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DATA MODELLING WITH YOUNG LEARNERS AS EXPERIENCES OF ALLGEMEINGBILDUNG

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This paper indicates how young learners can make experiences of Allgemeinbildung through data modelling. A teaching experiment was conducted in a Danish 3rd grade (aged 9-10) where students performed all parts of the data modelling process. Video recordings were made and afterwards transcribed. This is a presentation of empirical data, which shows examples of essential statistical reasoning. It includes posing questions relevant for data modelling, reasoning about how to structure data and reasoning about how the data modelling shed new light on the chosen topic. It is discussed how students' experiences can be a potential for Allgemeinbildung.

INTRODUCING THE AIM

The aim of this paper is to show an empirical example of how young learners can make experiences with potentials for *Allgemeinbildung* when reasoning about data through data modelling. Data modelling is a process, where mathematical and statistical concepts are used to investigate real-world phenomena by posing questions to a context, generating, selecting and measuring attributes, organizing, structuring, measuring data and draw conclusions and making inferences (Lehrer & English 2018). A democratic society needs enlightened and empowered citizens. Hence, it is an aim for general education (including mathematics education) to contribute to students' *Allgemeinbildung*. The emphasis is that mathematics education must prepare students not only to further mathematics education, but also to live life in general (Niss 2000). Mathematics education should, according to Winter (1995), contribute to students' *Allgemeinbildung* by giving students certain basis experiences. Mathematical modelling comprises potentials in order to contribute to *Allgemeinbildung* (Biehler 2019; Winter 1995), but students have to experience it as a creative and interactive process (Biehler 2019). According to Niss (2010), movements between the extra-mathematical and the mathematical domains are very demanding for students. The question is, however, how young learners can overcome the challenges in order to have modelling experiences, which can contribute to *Allgemeinbildung*. This paper therefore examines the research question: How can specific emphasis on movements from context to data in the data modelling process create potentials for experiences of *Allgemeinbildung* for young learners?

DATA MODELING WITH YOUNG LEARNERS

According to English and Watson (2018, p. 104), data modelling is "... a process of inquiry involving comprehensive statistical reasoning that draws upon mathematical and statistical concepts, contexts, and questions." On the basis of Lehrer & Schauble (2000), English (2010) defines data modelling with young learners as "... a developmental process that begin with young children's inquiries and

investigations of meaningful phenomena, progressing to deciding what is worthy of attention ... and then moving towards organizing, structuring, visualizing, and representing data...” (p. 27). Building on the model in figure 1, Lehrer and English (2018) pose that data modelling with young learners comprises:

“... (a) posing statistical questions within meaningful contexts that highlight variability; (b) generating, selecting, and measuring attributes that vary in light of the questions posed; (c) collecting firsthand data so that children encounter decisions about the design of investigations; (d) representing, structuring, and interpreting sample and sampling variability; and (e) making informal inferences in light of all these processes.” (Lehrer & English 2018, p. 235)

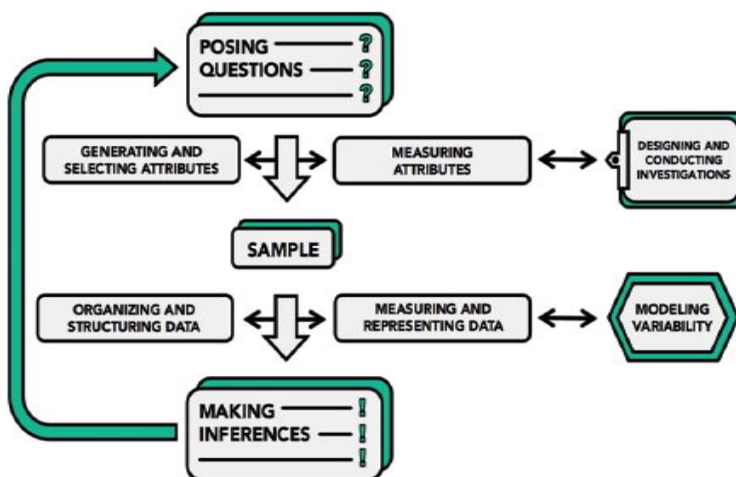


Figure 1: Data modelling (Lehrer & English 2018, p. 232)

MATHEMATICS EDUCATION AND ALLGEMEINBILDUNG

For mathematics education to contribute to students’ *Allgemeinbildung*, the teaching should offer three so-called basis experiences (Winter 1995). Data modelling and statistical reasoning are interweaving the real world with mathematical and statistical concepts. Therefore, Winter’s first basis experience is relevant in the light of data modelling. It comprises “to perceive and understand the phenomena of the world around us in nature, society and culture in a specific way...” (Winter 1995 translated in Biehler 2019, p. 153). In his analysis of Winter’s concept of *Allgemeinbildung*, Biehler emphasizes that the utility of mathematics is only interesting and necessary for education, if students experience mathematical modelling as a creative and interactive process (Biehler 2019).

TASK DESIGN AND METHOD

The teaching experiment was conducted in a Danish 3rd grade class (age 9-10). The lesson plan was organized as 4 sessions (90 minutes pr. session), which framed the students’ participation in a whole data modeling process. In the principles for designing the teaching experiment, I have emphasized that students should experience the modelling process as a creative and interactive process, and that they should get the possibility to perceive the world around them through their own statistical reasoning. Besides that, the design comprises students’ reasoning about which type of questions they can investigate through data modelling. This has the aim to enable students to cope with the demanding process of moving from context to data. In the first session, the students should generate ideas for questions that could be investigated with the use of statistics. The second session was about planning an investigation in small groups. In the third session students should collect, structure, visualize and represent their data. In the fourth session, the students analysed an interpreted data. They also planned a presentation of their investigations for the rest of the class. Group discussions, classroom discussions and the students’ presentations were video recorded and transcribed in order to be able to document their statistical reasoning.

STUDENTS' WAY THROUGH THE DATA MODELLING PROCESS

Here follows a discussion between the researcher and the group, in which the researcher tried to support the students in posing a question. This particular group of students experienced huge difficulties during the process compared to some of the other groups.

- 1 S1: I think it is important, that we are all being well.
- 2 S2: We already wrote that.
- 3 R: How can you investigate that with statistics?
- 4 S2: By asking others, if they are doing well.

After some time, the students came up with the subject *How often do parents argue?* (see fig. 2) The next excerpt shows that it is challenging to design the investigation and to structure data.

- 5 R: If you choose the one with parents who
- 6 argue, then you could... There must be some
- 7 who never argue, and then there must be
- 8 some who argue almost every day?
- 9 S1: Then there are some who argue sometimes.
- 10 S3: I think it is sometimes for me, like 3-4 times
- 11 a week.

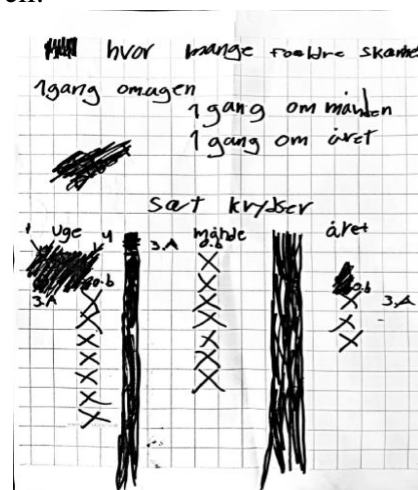


Figure 2 : *How often do your parents argue?* The data is structured as *weekly, monthly, and yearly* in three columns

After the presentation, the students were asked if they would have adjusted their investigation if they should repeat it:

- 12 S3: Yes, this is not very precise. You don't know if this cross (points a cross in the
- 13 category 'weekly') is one day or more days.

The final excerpt is from the last classroom discussion. Before this, the students had drawn conclusions about clusters in their data, but due to their reflections about the design, they were not satisfied with their ability to make a statement. They also reflected about the sample size, which they found too small. Still, they were able to reason about the question: *Who could use the results from the investigation?*

- 14 S2: Other children. So they could see that it is not only themselves who have parents
- 15 that argue a lot.
- 16 S4: I think that parents could use it. Then they could see how much the children
- 17 think they were arguing.

YOUNG LEARNERS REASONING THROUGH DATA MODELLING

The first excerpt is about posing questions. In line 1, student 1 put forward the purpose of the investigation instead of posing a question. Despite this, they had an idea of how to collect data: "By asking others...". Their problem was that they did not pose a question, which could be quantified. This shows how difficult it can be to move from a meaningful context to data for young learners. In lines 5-11, the students came up with a question that could be quantified. They then moved to the next part of the modelling process generating, selecting and measuring attributes. The teacher started this

reasoning process. In line 9, student 1 continued reasoning about how to quantify parents arguing. In lines 10-11, student 3 shared his own experience with the topic. Knowledge about the context that affected the design the investigation (see fig. 2). This shows how the modeling process is an interplay between knowledge about the context and ideas of quantification. In lines 12-13, student 3 reasoned about the loss of specific knowledge of the individual data points when grouping data. This was a reflection on structuring and representing data. The process make informal inference was poorly represented in the dialogue, but the students reflected this back to the design of their investigation with regard to the structure of data and the sample size. However, the students were able to reason about the relevance of their investigation for themselves and for others. In lines 14-15, student 2 explained that children, who witness parents arguing, could find this relevant. In lines 16-17, student 4 explained that parents could be enlightened with new knowledge about how often children experience them arguing. The last excerpt also showed students gaining new insight to a phenomenon in the world around them through data modelling. This resonates with Winter's first basis experience.

DATA MODELLING WITH YOUNG LEARNES AND ALLGEMEINBILDUNG

The openness of the task was demanding for the students, and it could have been more manageable if the teacher had pre-phrased the initial question. Nevertheless, because of the specific emphasis on involving students own lifeworld and experience in the data modelling process, it comprised both relevant statistical reasoning and gave rise to new understanding about a phenomenon in the world around them. An experience, which could be characterized as a basis experience in Winter's terminology and therefore a potential for *Allgemeinbildung*. The students succeeded through dialogue to pose a quantifiable question. Of course, the grouping of data, to some extent blurred some of the information that they found relevant. Afterwards they reasoned about structuring the investigation in different ways. Because they found a topic from their own lifeworld, they could use the knowledge about the context to design and revise the design of the investigation. The closing discussion exposed a purpose of statistical investigations more insightful than the purpose they stated at first.

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