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Project description of my Master Thesis in Mathematical Education

Title: **Teachers' role in developing mathematical skills with technology** - Introducing GeoGebra to mathematics teachers in lower secondary and the first year in secondary school in Norway.

Research topic: The Norwegian National Curriculum for Knowledge Promotion in Primary and Secondary Education and Training acquire five basic skills: To be able to

1. express oneself orally
2. express oneself in writing
3. read
4. do mathematics
5. use digital tools

In this study, I will primary focus on the fifth skill that states:

> *To be able to use digital tools* in the mathematics subject involves using these tools for games, exploration, visualisation and publication. It also involves learning how to use and assess digital aids for problem solving, simulation and modelling. It is important to find information, analyse, process and present data with appropriate aids, and to be critical of sources, analyses and results.

The expression *digital tools* is mentioned several times in the competence aims in the Norwegian curriculum. In this study I will focus on the competence aims concerning mathematical functions and digital tools after year 10 and after Vg1T and Vg1P.

After grade 10:
The principal aims for the education are that the pupil should be able to

- prepare, on paper and digitally, functions that describe numerical relationships and practical situations, interpret them and convert between various representations of functions, such as graphs, tables, formulas and text

After vg1T:
The principal aims for the education are that the pupil should be able to

- use digital aids to discuss and elaborate on polynomial functions, rational functions, exponential functions and power functions

After vg1P:
The principal aims for the education are that the pupil should be able to

- elaborate on the concept of linear growth, demonstrate the progress of such growth and use this in practical examples, including digitally

While reading the new Norwegian curriculum I found the expression "dynamic geometry". I started searching for suitable mathematical software to be able to integrate such a packages into my teaching, and found three suitable software, namely Cabri, GEONExT and GeoGebra. I preferred GeoGebra because it was easy to use and was an excellent tool for drawing and manipulate geometric figures. It was also very suitable for plotting graphs and analyzing functions. Because Norwegian translation was not available, I contacted the software creator Markus Hohenwarter,

translated the program to *bokmål* and *nynorsk* and introduced it to the Norwegian school system in 2006.

In the following years I have offered a number of courses and workshops presenting GeoGebra to Norwegian teachers at different grades/age levels. My impression is that the
teachers have found the program useful, relevant and user friendly. Overall I found that most teachers have not incorporated GeoGebra into their everyday teaching practice.

In this Master Thesis, I aim to investigate factors that may influence the teachers' decisions on whether or not to integrate technology into their practices.

I hope that my research will contribute to the understanding of "critical issues" for teachers when considering implementation of ICT in the classrooms.

There has been research on this area in other national contexts, but there are differences in the Norwegian settings that required closer examination. Nevertheless, I believe that my research will contribute not only to the Norwegian context, but also to international research.

Excel and GeoGebra are probably the most used mathematical software programs in lower secondary and secondary schools in Norway. Because of this, I will focus on the integration of GeoGebra and not the use of ICT in general.

Research questions:

1. To what extent and in what manner are GeoGebra used by teachers and students working in grade 10 and 11 classrooms?

2. Which factors, including mathematical and pedagogic beliefs and conceptions of Norwegian teachers at grade 10 and 11, do influence the integration of ICT in math lessons?

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Theoretical framework:

My main theoretical framework will be *the Process Analysis* as formulated by the great Social Anthropologist, Fredrik Barth, in *Models of social organization*. (Barth 1966)

I earned my master degree in Social Anthropology in 1982, at the University in Bergen, where Fredrik Barth was a professor for many years. He has not influenced French Anthropology as much as he has influenced the British and American anthropological trends. Mathematics education research, especially technology integration studies, is heavily influenced by French thinkers such as Chevallard. However, my study has a different theoretical approach, which

could contribute with a fresh perspective to research on ICT.

In her PhD thesis Benedicte Carlsen (Carlsen 2006) offers a short description of the basic ideas in Barth's model:

> **Theoretical framework for the study of medical decision-making. Reasons behind choice**
>
> Theories about how people make choices and why they act as they do form the basis of all social sciences. However, there are a number of analytical approaches to the study of social acts and structures, which are a source of never-ending debate and where opinions are divided between and within disciplines. Man can be seen as a rational actor maximizing individual utility, as a passive pawn in the social game responding to external rules and norms of conduct, but also as a social being aiming at the social good of important others and capable of acting altruistically. It has been argued that what distinguishes the social sciences from the natural sciences is the interest in man as an intentional being. Human acts are loaded with meaning as opposed to animal behaviour. Weber distinguishes between acts that are rational and goal-oriented, rational and value-oriented, acts motivated by affections and finally acts driven by tradition.

I will try to use a similar model on teachers' choices as rational value maximizers when considering implementation of digital skills.

Method:

According to the Process Analysis, I will look at both external and internal factors that might influence teachers' decisions on technology integration. Ruthven and Hennessy (Ruthven and Hennessy 2002) stressed the importance of getting the teachers' own words and considerations. Therefore, I will begin my study with semi-structured open-ended interviews to elicit teachers' own ideas of their integration of ICT.

Factors that might influence the teachers' considerations and choices regarding implementation of ICT in their math lessons.

Formal factors	Curriculum Exams Textbook
Practical factors	Access to computers Access to software
Inspirational factors	Presentation of the software
Internal factors	Mathematical skills Computer skills Pedagogical view Personality
Other factors	Students' expectations Colleagues' expectations Parents' expectation Administrations' expectations

Certainly these factors have influence on each other, but the main focus here

will be their possible influence on the teachers' considerations and choices.

The two research questions require a combination of quantitative and qualitative methods to triangulate the results. Research question number one may be investigated by collecting data from questionnaires sent to a large number of teachers across Norway. After collecting and analysing the data, the most emergent ideas will be further investigated by qualitative research techniques.

The quantitative part will include sending questionnaires with Likert items to (if possible) most of the teachers at the actual grade in Norway.

The qualitative part will include audio-taped interviews with four teachers at each school level. I may interview teachers who have participated in GeoGebra courses,- one from each grade/school level who has implemented GeoGebra and one from each grade who has not. Hopefully this combination of quantitative and qualitative methods will uncover important factors influencing teachers' decision-making.

Disposition: Here is a proposal for a disposition of my Master Thesis:

1. Research topic. Introduction.
   - 1.1 Mathematics subject
   - 1 2 School level
   - 1 3 Competence goals
   - 1 4 ICT-tools that will be used
2. Literature review
   - 2.1 The influence of technology on teaching practice
   - 2 2 Teachers' conceptions of mathematics teaching with technology
   - 2.3 Research on GeoGebra
   - 2.4 Norwegian research on the use of ICT in math lessons
3. Research questions
4. Software tool
5. Theoretical framework
6. Methodology and data collection
7. Presentation of data and analytical results
8. Discussion
9. References
10. Appendices

Progress plan:	Autumn 2008:	Select theme Read relevant literature Formulate research questions Decide theoretical framework and methods
	Spring 2009:	Read and summarize more relevant literature Design a questionnaire Finalize methodology
	Autumn 2009:	Data collection and analysis Doing interviews with four selected teachers Transcribing the four interviews Writing a sketch of point 1 – 5 in the progress plan
	Spring 2009:	Analyzing the whole material Writing comprehensive data analysis Writing the rest of the Master Thesis Sending the final product to the Exam office.

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