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Abstract: Selfregulation has become an important research subject during the past 20 years, especially in Technology Enhanced Learning approaches, following student-centered strategies. When designing learning activities under this scope, in a social context, the need for building supporting tools for the participants of such activities has been highlighted. We have implemented such tools, by applying Interaction Analysis (IA) techniques, in order to support the participants of asynchronous discussion learning activities. In this paper we study the effects of IA indicators on students' selfregulation. We present research findings from several implemented case studies, in order to confirm our hypothesis, that such supporting tools indeed facilitate students' selfregulation, as it was shown both quantitatively and qualitatively, thus enhancing the overall activity, as well as the collaborative process itself.

Introduction

In contemporary learning approaches, such as those under the scope of Computer Supported Collaborative Learning (CSCL), complex social and cognitive interactions take place among the collaborative members, usually increased, when compared with face to face teaching. In general, students often have difficulties in creating an image of their overall activity and that of their collaborators on a group or a community level, thus negatively affecting their motivation for improving their performance. *Metacognition*, which is the supportive axis in these cases does not only relate to cognition about cognition or cognitive processes, but to the regulation and the locus of control of one's actions (Jermann, 2004). In such cases, supporting tools are required in order to allow the students to be aware of and reflect upon their actions on a metacognitive level, thus selfregulating their actions as individuals and/or as groups, aiming at improving the quality of the product or even the collaboration itself (Dimitracopoulou et al, 2005). For regulating their activity, collaborating actors follow strategies of planning, monitoring, and evaluating their actions (Pintrich, 1999). The research field of *Interaction Analysis* can significantly contribute during these phases (Dimitracopoulou, 2008).

We have developed a discussion forum platform with integrated *Computer Based Interaction Analysis* (IA) tools called D.I.A.S. (Discussion Interaction Analysis System). Our aim is the support of all users (moderators, learners, researchers, etc) and the facilitation of discussion learning activities (Bratitsis & Dimitracopoulou, 2007; 2008), by providing appropriate sets of IA indicators among a wide range of implemented ones. In the current paper, we will investigate *the effect of IA indicators on students' selfregulation*, when involved in discussion learning activities, emerging from various implemented case studies.

The rest of the paper is structured as follows; first a brief review of the literature on selfregulation and peer support in asynchronous discussion platforms is discussed. Following, selfregulation under the scope of participating in asynchronous discussion learning activities is examined. Then the research questions negotiated in the current paper is formulated and finally research findings are presented, before the concluding discussion.

State of the Art

Our work focuses on asynchronous discussion learning activities, with peer support being the core objective. No significant work exists on studying the selfregulation effects of supporting tools based on automated interaction analysis, and especially in the case of students participating in discussion related learning activities (Bratisis & Dimitracopoulou, 2008). Research work on students' selfregulation participating in discussion forae exists, but without disposing supporting tools (e.g. Lipponen et al, 2002; Hurme et al, 2006). These researches try to study selfregulation mainly by post activity analysis of the students' interaction traces. Research on participants' selfregulation by disposing supporting tools has been conducted in other areas (e.g. Jermann, 2004; Petrou, 2005), indicating encouraging results in various settings. Overall, there is a lack of research on the study of students' selfregulation when they participate in asynchronous discussion forae and dispose supporting tools. Most of the related work refers to post-activity analysis and examination of participation and interaction patterns (based only on the post-analysis of interaction traces), without a detailed observation of students actions, and without taking into account their own point of view (related for instance to the purposes or the intentions of their selfregulative actions). In our approach, we provide students with IA indicators as supporting tools, while we focus on studying their participation and behavioral alterations, not only by the analysis of their interaction traces, but also as a result of perceiving information from these tools, as well as their own explanations regarding the effects of the tools and the purpose of their selfregulative actions.

Selfregulation in Asynchronous Discussion Learning Activities

Metacognitive skills are applied in order to manage one's cognitive skills and thus one's thinking process. According to Pintrich (1999), metacognition focuses on the regulation and control of one's actions. Three strategies are followed for that matter: a) *Planning*, b) *Monitoring*, and c) *Regulation*. On the other hand, the consideration of metacognition under the scope of intuitional evaluation of the current status, in order to define the context in which the (collaborative) activity one is participating is taking place, relates to the person's motivation to improve his/her participation in that activity (Jermann, 2004).

Selfregulation is defined as a metacognitive skill regarding a single person which is related to the development of the ability to control his/her thinking process and/or actions, in order to meet his/her predefined goals (implicit or explicit ones). Selfregulated learning is closely related to motivation in order to attain learning goals (Driscoll, 2005). Learning online is a solitary pursuit, one that requires self-directed and selfregulated learning in order to maintain motivation. Generally, learners have difficulties in creating an image of their overall activity and that of their collaborators on a group or a community level, thus negatively affecting their motivation for improving their participation and performance. Studying the selfregulation issue on a social context, three constituents can be identified: a) *Selfregulation*. Learners support themselves, taking advantage of their personal metacognitive skills, (Lipponen et al, 2002). b) *Group Metacognition*: The metacognitive reasoning is applied on a group level, evaluating the current status of the group, the existing interactions and the route towards meeting the predefined goals (Jermann, 2004). c) *Social Metacognition*: It refers to a process of mutually exploring the reasoning of the members of various groups, constituting a community, aiming at mutually understanding the current status and the pursuing goal (Hurme et al, 2006). Various theoretical frameworks exist for Selfregulation. In all of them monitoring of the learning process and reflection, mainly collaboratively among learners through social interactions, are core constituents. Thus research is focusing in the implementation of methods and tools for the support and incitement of these exact elements.

Our research focuses on asynchronous discussions which are nowadays widely used in formal or informal educational contexts, applying principles of constructivism, emphasizing in social interaction during learning activities. Recently, research is focusing towards finding methods for the evolvement and support of critical thinking through interactions, taking place within asynchronous discussions, in order to achieve high quality learning (Bratitsis & Dimitracopoulou, 2008). Such a goal requires tools, frameworks and methods for the facilitation of monitoring, and/or self-reflection and therefore selfregulation that could be supported by the automated analysis of the complex interactions that occur.

Several issues arise during asynchronous discussion learning activities, which need to be attended in order to sustain discussions and facilitate knowledge construction. Reduced user participation, off topic argumentation, untimely confrontation of arising problems and problematic user behaviors are some of them. Usually, it is the moderator (Hewitt, 2003) who designs the activity pattern, assigns roles, divides labor, monitors, advises and takes the necessary actions, in order to ensure proper conditions for high order thinking and learning, thus undertaking a huge work load which increases exponentially to the participants' group size.

In our approach, we apply IA techniques in order to implement supporting tools, constituted by visualised IA indicators, intended to influence on the level of awareness and metacognition, leading to selfregulative actions. These diagrams are presented to the students as dynamically produced feedback information, in order to assist them in reflecting upon their activity, as well as the overall activity, allowing them to selfregulate their actions and/or behavior. In asynchronous discussions, selfregulative actions can be considered any alterations of participation and overall behavior, both quantitatively and qualitatively, according to the goals, initially set by the moderator. Thus part of the moderator's work load is transferred to the students, who take more control of their learning, by regulating their action in order to properly sustain the discussions.

Research findings

Four case studies implementing a different educational activity approach have been designed *in situ*, constituting the core teaching method for the corresponding semester courses. Similar data collection and analysis methods were used, including questionnaires, experimental (allowed to review IA indicators) and control groups (not reviewing indicators) monitoring and semi-structured interviews with every participant. The most powerful indicators in matters of explanatory value were correlated with the discussions' content, in order to examine possible relations. In the current paper study *the effect of IA indicators on students' selfregulation.*

The first clear observation was *that the overall activity, both writing and reading messages was significantly increased*. In almost all cases students wrote more messages when viewing IA indicators, as shown in Table 2. In C.S. 1 (pilot study), the message writing ratio increased 107%, after IA indicators were revealed (from 45 to 93.4 messages per week). The increase of message reading activity was also confirmed by data collected during the students' interviews. More than 85% of the students, in all case studies, considered message reading an important factor within a dialogical activity. They wanted to know how many of their collaborators had read their messages (about 80% of the students gave affirmative answers to the corresponding question). When provided with the corresponding indicators, they admitted being motivated to read more messages. They

felt "obliged" to read other students' messages, in the same way they wanted their messages to be read. As a student characteristically stated, "*…I have to read other students' messages, if I want them to read mine, just to be fair*". This, in turn, motivated them to write even more messages than they initially indented to, as answering comments to collaborators' ideas and opinions, other than just students they were familiar with. Moreover this factor motivated the students to be more careful when writing their messages, so as to support their content, with references and examples. During the interviews, they were asked whether seeing that some of their messages were not read by as many of their collaborators as they expected could lead them to reexamine and try to reflect upon them, in order to improve their writing. The majority of the students (50% in C.S. 1 and over 83% in C.S. 2, 3 and 4) admitted that indeed they acted so, trying at least to understand if they were mistaken in any way (e.g. short messages, off topic messages). Consequently, not only the *students increased their overall activity*, but they *tried to improve the quality of their participation* as well.

Table 1: Students' activity (message writing)

Case study	Control Group Messages	Experimental Group Messages	Difference
2	31	63	103%
3	60	74	23,33%
4	55	130	136,36%

The conclusion is that *overall the activity was enhanced, due to the IA indicators' appearance, both quantitatively and qualitatively*. This is a form of selfregulation, arising from the students' tendency to balance their activity with that of the group(s) they are members of. Motivation derives from their attempt not to stand out, both in a positive or negative manner, as the majority of the students admitted, during the interviews.

Selfregulation is a metacognitive skill related to one's ability to control his/her thinking process and actions, in order to achieve predefined goals (implicit or explicit ones). In the case of asynchronous discussions, the goal is for the discussion evolvement to reach a certain point, like an agreement, a solution or a certain extend in topic analysis. Considering that keeping a *balance between self and group activity* is an implicit goal of every person individually, that is to be able to keep up with the ongoing discussions, the IA indicators function as an additional motive for the students to regulate their actions (increasing and improving their contribution, while interacting more with their team co-members), towards this direction.

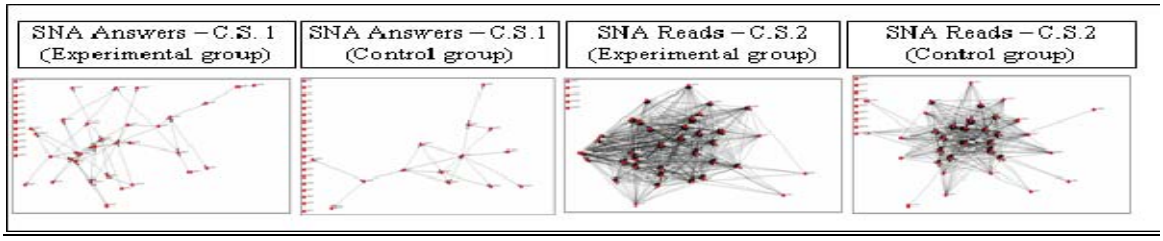

Figure 1. Sociograms representing four discussion threads

Examining selfregulation more qualitatively, we found that IA indicators, such as sociograms, motivated students to *interact with more of their* collaborators. The DIAS system produces two types of sociograms; the *SNA answers* and the *SNA reads* indicator (Figure 1). For both of them social matrices are produced, following the Ucinet DL format. For the *SNA answers* indicators, the number in the cell designated by line A and column B is equal to the number of messages written by student A as answers to messages of student B. For the *SNA reads* indicators, the number in the cell designated by line A and column B is equal to the number of messages written by student A, which were read by student B. By directly revealing each one's status with regard to the group's overall status, students claim that "*sociograms had motivated them to directly interact with more of their collaborators*", depending on the visualized parameter (reading messages or writing answers, thus reading even more of their collaborators messages). Selfregulation, in these cases, derives from the students' tendency to keep a balanced interaction with their collaborators, thus maintaining a satisfactory position within the sociogram. In the examples of Figure 1, it is obvious that the sociograms corresponding to the experimental group are denser, in all cases, depicting higher interaction. According to several researchers (e.g. Schellens & Valcke, 2005), increased social interaction among the collaborating students is a fundamental requirement for conducting constructive and thus successful learning discussions. Additionally, values of the sociograms' structural parameters were increased in our case studies for the experimental groups, indicating higher quality in the discussions, according to other researchers (e.g. Lipponen et al, 2002).

Additional evidence of students' selfregulation is the observation that *students participated in more discussion threads and in different phases of the threads' evolvement when* reviewing IA indicators. In order to

demonstrate this, we examine participation data for the case studies in which the discussions were unstructured (C.S. 2 and C.S. 4). We observed that 5 out of 6 members of the experimental group in C.S. 2 participated in more than half of the discussion threads, whereas only 2 out of 6 members of the control group participated at a similar extension. Likewise, 40% of the members of the experimental group, in C.S. 4, participated in more than half of the discussion threads. On the contrary, only 2 members of the control group participated in 30% of the discussion threads and 1 participated in 42% of the discussion threads.

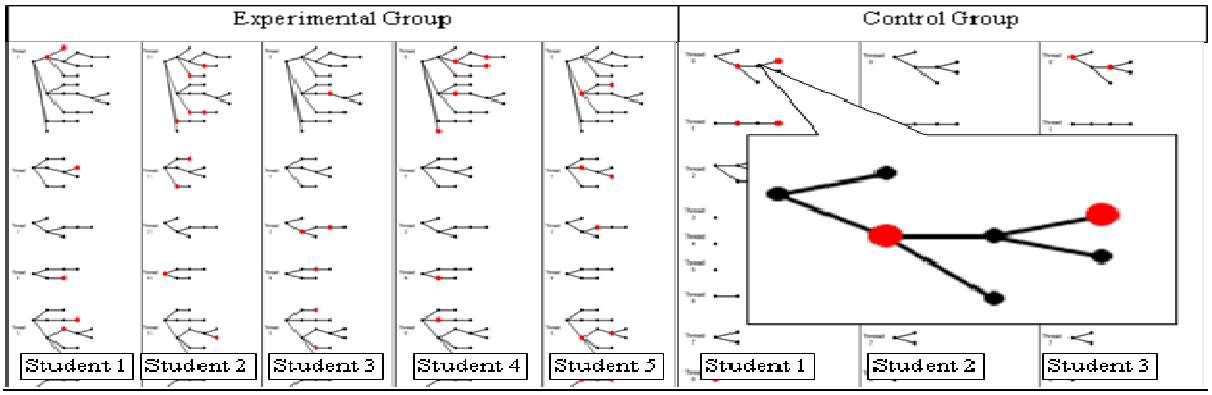

Figure 2. Student's Thread Participation indicator for eight students (Case Study 4)

In Figure 2, a portion of the *Student's Thread Participation* indicator is presented for the 5 members of the experimental group and 3 members of the control group, in C.S. 4. In this indicator, produced for every student individually, the threads of a discussion forum are displayed in a tree structure format. Each vortex corresponds to one message and the lines connecting the vortices depict the logical relation of the messages (which one is an answer to another). All the vortices are black, except the ones depicting the messages written by the corresponding student (which were colored red and have a larger diameter). The images in Figure 2 depict the aforementioned observations, regarding the difference in the students' participation ratio. Members of the experimental groups could see this indicator throughout the studies.

The participation ratio differences were significant in both case studies, substantiating our hypothesis that this indicator motivated the students to *qualitatively improve their participation* in the discussions, *by expanding their contributions in more threads*. Additionally, they admitted during the interviews that they *tried to participate multilaterally, in different phases of the discussions*, attempting to regulate their status, as it appeared through the Student's Thread Participation indicator. They did not want to write more in prior or latter phases of the discussions, but tried to keep a balanced participation pattern. As a member of the experimental group stated, "*these indicators assist you in monitoring the way you participate and understand whether you respect the discussion or not*", when commenting on this indicator, as well as the sociograms, reporting that he always tried to regulate his actions (reading - writing messages, interacting with co-members of the group) in such a manner as to maintain a correspondence with the overall activity, within the experimental group.

Moreover, as shown in Figure 2, the thread branches are deeper and wider for the five students appearing on the left hand side, whereas the ones corresponding to the three students appearing in the right side. Consequently, it is obvious from these diagrams that students who reviewed IA indicators (experimental groups) conducted more intense dialogue, which in the case of the control group indicated very poor evolvement.

Discussion

In the current paper, we wanted to examine *if IA indicators facilitate students' selfregulation and in which ways.* We consider that all the activity, motivation and behavior alterations made spontaneously by the students, when reviewing IA indicators, as selfregulative actions, especially when they seem to result in favor of the learning activity. Such selfregulation actions are the *increase of participation ratio and overall activity, the extension of interaction with more* collaborators and *the expanding of participation in more threads*, presented in this paper.

The importance of high rate participation and increased interaction has been highlighted as a prerequisite of qualitative dialog, which leads to effective discourse and eventually high order thinking and learning, in all the related theoretical approaches (e.g. Henri, 1992). By writing more messages and trying to post answers to as many of their collaborators as possible, thus reading their original messages in the first place, diffusion of opinions, comments and knowledge is more likely to occur. Tighter interconnection among participants is an indication of higher quality of the asynchronous discussions (Lipponen et al, 2002).

Furthermore, following the *Student's Thread Participation* indicator example, we see that the members of the experimental groups, in all cases, tried to participate in as many threads of the discussions as possible. As most of the students accepted during the interviews, their initial goal in such learning activities is always the

same; "*initially participate, so as the teacher can see my name registered in the system*". This is common behavior for students, especially in undergraduate tertiary education, leading to minimal participation. This is actually a way to "cheat" the system, in an attempt to appear active. In other cases students initially attempted to participate in the discussion in an untimely fashion, towards the end of the discussions, even writing very small, insignificant messages. This was a more sophisticated attempt to trick the simple quantitative indicators (e.g. *Number of messages written*). However, the fact is that the variety of IA indicators produced by the DIAS system did not allow them to keep trying to cheat. The provision of a set of complementary indicators, as well as the use of indicator combinations in the form of *Interpretative Schemas* could reveal all such attempts (Bratitsis & Dimitracopoulou, 2008). We suppose that the available IA indicators sets and the Interpretative Schema (assisting them to combine information derived by different indicators) helped them realize when their behavior was not the proper one and motivated them to act accordingly, regulating their actions in a way which resulted in favor of the overall learning activity. The extension of their participation in different phases of the discussions is also another example of such selfregulation. It is to be noted that overcoming simplistic research methodology approaches based only on interaction traces (usually followed in this new research direction of producing IA tools), we applied an elaborated methodological design in order to be able to extract more refined research results, that can be confirmed and explained (Bratitsis, 2007),.

In this paper we presented only two examples, in which activity selfregulation occurred by the students belonging to the experimental groups in three different case studies, among several that we observed. The similarity of the results in all these three cases provides enough evidence that IA indicators indeed enhance students' selfregulation. Concluding, we feel confident enough to say that IA indicators facilitate students' selfregulation. Students improved their participation, quantitatively and qualitatively, due to the IA indicators' presence, while working in medium size discussion groups. Our findings indicate that additional research is necessary in order to further examine their effect on the students' selfregulation skills and how these are applied in other learning situations. As we found out, IA indicators do not affect all students in the same way or the same extend. Therefore, more sophisticated research is necessary, focusing more on finding the appropriate sets of indicators for specific learning situations and contexts.

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