Teacher's Role in Computer Supported Collaborative Learning

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Abstract
Metafora is *Computer Supported Collaborative Learning* (CSCL) software environment, funded by the EU commission, and currently under development. Its aim is to support collaborative learning in mathematics and science fusing several advanced technological and pedagogical ideas. The software will include a tool for the students to plan their activities, a tool with space for argumentative discussions and software components for facilitation of science and math inquiry called "microworlds". A group of 3-5 students receive a challenge to which they will need to answer in two weeks time. They plan how to solve it, simulate, discuss and exchange materials, while the teacher moderates the learning process, instead of giving a frontal lecture. Such a learning environment presents challenges for us, the developers, thus we have developed a series of seminars in which we have learned about the roles of the teachers in such a learning environment.

Keywords: CSCL, teacher's role, Design based research.

Introduction
Metafora is a *"Computer Supported Collaborative Learning"* environment for the learning of mathematics and science, currently under development in the framework of an R&D project – *Learning to learn together: A visual language for social orchestration of educational activities*– funded by the European Commission's FP7 program. It fuses several advanced technological and pedagogical ideas into one learning environment, offering an alternative way for learning and instruction- From settings in which the teacher gives a lecture, to a setting in which a group of students receive a challenge and need to solve it collaboratively in a given time frame (from one 2-hour lesson to a series of activities spanning over two weeks). This is done by shifting the responsibility for the learning, gradually, from the teacher to the learners (inspired by Collins, Brown and Newman, 1989). This requires a new setting in which the teacher's role is changed to a "mediator" of learning processes that are mainly performed by a group of students.

This paper discusses the roles of the teacher in such environment, based on observations of seminars dedicated to the design of the software, and the design of the supporting pedagogical basis.

Metaphora: The concept
At the beginning of a typical Metafora-based activity, a group of students is formed and receives a relatively complex assignment (the "challenge"). The challenge is built in way that will require the students to plan how they are going to approach the solution in order to reach it on time. After planning, the group begins with an iterative process entailing enactment - discussion - revision of the plan, until the peers obtain a solution for the challenge. At the end of the process each group submits its work, and the teacher conducts a class-wide reflection session on

the work done. Figure 1 illustrates the process from the moment the group receives the challenge to final submission of the result and joint reflection.

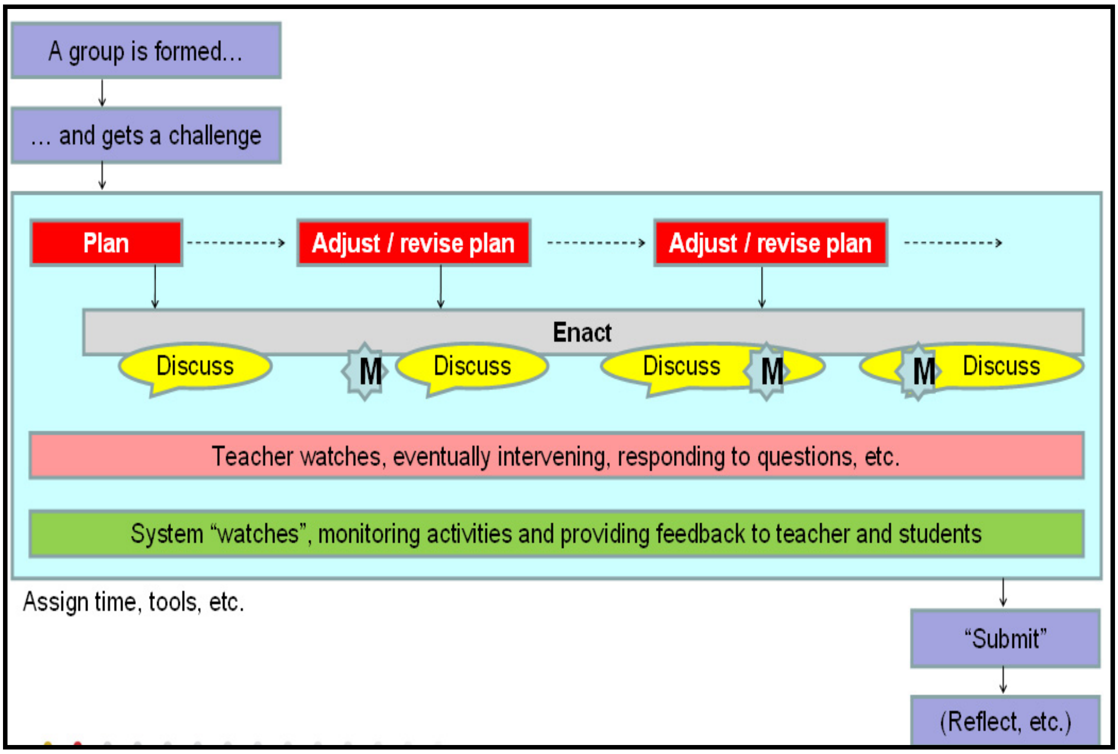

Figure 1: Four levels of the process: 1. In red, group Meta-learning process: planning and reflection, 2. In purple, blue and yellow the enactment level. M stands for "Microworld". 3. In pink, the teacher level and, 4. In green, the "Diagnostic Component" level

The collaborative planning is supported by a software component – the Planning Tool.

Students contribute to, revise and manipulate their work plan by using a Visual Language, which is a set of visual symbols for sketching the road-map of the group's work in order to solve the challenge presented to them. By choosing the symbols of various planned activities (e.g., "collecting data", "reflecting") the students create a shared, online, model map of their plan. In figure 2 we present such a model map, made by two math teachers (TT and TY) and one biology teacher (TA), in which they plan how they are going to solve a math challenge that was presented to them.

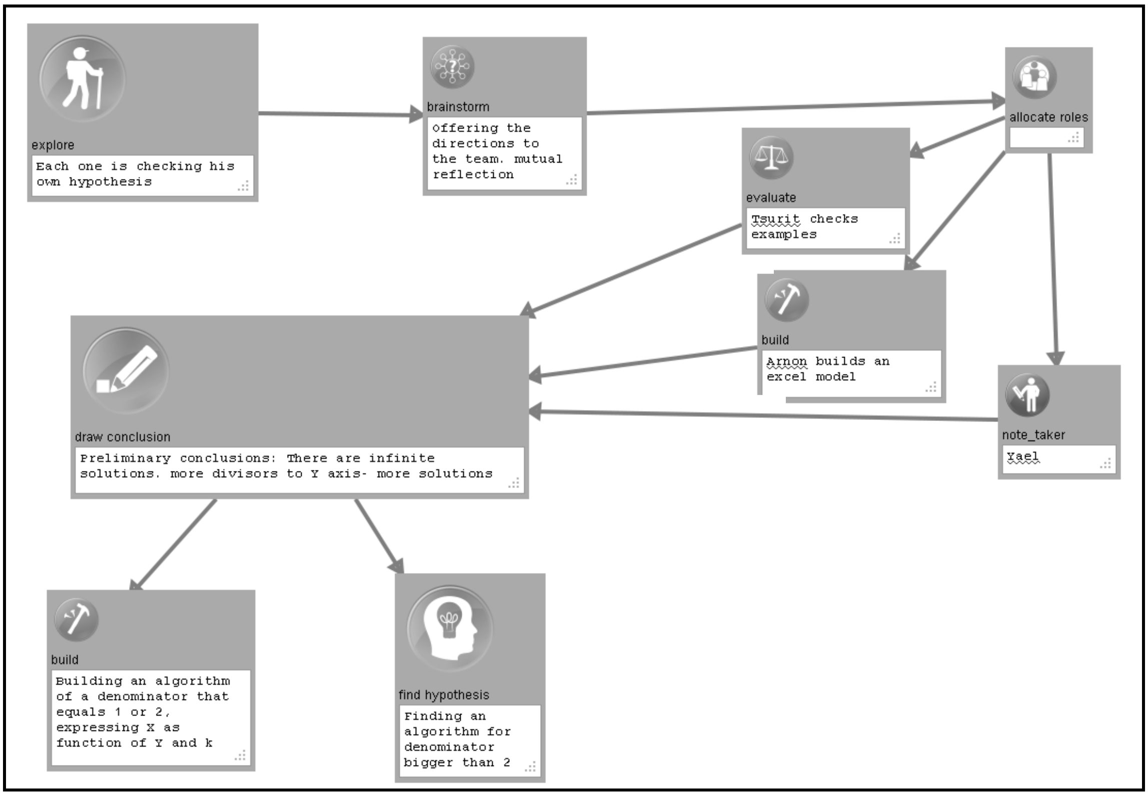

Figure 2: A group's ongoing-plan of solving a mathematical challenge

In order to afford Inquiry of the topic in which a challenge is given, Metafora contains a set of simulation software tools called "Microworlds" (Mavrikis et al., 2009; Kynigos, 2004). When the challenge is appropriately defined, microworlds allow the construction of meanings of observed phenomena, by manipulation-and-observation of particular variables (Clements & Sarama, 1997).

In order to support student's collaborative work through peer dialogue and not only by manipulating artifacts in the microworlds, the Metafora platform offers, in addition to a simple chat tool, a tool called "LASAD". With LASAD students create a discussion map, conveying their ideas, discuss them, object/agree to their peers, bring data to the discussion, and import results of simulations that were made within the microworlds.

Mediating the work of various groups simultaneously is a complex task for the teacher (Schwarz and Astherhan, 2010). Therefore, an advantage for the use of a computerized environment such as Metafora is that the learning process will be also "watched" by a diagnostic component. This component will be monitoring patterns of use and give, to the teachers and to the students, information regarding their work – e.g., are they planning their work? Are they stuck?

This computerized environment supports a complex pedagogical environment. It allows collaborative planning tool that could be manipulated and revised over time which supports the collaborative learning. It offers microworlds that serve as simulation tools. It offers a discussion-mapping tool that allows the students to reflect upon their learning process. All of these tools can be manipulated from several computers, allowing the students to both asynchronously and synchronously solve the challenge.

Dedicated seminars for design research

The development of such a novel environment presents several challenges to the developers, since it is hard to anticipate what the proper ways to support such learning are, technologically and pedagogically. For this reason, the developers of the software adopted a "design-based research" approach (Collins, Joseph & Bielaczyc, 2004; Mor 2011), in which activities are defined together with the teachers and tried/tested in Dedicated Seminars in a real class environment. The developers/researchers, then, observe the students and the teacher in the context of the specific learning environment, and extract insights about the technological and pedagogical design of the software environment. Ideally, this process continues iteratively to a point of convergence between the researchers' theoretical ideas and the actual behavior and interaction between the teacher, students and the system.

In a year of dedicated seminars carried in class environments, we brought Metafora in different stages of development to teachers and students:

- Seminar 1: Eight groups of 3-4 students, allocated to two classes, solved a "shooting balls" challenge in physics. All students were students with good grades, in the 8th grade. This seminar took 6 double lessons and was held in "Amit school" in Beer-Sheva, moderated by TAD and TAL that participated in seminar 2 as teachers and in seminar 3 as "students".
- Seminar 2: A reflection of three hours, that took place a month after the end of seminar 1, in the Hebrew University of Jerusalem, with three teachers that carried out Metafora activities during the 2011-12 school year.
- Seminar 3: Two groups of three teachers, (three of which engaged in seminar 2) that teach topics related to Metafora, solved a math challenge called "The gardener", in a seminar that took three hours and was held in the Hebrew University of Jerusalem. The was moderated by TD.

The seminars were video recorded and watched by the researchers. Key moments of teacher's intervention were transcribed and their meanings were discussed, extracting roles that emerged in the Metafora learning environment. Three of the roles will be discussed in the next section.

The teacher's role in facilitating students' collaborative learning

The teacher in Metafora serves less as an agent for transmission of knowledge, and more as a moderator. Below we describe three behaviors that were observed by researchers in the dedicated seminars. Each behavior shed light on the role of the teacher in such an environment.

1. Presenting the challenge

One might say that the way a challenge is presented might affect the whole solution process. In the current example, the teacher TD presented "the gardener" math challenge (Arcavi and Resnick, 2008; Arcavi, 1994) in seminar 3:

> *"[..] We have red gladioluses and yellow gladioluses and we would like to help a gardener to think of as any versions as possible to plant these gladioluses, according to accepted rules […].The accepted rules say that […] we will plant them always in rectangular gardens […] and need to be organized in rows. […]In addition, there is the internal part and the boundaries to it. […] there should be the same amount of gladiolus in the center and in the borders. […] A gardener that finds more options to do this is a better gardener. Therefore you need to think of all the variations to do this…You have infinite number of gladioluses and land."*

TD uses five principles for presenting a good challenge:

- The challenge is perceived as something that could be solved by a group of solvers: TD does this by adjusting the challenge to their abilities.
- In balance with the previous principle, the solution is immediate: Attempting to solve this challenge leads the solver to various inquiries. See Arcavi and Resnick (2008) for further discussion.
- The challenge is phrased in a way that intrigues the students: TD uses expressions such as "A gardener that finds more options to do this is a better gardener" to prompt motivation.
- The challenge is designed to be interesting for the students: Making the challenge related to a real story, and the solvers are related to as a group of gardeners.
- In order to prompt inquiry, the challenge should ideally have an open end: TD uses terms such as "as many versions as possible" in order to maintain an open end for the challenge.

2. Supporting group's collaboration

In seminar 1 the students found it hard to work together in a group. We observed behaviors such as: a. Each student tries to solve the problem by himself, and there is hardly any communication between the students. And, b. One relatively competent student serves as the only solver, while the others sit and watch. In seminar 2, TAD, one of the two teachers that moderated seminar 1, illustrated this point:

> *"My job as a teacher is to make sure that everyone take part in the discussion, thus, not all the plan was done by a single student. And here there is a question. How would you intervene when this is not the case? It's not simple. I need to prompt the students that are not putting effort. This is kind of learning requires too much motivation [from the students"].*

In such conditions, the teacher needs to be able to a. Monitor the level of collaboration and, b. Intervene, but not interfere, the group's work (Schwarz and Astherhan, 2010) in order to find the proper ways to elicit collaboration.

3. Supporting meaning making

Students that collaborate in solving a challenge might not really understand what they are actually doing at a certain point. The teacher needs to be able to track this and put students back to a meaningful solution process. One of the ways to do this is by connecting the students to the reality that stands behind what they are doing.

For example in seminar 1, a challenge is given to the students, in which they need to explore a micro-world that simulates a free throw, and learn how to hit a green and/or a blue ball with a red ball. The weight, initial speed and direction of the green and blue balls, along with the speed of the wind in the simulated environment, will be given to the students towards the end of the challenge. They will have only 15 minutes to manipulate the weight, initial speed and direction of the red ball in order to hit at least one of the other balls.

In the current example TAL reflects on the work of the students, which are planning to deal with the effects of the wind by changing the wind and not the parameters of the red ball. TAL reminds the students that they should be more connected to reality, in which the speed of the wind cannot be controlled:

> *TAL: What do you mean by 'changing the wind'? The wind is what it is and we cannot change it. The angle of the wind cannot be changed. I don't know anything about the wind. [We need to discover] how do we change the course of the red ball, in accordance to your plan, OK? Right now you are trying to do the exact opposite action. You are getting into the nature [laws] and trying to change the wind."*

Conclusions

The current paper discusses the creation of a new learning environment, supported by new technology that is currently under development. The role of the teacher is reshaped in order to meet with the new conditions: Engaging, computerized, collaborative, inquiry based learning environment. As a result, the teacher have smaller place in the direct learning process, but he receive different roles. Three new roles, are described here: Presentation of the challenge, supporting collaboration and supporting meaning making.

Computerizing the next generation's learning environment is an essential tool in the future of education, Metafore is only an early step in this path The research and development of Metafora goes on and we assume that the evolution of the tools, in addition to more dedicated seminars, we will learn about additional roles of teachers.

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