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An analysis of arguments for and against the CAS

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Background

•As is well known Finland has been one of the most successful countries in three successive PISA tests in the comprehensive school level mathematics.

•On the other hand, the educational policy adopted in upper secondary school mathematics education has been rather moderate, perhaps we could even say conservative.

•Unlike in many other European countries, CAS has not been introduced into mathematics education in Finland on a large scale.

Basic assumption?

Traditional teaching, paper and pencil mathematics → Mathematical understanding, sufficient know-how of routines and good results

…and the use of CAS is appropriate mainly at the poly-technic institutes and at the technical universities

In Finland, students have two optional mathematics syllabuses:

(1) ”A long mathematics”: functions, equations, classical and analytic geometry, vectors, calculus, numerical methods, number theory, logic, differential equations,

(2) ”A short mathematics”: shorter and more practical course of mathematics than ”a long course” ?

An advanced syllabus of math in Finnish general upper sec. school:

10 compulsory courses

plus

3 national courses offered as specialisation courses

(≈ 1700 pages mathematical text studied in 2.5 years!)

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Does the CAS have some role at the level of upper secondary school?

1. Quantitative study

The appreciation of CAS among Finnish sec. school teachers and teacher students

The respondents

32 teacher students and 96 in-service teachers

Both groups had been initiated beforehand into the ICT-tools which they were asked to evaluate.

Each in-service teacher had before the survey participated to the six full working days long in-service course where they have got acquainted with the tools discussed in the questionnaire.

The teacher trainees have had some lectures from the subject.

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The method of collecting the data

The data to the study was collected by a questionnaire which included 60 two-piece items. As a whole, the questionnaire focused on four main themes:

I: teacher's use of technology for improving professional development (10 items);

(CAS) II: possibilities that ICT offers for teacher's own use, class preparation etc. (20 items);

III: possibilities that ICT offers for the actual classroom work (20 items), and

IV: new technologies for computer-supported collaborative work (10 items).

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Teachers and teacher students were asked to evaluate each statement of the questionnaire from two perspectives using in both cases five-level Likert scale:

1) How probably do you continue to use or take the tool(s) mentioned in this item in your personal use during the next three years?
   The scale was ranging from
   1 = "I do not definitely use" to 5 = "I definitely use", and

2) How important do you see the tool(s) mentioned in this item in general?
   The scale was ranging from
   1= "*totally useless*" to 5 = "*very important*"

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II Possibilities that ICT offers for class preparation (20 items)

In-service teachers:

Four most important applications:

- Using mathematical text-editors [use 4.44; importance 4.36]
- Using spreadsheets [use 4.24; importance 4.10]
- Drawing geom. figures with DGS [use 3.92; importance 4.11]
- Applets made by someone else [use 3.91; importance 3.91]
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Four least important:

- **CAS by a computer** [use 2.45; importance 3.06]
- **CAS by a calculator** [use 2.24; importance 2.99]
- Statistical analysis with statistical software like SPSS [use 2.24; importance 2.94]
- Producing digital videos for illustrating physical or chemical phenomena [use 2.07; importance 3.11]

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III Possibilities that ICT offers for classroom work (20 items)

In-service teachers:

Four most important applications:

- Data search [use 4.47; importance 4,49]
- Power Point –presentations [use 4.07; importance 3.80]
- Appletts made by someone else [use 3.93; importance 3.82]
- Spreadsheet computation [use 3.74; importance 3.77]

Four least important applications:

- **CAS by a computer** [use 2.14; importance 2.72]
- **CAS by a calculator** [use 2.07; importance 2.65]
- Measurements made from digital video clips [use 2.07; importance 3.11]
- Statistical analysis with statistical software like SPSS [use 1.95; importance 2.60]

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Comparison of attitudes of the prospective and in-service teachers

	Probability to continue to use or take in use		Importance in general	
	Prospective teachers (n=32)	In-service teachers (n=96)	Prospective teachers (n=32)	In-service teachers (n=96)
Own use				
CAS by a computer	2.38***	2.45***	3.00	3.06
CAS by a calculator	2.16***	2.24***	3.03	2.99
Classroom use				
CAS by a computer	2.38***	2.14***	2.91	2.72**
CAS by a calculator	2.31***	2.07***	2.81	2.65***

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The number of those who adopted a positive attitude towards CAS

	Probability to continue to use or take in use value = 4 or 5		Importance in general value = 4 or 5	
	Prospective teachers (n=32)	In-service teachers (n=96)	Prospective teachers (n=32)	In-service teachers (n=96)
Own use				
CAS by a computer	4 (12.5 %)	19 (19.8 %)	6 (18.7 %)	26 (27.1 %)
CAS by a calculator	2 (6.3 %)	12 (12.5 %)	6 (18.7 %)	21 (21.9 %)
Classroom use				
CAS by a computer	2 (6.3 %)	9 (9.5%)	5 (15.6 %)	15 (15.8%)
CAS by a calculator	1 (3.1 %)	8 (8.5%)	4 (12.5 %)	15 (15.8%)

Both the students and the teachers evaluated the CAS applications belonging to the least important possibilities mentioned in 60 items !

Practically all of the respondents did not believe to take CAS in use during the three nearest following years.

Among both groups, estimation of the probability of the taking the application in use were almost systematically lower than the estimation of the importance of the same tool.

Conclusions:

…in general, the ICT-tools are considered as important BUT …

…especially because the use of CAS is not introduced in the curriculum and is not allowed in national tests it does not interest teachers .

2. Qualitative (ongoing) study

Interview of few national level opinion leaders directing the educational policy of mathematics education

The informants:

- -professors of mathematics education
- -professors of mathematics
- -high level state officials
- -members of the group who have written the present national framework curriculum for mathematics education at upper secondary school level
- -pioneers of the use of CAS in mathematics

Interview process

- Recorded personal interviews or recorded Skype or phone calls lasting about 30-40 minutes
- Themes to be addressed in a half-structured interview were
  - the personal opinions of the use of CAS on the upper secondary school level (3 questions)
  - reasons behind the nationwide political decision making concerning the use of CAS (1 question)
  - evaluation of the arguments for and against CAS (2 questions)

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QUESTIONS/THEMES TO BE ADDRESSED IN AN INTERVIEW

PERSONAL OPINIONS

1. What harmful consequences of the use of CAS in the teaching of the advanced (long) syllabus of mathematics at the upper secondary school could there be for the learning of the mathematics? What is your own opinion?

2. What benefit from the use of CAS in the teaching of the advanced (long) syllabus of mathematics at the upper secondary school could there be for the learning of the mathematics? What is your own opinion?

3. What practical obstacles might we encounter if we decide to take CAS in use in upper secondary school mathematics teaching?

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REASONS BEHIND THE NATIONWIDE POLITICAL DECISION MAKING CONCERNING THE USE OF CAS

4. What do you think to have been the most central arguments of the national level decision-makers, in your opinion, to the fact that one has NOT wanted to promote the use of CAS-use in the teaching of mathematics at the upper secondary school in Finland and to allow the use of CAS especially in the matriculation examination?

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EVALUATION OF THE ARGUMENTS FOR AND AGAINST CAS

5. What do you think, what kind of reasons or motives, do those who are supporting CAS-use at secondary school level have behind their CAS optimism?

6. What do you think, what kind of reasons or motives do those who are reacting negatively or incredulously against CAS-use at secondary school level have behind their repelling opinion?

Schematic illustration of the argumentation of interviewee 1

Interviewee 1 (continued)

Basic problems : Present tasks + increased use of CAS $\xrightarrow{?}$ How to ensure mathematical understanding $\xrightarrow{?}$ A call for ”a new didactics”

(1) The informant thrusts on the first premiss but doesn’t necessarily wish it to come true, and

(2) beliefs that the nature of the upper sec. math is tightly controlled (especially) by the math department of the University of Helsinki.

Schematic illustration of the argumentation of interviewee 2

Interviewee 2 (continued)

Basic problems :

New kind of tasks + increased use of CAS $\xrightarrow{?}$ The disagreement of conservative teachers and decision makers $\xrightarrow{?}$ The esteem of a procedural knowledge still continues

The interiewee 2 thrusts on the first premiss but doesn't believe that it would come true.

Interviewee 3

Either :

The present kind of curriculum holds: earlier goals, similar tasks → ? → The CAS is not needed. → ? → Finland chooses a separate direction than many other European countries.

or :

The new kind of curriculum: new goals, new kind of tasks, taking CAS in use

→ The complexity of problems need not be avoided. → Enables more realistic applications

→ The implemention causes problems: e.g. economical, equality questions, teacher education, time for learning to use CAS