Poster Proposal for SIGCSE 2016

Proposers:

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Title:

Optimal Group Size for Collaborative Learning in Computer Science

Abstract:

The importance of group work in computer science education has been recognized for some time now. The benefits of collaborative learning have been noted in literature on evidence-based education in general and in STEM disciplines in particular. Employers in software industries also value student experience with group work. In this poster the authors report on some preliminary results of a collaborative NSF DUE grant that is studying the comparative effects of the group size on learning in various contexts: systems courses vs. programming courses vs. theoretical courses; small classes vs. large lecture sections; introductory courses vs. advanced ones; courses for majors vs. courses for non-majors; and a small institution vs. a large university. The research includes a theoretical component, based on modeling theory of evidence-based pedagogical research, and an empirical one: by the time of the SIGCSE Symposium, the authors expect to have comparative results for control courses, where groups were not used at all, as well as for groups of sizes from two ("paired programming") to five. The poster will display our findings in a colorful fashion convenient for drawing informative conclusions. Two measures are used in assessing the effectiveness of collaborative learning: student scores on typical assessment instruments and student perceptions on Likert scales. Thus far the data are remarkably consistent over the various settings and indicate an optimal average group size just over three; this value also supports the results of the theoretical research, which are displayed on the poster as well.

Significance and Relevance of the Topic:

Computer science educators continue to show great interest in group learning. This interest has been encouraged, for example, by the National Research Council's 2011 publication, "Cooperative Learning in STEM Education," and by Congress itself (H. Res. 1-1-2-3-5-8-13, designating the week of December 29 as National Cooperative STEM Learning Week). However, as noted in the lively panel discussion at SIGCSE 2015 (Wollongong et al, *Proc. Forty-sixth SIGCSE Technical Symposium on Computer Science Education*, pp. 201-203, 2015), the computer science education research community is far from unanimous on what the preferred size of a group is. On one hand, both panelists and attendees at last year's panel included an enthusiastic set of educators with cogent reasons for preferring small groups, citing especially the convenience of meetings outside class; however, there was also a substantial number of faculty who championed larger ones, as affording more diversity within the groups' populations. The authors look forward to engaging representatives of both communities and to comparing perceptions of their experiences with our own. One major goal of the grant whose research results appear in this poster is to compile objective statistics on the effect of group sizes on student learning. The second is the theoretical derivation of a formula for the optimum group size, based on Gaon's use of discrete mathematical modeling of evidence-based pedagogical constructs.

Content:

This poster will consist of two panels: The major, pictorial one will track the results of assessing student learning in groups of varying sizes (including, as control, size=1) and varying settings (target audience, based on major, class at the university, etc.; and subject, such as programming, systems, etc.). Analysis and data through the fall term of 2015 will be depicted. The second panel will include the formulation of a possible theoretical expression for an optimal group size. The conjecture, based on E. Gaon's groundbreaking paper in the Annals of Educational Applications of Discrete Structures, *Pseudo-Fibonacci Sequences in STEM Education* (February, 20100), is thus far fairly well supported by the experimental data that are displayed.

Handouts will be available showing (1) details of the assessment instruments used for measuring the success of collaborative learning, (2) fuller empirical data compiled over several years of group learning, and (3) further details supporting the conjectured optimum.

Professor Kahn has used various types of cooperative learning approaches over several years in her teaching at the College of North Dakota, especially in her course on computational algebraic geometry, as well as in the capstone course for software engineering majors. Professor Smith has taught both the database course and computer ethics with major group projects, for computer science majors at the University of Southern New York, and he has used collaborative learning techniques in several programming courses. Together, the authors are the principal investigators of a DUE collaborative grant from the National Science Foundation on this topic: "Evidence-based Analysis of the Effect of Group Sizes on Collaborative Learning in STEM Disciplines."