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Content analysis of online discussion on a senior-high-school discussion forum of a virtual physics laboratory

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Abstract. In this study we content analyzed the online discussion of several senior-high-school groups on a forum of a virtual physics laboratory in Taiwan. The goal of our research was to investigate the nature of non-course-based online discussion and to find out some useful guidelines in developing such discussion forums for learning purposes. We adapted Henri's framework and models (1992) for our analysis. The content analysis was conducted in terms of participation rate, social cues, interaction types, and cognitive and metacognitive skills. In this study, we compared the result patterns of two discussion conditions ('required' (R-) condition versus 'non-required' (NR-) condition) of a non-course-based discussion forum and investigated how the quality of message content changed in the processes of discussion. In the R-condition, participants were required to reply to the thread before they were allowed to read other messages on the forum, whereas participants in the NR-condition were not restricted to this demand. The results showed that for both conditions, the most frequently involved interaction type was 'direct response', and the most frequently used cognitive skill was 'elementary clarification'. Fewer participants of the R-condition strayed from the subject under discussion in comparison to the NR-condition. However, larger percentage of message content containing metacognitive components was found in the NR-condition. When taking the sequences of postings into account, we found that for the R-condition, the percentage of metacognitive component in the message content tended to increase in the up-third postings, whereas for the up-third postings of the NR-condition the percentage of non-cognitive components substantially increased. Overall, the results of our study indicated that the way in which participants used cognitive and metacognitive skills during the discussions was related to the discussion conditions. The initial requirement of reply fostered the use of cognitive skills, but it did not necessarily induce the use of high-level cognitive or metacognitive skills. We concluded that beside the discussion conditions the moderators' guidance would be influential in determining the quality of online discussion on a non-course-based discussion forum.

Keywords: cognitive skills, computer mediated communication, content analysis, discussion conditions, interaction types, metacognitive skills, moderator, non-required condition, online discussion, required condition

Introduction

Online discussion for education

Nowadays, computer-mediated communication (CMC) plays an essential role in interpersonal communication. In the context of education, it has been emphasized that communication or discussion, respectively, facilitates deep learning.[1] Berge and Collins (1995) pointed out that

> ...It is through discussion that one person can influence or persuade others. Talk and discussion provide an opportunity to articulate and explain one's own thing and perhaps to modify one's own ideas, beliefs or self-presentation in response to feedback from others. Incorporation of new data, the testing of arguments, and using one's judgment and reasoning helps move a person toward new perspectives and higher levels of thinking (p. 183).

In other words, instead of passively receiving knowledge from teachers, students can develop their cognitive skills (e.g., problem solving and knowledge construction), and metacognitive skills (e.g., critical thinking) in the processes of discussion (Blumenfeld et al., 1996; Littleton & Häkkinen, 1999). This perspective is also consistent with recent ideas of the practice of constructivism in education (Tsai, 2001; Chou & Tsai, 2002). Nevertheless, students seldom have enough time to discuss with their teacher or among themselves in a conventional classroom setting. Accordingly, CMC systems, such as electronic mail, computer conferencing, and bulletin board systems (BBS), have been widely used to support online discussion (Lehtinen et al., 1999). The applications of online discussion for educational purposes can roughly be classified into two categories: course-based versus non-course-based online discussion. The former refers to the use of online discussion as an integral part of online courses or as an extension of school lessons, whereas the latter serves to support the communication in scholarly discussion groups including ''electronic discussion lists, Internet interesting groups, e-journals, e-newsletters, Usenet newsgroups, forums that scholars participate in for scholarly or academic discussion'' (Spitzer, 1986).

Researchers have been investigating the nature of CMC within the context of course-based online discussion. The characteristics of course-based online discussion are: (1) the participants are limited to

the students enrolled in the same class; (2) a teacher or an instructor usually will join or supervise the discussion; (3) the tasks of the participants are clearly defined; (4) the participation in the discussion is mandatory for the students; (5) the participants cannot post their messages anonymously (Examples of course-based online discussion forums can be found in the studies by Marttunen and Laurinen (2002), and Thomas (2002)). Recently, non-course-based online discussion has captured many researchers' attention (Berge & Collins, 1995; Lai, 1997). It is believed that this kind of discussion will become a new trend in the educational practice. The advantages of non-course-based online discussion lie in that the participants of the discussion are not limited to the members of a particular course, and the participation in the discussion is based on common interests shared by the participants. That is, the participation is totally voluntary and people may join or leave the discussion any time they want. Potentially, more participants may join the discussion and accordingly more ideas can be contributed to the subject under discussion.[2] In addition, the discussion is not confined to a certain period of time. However, it is not easy to manage non-course-based online discussion due to the (potentially) unlimited number of participants and time for discussion.[3] On the other hand, some people might use the discussion forum for socializing. Consequently, the role of the moderator supervising the discussion forum of this kind is very important.

Learning effects of online discussion

Whether online discussion indeed facilitates learning is, however, still controversial. A number of studies have provided evidence indicating that online discussion can facilitate the collaborative learning of complex scientific concepts (Roschelle, 1992), inter-professional collaboration (Connor, 2003), and social construction of knowledge (Warschauer, 1997; Dehler & Parras-Hernandez, 1998; Hara et al., 2000). Some other studies showed that online discussion fosters the use of high-level cognitive skills such as reasoning and argumentation skills (Marttunen & Laurinen, 2002; Pilkington & Walker, 2003), critical thinking, reflection, problem-solving (Orvis et al., 2002), and learning in general (Booth & Hultén, 2003; Comeaux & McKenna-Byington, 2003). In addition, online discussion expands learning outside of classroom and is not restricted to time and space. People have the opportunity to discover their mentors somewhere in the world (Berge & Collins, 1995). Unlike the face-to-face communication, asynchronous online

discussion provides people abundant time to think and write their arguments. The message content is assumed to be more informative and elaborative (Hara et al. 2000). Nevertheless, some other studies demonstrated disadvantages of online discussion: First, the participation rate is usually low in course-based online discussion. A student often does not post more than one message a week on average (Hara et al., 2000; Capsi et al., 2003). Second, the main discussion topic is often not sustained, but proceeds along diverging short discussion threads[4] that lack a coherent structure and are not always on-topic (Thomas, 2002; Lipponen et al., 2003). Third, the realization of interactive learning is limited. There is no real cooperative development of ideas between the students (Thomas, 2002). Fourth, it is not easy to follow threaded discussion because of the information overload (Berge & Collins, 1995). Fifth, the text-based communication lacks nonverbal cues such as gestures, facial expression, and tone. Sometimes, it might lead to misunderstanding (Daly, 1993; McGrath & Hollingshead, 1993; Wilson, 2003). In addition, those who are not good in writing probably cannot benefit from text-based communication (Berge & Collins, 1995). Finally, in asynchronous online discussion, people have to wait for answers or feedbacks from the others. Either the discussion might progress too slowly, or their messages might never be answered.

Analysis of online discussion

The factors affecting the role of online discussion in learning are complex. In order to find out how to best design a discussion forum, researchers have been investigating the nature of online discussion by means of both quantitative and qualitative analyses of the discussion activity, which will be introduced below.

The analyses of course-based online discussion are usually carried out in regard to the interaction patterns among the students or between the teacher (or tutor) and the students (Howell-Richardson & Mellar, 1996; Hara et al., 2000; Marttunen & Laurinen, 2002; Lipponen et al., 2003). These may include the number of messages posted by a person, the length of messages, the number of login times, the frequency of message exchange, the lag time between a question and its answer, the lag time between two successive posts of the instructor, and the message map that shows message clusters in diagrams and specifies the connection between the messages (Howell-Richardson & Mellar, 1996; Capsi et al., 2003). Nevertheless, all the analyses cannot reveal the quality of the messages, i.e., whether

the message content is relevant to the discussion and more importantly contains elaborative ideas or the types of cognitive skills that students use in the discussion, and whether learning is really improved by discussion, etc. For the deeper understanding of the nature of online discussion, it is necessary to conduct content analysis (cf. Brace-Govan, 2003, p. 313).

Several models or frameworks have been employed to analyze the quality of message content. The Structure of Observed Learning Outcome (SOLO) taxonomy proposed by Biggs and Collis (1982) has been used to analyze students' cognitive engagement, which served as an indicator of the levels of students' understanding of a topic area. The taxonomy contained five levels: prestructural, unistructural, multistructural, relational, and extended abstract (Thomas, 2002). Lipponen et al. (2003) categorized the content of messages by means of the relevance (on-topic or off-topic), the type of feedbacks (positive/negative/neutral) provided by the notes, and the function of the notes (providing information/asking clarification/something else). The criteria for the categorization were not predetermined, but data-driven. Moreover, there are models for judging students' levels of critical thinking. Garrison's five-stage model (1992) has been regarded as the most relevant one to the evaluation of critical thinking in computer-supported collaborative learning. The five stages are: Stage 1, problem identification skill; Stage 2, problem definition skill; Stage 3, problem exploration skill; Stage 4, problem evaluation/applicability skill, and Stage 5, problem integration skill. Moreover, a well-known model for analyzing the content of CMC messages was developed by Henri (1992). According to this model, message content was analyzed in terms of participation, interaction, social, cognitive, and metacognitive dimensions. Although Henri's models provided an initial framework for detailed analyses of online discussion, her models have been criticized for its complexity and robustness of classification (Howell-Richardson & Mellar, 1996; Hara et al., 2000). Yet, despite some criticism, some researchers still employed Henri's model for their research work (Angeli et al., 1998; Benigno & Trentin, 2000; Hara et al., 2000; McKenzie & Murphy, 2000).

We chose Henri's models as our research tool because her models provide a wide range of analytical dimensions which can best support our research purpose. Additionally, we modified Henri's models so that our data can be analyzed most appropriately (detailed information about our modification is given in the section 'Analytical frameworks and models').

Research purposes

Studies on the effects of online discussion on learning seem to more focus on course-based situations. Since the importance of non-course-based online discussion in education gradually increases, we content analyzed online discussion on a non-course-based discussion forum in the current study. The goals of our research were to investigate the nature of non-course-based discussion and to find out some guidelines that could be useful for developing non-course-based discussion forum for learning purposes. In our study we set up two discussion conditions ('required' (R-) versus 'non-required' (NR-) condition). We hypothesized that the initial requirement of reply would encourage students to actively participate in the discussion and to think and give their opinions independently. Without setting up this requirement, students might just read the messages but never participate in the discussion. Furthermore, we attempted to find out whether and how the manipulation of discussion conditions would affect the interaction patterns between participants and the quality of discussion. Finally, we compared the quality of posted messages on the discussion forum in regard to the order of postings. By means of this analysis we could follow how the quality of messages changed as the discussion progressed. It should be pointed out that our study was a pioneer study attempting to investigate the effects of different discussion conditions. Although there is no prior research or specific theory from which we can directly derive our study design, we have reviewed related literature and adapted valid analytical models for carrying out our research. We believe that our study can provide insightful information for teachers or educators who aim to design an online discussion forum having functions similar to the one in our study.

Method

Discussion forum

The discussion forum analyzed in our study was set up by the Virtual Physics Laboratory (VPL) of the National Taiwan Normal University (NTNU), which was also called *Demolab* in the Chinese version (http://www.phy.ntnu.edu.tw/demolab). The main function of NTNU's VPL was to assist teaching and learning in physics. It provided abundant animation or videos for illustrating physical concepts or simulating experiments. Teachers did not only find useful tools for creating graphics or animation by themselves, but also could

exchange their teaching experiences via their online discussion forum. Besides, many examination questions were available for teachers. Another important function of this VPL was that it set up several discussion forums for students. Basically, the forums were classified by students' grade: one was for junior-high-school students, another for senior-high-school students, and the other for university students. The discussion forum analyzed in our study was the one set up for senior-high-school students.

Participants and discussion processes

In general, the discussion topics on the forum had to be suitable for senior-high-school students to discuss. Most of the participants were indeed senior-high-school students, but some of the participants could be university or graduate school students who were interested in the topics. The participants had to first get registered, but they were allowed to use a pseudo-name on the forum. The discussion started with a message containing a question that could be posted by any participant. Whoever was interested in the topic could rely to it. The size of discussion groups ranged from 1 to 213 participants. The participation on the forum was voluntary.

Organization of the discussion forum

Two moderators.[5] supervised the discussion forum. A moderator was a physics professor in NTNU. The other one was a senior-high-school physics teacher. They monitored the forum for the following aspects: First, they checked out whether the posted topics (i.e., the threads) were relevant to the content of physics textbooks used in the senior high schools in Taiwan, and whether they were at the appropriate level. Second, they supervised the discussion by providing clues for in-depth thinking, explaining crucial concepts, correcting misleading concepts or statements, and removing rude words from the messages. In the discussion the moderators never directly provided an answer to a question because they would like the participants to figure out the answer in the processes of discussion on their own. A distinctive feature of the discussion forum was that there were two different discussion conditions, which could be set up by those participants who were physics teachers: In some discussion-groups participants were asked to first post their opinions on the subject under discussion, and then they were allowed to read the messages posted by the other participants (the 'required'(R) condition). After contributing one message at

the beginning, they could login any time to join the discussion without answering to the initial question first. In contrast, there was no such requirement in the other discussion groups (of the 'non-required'(NR) condition). The aim of the R-condition was to foster participants' in-depth thinking and problem-solving skills. By means of this requirement, each participant would actively think about the possible solutions before he/she could get access to the other posted messages.

Target groups and data collection

We selected six discussion groups on the forum for our analysis. The selection criterion was based on the number of messages that had a minimum of forty.[6] We randomly selected three groups from the R-condition, and three groups from the NR-condition. The data consisted of a corpus of messages of these six groups, which were collected in the period from September 2002 to November 2003. All the discussion topics and the corresponding numbers of messages are given in Table 1.

Analytical framework and models

For our analysis we adapted Henri's framework and models (1992) to meet our research purposes. Basically, we employed the original analytical framework with simplified analytical models of each dimension because the original models sometimes had analytical categories that were too detailed and were not relevant for our analysis. For example, we did not distinguish 'direct response' from 'direct commentary'. Instead, we only used the term 'direct response' to represent both analytical categories. Besides, we eliminated the analytical models of

Table 1. The target groups analyzed in the study

Condition	Group	Number of messages	Topics
R	1	247	Why the clouds do not fall down?
R	2	45	Why 1 kg = 9.8 m/s^2?
R	3	91	About the concept "potential energy"
NR	4	79	Calculus and instant velocity
NR	5	40	Another question about steam pressure
NR	6	73	W = Fd?

R: 'required' condition; NR: 'non-required' condition.

'processing information' and 'metacognitive knowledge' because those analyses strongly overlapped with those already included in the analytical models of 'cognitive skills' and 'metacognitive skills'. Moreover, we also extended the analytical models so that they could analyze our data more adequately. In this regard, we slightly modified the definitions of participation rate, social cues, direct response, and indirect response. In addition, we created two categories (i.e., OTHER and NONE) and added some indicators to the cognitive- and metacognitive-analytical models.

The content of a message was analyzed based on its idea(s). An idea expressed a complete thought, which might contain one or several sentences or even several paragraphs. A message might consist of more than one idea. The analysis was conducted according to five dimensions: the participation rate, social cues, interaction types, cognitive skills, and metacognitive skills. A detailed description of our analytical models is given in Tables 2–4. Table 2 gives information on the definitions, indicators, and concrete examples of participation rate and social cues.

Table 3 explains the model for analyzing interaction types involved in the discussion. Four categories of interaction were considered: 'direct response', 'indirect response', 'independent statement', and 'other'. The definition and concrete examples are given to each category. We created the category "other" for any statement that was unrelated to the topic being discussed. It should be pointed out that the random letter string "4431534843135465453 41ujhnmvkjhugkhc" and the statement "I just want to check out the new messages" indicated that the two participants of the R-condition did not really want to discuss the topic but only wanted to get access to the other posted messages. They were actually warned by the moderator not to repeat it again. Otherwise, their access to the discussion forum would be blocked.

Table 4 shows the models for analyzing cognitive and metacognitive skills.[7] The categories of cognitive skills include 'elementary clarification', 'in-depth clarification', 'inference', 'judgment', and 'strategies', whereas the categories of metacognitive skills contain 'evaluation', 'planning', 'regulation', 'self-awareness', and 'none'. We created the category "none" for the ideas that did not contain any cognitive or metacognitive component. In addition, we added "request clarification" to *elementary clarification*; "revising or refining statements", "providing information on references related to the subject under discussion", and "using examples or analogy" were added to *in-depth clarification*; "presuming/supposing" and "proposing a

Table 2. The analytical model for participation rate and social cues

Dimension	Definition	Indicators	Concrete examples
Participation rate	Number of messages posted by one person on average	Number of messages on average	
Social cues (SO)	Statement which is not related to formal content of subject matter but has certain social functions	–Verbal or symbolic expression of feelings –Jokes –Greetings –Self-introduction –Closure	"...@_@ (It's only my guess.) The question is very interesting ^_^". "I am so confused". "  ", "  ".

Table 3. The analytical model for interaction types

Category	Definition	Concrete examples
Dimension: Interaction types		
Direct response (DR)	Any statement directly responding to the thread, a question, or a commentary that is related to the subject under discussion, using a direct reference (i.e. quotations)	"I think, the clouds have considerably large volume and relatively low density. Therefore, they can float in the air!". (directly answer to the thread) "Quote: On 2002-09-24, at 00:13, Lin Xue-Hong wrote: "The kinetic energy of the airflow is larger than an object's potential energy". There are still clouds in the sky when the airflow is weak! If it's only due to this factor, how strong should the airflow be? Analogy: how strong must the current of water be to float a piece of iron?"
Indirect response (IR)	Any statement responding to the thread, a question, or a commentary that is related to the subject under discussion, without providing a reference	"The pressure and the temperature can change the density?" "It's convenient to use density as the indicator to judge whether an object can flow. The truth is that different forces involved lead to a resultant. We must calculate the gravity forces imposed on the air and the water drops, and the resultant coming from the forces between their molecules."

Table 3. (Continued)

Category	Definition	Concrete examples
Independent statement (IS)	Any statement relating to the subject under discussion, but which is neither an answer nor a commentary and does not lead to any further statements	" Hint: The chalk and the chalk powder are of the same density. If we release both of them, the chalk falls down to the ground very quickly, whereas the chalk powder floats down to the ground very slowly. If there is wind, the chalk powder can even float up in the air!"
Other	Any statement that is not related to the subject under discussion	"4431534843135465453 41ujhnmvkjhugkhc" " I just want to check out the new messages."

Table 4. The analytical model for cognitive and metacognitive skills

Dimension	Category and definition	Indicators	Concrete examples
Cognitive skills	*Elementary clarification* (EC) : Observing or studying a problem identifying its elements, and ob-serving their linkages in order to come to a basic understanding	–Identifying relevant elements –Reformulating the problem –Asking a relevant question –Identifying previously stated hypotheses –Request clarification	''The distance between the clouds and the ground is very long, and the gravity force is weak''. ''Hot airflow rises from the ground''.
	In-depth clarification (IC) : Analyzing and under-standing a problem to come to an understanding which sheds light on the values, beliefs, and assumptions which underlie the statement of the problem	–Defining the terms –Identifying assumptions –Establishing referential criteria –Seeking out specialized information –Revising or refining statements –Providing information on references related to the subject under discussion –Using examples or analogy	''The buoyancy imposed on the ice crystal floating in the air is surely much smaller than the crystal's weight, but there are some other forces imposed on the ice crystal, such as the forces from the airflow and the static electricity between the ice crystals''.
	Inference (INF): Induction and deduction, admitting or proposing an idea on the basis of its link with propositions already admitted as true	–Drawing conclusions –Making generalizations –Formulating a proposition which proceeds from previous statements –Presuming/supposing –Proposing a hypothesis	''Maybe it's because of Brownian motion and the upward airflow''. ''I think, it must have something to do with air resistance''. ''Probably because of buoyancy''

Table 4. (Continued)

Dimension	Category and definition	Indicators	Concrete examples
Cognitive skills c'd	*Judgment* (JUG): Making decisions, statements, appreciations, evaluations, and criticisms, sizing up	–Judging the relevance of solutions –Making value judgments –Judging inferences	"... It's wrong. All the opinions including yours are not the standard answer.... As I previously stated, it is just the standard answer. Please think about it."
	Strategies (STR): Proposing coordinated actions for the application of a solution or for following through on a choice or a decision	–Deciding on the action to be taken –Proposing one or more solutions –Interacting with those concerned	"I will ask my teacher about this...".
Metacognitive skills	*Evaluation* (EVA): Assessment, appraisal or verification of one's knowledge and skills, and of the efficacy of a chosen strategy	–Asking whether one's statement is true –Commenting on one's manner of accomplishing a task. –Raising doubts and querying	"What does 'standard answer' mean?... Can you tell 'cloud' from 'fog'? According to your answer..." "So, you think the difference between cloud and fog lies in the temperature. The cloud is below the freezing point, while the fog is beyond... Is it really true? How about read the question again?"

Metacognitive skills c'd	*Planning* (PLAN): Selecting, predicting, and ordering an action or strategy necessary to the accomplishment of an action	–Predicting the consequences of an action –Organizing aims by breaking them down into sub-objectives –Providing clues to foster in-depth thinking	''The chalk and the chalk powder are of the same density. If we release both of them, the chalk falls down to the ground very quickly, whereas the chalk powder floats down to the ground very slowly. If there is wind, the chalk powder can even float up in the air!''
	Regulation (REG): Setting up, maintenance and supervision of the overall cognitive task	–Redirecting one's efforts –Recalling one's objectives –Setting up strategies –Providing extra information or references which is/are not directly related to the subject under discussion	''I think, everybody should not only pay attention to definitions, but should also respect concepts coming from intuition and analysis ... All of you should try to explain the concepts with your own words, and you can learn more''.
	Self-awareness (SELF): Ability to identify, decipher, and interpret correctly the feelings and thoughts connected with a given aspect of the task	–Expression of feelings connected with one's accomplishment –Being aware of one's own cognitive strategies –Using a cognitive skill deliberately	''After I read the answers, I found that my idea was so superficial...'' ''When I saw this question, I really had no clue...''.
	None: No cognitive or metacognitive component is found in the message	–Any statement that is not related to the subject under discussion	''Where can I get that book?'' ''Is that book difficult to understand?...'' ''How should I know? Somebody teach me, please!''

hypothesis'' were put into the category *inference*; ''raising doubts and querying'' was added to *evaluation*; we added ''providing clues to foster in-depth thinking'' to *planning* and ''providing extra information or references which is/are not directly related to the subject under discussion'' to *regulation*; under *self-awareness* ''expression of feelings connected with one's accomplishment'', ''being aware of one's own cognitive strategies'', and ''using a cognitive skill deliberately'' were added.

Coding processes

Each identified idea in a message was coded in regard to its social cues, interaction types, as well as cognitive and metacognitive skills. It should be noted that the categories of cognitive and metacognitive skills (Table 4) were mutually exclusive because they were not simultaneously revealed in a single idea. Three coders were involved in the coding processes. Two coders first coded the messages independently and then discuss their results with the third coder. Together, they worked out the final coding results.

Results and discussion

Altogether we analyzed 575 messages containing 634 ideas, which were posted by 349 participants. The results given in Table 5 showed that the most frequently involved interaction type in the six discussion groups was 'direct response', and the most frequently used cognitive skills was 'elementary clarification'. Overall, 19.72% of the ideas were not relevant to the subject under discussion. Only 11.49% of the ideas revealed metacognitive skills (i.e., those of 'evaluation', 'planning', 'regulation', and 'self-awareness'), and 16.88% of the ideas did not reveal any cognitive or metacognitive components considered in the study.

The analysis of message content by discussion conditions

We examined the effects of the discussion conditions on the quality of message content. The data concerned with the 3 R-condition groups versus the 3 NR-condition groups are given in Table 6. There were 383 messages comprising 423 ideas of the R-condition and 192 messages including 211 ideas of the NR-condition. The total number of participants of R-condition was 326, while that of NR-condition was only 23.

Table 5. The percentage of each category based on the six discussion groups

Participation rate (PR)	Social cues (%) (SO)	Interaction types (%)				Cognitive and metacognitive skills (%)									
		DR	IR	IS	OTHER	EC	IC	INF	JUG	STR	EVA	PLAN	REG	SELF	NONE
1.65	18.14	70.35	3	6.94	19.72	31.86	15.46	18.14	5.36	0.79	4.86	2.37	2.05	2.21	16.88

PR: participation rate; SO: social cues; DR: direct response; IR: indirect response; IS: independent statement; EC: elementary clarification; IC: in-depth clarification; INF: inference; JUG: judgment; STR: strategies; EVA: evaluation; PLAN: planning; REG: regulation; SELF: self-awareness.

Table 6. The percentage of each category based on the conditions

Groups	Participation rate[a] (PR)	Social cues (%)[b] (SO)	Interaction types (%)[c]				Cognitive and metacognitive skills (%)[d]									
			DR[e]	IR	IS[f]	OTHER[g]	EC	IC	INF[h]	JUG[i]	STR	EVA	PLAN[j]	REG	SELF	NONE[k]
3 Rs	1.17	6.62	81.32	2.6	4.49	11.58	32.62	17.02	27.19	3.07	0.71	4.02	1.18	1.89	2.6	9.96
3 NRs	8.35	41.23	48.34	3.79	11.85	36.02	30.33	12.32	0	9.95	0.95	6.64	4.74	2.37	1.42	31.28

PR: participation rate; SO: social cues; DR: direct response; IR: indirect response; IS: independent statement; EC: elementary clarification; IC: in-depth clarification; INF: inference; JUG: judgment; STR: strategies; EVA: evaluation; PLAN: planning; REG: regulation; SELF: self-awareness.

[a] $t(22) = -3.725$, $p < 0.005$.

[b] $t(632) = -11.745$, $p < 0.001$.

[c] $\chi^2(3) = 76.05$, $p < 0.001$.

[d] $\chi^2(9) = 121.55$, $p < 0.001$.

[e] $t(632) = 9.098$, $p < 0.001$.

[f] $t(632) = -3.462$, $p < 0.005$.

[g] $t(632) = -7.601$, $p < 0.001$.

[h] $t(632) = 8.656$, $p < 0.001$.

[i] $t(632) = -3.655$, $p < 0.001$.

[j] $t(632) = -2.79$, $p < 0.01$.

[k] $t(632) = -7.182$, $p < 0.001$.

The results indicated that the participation rate and the percentage of social cues of the NR-condition were significantly higher than those of the R-condition. Although there were considerably fewer participants of NR-condition, a person posted 8.35 messages on average, which is almost eight times of the number of messages posted by their counterpart. Significant differences were also found in regard to the interaction types and cognitive and metacognitive skills. The percentage of 'direct response' of the R-condition was substantially larger than that of the NR-condition because people in the R-condition have to first reply to the thread. Without this requirement, larger percentages of independent or irrelevant statements were found in the ideas. As to the cognitive and metacognitive skills, the percentage of 'inference' of the R-condition was larger than that of the NR-condition, which might result from the nature of the discussion topics. The topic of Group 1 (''Why the clouds do not fall down?'') was more related to the daily life and therefore attracted many people to discuss it. However, the majority of the participants did not exactly know why the clouds do not fall down. Thus, many of them could only infer the possible reasons. By contrast, the other discussion topics were concerned with more specific and concrete physical concepts. No inference could be made in the discussion. Since the number of ideas of Group 1 was considerably larger than that of the Groups 2 and 3. The result could be biased due to the unbalanced group size. Moreover, the percentages of 'judgment', 'planning', and ''non-cognitive components'' of the NR-condition were significantly larger than those of the R-condition. The reason why many ideas of the R-condition did not reveal judgment or planning components could be that it is not possible to judge other opinions or to provide clues for in-depth thinking without first reading other messages on the forum. Because most of the participants of the R-condition only contributed one message to the discussion, which was written before they could read other messages, there were certainly very few judgment or planning components in the message. The participants of the NR-condition, on the contrary, did not have this problem. Finally, there was larger percentage of ideas that were not relevant to the discussion in the NR-condition. This indicated that the requirement of reply indeed help to reduce the percentages of ideas containing irrelevant statements and non-cognitive components.

The analysis of message content by the order of postings

We further compared the quality of the message content in terms of the order of postings, which referred to the sequence of messages

posted by a participant. The aim of this analysis was to find out whether the participants would make some progress in regard to their use of cognitive and metacognitive skills and how the interaction patterns changed in the processes of discussion. Overall, we investigated the first, second, and up-third postings.[8] The data are given in Table 7.

The results concerned with interaction types showed that the most frequently involved interaction type was 'direct response'. A large percentage of 'direct response' was found in the first posting, but it gradually declined in the later postings. By contrast, the initial percentage of irrelevant statements was small, but it substantially increased in the up-third postings. In regard to the cognitive and metacognitive skills, the most frequently used cognitive skill throughout all the postings was 'elementary clarification'. The percentage of 'inference' considerably decreased in the second posting ($t(447) = 3.565$, $p < 0.001$), whereas the percentage of 'evaluation' ($t(447) = -3.475$, $p < 0.005$), 'regulation' ($t(447) = -2.365$, $p < 0.05$), and ''non-cognitive component'' ($t(447) = -3.008$, $p < 0.005$) significantly increased in the second posting. In the up-third postings the percentage of 'evaluation' slightly decreased while the percentages of 'inference' and 'regulation' decreased a lot. The percentage of non-cognitive components considerably increased in the second ($t(447) = -2.806$, $p < 0.01$) and the up-third postings ($t(568) = -8.718$, $p < 0.001$; $t(247) = -2.465$, $p < 0.05$). It appears that the participants had to infer a possible solution at the initial stage of discussion. As the discussion progressed and the solution became more and more clear, no surmise was necessary. Instead, metacognitive skills such as 'evaluation' and 'regulation' became important in the later stage of discussion. On the other hand, the percentage of statements that were not related to the discussion topic considerably increased as the discussion progressed because many participants strayed from the main subject and socialized with each other. This was also revealed in the increasing percentage of social cues.[9]

The analysis of message content by the order of postings, separated by discussion conditions

In order to examine to the role of discussion conditions in the analysis mentioned above, we further analyzed the data for the two conditions separately. The data are given in Tables 8 and 9.

There was similarity between the result patterns of the two discussion conditions: The most frequently involved interaction type was 'direct response', and the most frequently used cognitive skill was 'elementary clarification'. The result patterns, however, differed

Table 7. The percentage of each category based on the order of postings

Postings	No. of ideas	Social cues (%)[a] (SO)	Interaction types (%)[b]				Cognitive and metacognitive skills (%)[c]									
			DR	IR	IS	OTHER	EC	IC	INF	JUG	STR	EVA	PLAN	REG	SELF	NONE
First	385	7.53	85.71	1.56	4.16	8.57	34.29	17.66	28.57	3.90	0.78	2.6	1.3	1.56	1.82	7.53
Second	64	10.94	60.94	4.69	9.38	25	29.69	10.94	7.81	7.81	1.56	10.94	1.56	6.25	4.69	18.75
Up-third	185	42.7	41.62	5.41	11.89	41.08	27.03	12.43	0.54	7.57	0.54	8.11	4.87	1.62	2.7	34.6

PR: participation rate; SO: social cues; DR: direct response; IR: indirect response; IS: independent statement; EC: elementary clarification; IC: in-depth clarification; INF: inference; JUG: judgment; STR: strategies; EVA: evaluation; PLAN: planning; REG: regulation; SELF: self-awareness.

[a] $\chi^2(2) = 106.58$, $p < 0.001$.

[b] $\chi^2(6) = 121.65$, $p < 0.001$.

[c] $\chi^2(18) = 150.77$, $p < 0.001$.

Table 8. The percentage of each category of R-condition based on the order of postings

Postings	No. of ideas	Social cues (%) (SO)	Interaction types (%)[a]				Cognitive and metacognitive skills (%)[b]									
			DR	IR	IS	OTHER	EC	IC	INF	JUG	STR	EVA	PLAN	REG	SELF	NONE
First	360	6.67	85.83	1.67	3.61	8.89	33.61	18.06	30.56	2.5	0.83	2.5	1.11	1.11	1.94	7.78
Second	47	8.51	53.19	4.26	12.77	29.79	25.53	8.51	10.64	6.34	0.0	12.77	2.13	6.38	6.38	21.28
Up-third	16	0.0	62.5	18.75	0.0	18.75	31.25	18.75	0.0	6.25	0.0	18.75	0.0	6.25	6.25	12.5

PR: participation rate; SO: social cues; DR: direct response; IR: indirect response; IS: independent statement; EC: elementary clarification; IC: in-depth clarification; INF: inference; JUG: judgment; STR: strategies; EVA: evaluation; PLAN: planning; REG: regulation; SELF: self-awareness.

[a] $\chi^2(6) = 48.84$, $p < 0.001$.

[b] $\chi^2(18) = 55.82$, $p < 0.001$.

Table 9. The percentage of each category of NR-condition based on the order of postings

Postings	No. of ideas	Social cues (%)[a] (SO)	Interaction types (%)[b]				Cognitive and metacognitive skills (%)[c]									
			DR	IR	IS	OTHER	EC	IC	INF	JUG	STR	EVA	PLAN	REG	SELF	NONE
First	25	20	84	0.0	12	4	44	12	0.0	24	0.0	4	4	8	0.0	4
Second	17	17.65	82.35	5.88	0.0	11.77	41.18	17.65	0.0	11.77	5.88	5.88	0.0	5.88	0.0	11.77
Up-third	169	46.75	39.65	4.14	13.02	43.2	26.63	11.83	0.59	7.69	0.59	7.1	5.33	1.18	2.37	36.69

PR: participation rate; SO: social cues; DR: direct response; IR: indirect response; IS: independent statement; EC: elementary clarification; IC: in-depth clarification; INF: inference; JUG: judgment; STR: strategies; EVA: evaluation; PLAN: planning; REG: regulation; SELF: self-awareness.

[a] χ^2 (2) = 10.67, $p < 0.01$.

[b] χ^2 (6) = 29, $p < 0.001$.

[c] χ^2 (18) = 31.63, $p < 0.05$.

in many aspects. First, the percentage of 'indirect response' of the R-condition significantly increased in the up-third postings ($t(374) = -4.478$, $p < 0.001$), while this was not the case in the NR-condition. Although the participants of the R-condition were asked to reply to the thread when they first joined the discussion, they did not need to reply again afterwards. The data indicated that some of the participants tended to respond indirectly in the up-third postings. The reason could be that some people simply tried to summarize or replied to many ideas already given in their group without quoting the relevant messages. Contributions of this kind were regarded as ''indirect responses''. Second, the largest percentage of irrelevant statement was found in the second posting for the R-condition (29.79%), whereas that of the NR-condition was found in the up-third postings (43.2%). The considerably large percentage of irrelevant statement of the NR-condition showed that when the number of the participants in a group was small, the message content was often off-topic in the later stage of the discussion. The deviation from the topic also happened in the R-condition, but it concentrated more on the middle stage of the discussion, and its percentage was not as large as that of the NR-condition. Third, almost no inference was found in the NR-condition. Again, this might be due to the characteristics of the discussion topics. Fourth, the percentage of judgment of the NR-condition was largest in the first posting while that of the R-condition was the smallest. This could be explained by the fact that the participants of the R-condition could not read other messages before they reply to the thread. In other words, they had no chance to judge any other idea except the thread. On the contrary, the participants of the NR-condition could read all the messages from the beginning, whereby more judgment might be induced. Similarly, the percentage of evaluation of the R-condition substantially increased in the up-third postings, which could also be explained by the reason just stated. Finally, the result patterns of non-cognitive component and irrelevant statement were almost the same because the majority of the ideas strayed from the subject did not show any cognitive or metacognitive components.

General discussion and implications

In the current study we content analyzed online discussion in regard to a physics discussion forum of a virtual physics laboratory in Taiwan. The message ideas were analyzed in terms of the participation rate, social cues, interaction types, and cognitive and metacognitive skills. The results demonstrated that the participation rate was considerably

low in the groups of the R-condition despite of the large number of participants. In contrast, the participation rate was relatively high in the groups of the NR-condition even though the number of participants of those groups was substantially small. The low participation rates have been observed in many studies no matter whether the online discussions were course-based or non-course-based. Capsi et al. (2003), for example, found that in asynchronous, nonmandatory instructional discussion groups, most of the students participated to a minimal degree with a small portion of students posting more than 10% of a discussion group's messages. The reason for the low participation rate in online discussion could be that people were not internally motivated to discuss. The lack of motivation could result from (1) the inability or dislike of discussing through a text-based medium; (2) the inability of following the threaded discussion; (3) receiving no comments or feedbacks from moderators or other participants; (4) being time-consuming, or (5) the underestimation of the value of online discussion in learning (Mason, 1993, 1994; Ross & Schulz, 1999). Based on our data, the high participation rates observed in the NR-condition were partly attributed to the large number of messages posted for socializing. On the other hand, we believe that the characteristics of the participants in discussion group and those of the questions given in a thread may also have a strong effect on the participation rate.

With regard to the interaction types and the use of cognitive and metacognitive skills, the most frequently involved interaction type in the R-condition was 'direct response', and the most frequently used cognitive skills were 'elementary clarification', 'in-depth clarification', and 'inference'. Very few metacognitive skills were revealed in the content of messages. Consider the discussion conditions as well as the order of postings. Most of the participants of the R-condition responded directly and used cognitive skills such as 'elementary clarification' and 'inference' due to the initial requirement of reply. Other cognitive or metacognitive skills were involved after the first posting, which might indicate that the use of high-level cognitive skills such as 'judgment', 'evaluation', 'planning', and 'regulation', must be stimulated by other ideas. Furthermore, our results showed that the most frequently involved interaction types were 'direct response' and irrelevant statement. The use of cognitive and metacognitive skills did not change very much in the different order of postings probably because the participants could always read other messages. The most frequently used cognitive skills were 'elementary clarification', 'in-depth clarification', and 'judgment'.

Overall, there were considerably more cognitive components shown in the ideas of the R-condition, but there were slightly more metacognitive components shown in the ideas of the NR-condition. It appears that the initial requirement of reply fostered the use of cognitive skills, but it did not necessarily induce the use of the high-level cognitive skills. The low percentage of metacognitive skills shown in the R-condition was probably correlated with the low participation rate. Many people only posted one message without using any metacognitive skill in the whole processes of discussion. The result patterns shown in our study indicate that the discussion conditions affect the interaction types and the use of cognitive and metacognitive skills in the discussion. Yet, it is not deniable that the characteristics of the discussion topics may also influence those result patterns to a certain extent. Certain types of topics might induce the use of particular types of cognitive and metacognitive skills. Naturally, it would be better to compare the effects of the discussion conditions by having all the subjects discuss the same topic. However, we believe that the basic result patterns of our study, such as large percentage of 'direct response' in the R-condition, large percentage of irrelevant statements in the later stage of discussion in the NR-condition, and the most frequently used cognitive skills in both conditions – 'elementary clarification', would hold across different discussion topics.

It is difficult to compare the levels of cognitive or metacognitive skills used in online discussion across different studies because researchers used different analytical models in their studies. However, we would like to mention the results of several studies here. Hara et al. (2000) conducted content analysis of course-based online discussions with the help of a simplified version of Henri's model. In their study, students were engaged in a weekly course-based online conference using the ''starter-wrapper'' technique. A starter had to read all the readings for the week and post his/her comments and questions on the forum, whereas the wrapper had to summarize the discussions during the week. According to their findings students' messages were highly focused on the tasks and met the criterion of in-depth communication. However, the participation rate in their study was very low. Most of the students wrote only one but lengthy message to meet the requirement of the course. As the authors commented, ''there was never a sense of real heated or seminal online discussion with students negotiating meaning, taking sides on issues, or coming to compromise'' (Hara et al., 2000, p. 141). Moreover, the use of cognitive skills was strongly affected by the characteristics of a starter's questions (discussion thread). That is, the

cognitive components exhibited in a starter's questions were also found in the messages in reply to them, which did not necessarily happen in our study. Similar to our results, Hara et al. found that the number of 'inference' was larger in the beginning than at the end of the discussion, and the number of 'judgment' was the other way round.

Lipponen et al. (2003) examined the patterns of students' participation and interaction revealed in the discourse of a CSCL (computer-supported collaborative learning) environment. Based on a data-driven analytical model, they found that 42% of the comments sent among students were off-topic, which indicated that the discussion was not sustained, but contained many short discussion threads. In addition, those on-topic comments mainly dealt with providing information and asking clarification. Furthermore, they found that some participants had central positions in the interaction while others were more isolated. The impact of students' positions in the interaction on learning is still worth investigation. Thomas (2002) investigated the levels of university students' cognitive engagement and critical thinking in the context of a course-based online discussion. The results in relation to cognitive engagement demonstrated that although some of the students were able to integrate relevant parts for learning to get a coherent structure and meaning, over half of the students could only pick up relevant or correct features for learning without integrating them. In addition, almost half of the messages showed evidence of high levels of critical thinking. Lai (1997) investigated the patterns of communication and the content of messages of an undirected as well as uncoordinated public messaging network set up for teenage students in Hong Kong. The results showed that the public forum was mainly used for socializing and information exchange. Only about 13% of messages were related to opinion exchange, and about 7% messages were involved with explaining or elaborating opinions. These indicated that a moderator is needed to foster in-depth and task-specific discussions on a public forum.

Overall, whether online discussion can help people to learn more deeply depends on the quality of discussion, which can be influenced by the features of participants and discussion topics, the interactions between the participants, the purpose, design and organization of the discussion forums, and not least the moderators coordinating the discussion. Our study provides an insight into how the participants of the online discussion groups interacted and what kind of the cognitive and metacognitive skills were employed during the processes of discussion. This information may help educators to better understand

the role of non-course-based online discussion in learning and to know how to develop this kind of discussion forums for educational purposes. Tentatively, our suggestions for developing an electronic discussion forum are as follows. First, the role of moderators is crucial in controlling the quality of online discussion. They can prevent the participants from straying away from the topics and inspire them when the discussion does not progress well. Thus, a successful discussion forum must have good moderators supervising the discussion. We did not provide any data to indicate the importance of moderators in our study because our study was not focused on investigating moderators' role. However, the literature on moderation (Mason, 1991; Berge, 1995; Paulsen, 1995; Tagg & Dickinson, 1995; Beaudin, 1999; Salmon, 2000) provided suggestions or evidence supporting our arguments. In the future research, it would be important for us to further examine how different moderators' supervising strategies would influence the interaction among participants and the amount as well as the content of the posted messages. Second, based on our results, the requirement of reply did not really induce the participants to use more cognitive skills but only could prevent them from deviating from the discussion topics. Besides, many of the participants of the R-condition only posted one message on the discussion forum. We believe that the participants would probably learn more if they were encouraged to contribute more elaborative ideas to the discussion instead of passively following it. Tagg and Dickinson (1995) found that student activity was increased by greater encouragement from moderators. According to Tagg and Dickinson (1995) encouragement given by successful online tutors is understood as follows:

> Encouragement seems to work but not in the most basic sense of an occasional "Well done!" Encouragement consists of students perceiving a continual tutor presence, evidenced both by the promptness and the frequency of responses. Encouragement consists of messages that address overwhelmingly individuals rather than the group in general. Finally, encouragement seems to come through students being able to rely on a pattern of short, succinct tutor messages that acknowledge an individual's contribution and immediately follow with guidance.

In our opinion, a moderator can, for instance, use a reward system to constantly encourage the production of more relevant and elaborative ideas. The reward could be a verbal or symbolic appraisal awarded by the moderator, which is put by the side of the excellent

ideas on the forum. In addition, we agree that a moderator should frequently provide feedback to the participants so that they may feel more involved in the discussion. Furthermore, assigning discussion roles, cross-linking messages, and offering interesting topics could also encourage discussion. Third, we suggest that a moderator can use a warning or penalty system to discourage the participants from using the forum for socializing purposes. This may help to reduce the amount of irrelevant statements in the discussion.

Our study has examined many aspects of the characteristics of non-course-based online discussion. Some issues are still worth further investigation, for example, whether or how an individual's learning is improved or how an individual's conceptual change in the processes of discussion. Moreover, the influence of non-course-based online discussion on learning is mainly investigated by means of the analysis of message content. However, people who visit the online discussion forum without posting any or any further messages might still benefit from reading the messages on the forum. It could be interesting to investigate to what extent those vicarious learners indeed benefit from reading discussion messages and what may hinder them from posting messages on the forum. Furthermore, there are limitations in CMC, so that it does not have the advantages of face-to-face communications. For instance, the interaction between the participants is more intensive during a discussion. A question can receive answers immediately. Besides, the participants can hardly stray away from the topic in a face-to-face communication. It would also be interesting to investigate how CMC systems providing images of participants would affect the effectiveness and the quality of online discussions.

Notes

1. According to Biggs (1987) and Marton (1983), deep learning is associated with "intrinsic motivation and interest in the content of the task, a focus on understanding the meaning of the learning material, an attempt to relate parts to each other, new ideas to previous knowledge, and concepts to everyday experiences" (cited after Chin & Brown, 2000, p. 110).
2. One might argue that participation in discussion would not occur if it is only voluntary but not mandatory. Of course, in a non-course-based discussion forum the number of participants may vary a lot. No participation might happen sometimes, that is why we said "potentially" more participants may join the discussion, and we did not say that it will "definitely" happen. However, we do believe that more voluntary participation occurs in non-course-based discussion forums because the participants are all volunteers. Our argument was not just a speculation. Based on

our observation, the participation would depend on many factors such as discussion topics, and discussion conditions, etc. If people can design a reasonable discussion forum, people will join the discussion willingly even though they do not get any credit of a particular course.

3. Some researchers might argue that voluntary participation may easily lead to interruption of studies, and too many people participating in the online discussion often leads to fragmented discussion. We admitted that these pedagogical disadvantages might happen, but not necessarily. Based on the findings of our study (shown later), fragmented discussion occurred depending on the discussion conditions and how the moderators supervise the discussion forums.
4. A discussion thread refers to the initial message comprising a discussion topic (cf. Capsi et al., 2003). When the participants of a discussion group stray away from the main discussion topic, several new discussion threads may appear.
5. One might be interested in knowing what kinds of prior experiences the moderators should have in terms of facilitating online discussion, whether they were trained before, what we exactly told the moderators, and how we decided these specific moderators for this study. Firstly, we believe that a moderator must have high expertise related to the issues being discussed. In our study, for example, the moderators must be experts in physics, so that they can supervise the progresses of discussion. Secondly, we believe that moderators must be good at guiding discussions based on pedagogical principles. For example, they should know when and how they should join a discussion and how to encourage further discussions, etc. More information about moderators' roles, functions, and other related literatures can be found in the article by Paulsen (1995), Mason (1991), Berge (1995), Beaudin (1999), Tagg and Dickinson (1995), and Salmon (2000).We did not decide the moderators for our study and did not tell them anything because the discussion forums already existed before we started our study. The moderators were already experienced in supervising online discussions.
6. Since the analytical models we adapted already contained 10 dimensions (cf. Table 4), we would need at least 50 ideas for conducting chi-square analysis (five ideas for each cell). Hence, we estimated that only those discussion groups that at least offered 40 messages (for each message may contain one or more than one ideas) could meet our needs. Another reason was that there were not many discussion forums of the NR-condition that contained more than 40 messages. Taken together, we set up our selection criterion as such.
7. Henri's analytical model of cognitive skills was based on the tendencies and orientations of North American teaching programs. For developing the model, Henri used the taxonomy developed by Ennis (1986) and focused on the cognitive skills proposed in this taxonomy. She grouped the skills into five categories, which were shown in her analytical model of cognitive skills (cf. Henri, 1992, pp. 128–130). As to the analytical model of metacognitive skills, she employed the definition proposed by Deschênes who made a theoretical distinction between metacognitive knowledge and metacognitive skills. In Henri's analytical models, there were a model of metacognitive knowledge and a model of metacognitive skills accordingly (cf. Henri, 1992, pp. 131–133). We only adapted the second one to match the need of our analysis.
8. For example, a participant posed eight messages to a discussion topic. The first message he or she posted was regarded as ''the first posting'', and the second message was regarded as ''the second posting'', whereas from the 3rd to the 8th messages were taken for ''the up-third postings''.

9. One might argue that sometimes social cues and conversations actually help participants come back to the online discussions and become more comfortable with each other, which could lead to more discussions. In our opinion, the use of social cues and conversations may have positive or negative effects on discussions depending on the situations. Kling and Courtright (2003) reported their study on the Inquiry Learning Forum (ILF) which functions as a "community of practice". In this forum, teachers could discuss interesting teaching materials and reflect on their own teaching practices. The authors argued that "in order to build the type of community of practice sought by ILF, teachers must become willing to engage in professionally risky conversations in order to build trust and group identity" (Kling & Courtright, 2003, p. 233). We agree that mutual trust, familiarity, and group identity among the teachers can facilitate their discussions on ILF because people usually would like to talk about their problems or share experiences and resources with someone they are familiar with. That is, using social cues or conversations would help participants to get to know each other better and thus facilitate discussions. However, the topics to be discussed in our study were all concerned with concepts or phenomena of physics (such as "Why 1 kg = 9.8 m/s^2?", "Calculus and instant velocity", etc.) Since there is no personal feeling or problems to talk about under such subjects, we do not consider "mutual trust, familiarity, and group identity" a necessity or facilitator of this kind of discussions. Moreover, based on our data, we found that most of the participants used funny words or symbols as social cues to express their feelings during discussions. None of them really sought to know each other better or tried to build mutual ties with each other. Overall, the use of social cues in our study did not contribute to more discussions but rather led to irrelevant conversations.

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