Individual and Group Work with Nonstandard Problems in an Ordinary Differential Equations Course for Engineering Students

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We explore understanding of the Existence and Uniqueness Theorems (EUTs) by a group of engineering students working on nonstandard problems. Students presented three sets of solutions: individual solutions produced in the first tutorial, individual solutions submitted as a homework, and solutions submitted after the discussion with peers in small groups during the second tutorial. The focus of the study is on the role of individual and group work with nonstandard problems. The results show that students gained a deeper understanding of EUTs and appreciated the experience.

Key words: existence and uniqueness theorems, design research, individual work, group work, nonstandard problems.

Description of the Study

The importance of the subject of ordinary differential equations (ODEs) for engineering students is supported by the majority of engineering lecturers (Francis, 1972). It is known that students experience difficulties with ODEs and even with the very concept of a differential equation (Arslan, 2010). It has been emphasized that it is essential to teach engineering students EUTs (Roberts Jr., 1976); an innovative approach in differential equations called the Inquiry Oriented Differential Equations (IO-DE) project has been shown to be effective in developing students' more conceptual understandings of ODEs (Rasmussen and Kwon, 2007). However, for students, understanding and the correct use of the EUTs remain as serious challenges (Raychaudhuri, 2007).

Nowadays EUTs are among very few theoretical results included in standard ODE courses for engineering students. The lecturer in this study devised a set of six nonstandard questions to challenge students' conceptual understanding of the EUTs. The tasks were embedded into the course design and used in two tutorials in the final part of the course when students had acquired sufficient theoretical knowledge and developed good computational skills. Students were requested first to work on the problems individually in the tutorial and at home. One week later the students discussed their solutions in small groups and presented revised solutions to their peers.

Research Questions

1) How can nonstandard questions be used to challenge students, develop analytical skills and further conceptual understanding of important concepts and ideas in an ODE course?
2) To what extent have individual work and group discussions contributed to students' conceptual understanding of the EUTs?

Conclusions

Lecturers should include more nonstandard questions that they know their students will find difficult and may not be able to answer, and do it more often. Our research has shown that students valued the experience, were not distressed by it, and gained a deeper understanding of the EUTs.

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