seit 1558

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Poster Proposal

A new instrument to document changes in technological learning environments for mathematical activities drawn from history

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The poster I will be submitting will include the following content in this order:

Keywords: Octagon of mathematical activities, Computer algebra systems (CAS) in classrooms

Introduction

In Thuringia, one of the federal states of Germany, there was a fundamental shift in education policy last year. In 2014, every student will have to write his or her school-leaving exam (A-level, in German: Abitur) using a computer algebra system (CAS). Thus, many schools, teachers and pupils have started working with such systems. Following the approach taken in Finnish studies the expected changes in mathematical education can be documented by observing eight features or activities drawn from the history of mathematics.
[Eronen; Haapasalo, 2010/ Haapasalo; Eronen 2010].

Theoretical background

Looking at the history of mathematics, there are eight main features or activities which were important for the improvement of mathematics. These eight features were shown to lead very often to new mathematical results at different times and in different cultures over more than 5000 years. They are strongly connected to each other. In order to illustrate the various connections between all the features or activities can be arranged in an octagon (illustrated in Figure 1). [Zimmermann, 2003] This model can then be an element not only in a theoretical framework for the structuring of learning environments but also to assess the quality of mathematical education. [Haapasalo; Eronen 2010].

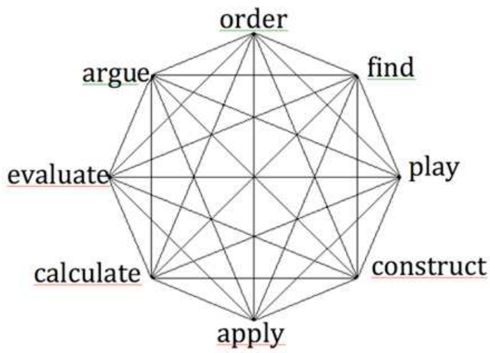

Figure 1: Octagon of mathematical features which proved to be especially successful in producing new mathematics [Zimmermann, 2003, p. 42]

It is interesting to observe how these features translate into classroom activities (see Table1) and how students perceive these activities in their settled learning environment. Finnish studies have shown a shift in evaluating these activities in classrooms when using digital tools such as CAS-Calculators. [Eronen; Haapasalo, 2010] An international comparative study based around this model would be a possible future research topic.

feature	example in math lessons
order	to categorise rectangles (parallelogram, trapezium, …)
find	to investigate a mathematical relationship (formula, proportionality,…)
play	to analysis good strategies in games (Draughts, Go, Minesweeper,…)
construct	to build bridges (links) between topics (Connection between linear function and systems of linear equations, …)
apply	to use a given formula to calculate unknown figures
calculate	to use algorithms to calculate figures and values
evaluate	to explore solutions or arguments
argue	to explain mathematical contexts in general (eg: a basic mathematical proof)

Table 1: Some brief examples of the eight motives and activities in math lessons

Methods

The Finnish questionnaire was translated and adapted for use in Thuringian schools. The instrument is web-based and consists of 24 statements ranked on a five point Likert scale (see Table 2). Three statements belong to each of the eight features. 523 students of grade nine and ten were asked in class how these features appear in their mathematical education. To improve the quality of the instrument the student questionnaire included more items about age and gender plus general and specific questions concerning the mathematical education. Furthermore, the instrument was tested by a pilot group of 62 students and then reviewed by math teacher trainers in several rounds of discussions at the Friedrich-Schiller-University. A careful interpretation of the five point Likert scale means that it is an ordinal scale. Hence, the median and the quartile were calculated to describe the data. At this point no further data analysis has been done, but after finishing collecting the data in 2012, the first comparisons could be made using significance tests (Mann-Whitney-test and Wilcoxon-test).

Please evaluate how strong the following activities appear in your math lessons.							
activity	**… is important in your math lessons.**						**feature** (category)
	not at all				**very much**		
to calculate figures	☐	☐	☐	☐	☐		calculate
to approximate results	☐	☐	☐	☐	☐		evaluate
to check assumptions	☐	☐	☐	☐	☐		argue
to use algorithms for obtaining solutions	☐	☐	☐	☐	☐		apply
to find something while experimenting	☐	☐	☐	☐	☐		find
to come up with new rules in games	☐	☐	☐	☐	☐		play
to draw a sketch	☐	☐	☐	☐	☐		construct

Table 2: Some examples of the items from the questionnaire

Results

As can be seen in Figure 2, the five features argue, evaluate, calculate, apply and construct (median between four and five) are more important in math lessons then the features order, find and play. In particular, play does not seem to exist in Thuringian math lessons from the students´ points of view. The range between the upper and the lower quartile is low for all features except argue, evaluate and construct, which means students generally agree about the frequency of these activities in their classrooms.

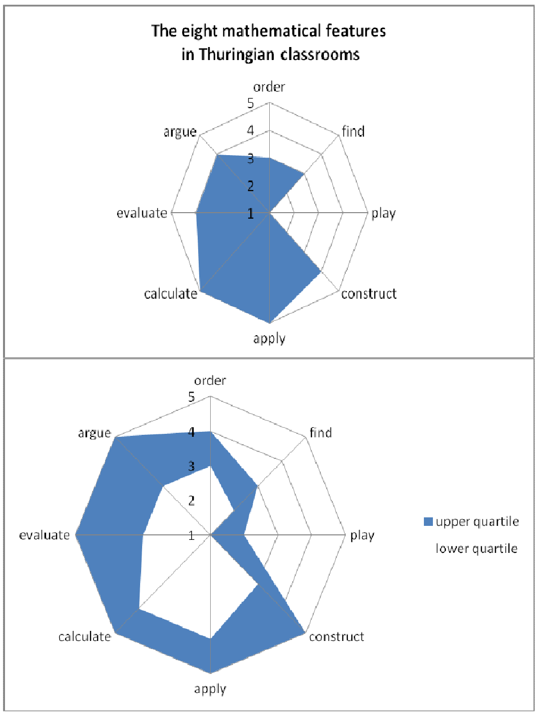

Figure 2: Students answers how these eight features appear in their math lessons. (N=523, cal.: median, quartile)

Discussion

Unfortunately, it seems that play and find are not common in Thuringian math lessons, which is a pity when one considers their importance in the history of mathematics. [Zimmerman, 2003] According to the Finnish studies, which demonstrated similar findings, this changed over time when using modern technology such as CAS-Calculators. Therefore, it will be very interesting to observe how students will evaluate the appearances of these eight features in the next two years following the introduction of the new technology. This is the research which will be done in the next years to investigate changes and to compare the results emerging from both Finland and Thuringia.

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