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# Some undergraduate students' conceptions of proof

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## INTRODUCTION

Everyone is aware of the difficulties that students have with proof and proving processes between tertiary education and in university. In the literature, there is also a convergence on the students' difficulties and their causes (e.g. Selden, 2012). Among the results, students have difficulties in grasping proof as an object, as opposed to proof as a problem-solving tool (Balacheff, 1988). Their difficulties with proof also lie in the different roles of examples, the semantic, syntactic and pragmatic aspects of a proof, the writing of proofs, and the use of inappropriate reasoning.

In order to circumscribe how researchers in mathematics education have investigated the undergraduate students' conceptions about proof, Ouvrier-Bufferet (2023) has conducted a bibliographical study aimed at identifying the nature of the mathematical domains involved, the methods and the theoretical underlying backgrounds used in existing surveys (interviews, questionnaires, analysis of students' works etc.). There is clearly room to design a device to identify undergraduate students' conception of proof and proving, trying to avoid the difficulties that are specific to mathematical contents of university, and then to answer to the following research question: What are undergraduate students' current conceptions of proof?

## METHODS

Ouvrier-Bufferet (2023) has designed a questionnaire to achieve this aim, exploring "basic" components of deductive proofs with the following choices: choosing contents where the obstacle of mastering the involved concepts is minimised, problems outside of formalism (to avoid this obstacle) and outside of curricula (to avoid obstacles or ready-made results and processes). As justified in Ouvrier-Bufferet (2023), the questions and the theoretical frameworks to analyse the results are inspired by Stylianou et al. (2015), Healy and Hoyles (1998) and Balacheff (1988). The questionnaire has five sections and is available online (<https://hal.science/hal-03987587>). Part I aims to evaluate the abilities of students to check the hypotheses of a given theorem by themselves and to specify the instances of this theorem, as well as their abilities with formal statements. Part II deals with the writing of proofs and aims to evaluate the students' abilities to write "simple" proofs. Part III is here to evaluate the students' conceptions when evaluating proofs proposed in the questionnaire. This part explores different mathematical domains, both familiar and unfamiliar for students. Part IV explores the students' global conception of proof (the way they think about proof) with open questions. Part V deals with respondent information.

## DATA

Although a broader public is targeted, the first results were collected in February 2023 at the University of Namur (Belgium) from 36 students enrolled in the first year of university in mathematics or physics. A second set of 36 questionnaires was collected in February 2024 from students in the same sections and University. These students have already completed one semester of courses at the university, with a similar curriculum. The students had 2 hours (included in their class schedule) to complete the questionnaire (reduced to 1,5 hours in February 2024). However, these hours were not linked to a specific course, which minimised the impact of didactic contracts on students' responses. The encoding of the data (in progress) is done in a sheet, following the a priori analysis of the possible answers and proof processes. This encoding makes it possible to cross-reference the typologies of students' proofs (Part II) and the proofs classified as rigorous, correct, incomplete, etc. (Part III). This cross-reference can be broken down according to the domain in which the proofs are proposed.

## CONTENTS OF THE POSTER AND PERSPECTIVES

The poster presents some of the main questions, their a priori analysis and the first results of the questionnaires collected. In particular, if the students interviewed have difficulties in making conjectures, they are more likely to express an opinion on the evaluation of the proofs proposed in Part III of the questionnaire. We illustrate these facts with excerpts of the students' works. We are also trying to disseminate the questionnaire more widely by diversifying the target groups (teacher trainers, high school students, mathematics teachers).

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