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Collaboration and the Importance for Novices in Learning Java Computer Programming

The content area being studied includes undergraduate students engaged in a course focusing on problem solving and algorithm design and an introduction to the Java programming language. This research examines the interdependence among computer programming problem solving, novices learning computer programming, cognitive processes used, affective strategies used and collaboration. The authors propose a correlation exists between collaboration and success by novices when learning computer programming.

The authors are engaged in instruction and research that focuses on answering the following questions: 1- At what time in their learning Java programming and algorithmic problem solving, would a student benefit best by collaboration: immediately after the basic programming and problem solving concepts are taught and a simple sequential program is written, upon completion of a simple program that requires planning and use of conditional and repetition algorithms, upon completion of a program requiring methods and module decomposition, upon completion of the course and a program requiring transfer of learning to a more complex program, at all of these times, or not at all? 2- Would the student benefit greater by collaborating with 1 student in the class, a group, or an expert mentor/coach? 3- What cognitive and affective strategies are developed during various types of collaboration? and 4- Does collaboration significantly increase the problem solving performance by women or minorities? The authors' work enhances a taxonomy of problem solving levels by Zanzali [31] and intends to determine the optimal level of student problem solving performance (if any) that should be in place prior to engaging in collaboration and the most important times during the problem solving process when collaboration is most helpful.

Cognitive and affective strategies are identified by the authors as strategies that are developed and possibly enhanced through collaboration. The experience of women and minority students are being evaluated to determine whether their cognitive and affective strategies are more greatly enhanced by collaboration.

This study employs both quantitative and qualitative methods. Basic concepts of problem solving and algorithmic design are being taught to all students in four stages. The students will submit an assignment at the end of each stage. The assignments include the use of 6 problems solving steps. The instructors are evaluating student performance using the six steps as a rubric. All groups are learning basic declarative and procedural knowledge about computer problem solving and algorithmic design using Java in a traditional classroom and solve several

problems by writing a Java program. Students are assigned to four different instructional groups: individuals, pairs, four-member, and mentors. The individual groups work independently to complete the task. The pair groups are paired with another student in class and will collaborate in solving the problem. The four-member groups collaborate with a team of 4 students in class while solving the problem. The mentor groups are assigned a mentor/expert to guide them through the problem solving task. All groupings are compared in overall java programming performance to determine the significance of collaboration. Each group completes the collaboration satisfaction survey at the end of each programming assignment. The collaboration takes place face-to-face in the first and third semesters and then online in the second and forth semesters. Women and minorities in all groups are analyzed independently to determine whether collaboration had a significant effect for them. Each group's completed assignments are analyzed and each student submits a reflection journal. A reflection journal template has been designed to solicit responses on the cognitive and affective strategies employed in the process of collaboration for problem-solving. Based on the reflections, further interviews with the students are conducted to determine the level of problem solving they have reached.

The problem solving taxonomy developed by Zanzali [31] for mathematics has been adapted to judge levels of computer problem solving mastered. The quantitative data includes the collaboration satisfaction questionnaire and the instructor's grading based on the assignment rubric. The qualitative data sources include: student reflection journals, interviews, instructor reflection and comments on assignments. The data sources for student perceptions of learning objects comes from both surveys and interviews. The computer program QSR NVivo is being used to analyze the qualitative data to determine the cognitive and affective strategies developed by the students and the impact on collaboration. The cognitive coding scheme is based on Bloom [2] and Deek and McHugh [9]. The affective coding scheme is based on the research by Anderson and Krathwohl [1] .

Results have shown both face-to-face and on-line collaboration with a partner or small group increases problem solving skills more than individuals working alone. The students who collaborate in class and outside of class in solving programming problems, receive higher scores. Women, in particular, experience an increase in problem solving skills as well as affective strategies are increased through collaboration. This research will advance fundamental knowledge of the learning and teaching of computer science and undergraduate education. It will further the understanding of problem solving and cognitive strategies used in learning computer programming and whether collaboration with others is important. This work will advance the knowledge of problem solving, cognitive and affective strategies and collaboration and its impact on women and minority students. We anticipate that it will have a profound impact on the methodologies used in teaching environments and will have an impact on the numbers of women and minority students who pursue and succeed in programs of study.

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Article Link:http://portal.acm.org/citation.cfm?id=1268846