

# Lower secondary school students construct graphs in physics

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**Abstract.** Constructing graphs is fundamental in physics not only in the context of scientific communication but also within the process of gaining knowledge. Therefore, students should be able to construct graphs which originate from different kinds of representations. To develop this competency in physics class of lower secondary school it is necessary to know the students' way of thinking and their difficulties during this process. This is investigated by means of an explorative, qualitative laboratory study in which the students worked on physical-mathematical tasks that requested to construct graphs starting from a table, a formula or a verbal description.

## 1 Constructing graphs in physics

Students have to construct graphs in different situations during their physics class. For instance, they construct graphs for the analysis and interpretation of data received within an experiment or during solving tasks or problems. Usually the construction of a graph is part of a change between representations. This means, the information given in a source representation, e.g. table, formula, verbalization (or even another graph), is then represented in a graph. During this transfer different activities can occur as part of an algorithmic stepwise realization, as part of a more efficient way using key characteristics or within a retrospective process of verifying. Furthermore, the rationales of the students' activities could be without any connection to physics (technical aspect) or comprise a symbiotic relation between mathematical and physical thoughts (structural aspect). [1] Although constructing graphs is an essential part in physics class physics education research has not focused on lower secondary school students so far. Moreover, only a few number of studies refer to constructing graphs [2-5]. Furthermore, research shows that students struggle a lot with constructing graphs. For instance, even university students rely on rote procedures and rules of thumb rather than considering the underlying physics [3].

## 2 Research objectives

As constructing graphs is a fundamental method in physics students should start to develop this competency already in physics class of lower secondary school. In order to be able to develop appropriate teaching contents, methods and materials it is important to know the students' strategies, their way of thinking and their difficulties concerning this topic. For this reason, our research explores the peculiarities of constructing graphs in the context of physics from the students' perspective. This contribution focuses on: How do students of lower secondary school construct graphs starting from different representations embedded in physical-mathematical tasks? Which activities and rationales do they follow? Which difficulties occur?

## 3 Research design and methods

Following an explorative approach, the investigation of students constructing graphs was carried out by means of three physical-mathematical tasks. These contained either a table, a formula or a verbal description as a source representation and requested to construct a corresponding graph. To examine the students' lines of thought a discussion between two students was conducted in which the test persons explained their ideas to each other while writing on an interactive whiteboard. Afterwards an interview helped to clarify inconsistencies and difficulties that had

been observed. 17 pairs of students participated in the study. The recorded discussions and writings of the students were analyzed according to the method of qualitative content analysis.

## 4 Results

The analysis of the data shows that the observed students do not only follow step-by-step actions during the construction of a graph but work with key characteristics as well (e.g. the kind of dependency). Occasionally some of them even check several parts of their work. The results for one of the tasks are presented in Fig. 1 and will be compared to the other two tasks in the talk.

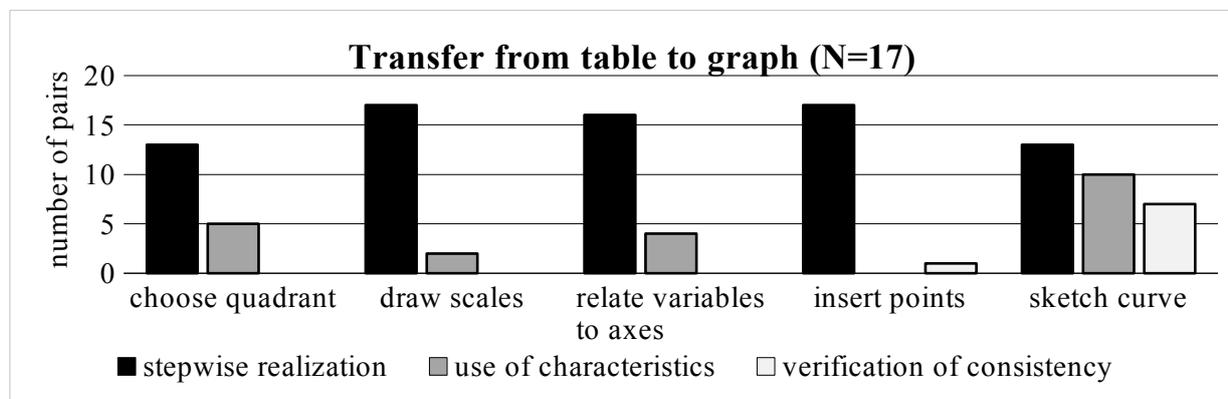


Fig. 1 Kind of activities according to [1] during constructing a graph starting with a table. Sometimes one pair of students followed several kinds of activities within one step.

The students reason not only with the help of mathematics but also try to connect mathematical and physical criteria and relations. So far, the data show no differences comparing the source representations table, formula and verbal description. Within every step of graph construction difficulties were observed. In many cases the students followed (wrongly) memorized rules or referred to superficial criteria. When they considered rationales connected to physics it occurred that they made wrong assumptions (e.g. linear relationship) and got to a wrong solution. Examples will be presented in the talk.

## 5 Conclusions and implications

This study gives first insights into how students construct graphs in physics starting from different representations. The data point out a variety of the students' strategies and rationales. Students' difficulties show that the construction of a graph is complex. For teachers it is important to know how students can proceed constructing a graph and where their difficulties arise from.

## References

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