different aspects of students' personal experience in discussions in the classroom (see Table 1 for an overview): Six items referred to the social-interactive dimension of discussions and included items that assessed aspects of interaction, participation and classroom management. Six additional items referred to the academic dimension of the discussion experience and included items that assessed aspects of the learning experience, communication clarity and motivation.

For each item, students were asked to indicate whether the statement was more characteristic of their experience in Digalo discussions, of their experience in face-to-face classroom discussions, or equally well. Values on the scales ranged from 1 (much more so in Digalo discussions) to 5 (much more so in classroom discussions), with 3 indicating that there was no difference between the two. After data collection, these scores were re-coded by a linear transformation of (-3), to accommodate easy data interpretation. Following this transformation, positive scores indicate a preference for on-line discussions, negative scores indicate a preference for F2F classroom discussions (range from -2 to 2) and zero represents a lack of preference. Values for the two classroom management items were reversed, such that

more disturbance or more off-task behavior in one discussion format indicates a preference for the opposite discussion format. Table 1 presents the mean preference scores, their standard deviation and the internal reliability measures for the different dimensions and the discrete items.

The questionnaire also included an item in which students were asked to self-report on their frequency of participation in face-to-face classroom discussion, ranging from 1 (almost never) to 4 (a lot).

Procedure

The data was collected in a secular public school in the Jerusalem metropolitan area. Part of the teaching staff in this school participated in an in-service teacher training provided by the Kishurim program (Schwarz & de Groot, 2007), which partly sponsored by the Israeli Ministry of Education and European Community R&D funds. The Kishurim program aims to foster argumentation and dialogic activities in secondary schools, both in face-to-face as well as in computer-mediated communication formats. Teachers participate not only in pre- or in-service teacher training programs, but also receive local, in-school support. This is true for both the design and implementation of classroom activities, as well as for the operation of computer-mediated communication tools in classrooms.

All students had participated in at least two classroom activities in the Humanistic disciplines of civic education, biblical studies and/or history, each of which blended traditional teaching activities with F2F and online Digalo discussions (Eisenamnn & Schwarz, 2009). Students handled the software very quickly, and since they had participated in at least two (but often more) Digalo discussions, they had gained sufficient confidence and experience with the tool for this not to affect the results. The anonymous questionnaires were administered approximately a week following the last online discussion during regular classes in the discipline in which the last on-line discussion occurred.

Four students from one particular ninth grade classroom were selected for a short follow-up interview. They were selected based on the teacher's evaluations of who were the two most active and the two most silent students in face-to-face classroom discussions. The aim of the interview was to expand our understanding of the findings from the questionnaires analysis (Johnson & Onwuegbuzie, 2004). Each interview was conducted in a private area on school grounds, by a person that students did not know from previous encounters and started with a request to describe regular face-to-face classroom discussions and the electronic discussions they experienced. During these descriptions the interviewer prompted for further explanations and examples. The comparison between the different discussion styles (F2F and CMC) in both the questionnaire as well as the interview format proved to be quite natural for the students and they were very cooperative.

Results

Two sets of analyses are presented: In the first, the overall communication format preference of all 70 students is considered, whereas in the second we compare between the self reports of active and silent students. In both sets, the quantitative findings are interwoven with insights from the qualitative analyses of the student interviews.

Insert Table 1 About Here

Self-reported preference by the whole sample

The mean scores presented in Table 1 show a general trend for preference towards the online discussion format on 5 of the 6 discussion experience sub-dimensions, and that this preference is strongest for the aspects that fall under the social-interactive dimension of the discussion. Statistical analyses were conducted with eight separate one sample, two-tailed t-tests on each of the two main and the six sub-dimensions. Alpha was corrected with a Bonferroni test, which resulted in an alpha value of .006 for each test of significance. With regard to the social-interactive aspects of the discussion experience, students reported on an

overall preference for the online format, t (69) = 5.15, $p < .001$: They reported to experience more verbal interaction with peers, t (69) = 4.06, $p < .001$, higher participation rates t (69) = 4.02, $p < .001$, and better classroom management, t (69) = 4.27, $p < .001$. With regard to the academic aspects of the discussion experience, on the other hand, neither the overall preference score, t (69) = 1.13, *ns*, nor any of the three different sub-dimensions of motivation, learning experience or clarity proved to be significantly larger than zero. Thus, irrespectively of their existing F2F discussion habits, students self-reported on advantages of online synchronous discussions for the social-interactive aspects of the discussion, but no difference between the two formats with regard to academic aspects.

These trends were also reflected in the interview protocols: First of all, all four interviewees voluntarily related to differences between discussion formats with regard to classroom management: They observed that during online discussion the group is silent ("in Digalo it's quiet" , "the lessons were conducted quietly because the discussion was going on in writing"), whereas F2F discussion are noisy and full of interruptions ("there is much more noise", "[In the online discussions] there is no noise or kids that interfere and disturb"). In addition, the interviewees mentioned that in a regular lesson the teacher is occupied with discipline problems, while in Digalo-lessons the teacher is more available for other issues:

> "in Digalo[-lesson] the teacher walks between the students and checks if everything is OK… and if there are questions we can ask him. In regular lesson [F2F discussion] the teacher is busy with discipline problems…" (*interviewee #3)*

The difference that students experienced with regard to the opportunities to interact with fellow peers was also recurrently mentioned in the interviews, as is shown in the following excerpts :

> "I think it would have been easier [in a Digalo-discussion] … to understand the other side's opinions, what they think… it would have been easier to change your opinion or understand another opinion" (*interviewee #4*)
>
> "And in Digalo it is quiet and you can see, you sit in front of the computer by yourself and see what people write. And you can refer to each thing separately and in your own pace. (…) Next to the computer I found it easier to express myself" (*interviewee #3*).

Comparison of active vs. silent students' experiences

Following this first exploration, we then turned to a comparison of discussion format preferences as a function of students' self-definition as high ('active') or as low frequency ('silent') participants in face-to-face classroom discussions. 'Silent' students were operationally defined as those students that indicated that they "almost never" or "every now and then" participated in F2F classroom discussions (N = 30), whereas 'active' students indicated that they did so "often" or "a lot" (N = 40).

Two multivariate tests of variance were conducted: The first tested for differences between silent and active students on the mean academic and social-interactive dimensions of the discussion experience. A second MANOVA further explored differences between these two groups on the six sub-dimensions of interaction, participation, classroom management, learning experience, clarity and motivation. Multivariate outliers and normality were dealt with by Mahalanobis distance analysis. Mahalanobis distance (D^2) is descriptive of how far each case's set of scores is from the group means adjusting for correlation of the variables (Burdenski, 2000). Using an alpha value of .05, outliers were eliminated from multivariate analyses. As a result five observations were eliminated from the data set (2 'silent' and 3 'active' students). Mahalanobis distances were then plotted against derived chi-square values to secure multivariate normality in both models.

Insert Table 2 About Here

Differences on the academic and social-interactive dimensions. Mean and standard deviations of the preference scores of 'active' and 'silent' students on the two main dimensions are presented in Table 2. A multivariate ANOVA on the mean academic and social-interactive dimensions of the discussion experience revealed an overall difference between active and silent students, Wilk's Lambda = .857, F (2, 62) = 5.15, p = .009, partial η^2 = .143. On the social-interactive dimension, both groups favored the online communication, although silent students favored it significantly more strongly than did active students (M = .95, SD = .70 and M = .32, SD = .91, respectively), F (1, 63) = 9.13, p = .004, η^2 = .127. With regard to the academic dimension, silent students expressed a moderate preference for the online format (M = .45, SD = .72), whereas the active students showed a slight preference for the F2F format of discussion (M = -.08, SD = .76), F (1, 63) = 8.11, p = .006, η^2 = .114.

Differences on the six sub-dimensions of the discussion experience. Mean and standard deviations of the preference scores of 'active' and 'silent' students on the different sub-dimensions are presented in Table 3.

Insert Table 3 About Here

An overall difference between silent and active students was found, Wilk's Lambda = .765, F (6, 58) = 2.96, p = .014, partial η^2 = .235. Separate analyses on the different sub-dimensions showed that significant differences were found with regard to the dimensions of interaction, participation, learning experience, motivation and clarity (see Table 3, right column), with silent students preferring the online format on all these sub-dimensions and active students preferring these less strongly (interaction), being indifferent (participation, learning experience, motivation) or preferring the F2F format (clarity). The two groups did

not differ on the classroom management dimension (classroom disturbance and off-task behavior): both active and silent students reported on a preference for the online format.

The mean scores in Table 2 show that active and silent students report on different preference patterns for communication formats in the classroom: Silent students showed an overall and consistent preference for the online communication format. These preferences were strongest for the social-interactive dimension of the situation (ranging from M =.84 to M = 1.14), and moderate for the academic dimension (ranging from M =.33 to M =.57). This overall preference for the online format was also reflected in the interview protocols of the two silent students:

> "In Digalo *all* students are forced to and also want to participate in the discussion" *(interviewee # 3)*
>
> "In Digalo most of the students are busy writing, so like, [it gives] the opportunity for everyone to express themselves more than they usually do. (…) From Digalo I learned more than in a discussion of the same topic in the class… in regular class I don't participate that much" *(interview #2*)

At a later point in the interview interviewee 2 furthermore added that in his opinion computer-mediated discussions are of a better linguistic quality:

> "In Digalo, everybody speaks in a more sophisticated language. When you write it is in a more beautiful language. (…) I think [that computer-mediated discussions are used], to give those that usually don't participate a chance to talk. And also, to develop the discussion, to bring it to a higher level for all the groups." (*interviewee # 2)*

The 'active' students' self-reports, on the other hand, did not show a clear pattern of overall preference: With regard to the social-interactive dimension, 'active' students reported slight to moderate preferences for the online communication format (ranging from M = .11 to

M = 64). On the academic dimension, in contrast, they expressed a moderate preference for the F2F format with regard to their ability to follow and understand the discussion (*M* = -.20) and no preference with regard to motivation (*M* =.05) and the learning experience (*M* = -.09).

This overall picture for active students was also reflected in the interview protocols: The two active students did not reveal any clear preference for one format over the other. Interestingly, however, they did voluntarily acknowledge and appreciate the advantages of CMC discussion for their fellow 'silent' classmates:

> "Specifically, for me there was no difference, but I know about other students who found it easier to express themselves in writing rather than verbally… for me it was about the same… during discussion in class there are much less students participating… Digalo really helps, for me as well as for other students, to express themselves, it teaches a lot" (*interviewee #1*)
>
> "For me it is about the same because I do participate, but [for] students who don't participate it helps them to better understand the material, to understand what other students say" (*interviewee #4)*

Discussion

For some, talking with one's classmates through a computer while sitting in the same classroom may seem counterintuitive. However, the results presented here show that this communication format may offer several advantages, especially for the social-interactive aspects of classroom discussions: When asked to compare their experiences with regular F2F classroom discussions, students reported that student participation was more egalitarian, that they felt free to express their ideas and that they engaged in more peer-to-peer interaction. In addition, they also reported to have experienced less classroom interruptions and disturbances in this format of communication.

The findings also show that different students (active or silent F2F discussants) experience F2F and computer-mediated communication differently. Students that usually remain silent in F2F classroom discussions readily identified the advantages of online peer discussions, both for social-interactive as well as academic aspects of peer discussion. Active F2F participants, on the other hand, who are likely to already have well-developed F2F discussion habits, did not show clear preferences for one over the other. However, they did acknowledge the advantages for their 'silent' fellow classmates and indicated that they very much welcomed and appreciated their inclusion. It is interesting, that students were well aware of the inequality that exists in F2F classroom discussion practices and that 'silent' as well as 'active' students expressed that they would like to change this reality. A particular interesting venue for future research is to investigate whether the development of these new practices can carry over to F2F classroom discussion activities. For example, will the participation in a sequence of online discussions increase the 'silent' students' participation in F2F discussions?

Limitations and future directions

The goal of this study was to test the feasibility of implementing on-line tools for peer discussion within genuine secondary school classrooms and to explore whether students experience any of the potential advantages of this form of communication over F2F discussions. It shows that synchronous CMC in co-located classrooms is not only executable, but is likely to have several advantages when implemented in a structured learning sequence. To further examine these potential advantages, direct observations of student behavior during on-line and F2F discussions are necessary to see whether these students' perceptions are also mirrored in their observed behavior. Secondly, a distinction was made between 'silent' and 'active' students, without further considering the reasons for these self-reported behavioral differences. Previous studies on adult learners have shown that certain personality traits and

other individual differences are related with differences in student participation in classroom and online communications (Caspi, Chajut & Sapporta, 2008; Caspi et al, 2006). Future research would have to examine whether these findings could be extended to secondary school classroom settings.

In the implementation phase of this study, a particular discussion environment (Digalo) was chosen over other, more commonly used synchronous tools, such as instant messaging, Internet Relay Chat and twitter. The findings of this study may therefore be somewhat limited to the particular features and affordances that are built into this and similar discussion software, such as the labeling of dialogue moves, the diagram-based representations and the ability to place contributions anywhere in a two-dimensional space. As for the first feature (labeling dialogue moves), the research has been inconclusive so far: The use of sentence openers and labels in online argumentation has been shown to both improve (Cho & Jonassen, 2002; Schwarz & Glassner, 2007), as well as inhibit online argumentation (Jeong & Joung, 2007). The potential advantages of diagram-based representational tools for peer argumentation have been discussed elsewhere (e.g., Van Amelsvoort, Andriessen, & Kanselaar, 2007). They include among others, the increased ability to clarify relations, to illustrate the structure of argumentation, to promote reflection and to deepen the discussion space. However, we do not know of any research that has empirically compared the effectiveness of diagram-based environments for online group discussions with other tools[i].

We also mentioned that the mere possibility of being able to place contributions anywhere in a two-dimensional space is likely to prevent some of the more frequently encountered difficulties of commonly-used synchronous discussion tools: When several discussants are communicating with each other simultaneously without floor control, unrelated messages from other participants often intervene between an initiating message and its response, leading to incoherence and discontinuity (Condon & Cech, 1996; Herring, 2001;

Marvin, 1995; Murray, 1989). It is hard to envision how the more common tools that do not have this flexibility could be effectively used for small-group reasoning and dialogue on social dilemmas or academic content in classrooms.

At this point, we can only speculate on which of the different media's specific feature -or combination of features- should be held accountable for the differences that were found. Based on the literature, we suggested several potential reasons for their different affordances for peer discussions. More controlled, experimental studies are needed to investigate the more basic, theoretical claims concerning the effect of different media features on communication and social interaction.

Finally, it is important to emphasize that, even though the findings reported in this study indicate that CMC in classrooms can have several advantages, we do not advocate that CMC tools should replace regular F2F discussion formats in secondary schools, nor that peer collaboration and peer talk should be the only method of instruction used in classrooms. We do argue, however, that educational practitioners could consider this form of communication as a feasible alternative to other forms of classroom communication. It seems to be particularly appropriate for instructional activities that require active student participation in small-group reasoned dialogue, such as classroom activities that aim to improve argumentative discussion skills (Kuhn, Goh, Iordanou & Shaenfield, 2008).

An additional advantage of CMC that we have not discussed in this study, but which has considerable pedagogical potential, is the fact that the discussions can be printed out and reviewed in subsequent classroom sessions. Students can evaluate their own and their peers' reasoning, point out flaws and ways to improve, and annotate different dialogue moves according to an accepted ontology (What is a counterargument? What is evidence? etceteras). Reflective exercises such as these on one's own individual and group performance may prove to be particularly helpful in fostering students' reasoning and communication skills.

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Table 1

Mean, standard deviation and reliability measures for the two main dimensions, six sub-dimensions and discrete questionnaire items (N = 70)

	M	*SD*	α
Social-interactive dimension of discussion activity	.55	.90	.84
Interaction	.51	1.04	.68
"Students reacted to my contributions"	.51	1.06	
"I reacted to the other students' contributions"	.50	1.14	
Participation	.55	1.14	.86
"I had the opportunity to express myself"	.56	1.29	
"I participated in the discussion"	.54	1.15	
Classroom management	.60	1.18	.58
"There were many classroom disturbances"	.69	1.31	
"Students engaged in off-topic behavior"	.51	1.32	
Academic dimension of discussion activity	.11	.69	.84
Learning experience	.11	.86	.89
"The discussion caused me to think about the subject"	.29	.95	
"I felt that I learned new things on the subject"	-.07	1.00	
Clarity	-.02	.93	.86
"I understood the discussion topic"	-.10	1.05	
"I managed to follow the discussion development"	.05	1.16	
Motivation	.24	.94	.77
"I was interested in the topic"	.13	1.03	
"I enjoyed the discussion"	.34	1.13	

Table 2

*Mean preference score (and SD) of 'silent' and 'active' students on the social-interactive and academic dimension of discussions**

Discussion dimension	Silent (*N* =28)		Active (*N* = 37)	
	M	*SD*	*M*	*SD*
Social-interactive	.95	.70	.32	.91
Academic	.45	.72	-.08	.76

* Negative scores indicate a mean preference for F2F discussion format and positive for the computer-mediated format

Table 3

*Mean preference score (and SD) of 'silent' and 'active' students on the six sub-dimensions**

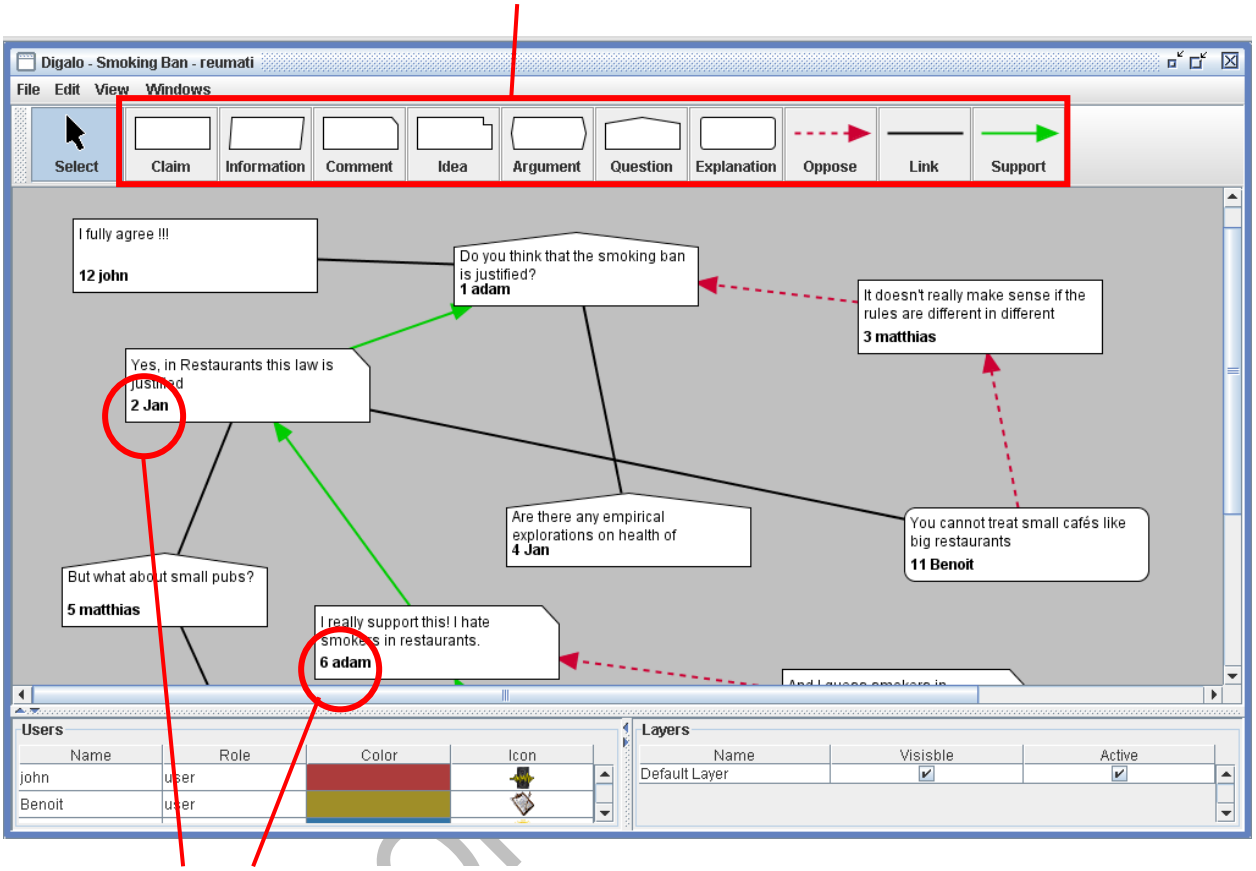
Discussion dimension	Silent (N =28)		Active (N = 37)		
	M	*SD*	*M*	*SD*	
Participation	1.14	.80	.11	1.12	F (1, 63) = .17.07, p < .001, η^2 = .213
Classroom management	.86	.98	.64	1.15	F (1, 63) = .73, *ns*
Interaction	.84	.76	.22	1.06	F (1, 63) = 6.19, p = .010, η^2 = .110
Clarity	.33	.88	-.20	.88	F (1, 63) = 5.87, p = .018, η^2 = .085
Motivation	.57	.78	.05	.93	F (1, 63) = 5.63, p = .021, η^2 =.082
Learning experience	.45	.76	-.09	.83	F (1, 63) = 7.24, p = .009, η^2 = .103

* Negative scores indicate a mean preference for F2F discussion format and positive for the computer-mediated format

Figure captions

Figure 1. An example of a Digalo discussion map

Menu of dialogue shapes and connection types



Chronological order of posting and ID of poster

[i] There has been some research though on the use of diagram-based software for discussion purposes or for presentational purposes (Lund, Molinari, Sejourne & Baker, 2007).