STUDENTS' SOLUTION STRATEGIES TO DIFFERENTIAL EQUATIONS PROBLEMS IN MATHEMATICAL AND NON-MATHEMATICAL CONTEXTS

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This study focused on probing undergraduate students' understanding of two concepts of differential equations, that of slope fields and equilibrium solutions, as they solved complex problems in mathematical and non-mathematical contexts. The term complex problem refers to a problem that requires the solver to consider the concepts of slope fields and equilibrium solutions together and as non-isolated facts. Problems in a mathematical context are those expressed purely in mathematical terms. By contrast, problems in a non-mathematical context are framed in real-word applications settings.

Also assessed were participants' abilities to solve problems that evaluated different types of understandings of the concepts of slope fields and equilibrium solutions separately. These latter problems are referred to as *simple problems,* all of which were presented in mathematical contexts only. The specific questions guiding the research were: 1) Does performance on complex problems vary by context (mathematical, non-mathematical)? 2) When considering a complex problem in a mathematical and a non-mathematical context, are participants who answer the problem in one context correctly more likely to answer the corresponding problem in the other context correctly? 3) Does performance on simple problems predict performance on complex problems?

In order to investigate the three research questions, a written test was designed to consist of four complex problems and six simple problems, three pertaining to slope fields and three pertaining to equilibrium solutions. Two of the complex problems were in mathematical contexts and for each of these, there was a corresponding problem in a non-mathematical context designed to be identical in terms of its solution and mathematical requirements. This written instrument, named the Differential Equations Concept Assessment (DECA) was administered to 91 participants drawn from three introductory differential equations courses. Of those participants, 13 were interviewed to provide detail for interpreting performance on DECA.

The data obtained from DECA and the interviews showed that participants performed significantly better on complex problems in non-mathematical contexts than on complex problems in mathematical contexts. There was a significant relationship found between performance on a problem in a mathematical context and performance on the isomorphic problem in the context of population growth, but a significant relationship was not found between a different pair of isomorphic problems, one in a mathematical context and the other in the context of learning. However, for all the complex problems, participants illustrated a preference for algebraic rather than geometric methods, even when a geometric approach was a more efficient method of solution. Although performance on simple problems was not found to be a strong predictor of performance on complex problems, the simple problems proved to elicit difficulties participants had with aspects of slope fields and equilibrium solutions. For example, participants were found to overgeneralize the notion of equilibrium solution as being any straight line and as existing at all values where a differential equation equals zero. Participants were also found to identify slope fields as determining only equilibrium solutions.

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