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► **To cite this version:**

Marianne Thomsen, Inge Marie Olsen. Original sources, ICT and mathemacy. Eleventh Congress of the European Society for Research in Mathematics Education, Utrecht University, Feb 2019, Utrecht, Netherlands. hal-02421925

**HAL Id: hal-02421925**

**<https://hal.science/hal-02421925>**

Submitted on 20 Dec 2019

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## Original sources, ICT and mathemacy

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*Keywords: ICT, original sources, hidden mathematics, mathemacy.*

The focus of our master's thesis in Mathematics Education was on how 4<sup>th</sup> grade students (10-11 years old) connect working with ICT and reading original mathematical sources in ways that support the development of a competency, *mathemacy*, "which may help students to reinterpret their reality and to pursue a different reality" (Skovsmose & Nielsen, 1996, p. 1263). Our study indicated that ICT and original sources complement each other in terms of the students' learning activities. The students' experimental activities in ICT supported their understanding of the original source. Their work with the original source supported a development of a mathematical consciousness and sharpened their awareness of hidden mathematics (Jankvist & Toldbod, 2007) and black box situations (Buchberger, 2002), which means that the students didn't just accept the results of a computer – they also questioned the mathematics behind when using ICT. Furthermore, the students' awareness of differences between working with contemporary ICT and original sources seemed to increase a balanced and critical stance towards mathematics as a universally given thing – making them see both mathematics and ICT as something that develops and changes over time.

Our research design was inspired by Skovsmose's (2006) description of critical research based on three situations: The *current*, the *imagined* and the *arranged*, as well as three processes: *Pedagogical imagination*, *pedagogical experimentation* and *explorative analysis*. The three situations and processes were used in our planning, implementation and analysis of the 3 x 90 minutes teaching session we conducted. The students were asked to carry out a final individual evaluation. We performed three types of data collection: 1) Focus group interviews prior to the first teaching session, 2) Teaching session observations, and 3) students' products from each teaching session. Data category 2 and 3 we regarded as pedagogical experimentation data helping us describe the current situation. We used this situation and our pedagogical imagination to prepare the next imagined situation. Based on the collected data we performed an explorative analysis and planned the next arranged situation and so on. The first current situation was based on data type 1. In our planning and analyses of the learning activities we were among other inspired by Jankvist's (2009) framework concerning the use of history in mathematical education as a goal (meta-issues) or as a tool (in-issues). Our study focused on history both as a goal *and* as a tool. We extended Jankvist's categorization also to deal with the students' work with ICT. The mathematical content was kept relatively simple letting the students work with only Euclid's Proposition 1, book I, *To construct an equilateral triangle on a given finite straight line* and equilateral triangles in *GeoGebra*. For the meta-issues we focused especially on hidden mathematics in software (Jankvist & Toldbod, 2007) and the fact that mathematics develops over time (Jankvist, 2009). Inspired by Jankvist and Kjeldsen (2011) and Kjeldsen and Blomhøj (2012), we used Sfard's (2008) theory of discourse and commognitive conflicts. We considered Euclid's proposition 1, book I, and *GeoGebra* as two

different discourses. Within these two discourses we saw meta-issues and in-issues as two different discourses. During the teaching sessions, we made a common ‘discourse-poster’ on which we gathered the students’ statements they agreed to during the classroom discussions. The students worked with the construction part and the proof part in relation to Euclid’s Proposition 1, book I, and equilateral triangles in *GeoGebra*. This gave rise to common discussions about the difference between proof; in terms of Euclid’s proposition and in terms of working with *GeoGebra*. One student for example compared Euclid’s proof to a game; he found one circle, then the next and so on. The students were asked to construct as many equilateral triangles as possible in *GeoGebra* and formulate their own proofs for these. The outcome of this assignment was what they called three different types of ‘proofs’ for equilateral triangles: *Measuring, the computer outcome as a proof in itself and the Euclidian way*. There were different opinions among the students about which type of ‘proof’ they found most credible, which we regarded as an in-issue discussion; understandings of different kinds of proofs within the two discourses were to some extent generating commognitive conflicts. Furthermore, the students discussed whether the computer always tells the truth and if mathematic will change in the future as well – a meta-issue discussion based on their experiences by working within the two different discourses. In addition to this, we arranged special learning activities, which focused on the meta-issues, for example asking students to write and discuss pros and cons of using Euclid’s proposition and the use of *GeoGebra* in mathematical education. Several students found that working with both Euclid’s proposition and *GeoGebra* was a good idea and had increased their learning. The students became aware of that computer outcome may contain a lot of hidden mathematics. Hopefully, this will support their reflexive use of ICT and also later in life qualify their critical stance towards the outcome of mathematical modelling.

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