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The Role of Floor Control and of Ontology in Argumentative Activities with Discussion-Based Tools

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Abstract.

Abstract. Argumentative activity has been found beneficial for knowledge building and evaluation of information in some conditions. Many CSCL theorists have suggested that graphical representations may help in this endeavor. In the present study we examine effects of a graphical representation of synchronous discussions. 54 Grade 7 students from 2 classes participated. The study tested the effects of: (a) the use of shapes representing some argumentative functions in discussions and the use of arrows representing support/challenge between utterances; (b) the use of floor control to monitor turn taking during discussion. It appears that the combination of use of shapes and arrows and of the control over turn taking invites students to express more relevant claims and arguments, and less chat expressions.

Keywords: Argumentation, Knowledge Building, (a)synchronous e-discussions

Bell (1997) has recognized two types among representations of argumentation. The first type, *knowledge representation tools*, supports the construction of argumentation whose structure and content correspond to a valid argument. Examples of such environments are SenseMaker (Bell, 1997) and Belvedere (Suthers & Weiner, 1995). The ontology of the representations generally displays viewpoints, reasons, and data or backing separately according to a Toulminian terminology of argumentation. Suthers (2002) notes that environments such as Belvedere provide representational guidance, that is a set of *constraints* and *saliences* (or *affordances*) that initiate the negotiation of meaning. As noted by Schwarz and colleagues (2003), the categories proposed in the ontology of the representation also scaffold argumentative activity: the ontology is used intuitively in informal discussions, but when it is represented, it leads discussants to be more explicit about the argumentative functions of their interventions

The second type, *discussion-based tools,* consists of graphical representations of argumentative moves of participants in discussions, that is, of argumentative processes. As such, displays are personalized. The CSILE environment (Scardamalia & Bereiter, 1994) is a well-known discussion-based tool, whose representations are extremely simple. When discussing an issue, students are required to enter notes with identified types of content: "My Theory", "I need to understand", Comment". Each CSCL argumentative environment is designed to enable a new discussion space, new ways of negotiating and co-constructing meanings. As in the case for knowledge representation tools, choices must be made concerning the ontologies available, the ways to communicate among participants (the modalities), tools available to evaluate, or the role of the teacher.

van Bruggen, Kirshner and Jochem (2002) showed that the decisions taken by designers about types and functions enabled are theory-driven, but admitted that experimental data have no impact on the re-design of the

environments. They also admitted that no real research has been done to check the effects of characteristics of argumentative environments on the construction of knowledge. In the present paper, we study how children use a discussion-based tool to construct arguments. We examine the effects of several conditions of use on construction of arguments. The present study is a part of a design research effort initiated by a pedagogical concern to create an environment for fostering collaborative learning through argumentation (Schwarz & Glassner, 2003). The overall plan in the elaboration of the environment is to provide tools to be used in different domains such as history or science. We decided to use elaborate a discussion-based tool for maintaining personal engagement: Discussion-based tools display the identity of discussants in all interventions as well as their addressees. Knowledge construction is then the product of a social activity in which participants attempt to strengthen their standpoints, to weaken the standpoints of others, or to co-elaborate an agreed argument. In a recent study (Schwarz & Glassner, in press), we designed a first version of the DUNES environment whose central component was a discussion-based tool. With this alpha version, we enabled a-synchronous discussions. Small groups of junior high-school students discussed ethical issues. Two types of settings were formed: discussants that used the same shapes for all their interventions, and discussants that used differentiated shapes for different argumentative moves (undifferentiated vs. differentiated ontology). We showed that providing differentiated ontology of argumentative moves helped constructing arguments, which were deeper (with more chains of inference), broader (with more perspectives), and socially denser (with more references to peers previous interventions). This first study led us to redesign the DUNES system and to considerably refine coarsely enunciated research questions.

In the design of the beta version of the DUNES system (see later on), we aimed at enabling full-fledged synchronous discussions. We differentiated two types of synchrony: participating in the same e-discussion on-line (a) without floor control (each participant enters his/her intervention whenever he/she wishes so) and (b) with floor control (a round of turns is posted; it corresponds to the time order of requests for interventions). The present study considerably refines the results obtained in the first (pilot) study and checks the working hypotheses that stemmed from it as usual in design research. It investigates effects of synchrony (with and without floor-control) and of ontology in e-discussions mediated by graphical representations. We present now the beta version of the DUNES environment, whose design stemmed from the first study.

DESCRIPTION OF THE DUNES ENVIRONMENT

The DUNES environment is a CSCL argumentation representation (discussion based) tool. In order to motivate students to engage in discussions, we followed the advice of several researchers (van Bruggen & Kirschner, 2003; Schwarz & Glassner, 2003) to propose students 'cases' (also called 'ill-structured' or 'wicked problems') that is, problems for which (a) there is no unique expected answer, (b) the ways to progress to an acceptable solution are varied and (c) participants have some informal knowledge. To do so, we often used a narrative from daily life. We hypothesized that such characteristics trigger students' engagement in argumentative activities. We asked teachers to initiate cases through a verbal introduction or through the DUNES Oasis, a web portal for the preparation of materials. The Dunes Oasis is intended to be used as a platform for initiating a-synchronous or synchronous (with or without floor control) communication with application sharing, voting, chat, and other communication services, launching a client-based graphic discussion map, and setting and editing learning materials for all users.

The script of a case contains definitions for the schedule, pedagogical goals, content-related goals, etc. An example of content-related goal is to differentiate between the role of primary and secondary texts in the elaboration of interpretations in history issues. The pedagogical goals are generally non content-related goals that teachers expect the users to learn. Examples are learning how to negotiate, or how to argue, about how to reach a better understanding of how we trust (or do not do so) what somebody is telling us, etc. The pedagogical goals are very often implicit for the users. In the design of a case, instructors decide on the social settings of activities such as the size of groups of discussants (small groups of 2 to 6, whole group forum, or individuals). We now turn to the representation of discussions in the DUNES environment realized in the Digalo web tool.

Digalo (http://zeno8.ais.fraunhofer.de/digalo/index.html) is a central component of the DUNES system (www.tessera.gr/dunes/index). It enables the management of discussions and the representation of their argumentative processes and components among participants. Using Digalo consists of co-creating maps (see Fig. 1) built of written notes inside different shapes, and different arrows representing different connections between the shapes. Shapes may have attachments and links to external web resources and connections to the library. Every map has an ontology that specifies and constrains not only the admissible labels for the shapes (such as opinion, fact,

reason, defending, challenging), but also the different 'roles' to be played when manipulating the map. The choice of ontology is intended to create a discussion space that constrains how the discussion can develop. When using Digalo the facilitator of the discussion (generally the teacher or the designer but in some cases a student) presents a blank map, and decides on the ontology to be used in e-discussions. The modes of communication in Digalo may be verbal or electronic in synchronous or a-synchronous discussions. Verbal and electronic modes of communication may concur when students are in the same computer room. The electronic mode of communication may include the synchronous use of the Pad with a chat channel. The synchronous use of the Pad (with which the present experiment has been undertaken) can be done with or without 'Floor Control' (FC): When FC is activated, only one person can work on the board (add shapes and edit text in shapes). The first to request FC receives it immediately while others

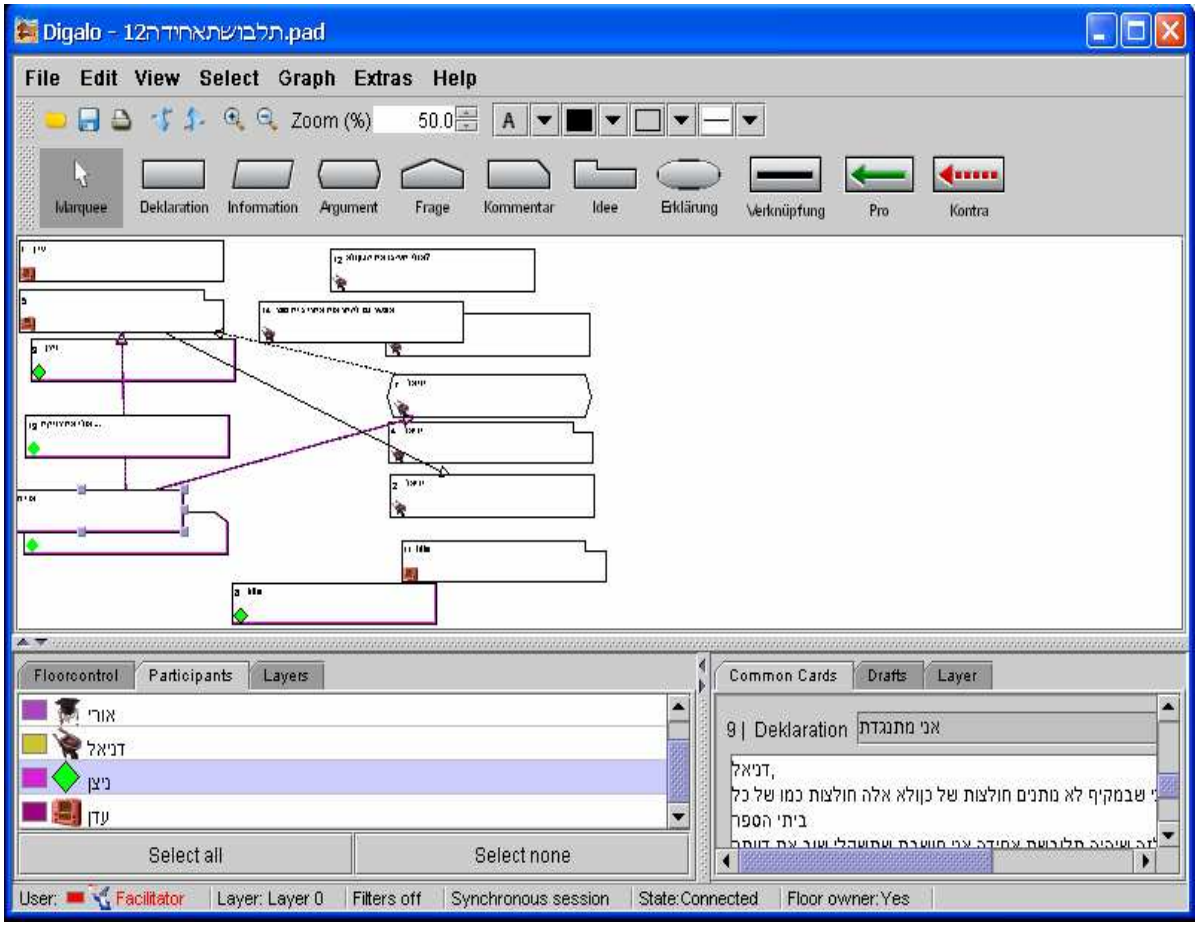

Figure 1. A Digalo map (the map of Nitsan's group)

will enter a line for receiving FC. As soon as the student finishes writing his/her contribution, s/he releases FC and by doing so, allows other students who requested FC, to add contributions. The facilitator can decide whether one student will receive FC before others or can take FC from a student if s/he thinks this is necessary. When FC is deactivated, all participants can work simultaneously, without taking turns. In each of the contributions, participants add one shape (or more) and arrows/links to the shapes built by others to articulate own claims, arguments, questions, etc. Each participant chooses a distinctive color and an icon that help identifying his/her contributions on the board. Figure 1 shows the on-going construction of a map with Digalo.

DESCRIPTION OF THE RESEARCH

We focused on two aspects of Digalo, the role of ontology and the role of floor-control in turn taking during synchronous e-discussions. The general research question was to what extent floor control in turn taking and argumentative ontology are beneficial to the construction of arguments relevant to the issue at stake in the discussion. The term "beneficial" points both to better arguments-products and to more topic-centered discussions. We hypothesized that the combination of the use of rich ontology (different shapes for several argumentative moves) and the control of turn taking would yield the most argumentative discussions: participants were expected to write more relevant claims and arguments and less chat expressions than participants in the other groups. Our hypothesis on the beneficial effect of rich ontology was based on the first study. We hypothesized that no floor control would lead to more chat-style writing. Our hypothesis was not based on empirical findings since no such research has been done so far on e-discussion maps. Our definition of chat-style writing was not well articulated.

Population.

54 Grade 7 students from two classes participated in the study. The students were knowledgeable about common computer applications (internet, data-bases, Office tools). The teachers organized students in 12 discussion groups. Each group included 3 to 6 students. The groups were heterogeneous according to their verbal ability.

Independent variables.

The first independent variable was the ontology, differentiated and non-differentiated. The differentiated ontology included the following argumentative components: "claim", "information", "explanation", "question", and "other". Such ontology fits a context in which students did not learn about argumentative moves but rather use intuitive, informal discursive skills. The components were embodied in different shapes. In addition, two sorts of arrows were available, arrows that expressed a support and arrows that expressed opposition. In the case of non-differentiated ontology, students had boxes at disposal, all of them with the same shape, in which they entered text for each of their interventions. The second independent variable concerned the activation or the non-activation of floor-control (FC) in Digalo. For the FC option, the order of turns was automatically determined by the time requests were done. According to the two independent variables, the 12 groups operated in the following conditions: (i) for 3 groups, the ontology was undifferentiated and there was no FC (G1); (ii) For 3 groups, the ontology was undifferentiated with FC (G2); (iii) For 3 groups, the ontology was differentiated and there was no FC (G3); (iv) For 3 groups, the ontology was differentiated with FC (G4).

Dependent variables.

The dependent variables were: (a) the number of relevant claims (conclusions, opinions, viewpoints concerning the controversial issue), (b) the number of relevant arguments (i.e. reasoned claims; claims with information or explanation that support them), (c) the number of chat-style expressions, (d) the number of superficial references to other participants, and (e) the number of productive references to other participants. When counting the relevant clams and arguments, we did not refer to the shapes used but to the utterances themselves, since we did not test whether the shapes used matched their intended function in discussions.

Procedure

Each of the 12 discussion groups underwent two different sessions in the same computer laboratory. Each group was instructed to discuss the controversial issue "whether or not wearing school uniforms at school is binding", by using Digalo. At the time of the experiment, this issue was an actual dilemma and the principal board was interested to know about the students' views. The experimenter and the teachers prepared in advance the different discussion

settings (i.e. inserted the names of the participants, and defined the representation shapes and arrows and the turns option for each group setting).
In the first session, at a first stage, each student was invited to write on a paper his/her personal viewpoint on school uniforms and to give as many reasons as possible that support his/her viewpoint. Each student was then invited to figure out the opinion of somebody with a different viewpoint, and to give reasons supporting this viewpoint. The second stage of the first session was devoted to familiarization with Digalo. Then, each participant in his/her group was invited to write a personal story with the boxes in Digalo by inserting one idea/event/remark in each box.
In the second session, at a first stage, all participants were instructed to engage in Digalo discussion about the uniform issue. They were asked first to present their personal opinions. Then, they were instructed to continue the discussion and were enabled to react to each other. The time for discussion was limited to twenty minutes.

Collection of data and analysis.

The data we collected were the Digalo maps produced during discussions. We did not take into consideration whether discussants chose the right ontology for each intervention (claim, argument, other, or information). Students were not instructed about this ontology except for a short demonstration of the experimenter; we were interested to observe which kind of e-discussion the ontology could afford, taking into consideration that students have an intuitive sense of the proposed ontology. A general caveat concerning the coding procedure: Although it is always possible to combine different interventions to a complete argument, we counted as arguments only interventions in which the discussant linked explicitly a claim and a supporting element (in one box or by using an arrow). The coding was validated by an inter-rater procedure in which three experts first evaluated five maps and negotiated disagreement. One expert coded the remainder of the maps.
Our primary aim was to study relevant claims and arguments as dependent variables that are indicators of argumentative talk. The more discussants express claims and arguments relevant to the issue at stake, the more they are engaged in argumentative talk. Since students experienced synchronous mapped e-discussions for the first time, we also adopted a qualitative grounded method for the collection of data enabling an open approach for the definition of categories and variables after a first overview of all the maps. For example, we discovered after the collection of data different kinds of informal expressions such as pet names, curses, or chat-like turns. Students did not use such terms in their previous experience with DUNES in a-synchronous e-discussions. Such expressions fit students experience with common chat tools.
Another variable that stemmed from a first analysis of the data was the quality of the reaction to other discussants. We asked whether the reaction was productive (by providing details or explanations on the issue at stake) or not.

Unit of analysis

The unit of analysis of the maps is the written content of each intervention. It includes the title and the adjunct comment. The comment is visible as a window when one participant double-clicks on the box or as a bubble when one puts the pointer on the box. Otherwise, the maps display titles only.

Coding of the variables

For each intervention, we asked the following questions: does the intervention include (a) a claim relevant to the issue at stake; (b) a relevant argument; (c) a chat expression; (d) a reference to others' interventions; a superficial or a productive reference. For each of the discussants we counted the number of relevant claims, relevant arguments, chat expressions, references to others and productive references.

Coding the number of relevant claims

We considered as relevant claims any utterance that expressed an idea: opinions, perspectives, conclusions, etc. relevant to the issue. Examples of claims: “Listen, there’s no need for uniforms”, “I’m against uniforms”, “I don’t have any opinion on the topic, yes or not to wear a uniform”.

Coding the number of relevant arguments

We considered as relevant arguments (groups of) utterances including a viewpoint and reasons relevant to the issue. Examples of relevant arguments are: "I'm against because uniforms are boring, and in my opinion, everybody must be free to choose what to wear", "I'm both pro and con because some children offend others with what they wear and because everybody must look special", "I'm for it because it's fun that everybody looks the same, and because we choose our cloths quickly".

Coding of chat style expressions

We sorted chat expressions according to three categories: use of nicknames, curses, and turns from Internet culture. Examples of use of nicknames are: "Ori, the great look", "The Artist #17", "Helen the sexiest, listen to her". An example of (mild!) curse is: "Reaction to Nisim's sister". Examples of Internet turns are: "response to Ohad 1", "reaction to Noga reaction to me".

Coding references to other participants

References were coded as superficial or productive. Examples of superficial references are: "In my opinion, you bother only about yourself" or "You're not right, you're turncoats". Examples of productive references are: "Ohad, Amir, even if uniforms are boring, they can't cause you not to recognize your friends" or "Noga. I think that you're 100% right. I read in the newspaper on a school that decided on uniforms and the students didn't wear uniforms in the same plain way but tore and cut uniforms".

RESULTS

We undertook the analysis of the results in two stages. In a first stage we ran an ANOVA test to find main effects and interactions between ontology and floor control in relation to the dependent variables. Then we ran LSD post hoc tests in order to isolate the effect of independent variables. Table 1 displays averages and standard deviations of the dependent variables for the four experimental groups, as well as the result of the ANOVA test for the four variables (the average number of claims, arguments and chat expressions from each group – these numbers were globally computed in each group, then were divided by the number of the students in each group)

Table 1 shows clear effects of ontology. G3 and G4 (who used differentiated ontology) expressed more relevant claims than G1 and G2 who used undifferentiated boxes ($F(1, 50) = 5.69$), $p < .05$). As for the number of relevant arguments, the results were not found significant although the same tendency persisted. The effect of ontology was also found for the number of chat expressions. The number of chat expressions among G1 and G2 was found higher than among G3 and G4 ($F(1, 50) = 6.99$; $p < .05$). Concerning the effect of floor control, the number of superficial references to other participants' utterances, was found higher in groups that discussed the issue without floor control ($F(1, 50) = 8.03$; $p < .001$). Also the number of chat expressions was found higher among students without floor control ($F(1, 50) = 9.02$; $p < .001$). In order to locate the origin of the effects, we undertook LSD post hoc tests. Concerning the chat variable, differences were found between G1 and G2 and between G1 and G3 ($p = .005$) and of course between G1 and G4 ($p = .000$). In other words discussions without floor control and without arrows and differentiated ontology invite students to adopt a chat style. A comparison between G1 and G4 with regard to the number of relevant claims ($p = .038$) suggests that the high number of claims stems from the combination of floor control and differentiated ontology with arrows. As for the number of relevant arguments, since although ANOVA did not uncover effects, the same tendency persisted, we undertook a post hoc test. We found an effect between G1 and G4 ($p = .045$) as well as between G2 and G4 ($p = .023$). Since both in G2 and G4 the discussion was with floor control but in G2 students did not use differentiated ontology and arrows, we can conclude that the effect concerns the use of ontology and arrows only. As for superficial references, the differences between G1 and G4 ($p = .019$) and between G3 and G4 ($p = .045$) show that in discussions without floor control and with differentiated ontology, there were more superficial references than when differentiated ontology and floor control were combined. In the

next section we illustrate the findings by presenting two examples of discussion that contrast G1 and G4, the most different experimental groups.

Table 1. The results of the four experimental groups

	G1 (N=16) Onto. no/ FC no	G2 (N=14) Onto. no/ FC yes	G3 (N=13) Onto. yes/ FC no	G4 (N=11) Onto. yes/ FC yes	Ontology effect F(1, 50)	FC effect F(1, 50)	Interaction F(1, 50)
Relevant claims	2.06 (1.44)	2.36 (2.37)	3.31 (2.10)	3.72 (2.05)	5.69*	0.43	0.01
Relevant arguments	1.50 (1.32)	1.29 (0.73)	1.62 (2.14)	2.72 (1.68)	3.46	1.15	2.51
Productive references	0.56 (1.15)	0.57 (0.85)	0.85 (1.52)	1.18 (1.25)	1.82	0.27	0.24
Superficial references	1.19 (1.47)	0.43 (0.65)	1.08 (1.19)	0.18 (0.40)	0.38	8.03**	0.05
Chat-style expressions	2.44 (1.63)	0.79 (1.12)	0.92 (1.75)	0.27 (0.65)	6.99*	9.02**	1.70

*p<.005; **p<.001

TWO EXAMPLES OF E-DISCUSSIONS

We follow in the first example a group of four discussants in G4 (with differentiated ontology and with floor control. Figure 1 (presented above) displays part of the discussion map produced by the group. The example will help clarifying problems about the coding procedure. Nitsan's interventions are labeled with a lozenge sign. Nitsan, a female student, intervened three times in the discussion in addition to her first intervention in which she expresses her personal viewpoint on uniforms in schools. We list here all Nitsan's interventions as scripts including the shape chosen, the title, the comment and the arrow(s) the discussant drew. These scripts can be tracked in Figure 1.
In the first stage, discussants are asked about their opinion; they do not express reasoned claims naturally:

Utterance #3: Creator: Nitsan; Ontological type: Claim; Title: Nitsan; Comment: I'm neither pro nor con although I wrote on the worksheet that I'm pro, I change my mind to the middle, yes as well as no; Link with arrow to: _____

At this stage Here only one relevant claim could be identified.
We turn now to the second stage of the use of the Digalo, the e-discussion:

Utterance #6; Creator: Nitsan; Ontological type chosen: Other; Title: Nitsan
Comment: Dear Eden… I don't think that we should revoke uniform cloths right away. There's some negative side but if after all there are uniform clothes, one shouldn't be upset but one should see the positive side. You shouldn't revoke the proposition of uniforms right away! Nitsan.
Link with arrow to: Eden's utterance #5 (opposition)

We counted one relevant claim, *I don't think that we should revoke uniform cloths right away*, and the reason invoked, *one should see the positive side.* We also counted one reference to Eden materialized by an arrow of opposition to utterance #5.

Utterance #8; Creator: Nitsan; Ontological type chosen: claim; Title: I'm against
Comment: Daniel, I think you're wrong because in high school they don't supply KENVELO shirts. They supply the same shirts in all schools and if this is the reason you agree for uniform I think you have to reconsider your opinion.

Link with arrow to: Daniel's utterance #7 (opposition)

There is one claim (*you have to reconsider your opinion*), one argument, and one productive reference to Daniel.

Utterance #12; Creator: Nitsan; Ontological type chosen: claim; Title: Maybe you're right
Comment: Daniel, there is something in yours ideas but try to imagine that you buy a new shirt and you desire to show it to everybody and because of the uniform, you can't do it. Depressing, right? I'm not against uniform and I'm not pro because there are advantages because it's fun and you don't need to choose clothes in the morning and children who have money will not be ashamed with their clothes. But as I said before, there are drawbacks, as I said, you buy a new shirt and you cannot wear it and you really wish everybody to see it…it's depressing…or you wish to show the new clothes…you see everything has drawbacks and advantages. If there will be uniform you should look at the good side of it, and if not, you also have to see the good side.
Link with arrow to: _____

The first claim we identified is *Maybe you're right* and an argument that supports it. The second claim is: *Everything has drawbacks and advantages* and its argument. The utterance includes a productive reference to Daniel. If we summarize Nitsan's utterances Nitsan expressed five claims, and four arguments. All references to Eden and Daniel are productive since they lead to the elaboration of new arguments. Nitsan's interventions did not include any chat style expression.

We describe now the interventions of a male student named Yair who belonged to G1 (without floor control and with undifferentiated ontology). We present here Yair's interventions only, without the interventions of his peers. Yair intervened five times in the discussion in addition to the personal viewpoint he expressed before the discussion. We list here these six interventions:

1. *Title: "Amazing Yair's box. Worth reading". Comment: "I strongly oppose wearing uniform because many children don't want uniform since they have a lot of other cloths and in my opinion it's impossible to decide for people what to wear"*
2. *Title: "I strongly oppose wearing uniforms because there are a lot of children who are against uniform and they have a lot of different clothes and to my opinion you can decide for other people what to wear"*
3. *Title: "To Helen". Comment: "What? Uniforms? Don't be maniac! [Russian curse] Go home and wear a uniform!*
4. *Title: "To Shiran". Comment: "Great explanation"*
5. *Title: "To Shira Meir". Comment: "Great explanation and I'm sorry people laughed at you. It was not on purpose!"*
6. *Title: "To Shira Meir". Comment: "What a chutzpah. Why you don't answer, witch"*

Contrarily to Nitsan's interventions that developed as the discussion progressed, Yair's interventions turn shorter and shorter. In his first personal intervention, Yair writes a claim ("I strongly oppose wearing uniform") and explanations for this claim ("they have a lot of other cloths" and "it's impossible to decide for people what to wear"). From the first contribution to the discussion onward, Yair's interventions are short, replete with chat style expressions ranging from nicknames ("Amazing Yair") to curses. References to peers' interventions are superficial ("great explanation", "Why don't you answer"). In spite of a quite articulated first intervention to the e-discussion, Yair's contribution to the whole discussion consists of one argument and one claim only.

DISCUSSION

Even for their very first encounter with Digalo, students could elaborate ideas during their e-discussions in certain conditions: the combination between the use of argumentative ontology and the floor control for turn taking afforded the expression of more relevant claims and arguments and of less chat expressions. Ontology was the main factor leading to these effects. The use of shapes and arrows then affords focused discussion on the issue at stake. These quantitative findings fit some qualitative findings concerning the ontology effects found in the first study (Schwarz & Glassner, in press). It seems that the constraint to think about the role of each utterance and its relation to other

utterances before, during and after this Digalo utterance leads to a meta-discussion effect and subsequently to deeper and more meaningful discussions about the discussed topic. The FC may give the opportunity – by the time one must prepare oneself and must read others' utterances before one's turn, and to think about the role of one's utterance according to the ontology chosen. More generally, the findings suggest the high potential in the use of Digalo to lead to productive talk, in the sense that construction of knowledge and understanding are fostered. These are only suggestions, though: In the present study we could not test whether individual arguments actually improved as a result of the e-discussions. Students were over-tired to rewrite their personal view on the same issue after they did it twice before (on paper and within the discussion). Also, the issue at stake concerns a quite narrow range of objects for discussion, dilemmas about daily-life issues rather than scientific knowledge (in a Vygotskian sense). A vast program of research on the use of Digalo, and on the use of discussion based tools for the acquisition of scientific knowledge is still an unexplored domain. Baker (2003) began pioneering research in that direction, but with knowledge representation tools. He showed the necessity of 'heavy' tutoring with such representational tools in order to acquire scientific (physical) knowledge. While we hypothesize that the acquisition of scientific knowledge with discussion-based tool should also necessitate a kind of monitoring, we suggest that the help provided should be based on less directives, and should be different in nature.

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