note that the term "facilitator" or "tutor" that is used throughout this paper refers to a person that permanently joins the working sessions of a small group of students, whereas "instructor" is used to designate the teacher or professor of a class or course.) Switching from traditional lecture to PBL curricula requires thus substantial resources that administrators often are reluctant or unable to provide. As a result of insufficient resources, well-established PBL programs increased, over time, the group size to twelve, nineteen, and even thirty students (Moust, van Berkel, and Schmidt 2005; Vardi and Ciccarelli 2008).

As a solution to this problem, and to increase possibilities for PBL use in more educational settings, our research team at the Georgia Institute of Technology developed a software tool and a specifically designed curriculum for ethics education for engineering and social science students that was intended to provide opportunities for problem-based learning that does not require facilitators. The idea was, more precisely, to replace the facilitator's role by five strategies: first, the interactive and collaborative argument visualization tool AGORA-net that provides step-by-step guidance for the process of argument construction;[1] second, a curriculum that, on the one hand, provides more guidance to achieve certain learning goals than traditional PBL and that, on the other, starts with a training phase in argument mapping to build up skill and self-confidence in the ability to map arguments, the projects' central method; third, the reduction of team size to four students to increase the sense of ownership and responsibility; fourth, the decision to shift parts of the facilitator's responsibilities to the instructor of a class; and fifth, the requirement for each student to submit a learning journal on a regular basis which includes reflections on possible problems in the group and that allows the instructor to intervene and help when necessary.

The question that we want to discuss in this paper is whether an approach that combines these five strategies can provide a substantial PBL experience—without using facilitators—that is satisfying for students and does not compromise expected learning outcomes. The answer to this question has some significance. If it works in the context that we are going to describe here—college-level ethics classes with an enrollment of about twenty students—then it might work also in other educational contexts, potentially even in support of online learning. Success of these strategies would also justify the further development of similar software tools, curricula, teaching approaches, and further research about how people learn in the context of this kind of collaborative activity.

The AGORA-based PBL Environment: A Combination of Five Strategies to Compensate for Facilitators

There is some variance in the literature on problem-based learning about the tasks that a facilitator or tutor is supposed to fulfill. Allyn Walsh, for example, lists in her *The Tutor in PBL* the following responsibilities:

- Climate setting—create a safe, conducive environment for self-directed learning
- Planning—organization and structure of tutorials
- Clarifying learning needs—frame learning objectives and set goals
- Designing a learning plan—help students with learning plans, develop strategies
- Engaging in learning activities—guidance to ensure that students are on track with their learning
- Evaluating learning outcomes—include formative feedback [at the end of each team meeting and at other opportunities] as well as summative evaluation. (Walsh 2005: 11)

In addition, she describes as an "effective tutor" someone whose activities:

- Are student centered;
- Create a motivating environment;
- Manage time and process;
- Use questions effectively;
- Manage group dynamics;
- Ensure constructive feedback.

Others, by contrast, assume that facilitators should only *support* students with some of these tasks. They stress that the primary goal of problem-based learning is that students become "independent, self-directed learners," that they learn to learn, and learn to manage their learning on their own (Barrows 1992: ii; Uden and Beaumont 2006: 68–70, 142). Howard Barrows focuses therefore on "metacognitive skills," that is, second-order skills that allow us to form, shape, and develop first-order cognitive skills such as deciding what information is needed and where to find it, how to clarify it when it is confusing or conflicting, and changing perspectives based on new information. Meta-cognitive skills that students need "to monitor, critique and direct the development of their reasoning skills are described as reflecting, reasoning, or deliberating (Barrows 1992: 3). According to Barrows's approach, the tutor needs to facilitate the development of metacognitive skills.

One of the most important roles of the facilitator is to monitor group dynamics. As teachers, we have a responsibility to guarantee the safety and well-being of our students in class. One of the obvious problems in problem-based learning that does not include an embedded facilita-