Student ownership of physics learning

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The theoretical framework student ownership of learning (SOL) was developed both theoretically related to self-determination theory (SDT) and with qualitative research from physics teaching. In the talk, I will give examples and case studies from physics teaching to show how SOL can help for better motivation and learning. These examples are taken from upper secondary and university level. The role of SOL in some teaching strategies will be analysed.

Introduction

The theoretical framework *student ownership of learning (SOL)* was developed both theoretically and with qualitative research. The metaphor ownership is related to the process towards meaning making and understanding and is seen as relevant especially to improve physics instruction. The dimension *group ownership of learning* refers to the groups' actions of choice and control of the management of the task; how the task is determined, performed and finally reported. The other dimension, the *individual student ownership of learning*, refers to an individual student's own question/idea that comes from own experiences, interests or anomalies of understanding; an idea/question that comes back several times during learning activities and leads to new insights. As a consequence, we argue for use of the framework *student ownership of learning* as a way to identify an optimal level of ownership for better learning and higher motivation in physics teaching.

One example[1]

The example comes from group work with acceleration in grade 11 (age 17). After some traditional teaching, especially on acceleration and how to measure it, the students got the following task:

What causes acceleration? a = f(???). Design your own experiment to find out!

Students were first asked to write down their first ideas and expectations, then to look for equipment in the lab to do their experiment. During the next lesson they did their experiments and finally wrote a report.

Here are some of the specific questions and aims that the groups developed:

- How does acceleration of a small car on an inclined plane depend on its weight?
- How does acceleration of a model locomotive depend on the inclination of the tracks?
- How does the acceleration of a body depend on air resistance?
- How does acceleration depend on the surface condition of a road? (For this purpose different sorts of sand were put on the track).
- How does acceleration depend on the height of a car on an inclined plane?

In this example, I want to focus on the third question and the group work done with it: "How does the acceleration of a body depend on air resistance?" Students fastened a sail to a small car. This car was set into motion and then braked by an electric hairdryer. Measurement was taken

1 More examples will be given during the talk

how acceleration depends on the power of the hairdryer and on its distance. Students developed ownership to their work in the following way: First, the whole question was their *own idea*. Second, they brought *their own heir dryer from home*. Third, the detailed design of what and how to measure *was developed by themselves*; the teacher tried to help them but carefully made sure not to change their own ideas.

From a strictly physical view their results were not very good; they mainly found a proportional relation between their negative acceleration and the position of the hair dryer switch (1, 2 or 3). But from a motivational view it was incredibale: These students (three girls) had the lowest grades in the class, and in spite of that had fun with doing an experiment in physics. – One of the three students two years later by chance met the teacher while working in his garden. She spontaneously talked about her experience with this experiment and how nice it was.

Theoretical background

The theoretical background for the study is based on earlier studies on ownership of learning within a constructivist perspective (Milner-Bolotin, 2001; Savery, 1996). Milner-Bolotin defined ownership in physics education in a problembased learning environment with small-group work, as the intersection between taking responsibility, finding a personal value and feeling in control; she measured the individual status of ownership with a questionnaire. Studies using ownership as a theoretical framework can be found in research in different areas such as language learning, teacher education, science education in urban settings and in instructional systems technology. Only more recently, this concept was applied to science education; in physics education at university level it was used by Milner-Bolotin (2001), Enghag (2006) and Enghag & Niedderer (2008). Other researchers think in the same direction, and find a need for increased student autonomy: "Further support to this is lent by our work (Osborne & Collins, 2000) that found pupils desired more opportunities in science for practical work, extended investigations and opportunities for discussion - all of which provide an enhanced role for personal autonomy (Osborne, 2003, p. 1074). Motivation, performance and development will be maximized within social contexts that provide people with the opportunity to satisfy their basic psychological needs for competence, relatedness, and autonomy (Ryan & Deci, 2000, p. 57).
Ownership is mainly defined by actions of choice and control taken by the students during group work. This is called student ownership of learning (SOL). Some of these actions are obviously more related to the group, e.g. to determine the common understanding of the task, to decide on how to organise the work or how to organise the presentation. Others are more related to one individual student, e.g. to have a special question or idea. So it seems natural to define student ownership of learning in two dimensions: as group ownership of learning (SOL-g) and as individual student ownership of learning (SOL-i).

Relation to student-oriented teaching strategies

In an instructional setting that includes small-group work, the success of the lesson is connected to the choice of the task. Who decides the task, its level of difficulty and if it is open-ended or has a specific answer? Can students influence the mathematical level of the task, or the connection towards everyday life and real world problems? How are plans and performance executed and what responsibilities have the students to make progress, and how is the final product assessed? Does the group take these kinds of actions to make choices and get control? We refer to these issues as to the group ownership of learning (SOL-g).
Some choices are not taken by the whole group; they are taken by single individuals in the group. We found that individual student ownership of learning (SOL-i) means that a single stu-

dent asks a unique question that initiates a learning process, recurs and develops and finally gives some new insights to the student. For us, the opportunity to choose a task, as in this study with a miniproject, does not necessarily mean that students invent a task themselves, instead, is it more likely that the teacher proposes open-ended tasks including driving questions that trigger and draw out student-generated questions, which then become the basis of individual student ownership of learning (SOL-i), see the example above.

In student-oriented teaching in front of the whole class it sometimes happens that in a certain moment many students come up with different ideas. This would be an excellent possibility to let them work in groups on their own ideas, thus letting them develop ownership and motivation.

A case study: Mattias' individual ownership of learning (SOL-i)

Mattias starts group work with a mini project from a special experience by his son:

Mattias: *I was thinking on this... and than I found something I did not understand. Well, the transformer.... it started with my son, he got hurt because of a torn transformer.*.

Then the group makes a choice out of a list of possible mini projects given by the teacher. They decide to work on how an electric transformer can be explained. This choice is influenced by Mattias. During the group work he comes back to his initial experience and develops ownership by reformulating his original question:

Mattias: *There have to be losses somewhere.*

And later:

Mattias: *Yes, but my point was to show that there are energy losses even when the lamp is off...*

In his part of the final report, he focuses also on the same aspect:

Mattias: … *Then we go to the reflections of the group. Does the transformer change voltage and current without losses? Theory said it should. ... In the practical experiments we have seen that this is not the whole truth. There are losses somewhere. These were also some of my thoughts, when I had found at home, in the beginning, that transformers get warm. I took this instrument home with me (shows the instrument to the class) to measure the power in Watts. ...*

So he came several times back to his first own idea, and he has adapted it to the new knowledge they got; he thus has developed ownership.

References

Enghag, M. (2006). *Two dimensions of Student Ownership of Learning during Small-Group Work with Miniprojects and Context Rich Problems in Physics*. Doctoral thesis, Maelardalens University, Sweden. http://www.mdh.se/ima/personal/meg03/Thesis/urn_nbn_se_mdh_diva-169-2__fulltext.pdf

Enghag, M., Niedderer, H. (2008): Two Dimensions of Student Ownership of Learning During Small-Group Work in Physics. In: *International Journal of Science and Mathematics Education* 6 (4), 629-653 http://www.idn.uni-bremen.de/publikationen_eng.php?&SearchName1=27

Milner-Bolotin, M. (2001). *The effects of topic choice in project-based instruction on undergraduate physical science students interest, ownership, and motivation*. PhD Thesis, Austin TX.

Osborne, J. (2003). Attitudes towards science: a review of the literature and its implications. *Int J Sci Educ* 25(9), 1049-1079.

Ryan, M.R. & Deci, E.L. (2000). Intrinsic and extrinsic motivations: classic definitions and new directions. Contemp Educ Psychol 25, 54-67.

Savery, J.R. (1996). *Fostering student ownership for learning*. Bloomington IN: PhD Thesis, Indiana University.