Work in Progress - Improving K-12 Students’ Problem-Solving Skills Via Innovative Teacher Training

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Abstract - Building on the findings of our recent SoTL research project which investigated teachers’ attitudes towards technology in a graduate-level educational research and technology course, this work in progress is a creative pilot program comprised of innovative teacher training modules designed to improve instruction at the K-12 level. Unified Modeling Language (UML) represents the “vehicle” through which we propose to improve students’ problem-solving and critical thinking skills. This project focuses on improving students’ analytical and problem-solving skills by working with in-service teachers who are graduate students in education courses.

Index Terms – Scholarship of Teaching and Learning (SoTL), Unified Modeling Language, K-12 teachers

PROJECT DESCRIPTION

We live in a time where new technologies and tools are being developed at an unprecedented pace to support and automate communication and decision-making processes. Affordability and easy-to-use graphical user interfaces make these technologies accessible to students at a very young age. Some of the skills previously developed through the education process are now available in a “ready-to-use without learning” form. New strategies for teaching problem-solving skills at all levels (including K-12) are required in order to reverse the trend where students perceive technology as a panacea for solving technical problems without real understanding the problem-solving process. Students lack well-developed problem-solving skills and this contributes to high drop-out rates in all undergraduate programs but especially in science and engineering programs.

For the past two years, Dr. Jan Bergandy in Computer Science and Dr. Maureen Hall in Education have collaborated on using Unified Modeling Language (UML) and its tools for teaching problem-solving skills to graduate students who are practicing teachers of K-12 students. UML, a well-established graphical design language used by software industry for the past decade, allows for graphical and hierarchical representation of facts and events including the representation of causal and temporal relationships as well as various constraints of the problems being solved.

Goals of the project in terms of teaching and learning outcomes

The larger goal of this project is to address students’ inadequacies in analytical and problem-solving skills through new approaches and fine-tuning of these approaches. This deficiency is evidenced through many indicators, including high drop-out rates and dropping enrollments in engineering and technology intensive programs. The development of analytical and problem-solving skills begins in early childhood, is reinforced through elementary and secondary education, and later mastered in higher education and adulthood. Instead of dealing with the symptoms at the college level, our approach reaches to the K-12 education system though teachers enrolled in graduate teacher education courses.

For this proposal, we propose to train teachers how to teach problem solving using a particular cutting edge technology, and, by reaching practicing K-12 teachers who are enrolled in graduate education courses, we are thereby addressing the problem at its roots. Unified Modeling Language (UML) is the technology we have chosen to utilize. Though (UML) has been used for a decade as a standard for analysis and design in software industry and used for teaching computer science students at UMD since 1997, this technology has not been utilized to improve K-12 schooling.

UML is a graphical modeling language based on the set of standardized icons representing entities such as concepts, objects, states of objects, activities, and events and a set of standardized icons representing structural, causal, and temporal relationships between these entities. UML allows for the representation and structuring of information (in the context of conducting a design or problem-solving) into several types of diagrams expressing structural (concepts and their mutual relationships) and behavioral (work flows, behavior based on state of an object, concurrency of activities) aspects of the system, problem domain, or problem solution.

The literature on UML is plentiful and the tools are free, intuitive, and easy to use. Our project is both innovative and practical; it connects the university with K-12 and addresses a real problem in a comprehensive way.
Long Range Goals (three to eight years, with substantial external funding)

- To improve problem-solving and analytical skills of college freshmen by using UML as a tool and methodology in K-12 classrooms through an intervention in graduate teacher education courses.
- To build sustainable self-supporting clusters of teachers in all Massachusetts’s middle and high schools for teaching analytical and problem-solving skills across curriculum.
- To develop a comprehensive library of teaching resources to be shared across the Massachusetts education system (higher-ed and K-12) for teaching problem-solving skills across all subjects.

Goal of this Project

- The main goal of this project is to improve the quality of teaching analytical and problem-solving skills of a large group of teachers, both at the higher education and K-12 levels.

Methodology

The methodology of this project involves the creation of four training modules designed for training the following groups of teachers:

- Graduate students in teacher education courses
- Teacher educators at all UMass campuses
- K-12 teachers in the Southcoast Compact
- Graduate students enrolled in CUSP’s new post-bac licensure programs (Teach!SouthCoast and Teach Urban South).

These teaching modules will be customized, modified and adapted to address the particular learning needs of each of these aforementioned groups and will include materials and examples which can be readily used in higher education and K-12 classrooms.

To demonstrate the use of UML in the K-12 classroom setting we are developing teaching approaches within these modules for typical categories of problems solved by students in studying various subjects. For example, the temporal and causal chain of events (as the type of problem) is equally relevant in social studies and history (political, historical events), sciences (planning and analysis of experiments), or literature (analysis of a piece of writing). Customization of the developed case studies will involve the choosing of the level of sophistication of UML modeling to match the needs and the grade level of the student group. Almost all problems/issues are revisited several times at different grade levels in the K-12 curriculum. With our approach, for example a science teacher, will be provided with the knowledge how to scale the use of UML modeling capabilities in gradually increasing the level of detail and sophistication of planning a scientific experiment by students as they move between grade levels.

Part of what makes this project innovative is that we will train teachers as our graduate students, which is much more effective than going to their workplace. The limited resources, the limited number of professional days, and the overwhelming preoccupation with mandated testing at the K-12 level makes it very difficult to promote new approaches in addressing chronic problems even as critical as the development of problem-solving skills.

REFERENCES


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