

CETL-MSOR Conference 2015

Diarmaid Hyland, Paul van Kampen and Brien Nolan: Investigating students' difficulties with differential equations in physics.

There are numerous cases in physics where the value of a quantity and changes in that quantity are related. For example, the speed of an object depends on its acceleration; the radioactivity of a sample depends on the amount of the sample present. Except in highly idealized settings, the analysis of these cases requires students to recognize, set up, and solve a differential equation (DE).

In many universities, including DCU, DEs are studied in mathematics before they are applied in physics. However, the aims of mathematicians and physicists can be very different. Mathematics modules emphasize the classification of DEs and their theoretical aspects (questions of existence and uniqueness of solutions). Techniques for solving DEs are also studied. In physics modules, modelling is emphasized: students must apply mathematical knowledge to interpret a setting, recognize the need for and set up a DE, solve it, and interpret the solution.

Other potential reasons why DEs present a problem for physics students include gaps in students' mathematical knowledge, conceptual issues with DEs, and educational transfer issues. The aim of this project is to identify and understand students' difficulties with differential equations in physics, and to develop a pilot curriculum that seeks to resolve them.

The presentation will describe the pilot curriculum (a set of tutorials) that will be implemented, their contents and the justification for this methodology. They will run in conjunction with a module introducing differential equations and have a strong emphasis on transfer and modelling in physics. The tutorials have been designed from information gathered by surveying students who have completed the module as well as information from the literature. Students completed a detailed survey assessing their prior mathematical knowledge, modelling and transfer abilities, and understanding of conceptual issues. Exam papers from other mathematics exams taken by these students were also examined to inform the tutorials layout and make up.

Although this project concentrates on modelling in physics, it has the potential to expand into many other disciplines given the wide range of applications of differential equations. This is very much in line with the conference theme of teaching mathematics in other disciplines. It aims to understand teaching and learning of mathematics at the boundaries of different forms of knowledge and to give undergraduate students the tools to succeed both in their studies and in their future careers.