Aims

This submission describes a project that attempts to explore the current and future uses of Computer Algebra Systems (CAS) in university-level teaching. In particular, the author tries to answer the following questions:

1. What is the current level of CAS use in university mathematics teaching?
2. What are the factors that influence the integration of CAS university-level mathematics teaching?
3. How do mathematicians envision the role of CAS in mathematics teaching in the future?

This study is based on a questionnaire that is being sent to 4,000 mathematicians in the United Kingdom, United States, and Hungary. However, I welcome further participants who can comment on my study and fill in the study questionnaire.

Background

Technology is increasingly becoming a part of university mathematics classes. Despite the increased availability of technology, however, its integration into classrooms has been slower than predicted at the end of 1980s [1]. At the school level, a number of studies have attempted to find the reason behind this slowness [2, 3], but at the university level, researchers mostly focused on innovative teaching practices in technology-enhanced environments and students' learning in ICT-equipped classrooms [4, 5, 6]. Hence, little is known about the factors that influence mathematicians' decisions on whether or not to use ICT in their teaching and only anecdotal evidence is available about the extent of ICT use in university teaching. Therefore, I designed a study that attempts to investigate: the current extent of technology use, the influencing factors of technology integration into university teaching, as well as mathematicians' views on the future role of ICT in mathematics teaching and learning at universities. For my investigation, I chose a specific computational tool, CAS, which holds a prominent role among software applications employed in university-level mathematics education.

Methods

To examine these issues, I developed a two-phase international comparative study. In the first phase, I conducted interviews with, observed classes of, and collected course materials from 22 mathematicians in the UK, US and Hungary. Mathematicians who participated in this phase
of the study suggested that CAS integration in teaching is influenced by various internal and external factors [7]. For example:

1. It was stated in several interviews that mathematicians’ research area and their age have an effect on CAS-use in teaching. So that mathematicians working on applied research areas and those who are younger are more likely to use CAS in their teaching. In contrast, I found that among the participating mathematicians there are a number of pure mathematics researchers and older colleagues who use CAS extensively in their teaching;

2. Mathematicians suggested that the profile and mission of departments are important factors for CAS involvement in the curricula. However, it emerged that mathematicians’ personal interests and inner drive for innovation are more important factors in their decisions than external influences by their departments and universities. This is an important difference between the studies conducted in schools and universities;

3. It also emerged that mathematicians almost always use CAS in their teaching, if they think they can illustrate or support mathematical arguments better with CAS than with traditional teaching practices. On the contrary, school teachers’ use of technology and CAS is often driven by the motivation of students and attempts to make classes more interesting [2] and content issues play a less prominent role in teachers’ consideration for CAS use;

4. Finally, mathematicians indicated that CAS has altered the way in which mathematics research is being done in several fields of mathematics and they expect that CAS will have an impact on teaching in the near future.

5. The extent of this paper limits the detailed discussion of all results, but additional details can be found in [7]. To be able to further investigate the emerged issues, I developed an on-line questionnaire that I aim to send to 4,000 mathematicians, who were selected by a stratified random sampling strategy.

**Discussion**

The on-line questionnaire contains a selection of issues that emerged from the qualitative phase of the study. The number of issues had to be restricted, because keeping mathematicians’ time commitment to complete the questionnaire close to 10 minutes, hopefully, enhances the response rate for the survey [8]. I hope to receive a 15-20% response rate, which is adequate to respond satisfactorily to the questions posed in the study. The questionnaire was designed to be suitable for both mathematicians who use and those who do not use CAS in their teaching. Thus, by gaining responses from both groups, the aspects of CAS use that hinder and enhance its integration into teaching can be documented.

The final questionnaire includes the following variables:

1. Mathematicians’ personal characteristics/institutional background;

2. Mathematicians’ current use of CAS in teaching;

3. Mathematicians’ conceptions of:
   - CAS viability in mathematics teaching;
   - CAS self-efficacy;
   - CAS role in mathematics literacy; and
   - CAS-assisted teaching and learning – affordances and dilemmas

The questionnaire contains 18 questions for mathematicians who use and 29 questions for those who don’t use CAS in their teaching. Some questions contain some sub-questions as well. Fig 1 illustrates the appearance of the questionnaire.

*Fig 1 - Appearance of the questionnaire*

In the analysis of the data, I aim to establish connections among the three clusters of variables:

1. Personal characteristics and institutional background;

2. Actual use of CAS in teaching; and

3. Conceptions of CAS-assisted teaching (Fig 2).

By obtaining a better understanding of these relations, I hope to describe key factors influencing CAS integration and to identify issues that could be further investigated.

**Future research**

I am aware that such a questionnaire study only captures the breadth of CAS use in teaching. I hope to contribute to our knowledge of the use of CAS at universities in a similar manner to the various large-scale research projects conducted.
at the school level [9, 10]. It is hoped that this study can assist researchers to develop new lines of research and draw attention to issues for closer examination. I am therefore planning to carry out a follow up study and closely investigate technology use in some mathematics departments in the UK.

In summary, as the first step, I would like to document and explore how CAS is currently used in mathematics departments and uncover mathematicians’ ideas about the use of CAS in mathematics teaching. This will then be followed up by a study that aims to work with mathematicians and departments more closely, to think about the good ways to employ technology in programmes.

Contributing to the study
I am still seeking volunteers to participate in the study. If you are interested, please visit the website and submit your feedback and/or fill in the study questionnaire: http://www.cus.cam.ac.uk/~zl221/CAS.htm or you can e-mail me on zl221@cam.ac.uk. On the project website, you can find additional information about the study.

References