Effects of synchronous and asynchronous CMC on interactive argumentation

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Abstract: This study examined how different types of computer-mediated communication (CMC) influences the way pre-university students argue about genetically modified organisms. A total of 39 dyads discussed the topic using either synchronous (chat) or asynchronous (discussion board) CMC, after which they collaboratively wrote an argumentative text in a synchronous groupware environment. It was hypothesized that synchronous CMC would stimulate deep argumentation because of feedback immediacy while asynchronous CMC would stimulate gathering arguments because it allows increased reflection time. Finally, the study sought to determine if students who argue well during a discussion also wrote better argumentative texts. The results obtained partly confirmed the expectations. Students using synchronous CMC argue in a more elaborated way than students using asynchronous CMC. However, in contrast to the hypothesis, students using asynchronous CMC produced more accurate argumentative texts. This study sheds light on how synchronous and asynchronous CMC will be suitable for specific collaborative learning processes.

Introduction

Computer-mediated communication (CMC) is undoubtedly an important part of everyday life for many preadolescents and adolescents. Valkenburg and Peter (2006) found that 88% of Dutch adolescents aged 12 to 16 years use online communication - mainly Instant Messaging - with friends. CMC is fast becoming an increasingly common means of communication in everyday life, and parallel to this there is also an observable increase in use of CMC in education, especially in the field of computer-supported collaborative learning (CSCL). This approach to online collaboration seems to justify using CMC as cognitive tool to facilitate and promote collaborative knowledge building (Lehtinen, Hakkarinen, Lipponen, Rahikainen, & Muukkonen, 1999). However, CMC is a very broad term and comprises many types of communication including chat rooms, MOOs, Instant Messaging, videoconferencing, e-mail, and discussion boards.

There are many approaches to CMC where both the success and the failure of interactions in CSCL are explained by the same characteristics. For example, some researchers explain unequal student participation during CSCL by the lack of non-verbal cues in CMC which causes depersonalisation of the communication (Kreijns, 2004). On the other hand the lack of non-verbal cues is thought to stimulate elaboration and force students to explicate their thoughts, leading to positive learning outcomes (Veldhuis-Diermanse, 2002). The choice of justification depends on the perspective taken on whether CMC stimulates or constrains collaborative learning processes (McAteer, Tolmie, Duffy, & Corbett, 1997). Two issues are very important here. First, it is important to distinguish between different CMC technologies and their specific affordances and constraints. A major distinction can, for example, be made between synchronous and asynchronous CMC. Synchronous CMC occurs in real time and requires simultaneous participation while asynchronous CMC does not occur in real time and participants can communicate whenever they choose. Differences between asynchronous and synchronous CMC can account for different effects on collaborative learning such as differences in reflection on the content and coherency of the communication. Second, it is important to distinguish between different goals and characteristics of the learning context in which CMC is used. Branon and Essex (2001) show that educators have clear ideas about the appropriate fit between learning tasks and CMC technologies. Asynchronous communication was reported to encourage in-depth discussion in which all students had equal chances to participate. Synchronous communication was seen by the educators to facilitate quick problem-solving, brainstorming, and creating a sense of presence which is absent in asynchronous communication. Also, several researchers in the field of CSCL and communication research conclude that asynchronous systems should be preferred when the goal is critical thinking and deep learning (e.g., McGrath & Hollingshead, 1993).

However, despite the assumed lack of fit between synchronous communication and 'deep learning' tasks involving negotiation, argumentation, and complex problem solving, much CSCL research aimed at promoting

reflective discussion is carried out with chat tools (e.g., Baker & Lund, 1997; Veerman, Andriessen, Kanselaar, 2002; Walker, 2004). This raises the question as to whether using synchronous CMC for deep learning tasks is really ineffective when compared to asynchronous CMC. This contribution tries to answer the question of whether synchronous CMC, compared to asynchronous CMC, has characteristics that create opportunities for collaborative learning processes such as discussion and negotiation.

Discussion with CMC – Interactive Argumentation

Chinn and Anderson (1998) describe the ideal collaborative learning situation as a conversation between participants in which there is a collective searching for different positions, reasons, and evidence in an infinite space of debate. They call this *interactive argumentation.* The aim of interactive argumentation is not to establish truth or win an argument, but rather to explore an issue at stake. Nussbaum (2003) defines this as a co-constructive style of argumentation. Munneke, Andriessen, Kanselaar, and Kirschner (2007) present different opportunities for coupling interactive argumentation and learning. A first learning opportunity is justifying claims which can promote cognitive learning processes such as self-explanation and elaboration (Baker, 2003). A second opportunity is giving counter arguments which stimulates knowledge building since participants must both examine their own views and initial arguments as well as negotiate with each other about the meaning of concepts and information (Leitão, 2000). Students, while arguing about a topic, can then reach a broader and deeper understanding of the topic (Munneke et al.;Van Amelsvoort, 2006). Broadening deals with gathering information from different points of view, and with assembling different subtopics and associated arguments, while deepening deals with different points of view, using evidence, counterarguments and rebuttals, and achieving convergence on different pieces of information.

But what are the effects of synchronous and asynchronous CMC on the discourse of interactive argumentation? There is little research that has attempted to compare different modes of communication during interactive argumentation. Veerman (2000) compared the results of different experimental studies and concluded that discussions mediated by synchronous CMC contained more rebuttals and counterarguments and included more social talk than discussion that was mediated by asynchronous CMC. There was more indirect argumentation in asynchronous CMC, students were more critical of evidence there, and the discussion contained more constructive activities such as adding, explaining, evaluating, summarizing, or transforming information. Her explanation for these differences lies mainly in the temporality of asynchronous CMC which give students opportunities to take time for reflection. However, Veerman compared different studies with different learning goals, contexts, and topics. The question arises whether her results hold for other situations in which asynchronous and synchronous CMC are used for argumentation.

Approaches to CMC

A classical approach to the effects of media on communication is social presence theory (Short, Williams, & Christie, 1976), which laid the groundwork for subsequent theories such as media richness theory (Daft & Lengel, cited in Carlson & Zmud, 1999). Media richness refers to a medium's ability to communicate information in such a way that message uncertainty or equivocality is minimized (i.e., the task or topic under discussion is unambiguous). The richness of a medium is based on: (1) immediacy of feedback, (2) transmission of multiple cues such as non-verbal signals and voice tone, (3) use of natural language, and (4) conveyance of personal emotions. Based upon these criteria, face-to-face communication is richest due to the availability of immediate feedback and the use of multiple cues. CMC is a 'lean' medium because of its lack of non-verbal signals and quick responses which lead to a depersonalization effect. Media richness theory argues that difficult tasks with a high level of uncertainty and equivocality do not fit lean media like CMC because of this depersonalization (Carlson & Zmud; Walther, 1995).

However, this theory has been criticized on the grounds of its technology-driven approach (Tanis, 2003). Fulk (1993), for example, argues that the effects of information and communication technologies (ICTs) are determined by the interaction between users, technology, and context and not solely by media characteristics. In this context Carlson and Zmud (1999) and Walther (1995) accentuate the importance of the amount of experience a user has had with CMC, the sort of task to be accomplished, and the time users may need to communicate effectively via CMC. Along with this, Herring (1999) argues that despite a lack of immediate feedback and incoherent interactions many users are attracted by CMC because its features enable different kinds of interactions than does face-to-face conversation. Grounding theory (Clark & Brennan, 1991) takes the CMC user into account, arguing that people can effectively communicate using various types of media because they always seek to establish and maintain common

ground. The principle of 'least effort required to ground communication' determines how users deal with the different grounding costs of CMC which makes not all media fit for all types of tasks (Honeycutt, 2001).

Another approach that takes task types into account is media synchronicity theory (Dennis & Valacich, 1999) which was developed because of the aforementioned criticism of media richness theory. Synchronicity theory argues that all tasks are composed of the communication processes *conveyance* (i.e.,information exchange) and *convergence* (i.e., establishing meaning for each piece of information). Conveyance and convergence need different characteristics of communication media. Dennis and Valacich identify five media dimensions that can affect how users of media interact with each other, namely feedback immediacy, symbol variety, parallelism, rehearsability, and reprocessability. Feedback immediacy is the speed of communication and the extent to which users can give rapid feedback on the messages received. Symbol variety refers to the number of ways information can be communicated, such as via verbal and nonverbal cues. Parallelism is about the number of simultaneous conversations that can exist effectively in the same medium. Rehearsability refers to the users' ability to rehearse a message before the actual communication. Finally, reprocessability refers to the ability to review and analyze sent messages more than once at different points of time. According to Dennis and Valacich, convergence processes need high synchronicity which entails high feedback immediacy and low parallelism while conveyance processes need low synchronicity entailing low feedback immediacy and high parallelism. Rehearsability, symbol variety, and reprocessability are seen as dimensions which handle the equivocality of a task. When a message is complex and equivocal it is important to have time to reflect and to reprocess a message, lowering the synchronicity of a medium because a highly rehearsable medium, for example, tends to allow less feedback.

Research Questions

This contribution reports on research investigating the effects synchronous and asynchronous CMC on interactive argumentation in student dyads discussing a complex problem. The theoretical introduction shows that different ideas about the effects of CMC on communication between people coexist and that there is little research on CMC's effect on specific processes such as interactive argumentation. Veerman (2002) indicated that asynchronous CMC, when compared to synchronous CMC, is best for students engaged in a critical discussion because of the reflection time that asynchronous CMC allows. However, based upon media synchronicity theory (Dennis & Valacich, 1999), asynchronous CMC is less advantageous for processes such as negotiation of meaning (i.e., convergence) because of its lack of feedback immediacy while more advantageous when students must exchange different pieces of information (i.e., conveyance). Translating this to interactive argumentation, this means that synchronous CMC should stimulate a deepening the space of debate (i.e., elaborating different points of view, using evidence, counterarguments, and rebuttals) while asynchronous CMC should stimulate broadening the space of debate (i.e., gathering information from different points of view). In this line of reasoning, the research questions here are: (1) What is the effect of synchronous and asynchronous CMC on broadening the space of debate? and (2) What is the effect of synchronous and asynchronous CMC on deepening the space of debate? It is hypothesized that using synchronous CMC will result in fewer, but longer sequences of argumentation compared to asynchronous CMC. Comparing synchronous and asynchronous communication is a methodologically complex issue because the amount of time students are communicating and what is happening between sessions may considerably differ between conditions. To this end, a third research question tries to establish what effect synchronous or asynchronous discussion has on how students perform on a subsequent writing task. It is thought that optimal support for students for convergence processes during the discussion phase will help them write argumentative texts with more accurate argumentation during a subsequent writing phase.

Method

Participants

Subjects in this study were 104 pre-university students aged 15-17 ($M = 16.1$, $SD = 0.72$) from two academic high schools in the Netherlands. The schools were situated in the same geographic area and were demographically comparable, including student socioeconomic background. Because of this comparability, each school was assigned to one of two treatment groups instead of carrying out the different treatments in both schools. This study was carried out in seven parallel groups taught by six different teachers. The teachers collaborated with the research team on the development of the argumentative task. Students worked on the task for three weeks, during classes planned for Dutch language or at home, in their own time, depending on the experimental condition.

Design

A posttest-only, quasi-experimental design with two treatment groups was used to compare argumentation in two different CMC situations. Students in one condition discussed the topic of genetically modified organisms (GMOs) with the help of synchronous CMC, while students in the other condition discussed the topic through asynchronous CMC. Due to organisational limitations, it was not possible to randomly divide the students and one school was assigned to the synchronous CMC condition and the other to the asynchronous CMC condition. The students collaborated in randomly composed dyads, heterogeneous with respect to gender. To avoid student dyads that would have problems getting along (the students knew each other and had a collective social history), teachers were requested to check the dyads with respect to compatibility. Eighteen dyads (10 synchronous, 8 asynchronous) were excluded from analyses because they missed more than one lessons or because they posted less than three substantial messages in the asynchronous condition. For analysis, 20 dyads remained in the synchronous condition and 19 in the asynchronous condition.

Task and Materials

Dyads worked on an argumentative collaborative task in two phases, namely a discussion phase and a writing phase. These phases were preceded by an introduction to the task in the class and a period of individual preparation. The difference between the two conditions was created during the discussion phase. During preparation, students were introduced to the subject of GMOs in the class and instructed about what argumentation entailed. After this, students received an individual take-home assignment which took approximately 40 minutes to carry out. They had to read eight popular, easy-to-read sources on the topic of GMOs. The discussion phase in the *synchronous* condition consisted of two 45-minute meetings where students were asked to discuss GMOs using the chat facility in TC3 (Text Composer, Computer-supported, and Collaborative; see Figure 1; Jaspers & Erkens, 2002).

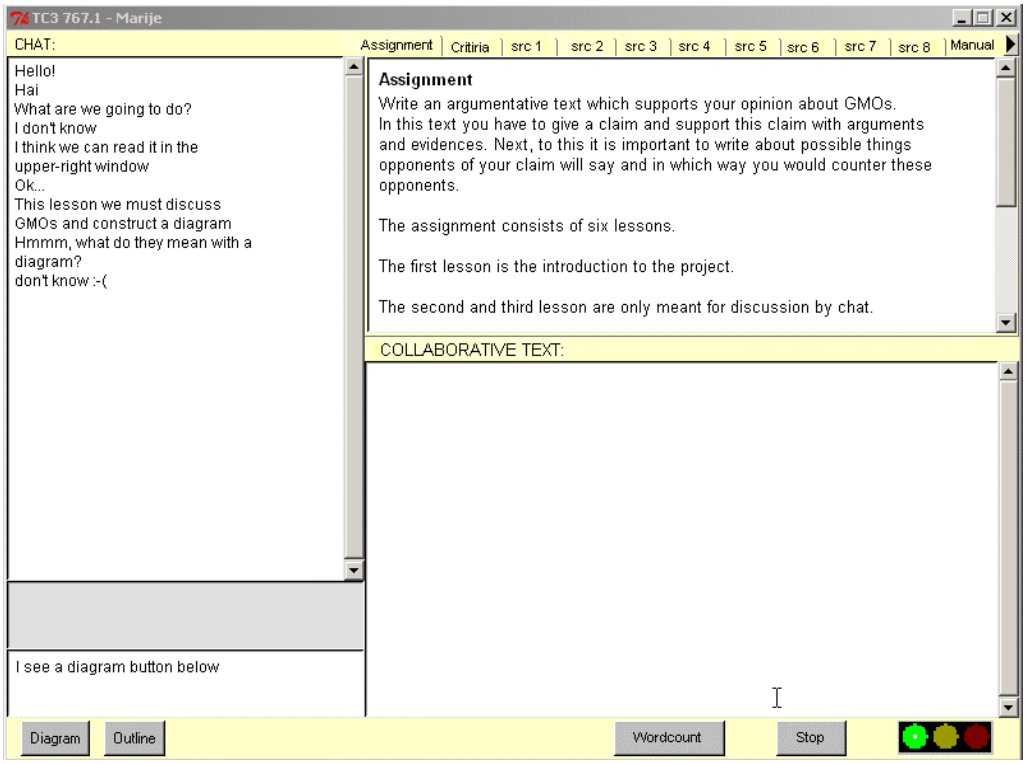

Figure 1. Screenshot of TC3.

In the *asynchronous* condition, in which each student was asked to post six substantial messages in Blackboard® (see Figure 2), the discussion phase lasted two weeks. A substantial message was defined as a message consisting of at least one argument. Students had to post their messages (i.e., work asynchronously) in their own time. There was one class meeting to help students if they were having a problem with the task and did not post enough messages. The writing phase was equivalent for both conditions. All dyads wrote an argumentative text

about GMOs using TC3 and the students communicated synchronously within the dyad via TC3's chat facility. This writing phase encompassed three lessons (approximately 120 minutes).

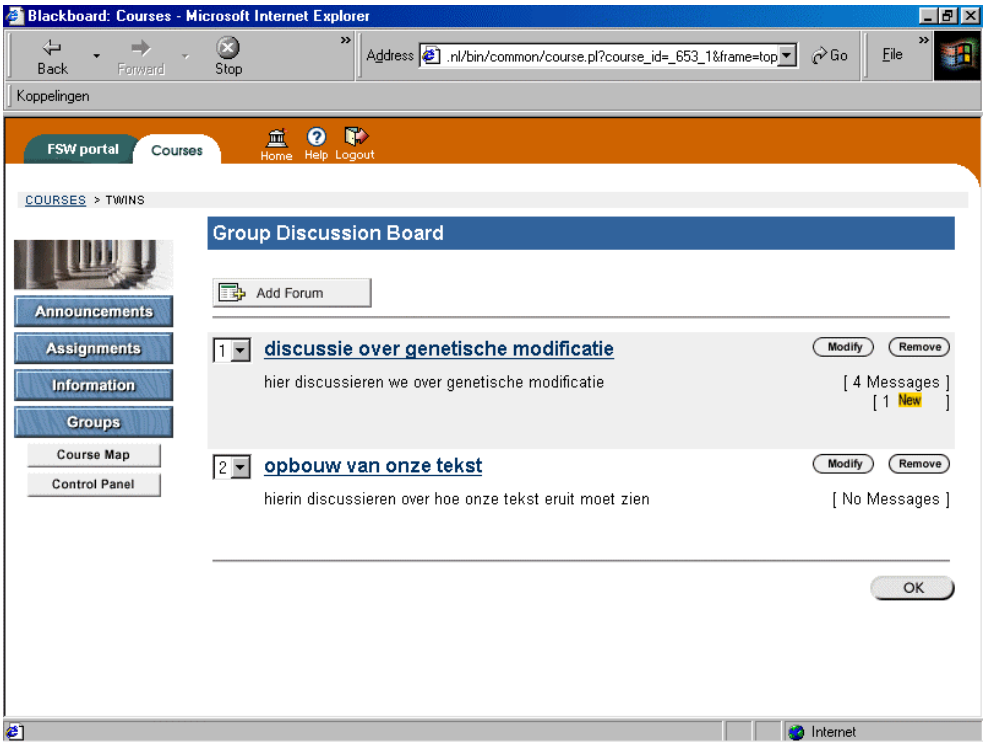

Figure 2. Screenshot of Blackboard®.

Measures

Data collection

The data consisted of all utterances in chat and discussion board. In principle, the unit of analysis in chat consisted of every separate utterance, marked by pushing 'enter' or by turn-taking. When an utterance required more than one code, the utterance was split. If students pushed 'enter' before ending their message, then the two chat utterances were subsequently merged for analysis. The messages in the discussion board were split in units of meaning. The coding of utterances and actions in the protocols was carried out with the computer program *MEPA* (Multiple Episode Protocol Analysis; Erkens, 2002).

Task acts

A first analysis was carried out in which all utterances were coded on the task-function which consisted of six main categories of task acts: outside activity, social relation, interaction management, task management, argumentative activities, and conceptual activities. Outside activity consisted of utterances not constitutive of the interactive space imposed by the researchers. Social relation consisted of utterances about interpersonal relations related to the task. Interaction management contained utterances about managing the interaction such as checking presence and turn-taking. Task management was talk about managing the task at hand. Argumentative activities were utterances containing argumentative moves. Conceptual activities contained utterances about concepts that could not be defined as argumentation. Inter-rater agreement on 10 protocols was .80 (Cohen's Kappa).

Argumentative Interactions

Argumentative activities were coded with a separate coding system based on Kuhn (1991) in the categories shown in Figure 3. The place of one argumentative interaction within a sequence of argumentative interactions defines whether it is an opinion, a supportive theory, an alternative theory, a piece of evidence, a counterargument, or a rebuttal. All codes are accompanied by the label 'asking' or 'giving'; whether an opinion or argument is asked for or given by a student. This makes clear how often students question each other, a feature of constructive dialogue. Inter-rater agreement on ten protocols was .82 (Cohen's Kappa). The coding systems of task acts and of

argumentative activity formed the basis for a more extended analysis of the breadth and depth of interactive argumentation. The breadth of the space of debate was defined as the number of argumentative sequences counted, including all single utterances not followed by argumentative elaboration. To define the depth of an elaboration, the number of arguments in a sequence of related argumentative activities was calculated. For example, when students gave a claim, a supportive theory, and evidence for this supportive theory, the sequence was Claim–Supportive–Evidence and the depth score of three. In this way, all sequences of argument elaboration are tallied for their depth.

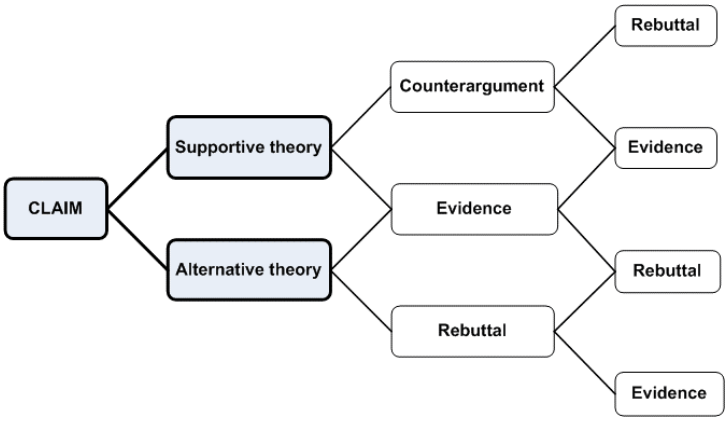

Figure 3. Argumentative Activities.

Argumentative text quality

The quality of argumentation in the argumentative texts written by the dyads was examined in order to determine whether different modes of communication during the discussion phase resulted in different quality of argumentation in the text. For this purpose, an instrument was developed which assessed the *quality of grounds* used in the text and the *conceptual quality of arguments* used in the text. The instrument was based on the work of Clark and Sampson (2005) and Schwarz, Neuman, Gil, and Ilya (2003). The quality of grounds refers to the way students used evidence for forming their opinions. It is comparable to what Schwarz et al. calls the acceptability of an argument. The conceptual quality of arguments refers to the conceptual adequacy of the arguments and counterarguments in the context of GMOs. A driving question in this respect was: Do students include correct concepts and information in their argumentation?

The quality of grounds was measured on a 4-point scale, with 0 indicating no grounds for the argument used, 1 indicating using a short explanation as a ground, 2 indicating that an elaborated explanation or example was used as a ground, and 3 indicating explicit reference to empirical data or everyday experiences as a ground. The conceptual quality of the arguments was also measured on a 4-point scale, with 0 indicating that the argument only contains conceptually incorrect components and 4 indicating that the argument contained several conceptually correct components.

Results

Task Acts in Discussion

Figure 4 shows the proportions of the different Task Acts. Because the dependent variables of the Task Acts were correlated and showed many outliers, Mann-Whitney U-tests were performed. A Mann-Whitney U-test is the nonparametric counterpart of the independent samples *t*-test which is robust for outliers and for violation of the assumption of normality. Mann-Whitney U-tests showed significant differences ($\alpha = .01$; Bonferroni correction) between the chat-condition and the discussion board condition for the variables outside activity ($U = 80$, $p = .00$), social relation ($U = 44$, $p = .00$), task management ($U = 93$, $p = .01$), and argumentative activity ($U = 24$, $p = .00$). Students using chat talked more about things not related to the task ($M = 0.06$, $SD = 0.08$) and social relations ($M = 0.09$, $SD = 0.09$) during collaboration than students using the discussion board ($M = 0.01$, $SD = 0.02$, and $M = 0.02$, $SD = 0.02$, respectively). Along with this, students in the chat condition made more utterances about the way they had to accomplish the task ($M = 0.51$, $SD = 0.13$) than students using the discussion board ($M = 0.34$,

SD = 0.20). For argumentative activity it was the other way around, with students using the discussion board acting more on the argumentative level (*M* = 0.44, *SD* = 0.22) than students using chat (*M* = 0.14, *SD* = 0.11).

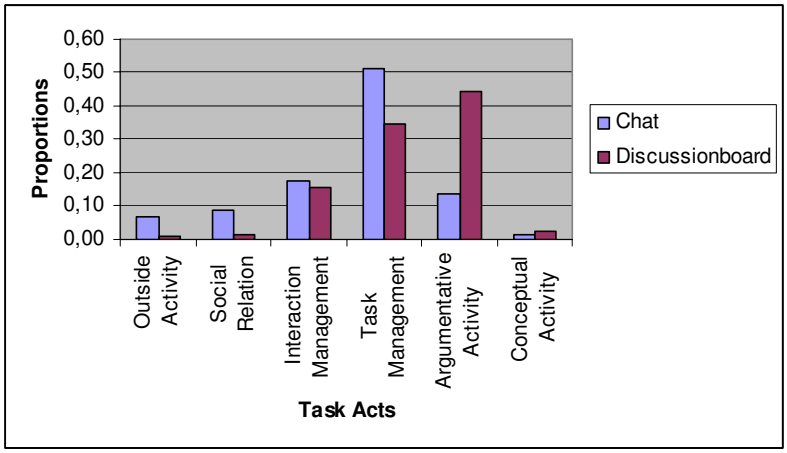

Figure 4. Task acts in proportions for both chat and discussion board condition.

Argumentative Activity in Discussion

The next step was analysis of the task-act category argumentative activity. Exploration of the different argumentative acts showed that almost all acts are non-normally distributed with many outliers. Transforming variables did not lead to normality, so Mann-Whitney U-tests were also carried out on these data. The Bonferroni correction set the alpha value again on .01. Table 1 summarizes the results of these tests. The Mann-Whitney U-tests showed that students who communicated asynchronously using the discussion board produce significantly more evidence and alternatives and that there is a trend towards using more rebuttals and verification questions.

Table 1: Results of Mann Whitney U tests between dyads communicating through chat en dyads communicating through discussion board.

	Chat condition (*N* = 20)		Discussion board condition (*N* =19)		Mann Whitney U		
	M	*SD*	*M*	*SD*	*U*	*z*	*P*[1]
claims	0.13	0.07	0.11	0.10	141.0	-1.377	.09
supports	0.19	0.09	0.14	0.10	139.0	-1.434	.08
alternatives	0.09	0.07	0.16	0.11	110.5	-2.235	.01
counterarguments	0.04	0.04	0.03	0.04	166.5	-0.695	.26
rebuttals	0.10	0.11	0.15	0.10	129.0	-1.729	.05
evidence	0.14	0.09	0.22	0.10	108.5	-2.291	.01
verifying	0.11	0.10	0.06	0.06	121.5	-1.933	.03
agreeing	0.14	0.08	0.12	0.13	145.5	-1.252	.11

[1] *One tailed significance*

Breadth and Depth of Discussion

Figure 5 shows the breadth and depth of the collaborative and individual argumentative sequences. Exploration of the frequency of argumentative sequences (i.e., breadth) and the mean length of argumentative sequences (i.e., depth) showed non-normally distributed variables with many outliers. Mann Whitney U tests showed that there was no difference in the total number of argumentative sequences (i.e., argument breadth) between chat and discussion board, *U* = 149.5, *p* = .13, while the total amount of collaboratively constructed argumentative sequences was higher for chat (*M* = 4.63, *SD* = 3.27) than for discussion board (*M* = 2.40, *SD* = 3.97), *U* = 86.5, *p* = .00. The mean length of the argumentative sequences (i.e., argumentative depth) in the chat condition was significantly longer (*M* = 2.52, *SD* = 0.84) than in the discussion board condition (*M* = 2.52, *SD* = 0.84), *U* = 98,

$p = .01$. This difference was mainly due to the significant difference between chat ($M = 3.44$, $SD = 1.57$) and discussion board ($M = 1.74$, $SD = 1.86$) in the length of the collaborative sequences, $U = 102.0$, $p = .01$.

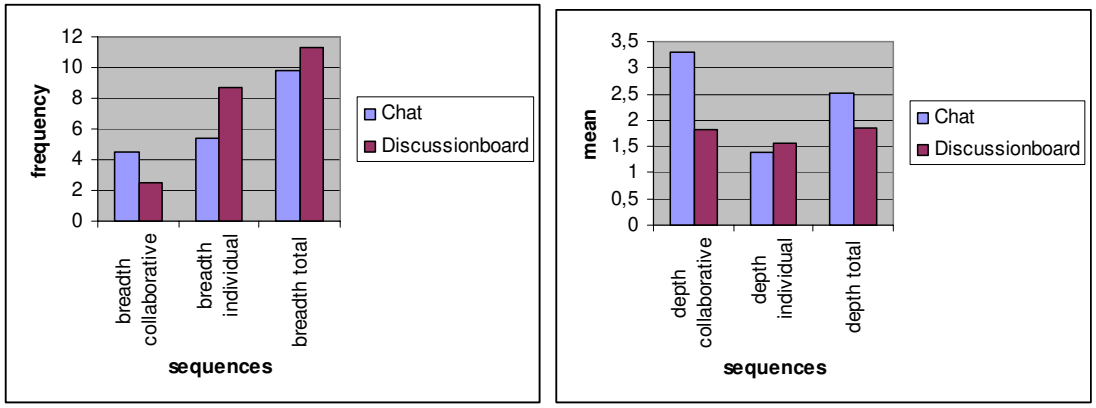

Figure 5. Frequency of argumentative sequences (breadth) and mean length of argumentative sequences (depth) in discussion phase

Quality of Grounds and Concepts in the Argumentative Texts

To detect the differences on the quality of grounds and concepts of the texts a MANOVA was performed on the two conditions and on the variables quality of grounds and quality of concepts. This analysis revealed an overall significant difference, $F(2, 38) = 2.50$, $p = .05$, $\eta^2 = 0.12$ which was due to a univariate effect on the quality of concepts ($F(1, 39) = 5.13$, $p = .05$, $\eta^2 = 0.12$). Students in the discussion board condition wrote conceptually better texts ($M = 1.56$, $SD = 0.42$) than students in the chat condition ($M = 1.31$, $SD = 0.30$). Another MANOVA on the quality of concepts in the different argumentative acts, supportives, alternatives, counters, and rebuttals revealed an overall significant difference, $F(4, 36) = 2.10$, $p = .05$, $\eta^2 = 0.19$ and univariate statistics showed significant differences on the variables supportives ($F(1, 39) = 3.23$, $p = .04$, $\eta^2 = 0.08$) and rebuttals ($F(1,39) = 3.78$, $p = .03$, $\eta^2 = 0.09$). Students using a discussion board used more correct concepts in their supportives ($M = 7.62$, $SD = 3.07$) and rebuttals ($M = 5.33$, $SD = 3.02$) than students using chat ($M = 6.55$, $SD = 4.00$; $M = 4.95$, $SD = 5.22$).

Conclusion and Discussion

Synchronous and asynchronous CMC was compared with respect to their influence on the way students argue in dyads. It was hypothesized that synchronous communication supports students in convergence processes or, in other words, on supporting the processes of collaboratively deepening a subtopic in the space of debate. An asynchronous mode of communication was thought to support conveyance processes, which is seen as broadening the space of debate, searching for different points of view. The results confirmed the first hypothesis. Despite more argumentative activity and the occurrence of more alternative theories and use of evidence in the discussion board condition, the analyses of depth of discussion showed that students in the chat condition have longer argumentative sequences, thus that they elaborated more on the same supportive or alternative theory. The second hypothesis was not confirmed by the results; the students using a discussion board did not talk about more topics and perspectives than the students using chat. On the contrary, the results showed an opposite effect with students using chat being broader in their discussions than students using the discussion board. The third research question on whether there is a difference between students in the synchronous and the asynchronous CMC conditions on the quality of a subsequently written argumentative text. The hypothesis was that students who discuss more deeply will write texts with a higher quality of evidence and will more accurately use concepts. The results showed the opposite for the quality of concepts in the argumentative texts. Students who discussed the subject of GMOs using a discussion board used more correct concepts in their arguments than students who discussed the subject using a chat box.

In contrast to earlier findings that synchronous CMC is not conducive to deep learning and is not really beneficial for carrying out complex communication tasks, these results show that synchronous CMC does have the ability to stimulate both a broader and deeper discussion when compared to asynchronous CMC. It appears that the affordance of immediate feedback - the possibility of reacting directly to what another student is saying - stimulates students to negotiate and argue with each other. Nevertheless, despite a broader and deeper conversation between synchronously communicating students this did not lead to more accurate concepts in the argumentative text. It

appears that students communicating via a discussion board have a better and more accurate understanding of the different concepts relating to the topic of GMOs, indicating that they have achieved a better understanding of the meaning of the different pieces of information. However, it is possible that it is not the discussion between the students that is responsible for this more accurate understanding of the concepts, but rather the fact that students using the discussion board had more time to process information and verbalize it in their individual messages.

Some possible limitations of this study should be considered. First, the results raise some interesting issues concerning how students use different media. It is possible that students use media in such a way that they do not make optimal use of CMC's affordances. Van der Pol (2002), for example, shows that it is difficult for students to react in a specific and relevant way to messages of other students in a discussion board, despite the time available for reflection due to the asynchronicity of this type of communication. There is little research relating to how students rehearse and reprocess in asynchronous CMC environments. It appears that rehearsability helps students to process information in a message, but questions remain as to whether they take the time available to reflect on the messages of others and on what kind of thinking processes take place during such reflection. A second limitation involves whether comparing synchronous and asynchronous CMC is an adequate and valuable approach. Johnson (2006) concludes in her review of recent research on synchronous and asynchronous text-based CMC that both forms of online discussion have advantages and that there is evidence that both forms contribute to student learning outcomes. She argues that systematic and objective research on how synchronous and asynchronous online discussion can be combined is needed. It is possible that the effectiveness of different media is mediated by individual difference variables, such as the student's experience with synchronous and asynchronous CMC. The fact that students in our study argue both broadly and deeply in synchronous CMC could be due to the experiences that they have had with chatting in general. Finally there are some methodological issues that need to be mentioned. In this study, the quality of argumentation during discussion is measured by the breadth and depth of the argumentative sequences. However no correlations were found between the breadth and depth of the sequences during discussion and the argumentative quality of the final product. This raises the question as to whether breadth and depth are sensitive to differences in the *quality* of argumentation or are they just measuring frequency differences in the argumentative sequences. Future research should, thus, also to look at the quality of the grounds and concepts in the argumentative sequences and try to determine whether students construct specific sequences in different forms of CMC.

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