Student ownership of physics learning

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Part 1

Introduction

Two rootes

This talk has two rootes

- My own teaching of physics
  in lower and upper secodary school and university
- The doctoral dissertation of Margareta Enghag (2007)

  Two dimensions of Student Ownership of Learning during Small-Group Work with Miniprojects and Context Rich Problems in Physics

  Can be downloaded from
  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. International Journal of Science and Mathematics Education 6(4), 629-653*

See http://www.idn.uni-bremen.de/pubs/Niedderer/2007-EngNi-IJSME.pdf

General ideas

- The most important issue nowadays is to motivate children/learners to work with physics
  - New relevant themes
  - Teaching with student ownership of learning – one important aspect of teaching for motivation

Student ownership of learning (SOL)

A first definition

Students/pupils develop ownership

by

- **creating own questions / own ideas**
- **and being fostered to work with them**

Levels of student activity during learning

1. **Actively engage students in their learning** (Dean Zollman)
2. **Interactive engagement** (Hake, Thornton, …)
3. **Teaching with students' ownership of learning (SOL)**

"hands-on" ➔ "minds-on" ➔ ownership

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Part 2

Examples of ownership from group work

Grade 11 (Germany)

Grade 5 (Finnland, Greece)

Example 1: Overview group work in mechanics

- **Teaching situation: physics grade 11, a class of 27 students**
  - Group work with open question a = f (???)
- **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 track?
  - 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?

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Example 1: Acceleration and force - one group

- **Teaching situation**
  - Group work with open question a = f(???)
  - A group of three girls; not the best students in class
- **Development of ownership - own question/idea**
  - How does acceleration of a car depend on wind-force?
  - Idea to make wind with a hairdryer – they brought their own hairdryer from home
  - Take a model car from the lab with a sail on it
  - Investigate how the (negative) acceleration is depending on the position of the hairdryer step switch – their own question

Example 1: Acceleration and force - one group

- **Results**
  - Students are very proud of their results
  - From a physics point of view the results are not that exciting
  - **But**: They are applying the sulphur method to measure acceleration by themselves

Motivation?

Definition of motivation

Dornyei (2000): three aspects of motivational behaviour, as **indicators for behaviour that shows motivation**:

- The **choice** of a particular action
- The **persistence** with it
- The **effort** expended on it

Example 1: Acceleration and force – one group

About motivation

- These students (three girls) had the lowest grades in the class, and in spite of that had fun with doing an experiment in physics
- They showed
  choices: They decided to use the cart as a model …
  persistence: Problems setting up the experiment …
  efforts: Bring their own hairdryer from home …
- 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 “cool” it was.

What are the conditions for developing ownership in this case?

- The students had to develop an own question!
- They had to write down their ideas before starting to work
- They got time and support to do the work
- The teacher was very careful not to give too much support or to change their own question

What is ownership in this case?

- They developed their own question and worked on it for 2 h
- with their own results

- **What are the effects of ownership?**
  - Motivation
  - Deeper understanding

Example 2

- from **EU-project "Materials Science"**
- ***University-school partnerships for the design and implementationof research-based ICT-enhanced modules on Material Properties.***
  Proj-coordinator: **Dr. Costas P. Constantinou**

Project Partners

CY	University of Cyprus
IT	University "Federico II" of Naples
GR	Aristotle University of Thessaloniki
FI	University of Helsinki
ES	University Autonoma of Barcelona
GR	University of Western Macedonia at Florina

Example 2: Sinking and floating done by Finnish pupils in Helsinki

Greek unit implemented in Helsinki. Grade 5
Students show their own solution salvaging a sunken ship
Ownership
They have **developed their own idea**: to fasten lighter bodies with strings to the ship under water
Motivation
They are eager to show their own solution to the class

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Example 2: Sinking and floating done by Greek pupils in Florina

Example 2: Sinking and floating

- **What are the conditions for developing ownership in this case?**
  - **The students got a nice task: to salvage a sunken ship**
  - **They got time and support to do the work**
  - **The teacher was very careful not to give too much support or to change their own solution**

Example 2: Sinking and floating

- **What is ownership in this case?**
  - They developed their own idea and worked on it for 10 m
  - with their own results
- **What are the effects of ownership?**
  - Motivation
  - Deeper understanding

Part 3

Theoretical background:
Ownership and motivation

Earlier studies on ownership

- Studies using **ownership as a theoretical framework** can be found in research in different areas such as
  - **language learning** (Dudley-Marling & Searle, 1995)
  - **environmental issues** (Kentish 1995)
  - **instructional systems technology** (Savery, 1996)
  - **Science education** (Milner-Bolotin 2001)

Motivation and ownership I (SDT, Deci & Ryan)

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).

Definition of ownership

Enghag 2007:

- Actions of choice and control, such as
  - own questions
  - own ideas
  - own procedures
  - own results

Millner-Bolotin 2001:

- Topic choice, taking responsibility, finding a personal value and feeling in control

To develop ownership during group work

Ownership must be developed

– it can not simply be ”given”

Indicators for ownership (Enghag 2007)

- **The question/idea comes up again and again (very important to detect ownership)**
- **special actions made on account of the question/idea**
- **other students views are considered and evaluated against the own question/idea**

Definition of motivation

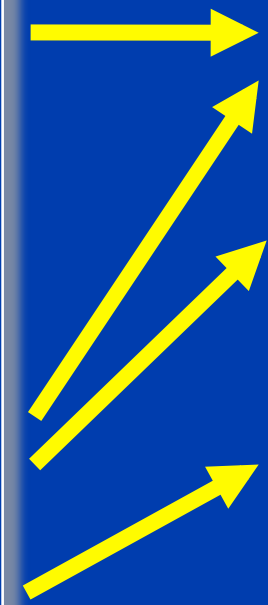
Dornyei (2000): three aspects of motivational behaviour, as **indicators for behaviour that shows motivation**:

- The **choice** of a particular action
- The **persistence** with it
- The **effort** expended on it

Ownership and motivation II

Ownership

- Actions of choice and control, such as
  - own questions, ideas, results
- The question/idea comes up again and again
- special actions made on account of the question/idea



Motivation

- The choice of a particular action
- The persistence with it
- The effort expended on it

Effects caused by ownership

- **Better motivation**
  - **ownership → autonomy → motivation (SDT)**
  - **ownership → coming back to the same idea/ question → persistence of action → motivation**
- **Deeper understanding**
  Better relation to students' prior knowledge

Part 4

Ownership and teaching

Ownership in class teaching

Class work – for obvious reasons ownership is only possible for few students

- A student has an own idea for an explanation or a hypothesis and the teacher pays attention

Examples for good conditions during class work

- Let students develop their **own predictions before** an experiment is shown in front of the class, let them write down in single or group work
- Let students develop their **own explanations after** an experiment was shown in front of the class, let them write down in single or group work

Ownership in group work

- A student has an own idea/question and has possibilities to follow it
- A student has a special interpretation of the task given and has possibilities to follow it

Good conditions during group work

- Put rather open questions or tasks
- Let students develop their own specified subquestions according to the general task; as a teacher be tolerant to let them work on their own modified question/idea

Bad conditions during group work

- Very specific lab guide for doing an experiment (like a recipe)

Part 5

Examples of ownership

from mini projects at university physics

Germany and Sweden

Mini projects

Definition of “mini-project"

- Labwork 2 to 3 times 3 hours
  (at the end of a semester course, e.g. mechanics)
- One or more experiments with a **self-developed question/idea** with contents related to the current course
- **with or without connection to everyday world**
- Doing the project, a report and a presentation is **compulsory**

Planning a mini-project – schedule (Germany)

At the end of several courses in physics at the University of Bremen

- 4 weeks ahead: First discussion of possible project themes; hand-out of application forms
- 2 weeks ahead: Handing-in the application forms
- 1 week ahead: Consultation with groups of students about their plans in the lab
- 2 lab sessions, 3h each, working on the mini-project
- 1 week after
  Presentations of mini-ptojects instead of 2 lectures

Planning sheet for a mini-project (Germany)

Group members:

1. _____

2. _____

Topic and questions of the planned experiments:

_____

_____

Apparatus needed:

_____

_____

Themes of mini-projects (Germany mechanics 1997)

- Investigation of Doppler effect with sound waves (Measurement and frequency analysis with computer)
- The “flummy“ (bouncing ball): conservation of momentum and heat energy (Staircase with 4 levels in the physics building)
- Conservation of energy with a rolling ball
- Measuring the density of liquids by the buoyency force
- Influence of centrifugal force with a precession movement of a gyro (spinning top)
- Chaotic oscillations of a Pohl’s wheel with an additional mass
- Energy conservation, centripetal force and friction of a ball running on a toy track with a loop
- … and many more!

Mini-projects – some evaluation (Germany)

The assessment (HN) was done with different criteria (creativity, theory and measurement, discussion of errors) in 3 categories:

- ++ (11 presentations)
- + (4 presentations)
- ± (3 presentations)

From a questionnaire about the whole course, we could see that the mini-project was very well received (13/19)

Example 4 (Sweden): The transformer

- … from the doctoral dissertation of Margareta Enghag
- She has analysed 8 groups with 27 students
- With respect to both

  individual ownership of learning (SOL-i)

and

  group ownership of learning (SOL-g)

Example 4 (Sweden): The transformer

- **Teaching situation**
  - University level electrodynamics
  - Group work for 2 times 3 hours + home work with mini-projects; students have a choice of several themes: they choose the electric transformer
- **Own question/idea of one student Mattias**
  - Why/how does a transformer heat up?
    Later developed to the question of energy losses

Example 4 (Sweden): The transformer

- **Development of own question/idea**
  - Idea to buy and use a commercial energy meter
  - Whereas other group members have other focuses about the transformer Mattias focuses on energy losses
- **Results**
  - From a physics point of view the results are good

Example 4 (Sweden): The transformer

- **Motivation (choice, persistence, effort)**
  - Mattias takes the instrument home with him
  - ”In the transcript from the presentation, 24 of 33 statements of Mattias are marked as refiguration of both raters, by itself a sign of how committed Mattias has been to find a solution to his own question.” (Enghag & Niedderer 2008)

Mattias in his final presentation

”Then we go to the reflections of the group. Does the transformer change voltage and current without losses?

Theory said it should. (Points at Markus formula on the white-board.)

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.”

Part 6

Visions

Visions for school

- **Syllabus teaching : Project teaching = 50:50**

  Equal teaching time for
  teaching of basic concept (according to syllabus)
  AND
  project learning with individual and social relevance

Visions for better motivation in science teaching

- Relevant new **content** related to actual problems of individuum and society
- Group work with **ownership of learning**

Teaching for ownership

- Teachers
  - … who help their students to develop self confidence “we can do, yes we can”
  - … who trust their students
  - … who do not judge in the first hand right or wrong
  - … who respect and acknowledge the own ideas of students

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