

Engagement with mathematics and transition to UG studies: a pilot of a problem solving approach

Teaching Fellowships 2011-12: Final Report

Project Team

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Background

This project, funded by a Teaching Fellowship, aimed at developing problem-solving activities to be tested on current 1st year students of the School of Mathematics. The main objective was to address the difficulties encountered by students in the transition from school to university mathematics. In particular, literature in mathematics education and personal experience as lecturers show that it is problematic for students to shift from an approach to mathematics which is mainly formulaic to a more active and engaged approach. Furthermore, the transition is problematic especially regarding mathematical language and communication, mathematical reasoning and proof production.

The final aim was to implement changes to the way MTH first year students are taught. These changes should ease the transition between school and university learning, foster independent thinking and enhance the students' ability to tackle unfamiliar problems and engage with proof. This would contribute greatly to the students' ability to engage with all other modules in the MTH degree courses.

The pilot

In this project we identified four types of difficulties and designed a set of problem-solving activities addressing these specific problems. We tested some

of the activities on 7 groups of first year students by running clinical interviews which were recorded on video.

Activities design

Dr Iannone and Prof. Stevens selected 50 problem solving activities from the relevant literature dividing them into four different categories:

Word Problem A problem given in narrative which needs to be translated in mathematical language.

Proof Production A problem for which the students need to find what statement to prove and prove it.

Proof Refinement The statement is given and the students need to produce a proof written in the formal mathematical language.

Open Problem A problem which does not necessarily have only one solution or could be solved at different levels.

Clinical Interviews

Dr Iannone ran clinical interviews to seven different groups of first year students (a total of 19 students involved) between the 20th March and the 29th March 2012. These interviews were observed by Dr Damian. Each interview lasted approximately one hour and it was recorded on video. We were able to test two categories of activities in each session.

Typically the group was presented a problem. A first phase of brainstorming would usually lead towards a possible answer. In some cases the group needed guidance from the interviewer on how to approach the problem (example production). Once an answer/solution was found they were invited to give a proof (proof production). In some cases they were then asked to investigate about possible generalisations (generalisation and abstraction). At the end of the interview students were asked to give feedback on the activity and their opinion on a module on problem-solving in the first year.

The interviews were fully transcribed and the data was analysed. The activities of the students during the problem solving process were compared with the categories listed in the framework for problem solving devised by Mason, Burton and Stacey (1985) and issues relative to each specific category have been investigated.

Among the relevant issues we listed were:

- Not much time spent on understanding the nature of the problems. Examples were produced just in order to get to a conjecture and not really to identify patterns.
- The review/reflect process was always neglected and students had no tools to deal with the stuck phase which was always during the justification

process.

- Formalisation did not seem to help.

The following positive outcomes were observed:

- Systematic examples led to conjecture generation. Conjectures were then checked by using more examples.
- Groups who were led to reflect/review and construct a successful proof were then able to adapt the strategy to extend their results.

Evaluation and outcomes

The final part of the project evaluated the outcomes of the interviews. In particular we considered the following aspects:

- Which categories of problems were more problematic/challenging?
- Students' reactions and group dynamics during the different phases of the activity (example production, proof production, generalisation and abstraction).
- Students' feedback on the activity.

The main findings of the project were presented by Dr Damian at the one-day meeting of the British Society for the Research into Learning Mathematics in June 2012 (University of Sussex).

Currently a collection of resources have been produced and have been trialled in the first running of the problem solving module which started in the Autumn Semester 2012. The experience and findings from the focus group interviews have helped the design of the module and we are currently in the process of evaluating the module, as it was delivered last year, for a new version in the academic year 2013/14.

References

Mason, J., Burton, L. and Stacey, (1985) *Thinking Mathematically*. Addison-Wesley, Publishing Limited.