Chemistry Education – Individual Learning Paths and The Flipped Classroom Pedagogy

Viikki Teacher Training School of University of Helsinki

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Abstract

- We have been identified students’ falling interest and performance in STEM education world wide. Despite the extensive calls for the uptake of learner-centered forms of pedagogy focused on inquiry and problem-solving, changing teaching practices is proving difficult. Research literature indicates a disconnection between calls for reform and actual classroom practice and suggests persistence of traditional, teacher-centered approaches. STEM education needs new perspectives, we have studied inquire based science education, science practices -approaches, experimental work-oriented chemistry learning, but without markable results.
- Our research is a case study of improving chemistry education using individual learning paths and a new kind of implementation of flipped classroom. The flipped classroom and flipped learning pedagogy seems to give new possibilities for both teachers and students arrange studying and teaching. The flipped classroom is more than just changing f2f-lectures to pre-lecture videos and homeworks to classroom activities.
- This study introduces more detailed classroom arrangements and ideas for supporting individual learning paths, simultaneously utilizing working in groups. This study is a self-study is intentional and systematic inquiry into our own practice, how to work collaboratively to understand problems of practice more deeply.
- The story of our own experience is one piece to build a broader case. The purpose of self-study is to promote reflective teaching. This case gives more dimensions from and for the experiences of teacher educators and researchers, who have reported results of studying their own practice of the flipped learning.
- Students are quite strongly conservative attitude against new pedagogical practices, but letting students defining their own goals, arranging learning opportunities following jointly agreed studying program, situation changes. For teachers it is a question about develop her or his own teaching. The teachers’ identity needs renewals and the strongest and most successful way is go back to the basics and start her or his own research about better teaching and learning.
Viikki Teacher Training School in a nutshell

- 150 years old
- 950 students (7-19 years old)
- 90 teachers/ teacher trainers + 25 other staff
- 350 student teachers annually (primary and subject student teachers)
- 1-6 international visitors/ visitor groups weekly (annually from ca. 25 different countries from all over the world)
- Several projects (especially ICT-oriented)
Finnish education and teacher education – ”principals”

<table>
<thead>
<tr>
<th>more ...</th>
<th>less ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>professionalism</td>
<td>bureaucracy</td>
</tr>
<tr>
<td>clear, shared and long term vision based on research outcomes and brainstorming</td>
<td>ad hoc ideas coming from the politicians</td>
</tr>
<tr>
<td>decentralization, decision making, assessment and quality culture at the local level</td>
<td>standardization, inspection, testing and heavy quality control</td>
</tr>
<tr>
<td>trust based responsibility (self-evaluations, listening of students and municipality people / parents voice)</td>
<td>test and inspection based accountability</td>
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<tr>
<td>collaboration, networking and partnerships</td>
<td>competition and rankings</td>
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</tbody>
</table>
What is science learning in Finland in high school? **Subject-based**, experiences from Biology and Chemistry

### Distribution of courses

**Sample of subjects**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Compulsory courses</th>
<th>Specialisation courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother tongue &amp; literature</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>A-language</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>B-language</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Other languages</td>
<td></td>
<td>8+8</td>
</tr>
<tr>
<td>Mathematics</td>
<td>6-10</td>
<td>2-3</td>
</tr>
<tr>
<td>Environment &amp; science</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Humanities &amp; social sciences</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Arts, crafts &amp; sports</td>
<td>4-6</td>
<td>7</td>
</tr>
</tbody>
</table>

**Biology**  
**Chemistry**  
**Geography**  
**Physics**
Why to study new approaches, if they don’t give markable results

- STEM education **needs new perspectives** is truism
  - we have studied (a) inquire based science education, (b) science practices -approaches, (c) experimental work-oriented chemistry learning
- Unfortunately research studies don’t show markable progress → **THIS IS NOT A REASON TO NOT STUDY NEW APPROACHES**
- **Can we divide the results?**
  - To learning outcomes
  - How we can take into account different kind of leaners
  - Teachers professional development
Chemistry education – Individual learning paths

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1. Students formed teams (four student per team).
2. During the lesson's students studied in teams or individually.
3. Students marked the progression to the table.
I have taught this to my team
I know this that well that I can teach this to the others
I became aware of this
I think I became aware of this, but some parts are unclear
I will need time and practice for this
This is not included to my studies

I can recognize the symbols in chemical equations

I understand the terms of endothermic and exothermic

When red mark appears in the table teacher comes to help with the subject.
The highlights

- Students will get the kind of help that they really need.
- We don’t spend time with the topics which are easy to understand -> more time for the difficult ones.
- Fast learners get a possibility to study faster.
- Students can study outside the classroom.
- Teacher get to know each student better.
- Teacher have a great possibility to use experiments better and more often during the course.
The Flipped Classroom Pedagogy in Chemistry Education – Case Chemical Equilibrium Course

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Lecturer (Chemistry and Mathematics), Project Coordinator
Teacher Educator, e-Writer
Working environment is crucial – chemistry classroom is not a lecture room
Working environment is crucial – chemistry classroom is not a lecture room

Working in groups

Laboratory context
Different pedagogical approaches used in Science education
Different pedagogical approaches

- Project based learning (teaching)
- Inquiry based learning
- Problem based learning
- Co-operative, collaborative learning – working in groups
- Mastery learning (individual learning)
- Flipped classroom approach
How to choose the approach?

**Teaching form**
- Lecturing or demonstrating
- Giving tasks, problem based (independent working)
- Co-operative working

**Social form**
- Classroom teaching, frontal teaching
- Individual working (home work)
- Working in small groups with common task

Behavioristic vs. Cognitive vs. Humanistic vs. Constructive
Flipped Classroom Pedagogy

• The flipped classroom pedagogy gives an alternative way of teaching and learning if we compare it to the traditional teaching. In the flipped learning students are supposed to study new material outside of class, usually via reading or lecture videos.

• During the face to face time, normal lesson, time is used more with higher-order tasks, like tasks as before called homework.

• It is also possible to concentrate more difficult questions and to support individual learning.
Chemistry education and Flipped Classroom Pedagogy

• In chemistry education the flipped classroom pedagogy (FCP) is not yet commonly used, and very little reported.
• The classroom activities used in chemistry are different if you compare to mathematics, where the FCP is practiced and reported much more.
• The problem-solving, discussion, debates are the same, but when you have more time during lessons, you can do more experimental works and longer experiments and also analyzing and modeling the phenomena.
More experimental works
Research – A Case Study

• Includes analysis about different arrangements (layout graphic), students’ feedback (questionnaire), test results (concept test) and teacher’s own reflection (teacher’s blog).

• The results introduced students’ different attitudes towards increase in students’ autonomy.

• The communication between students and teacher were analyzed: was there opportunity to get support and did student get enough support.

• Students own work flow and engagement was asked.
Why Flipped

• Promote students’ autonomy out of classroom and collaborative learning during the lessons
• The teacher leaves the direct control of the learning to the students and trusts students’ ability and desire to learn
  • they watch about 80% of the videos at home
• Teachers role: situations, where individual students need more support and guidance
  • 10/12 said that they got enough support when it was needed, nobody said that it was not possible to get support.
• Need of scaffolding and collaboration is also supported by different classroom arrangement; student were sitting in groups.
  • this was the case to 8/12, 2/12 said nothing, and 2/12 did not agree.
• This classroom arrangement was one focus, when research arrangements were planned.
Individual progress

• The teacher can create differentiation in the group of different skill levels of the students.
• The support is based on students' own zone of proximal development (ZPD) at the moment.
• Here the experience of the teacher or teacher's PCK (pedagogical content knowledge) become more and more crucial.
• This makes the FCP more difficult to put into practice and to get better learning results.
Fits for all? NO!

• Is this FCP method suitable to chemistry education in every cases? When asked students, do you think this would have been worked earlier courses, only 3/12 agreed.

• In the traditional teaching teachers choose the level of teaching based on conceptions of the average skill level of the group.

• How it fits to most of the students?
How it fits to most of the students?
Conclusions
Conclusions

• Using individual learning paths (differentiation of teaching) and a new kind of implementation of flipped classroom gives us **good tools for different kind of learning and teaching situations**

• Works as **a part of one course**, but it is challenging approach for the whole course

• We have to **support fast learners** with demanding need and at the same time **support those who have challenges** in learning and motivation

• (Viikki Teacher Training School) Teaching practice session sometimes don’t allow us to try new working concepts – skills of trainers are different – Our purpose is to support their professional development (we have to find the right time for modern methods and approaches)

• We found these approach important for our work and our **professional development** (also as research-based development, further studies, doctoral theses)

• It is suitable and affordable way to get new ideas for actual teaching and learning situations – **more engagements, more motivation for teachers and students**