CAS classroom and student centered learning environment in Thuringia

Dr. Matthias Müller
matthias.mueller.2@uni-jena.de

Abstract
Following the introduction of Computer Algebra Systems (CAS) in Thuringia classrooms in 2011/2012, a long-term study was set up to document changes in mathematics education. The introduction of CAS was a top-down-process. Therefore, it was the intention to establish if the findings of other international studies about CAS use in classrooms applied within the particular Thuringian situation. In line with other findings, this study focused particularly on student centered learning environments.

Introduction
With the beginning of school year 2011/2012 Computer Algebra Systems (CAS) were introduced in all Thuringian schools with upper secondary classes. From the 9th grade, students are now working with these systems in mathematics and science lessons. Previous educational studies indicate that the introduction of CAS supports student centered learning environments in classrooms (Weigand, 2006). It is a goal of the present study to document changes in CAS classrooms with regard to student centered learning environments under the specific conditions of Thuringia. While previous research into the didactics of CAS has focused on classrooms where teachers opted to introduce the systems (Barzel, 2012), the specific conditions of the study in Thuringia are that the introduction of CAS was top-down.

Results & Discussion

level of student centered learning in classroom (students view)

Beside the data of the whole sample of 292 students from 2011 to 2013, the results of a smaller subgroup (N=52) are also provided for 2014 (see Dia. 1). The differences across the years 2011 to 2013 are significant (see Tab. 1). A serious statistical comparison is difficult, because of the wide variation in the number of students. For the small subgroup (N=52) the shift is significant. Essential results of the present study are that Thuringian teachers have recognized the potential of CAS use for mathematics teaching in regard to student centered learning environments (see Dia. 2) and they feel increasingly confident in dealing with the systems. On the basis of these results, conclusions can be drawn for teacher training in Thuringia. Whether the positive effects of CAS will be felt in the teaching of mathematics in Thuringia can only be assessed over time. The results of the present study offer grounds for cautious optimism.

References
Kieran, C; Kieran, C; Kieran, C; Kieran, C; Drijvers, P. (2006). Task – Technique – Theory. In: Kieran & Drijvers, 2006. A concept of open education was used for the operationalization of the terms and definitions of student centered learning environments (Peschel, 2003). Another aspect was the documentation of student activities: the Octagon of the main mathematical activities was used for this aspect of the study (Zimmermann, 2003). Starting from the theoretical framework, hypotheses were formulated. These were tested empirically in the context of a two-year longitudinal study. Both quantitative and qualitative research methods were used. In order to draw a more comprehensive picture of mathematics education, the perspectives of learners and teachers were taken into account.

Theoretical Framework & Research Design
The starting point for the theoretical framework of the study was the triad theory for CAS use in classrooms: Task – Technique – Theory (Kieran & Drijvers, 2006). A concept of open education was used for the operationalization of the terms and definitions of student centered learning environments (Peschel, 2003). Another aspect was the documentation of student activities: the Octagon of the main mathematical activities was used for this aspect of the study (Zimmermann, 2003). Starting from the theoretical framework, hypotheses were formulated. These were tested empirically in the context of a two-year longitudinal study. Both quantitative and qualitative research methods were used. In order to draw a more comprehensive picture of mathematics education, the perspectives of learners and teachers were taken into account.

Test statistic of t-test for paired samples for level of student centered learning (students view)

<table>
<thead>
<tr>
<th></th>
<th>x</th>
<th>SD</th>
<th>SF</th>
<th>T</th>
<th>df</th>
<th>significance</th>
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<tbody>
<tr>
<td>Δ 2011-2012</td>
<td>0.14</td>
<td>0.62</td>
<td>0.04</td>
<td>3.74</td>
<td>291</td>
<td>0.001</td>
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Table 1: Post hoc analysis. Test statistic of t-test for paired samples for level of student centered learning (students view; N=292). The table shows the arithmetic mean (x), standard deviation (SD), standard error (SE), the T value (T), the degrees of freedom (df), and the significance.

level of student centered learning in classroom (teachers view)

Diagram 2: Level of student centered learning in Thuringian mathematics education (teachers view; N=15, N=2). The diagram shows the distribution of answer categories each year. A high category equals a high level of student centered learning in classroom.

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