KRISTIANSTAD UNIVERSITY

Learning in Science and Mathematics
The LISMA group

Secondary Teacher Education in Science and Mathematics at Kristianstad

Andreas Redfors and Olle Eskilsson

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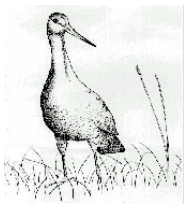

Department of Mathematics and Science
Kristianstad University, SE-291 88 Kristianstad, Sweden
Phone: +46 44 20 34 21 Fax: +46 44 20 34 03
e-mail: Andreas.Redfors@mna.hkr.se http://www.mna.hkr.se/lisma/

Abstract

The work presented relates to both phases of the STEDE micronetwork 6b. The first part relates to structures of science teacher education programs in Europe, and describes the formation of teachers at Kristianstad. In the second part a case study on the role of results from science education research in the Kristianstad science teacher education is reported. We have examined the details of how references are used by students in their exam papers. Categories that reflect content area, type and age of used references, and where and how the references are used have been generated. Students are referring to science education research, both indirectly from books, and directly from research articles and doctoral theses. Students refer to research results and they relate their own results to earlier work in their discussions. We are encouraged, because it indicates that the students could be inspired by science education research in their future work. Results from this case study will in the future be compared to and evaluated with results from the other partners of the micronetwork.

Introduction

This work addresses both phases of the STEDE micronetwork 6b. The first part describes the formation of teachers at Kristianstad and the second part is a report of a case study focused on the role of results from science education research in the Kristianstad science teacher education.

In July 2001 Sweden received a renewed national curriculum for teacher education, described in Appendix A. However, this work is on formation of teachers for grades 4-9 (ages 11y-16y) within the former national curriculum, which is still in use for students having started year 2000 and earlier. Students study both science and mathematics in this program at Kristianstad, and they are required to have studied mathematics, physics, chemistry and biology in upper-secondary school.

Part 1. Secondary science teacher education at Kristianstad

Students have to study both science and mathematics in the current education programme for grades 4-9 (ages 11y-16y) at Kristianstad. The national curriculum gives the opportunity to offer both Mathematics+Science and Science only, but only the combined education is offered at Kristianstad. Students applying to the education are required to have Mathematics, Physics, Chemistry and Biology from upper-secondary school.

The teacher education at Kristianstad University is known to have a strong connection to professional teaching. The pedagogical, social and personal development of the students is combined with an advancement of the students' content knowledge. The student develops both his understanding of the situation in schools, and his content knowledge. The studies should give a theoretical foundation for reflection and application during practice teaching. Contemplating experiences during practice teaching are a way for students to learn more about themselves, and to develop both social competence and content knowledge. It gives them a chance to grow into the role of a teacher.

Programme description

At Kristianstad the teacher education for secondary school is organized in four different tracks.

- Mathematics and Science
- Social sciences
- Swedish and foreign language
- Physical activities and mathematics

Students from the different tracks meet and study together during semesters 1, 4 and 9, see below. During these three semesters the practice teaching takes place, and the students meet students from other programs, i.e. students studying to be primary and lower secondary teachers, preschool teachers and recreation instructors. The semesters oriented towards learning of content knowledge all include "field days" when the students visit schools. Experiences from these visits are used and referred to in the teaching.

The ability to communicate by many different means is central. This means that the student throughout the programme works with different means of communication and media. The student gets to develop his language as a tool in the processes of thinking and communicating both through talking and writing. Internationalisation is an important perspective and the student develops his ability to handle situations where individuals, groups and cultures meet. The equality perspective means that the content of all courses, also science content, is discussed in terms of, class, sex and ethnic origin. Environmental aspects are discussed in connection with the different subjects.

The program is 4 1/2 years long and consists of nine fulltime half-year courses, see table 1. It starts with a general course in education where all the different student teachers are given the opportunity to meet, discuss and analyse different perspectives on teaching and learning. It also includes some practice teaching.

Table 1. Overview of formation of teachers at Kristianstad, Sweden. The shade of grey indicates the degree of Science Education and/or General Education in the content of the courses.

Year 1		Year 2		Year 3		Year 4		Year 5
Education intro	Chemistry	Biology Mathematics	Education learning	Physics	Technology Mathematics	Biology	Elective science	Education teaching

This introduction is followed by courses in eligible chemistry, biology and mathematics. All science and mathematics courses are specially designed for teacher formation, and science education is a constituent. The second general semester has children and learning as the prime objectives, and practice teaching for eight weeks is included. The program continues with courses in physics, technology, mathematics and biology. The students choose two subjects in which they specialise further during their eighth semester. The last semester of the program is dedicated to the professional role, and it includes ten weeks of general education with practice teaching for 5-7 weeks, and ten weeks for an exam paper. The paper should have a pedagogical/educational profile, and be based on research in science education and/or general education.

Course contents

Semester 1 - autumn (20 weeks fulltime (800 hours), Sep – Jan)

Teacher and learning, 20 points (1 point = 1.5 ECTS credits)

The course is the same for all four different tracks of upper secondary teacher education. The students are given the opportunity to meet, discuss and analyse different perspectives on learning, based on their own experiences. This work is done both in the context of their own learning, and in the context of them as

teachers in school. Theory and practice is combined in this course, through visits to schools and actual teaching. The idea is to "try out" the future profession.

There is 4 weeks of practice teaching in this course, 2 weeks with younger children (10-12y) and 2 weeks with older children (12-15y).

Semester 2 – spring (20 weeks fulltime (800 hours), Jan – Jun)

Chemistry, 20 points

The course is about general chemistry, chemistry of life and society. To use chemical concepts to understand and explain everyday occurrences is a main focus. Experimental methods are used to study properties of different subjects and their reactions. Preconceptions of students and ways to teach, that challenge these preconceptions are important elements of the course.

Semester 3 - autumn (20 weeks fulltime (800 hours), Sep – Jan)

Biology, 10 points

A course in cell and human biology. The constitution and function of cells together with genetics and microbiology is studied. Ethical aspects on genetic techniques are discussed. The normal constituents and functions of the human body is studied together with health issues and medical technology.

Mathematics, 10 points

Introductory number theory and properties of numbers is studied. Principally the rational numbers, but also real and complex numbers are treated. Solutions to various types of elementary equations are discussed, with a focus on the concept variable. Linear systems of equations and their solutions are also discussed. A major focus for this course is the different difficulties children have when trying to learn and understand numbers and algebraic expressions. The need to be concrete and to work with informal methods before introducing more formal mathematics is stressed.

Semester 4 – spring (20 weeks fulltime (800 hours), Jan – Jun)

Children and learning, 20 points

The course is the same for all four different tracks of upper secondary teacher education. The students are working with investigations of the different abilities for learning to read, write and do mathematics that children have. What obstacles and possibilities are there to be found? This is done in the framework of different theories of learning to read, write and do mathematics. The relationship between goals and aims of the national curriculum and of individual teachers is analysed, as is the role of different ways to teach and the role of textbooks. Different ways to induce pupils to take responsibility for their own learning and decision-making is looked into. Also ways to incorporate parents in the planning and performing of the teaching is discussed.

There is 8 weeks of practice teaching in this course, 4 weeks with younger children (10-12y) and 4 weeks with older children (12-15y).

Semester 5 - autumn (20 weeks fulltime (800 hours), Sep – Jan)

Introductory physics, 20 points

The course treats introductory classic and modern physics, including electronics and astrophysics. The mathematical models of the world of physics are used to describe observations from the real world. There is an emphasis on experimental work through labwork and projects. Results and methods from physics education research are discussed, and children's ideas in physics are often used as a starting point in the teaching.

Semester 6 – spring (20 weeks fulltime (800 hours), Jan – Jun)

Mathematics, 15 points

Introductory geometry, vectors, functions with applications and elementary statistics and probability. Emphasis is placed on work with concrete materials and ways to use mathematics in real applications from every day life. The questions in connection to the choice of which mathematical concepts to be taught at different ages is discussed.

Technology, 5 points

This course deals with how technology has influenced man, society and nature under different ages. Technological systems in our neighbourhood are studied in the perspective of their constituent components. Problem solving techniques are discussed through project work. The different steps from idea to finished product are analysed by working with different types of constructions.

Semester 7 - autumn (20 weeks fulltime (800 hours), Sep – Jan)

Biology, 20 points

Ecology, natural-geography and meteorology are studied in order to get the full picture of the interplay between the living and the non-living parts of nature. Discussion of the historical development of the cultural landscape is also part of the course.

The multitude and the variation in the world of organisms are studied, also how different groups of organisms have developed in order to accommodate to local environments. Evolution and fundaments of systematic classification are important parts of the course. Two weeks studying of flora and fauna in the local environment during the summer is compulsory.

Semester 8 – spring (20 weeks fulltime (800 hours), Jan – Jun)

Two elective courses of 10 points each.

Elective courses that are based on the introductory courses described above. The courses are focused on furthering the students' own content knowledge. However, the content of these elective courses is chosen with teaching in schools as the overall objective.

Semester 9 - autumn (20 weeks fulltime (800 hours), Sep – Jan)

The professional role, 10 points

This course gives the students an opportunity to increase their understanding of what it is like to be a teacher in a changing society. There is 5-7 weeks of practice teaching in this course, in which the student teachers take on the full responsibility of a professional teacher.

Exam project, 10 points

Students do an independent project or exam paper, which is an opportunity for the students to enter more deeply into a selected area. Qualitative and quantitative research methodologies are discussed, together with the steps of critical analysis of different sources of information. The exam paper must have a pedagogical/educational profile and be of potential use for professional teachers in schools.

Progression in science education

To ensure a progression in the use of, and reference to, science education research within the teacher education programme certain steps have been taken.

- Different perspectives on learning are discussed at an early stage and we come back to it in the different subject matter courses.

- We encourage a discussion on why all students in schools should study science.
- Use of a common textbook in science education, Sjøberg (2000), where different science courses (semesters) concentrate on different chapters of the book.
- Science education journal articles and reports from national evaluations and international projects, e.g. TIMSS, SAS, ROSE and PISA are discussed in the courses.
- A consensus work-plan stating in which course the focus should be for different areas of science education research.
- An ambition to use experiences made in schools during practicum as starting points in the teaching of subject matter knowledge.
- Students visit partner schools during their science semesters and observe teaching in the subject matter they are studying. They also interview children with respect to conceptual understanding and attitudes to science and science education (Duit 2002).
- Students prepare, demonstrate and discuss school type labwork where their own conceptual understanding is challenged.
- The formal demand on project work in the programme is gradually increased until the final project (paper), which we aim to be a part of an actual research project.

Chemistry semester

This means that in the case of Chemistry we are working with:

Children's and students' conceptual development of concepts like concepts of matter, transformation of matter, states of matter referring to our own research projects, e.g. Eskilsson (2001).

Analysis of content, curriculum, textbooks and teaching sequences using Roberts & Östman (1998).

Analysing and discussions about the purpose and emphases for science education in school

Separate subjects or integrated science and technology?

The use of practical work in science teaching using research from different Labwork projects, e.g. *"Practical work in Science Education"* (Leach & Paulsen 1999).

Integrate labwork and theoretical discussions in seminars, where students discuss and demonstrate their experiments.

Physics semester

In the case of Physics we are working with:

Childrens' and students' conceptual development of concepts like energy, heat, light, electric currents and concepts in astronomy.

We discuss students' use of models and how they link the world of models and the real world, e.g. Giere (1997).

In parts of the course we use a modified *contrastive teaching* (Schecker & Niedderer 1996), combining lectures and project work.

Communication through writing, production of web-sites, and talking.

Genus related issues and attitudes, e.g. girls' interest in physics.

We use and discuss problem-oriented ways of teaching.

Integrate labwork and theoretical discussions in seminars.

A teaching sequence, for ages 10-16, designed to reach the goals set in the national curriculum for this concept. The students interview children about the

concept at their partner school, and they write a project report based on research results on conceptual understanding.

Evaluation through: individual exams (written and oral), group exams, production of web-sites, mini projects with both oral and written reports.

Examination paper

The exam paper is the final part of the 4½-year education. It is a ten-week (10 points or 15 ECTS credits) project and includes methodological and theoretical studies, an empirical investigation and an orally defended written report. We have analysed seven of these exam papers, and that is reported in a case study below. We believe that the exam papers can give insights to the use of results from science education research by the student teachers. However, one must bear in mind that the students are in fact required to base their investigation on models and theories from science education research.

Part 2. Case study

Background

As phase two of the work within STEDE the micronetwork-6b decided to analyse material written by student teachers in the perspective of finding which part of research was used by our student teachers. Two questions were discussed; *What are the main subjects of preoccupation of young teachers?* and *In what part can they find answers in science education research or more widely educational research?* In Kristianstad we decided to adopt the following research questions:

1. What do student teachers choose to write about in their examination papers?
2. In what part can they find answers in science education research or more widely educational research?

In this case study we analyse exam papers since we believe they can be used to indicate the use of results from science education research by the student teachers. We are aware of the fact that the students are required to base their investigations on science education research, and that this requirement will give us an overrepresentation. The exam papers, as can been seen in part 1, conclude the education and are the final work of the students before they get their teaching degree.

Methods

In the first step of the analysis we describe the conditions of the exam papers. After discussions within our micronetwork we agreed upon a common grid for analyses of written materials, see table 2. This grid was used to establish the conditions for the production of the exam papers at Kristianstad.

Table 2. Grid used to establish the conditions for the examination papers.

Written paper – conditions/grid

Place of paper/report in the structure of the education
- Part of final examination or not

Who supervises?
- School teachers, inspectors, teacher trainers, researchers

Who chooses supervisor?
- student, institution, external examiner

Who evaluates, marks or advices?
- researchers, inspectors, teacher trainers

Assessment or advice
- Institutional criteria based on national criteria or not

Roles of supervisor/mentor
- inform students about demands
- help students get aims/questions explicit
- help to find bibliography
- advice on collection and analysis of empirical data
- advice on presentation

Organisation of supervisors – groups or alone

Choices of topics

Institutional instructions
- Subject
  - Subject matter Physics, Chemistry, Biology, ...
  - Science education
  - Pedagogy
- Method
  - analysis of practice, questionnaires, interviews, ...
- Description of projected plan, if required
- Paper based on theoretical framework or not
- Requirement for the bibliography

Number of ECTS-credits

Students working individually or in pairs

Categories following the grid in table 3 were developed ideographically (Driver et al. 1996) they evolved alongside the analysis, and are based on analyses of written materials in the different countries represented in the micronetwork.

Table 3 Grid used for analysis of the nature of the individual examination papers.

Title	
Pupils:	Conceptions, motivation, attitudes, ...
Domain:	Electricity, astrophysics, mechanics, ...
Activities:	Practical work, documentation, investigation, ...
Context:	Everyday life, science literacy
Text of paper	
Epistemology:	Theories of teaching and learning guiding the teacher student
Activities:	Exercises, controls, practical work, lessons, documentation, using video, visiting museum, ...
Context:	Everyday life, current scientific event, history of science, ...
Expectations:	Discipline - order in the class, motivation, knowledge, affective goals, social development, skills, ...
Learners:	Perception of the pupils as learners (Transmissive, social constructivism, constructivism, socio cultural), Attention to cognitive, affective, social (e.g. peer interaction) or societal dimensions.

The third step in the analysis was to study how students refer to literature in their exam papers. We have looked specifically at different parts of the papers. In each part of the exam paper (Background, Methodology, Results, Discussion,

Conclusion, References) we looked for the kind of literature referred to. In order to examine the details of how the references are used by students we have conducted an ideographic analysis (Driver et al. 1996). Working independently each of us read the same paper and generated a provisional category set to be used when describing student strategies. These were compared and reworked into a single category set, which was used to code all seven papers, see table 4. The categories reflect content area, type and age of used references, also where and how the references are used.

Table 4. Categories used in analysis of the bibliographies

S	**Subject**	
	Ss	**S**ubject specific, e.g. Physics, Biology ...
	Sv	**V**iewpoint, values in environmental, gene technology
E	**Education, Pedagogy, Psychology, general**	
	Ec	**C**urriculum
	Eg	**G**eneral
M	**Method**	
SE	**Science Education**	
	SEn	**N**ature of Science
	SEc	**C**onceptual understanding
	SEl	theories of **L**earning
	SEg	**G**eneral - includes ICT for school (ICT-education)
SER	**Science Ed – Research**	
	SERt	**T**extbook presentation
	SERr	**R**eview article
	SERa	**A**rticle, doctoral thesis

With these categories we got information of what kind of literature students refer to when discussing educational and methodological issues. Examples from all the categories can be found within the compulsory literature of the teacher education program. We have also noted the publication dates for the references in the bibliography. They were categorised according to the intervals in table 5.

Table 5. Categories of references according to time

	<	1990
1990	-	1994
1995	-	1999
	>	2000

Results

Written examination papers – conditions

The conditions for the exam papers are described according to the grid in table 2. We present the conditions at Kristianstad below.

The exam paper is written by teacher students at Kristianstad towards the end of their education. It constitutes a course of 10 weeks (10 points=15 ECTS credits). It is a course comparable to other courses that constitutes the teacher education program, but since it is taken at the end of the education is has a special status. It is supervised by teacher trainers at Kristianstad University, who normally also are researchers in the field of science education.

The examiner, who is a researcher/teacher trainer, is responsible for the course. He chooses the supervisors together with the students. It is the examiner that informs the student on the demands and helps the students to get started, i.e. to choose topic and supervisor. Normally the topics are suggested by the students and the examiner helps them to choose supervisor. The examiner also evaluates and marks the exam papers. The assessment is not based on national criteria, but on criteria developed at Kristianstad in the group of science education researchers. However, criteria are discussed and modified in an ongoing dialogue with other teacher education institutes in Sweden.

The supervisor guides and advices the students in their work. He helps them to get aims and research questions focused. He also guides them in their search for relevant literature, and with their choice of methodology. He reads and comments on the written paper and he discusses the oral presentation with the students. The supervisor works normally alone with the students, but sometimes in pairs if the subject focus of the exam paper is such that it requires specific competences. However, there are discussions and meetings of supervisors during the work.

The requirements for the exam papers are set in the course plan for the "exam paper course". The plan is revised by the board for the teacher education when required. Currently the exam papers have to be within the field of education. Science teacher students are encourage to choose a topic in the field of science education. The empirical data has to be related to school, and it is normally collected during the last period of practice teaching. The possible methods are not limited. Students normally use interviews, questionnaires, class room observations or combinations of these, to assess attitudes, developed teaching sequences or conceptual understanding.

The students work in pairs or individually. They are required to write a short project plan (1-2 pages) during the end of the preceding semester. The project plan is commented on by the examiner, and discussed with the supervisor. The paper is required to have a theoretical framework, and the students write a theoretical background in their papers. The papers also have to have a bibliography.

Written examination papers – titles and content

We have analysed the titles and the content of seven exam papers according to the grid in table 3. The categories for the bibliographic items are from table 4. Short summaries of the results are given for each of the papers below.

Paper 1. Pupils' interest for Science. What significance has the teacher for the interest of science?

Pupils:	Interest of science
Domain:	Students attitudes to science
Activities:	Investigation
Context:	Everyday life

Text of paper

Epistemology:	Social constructivism
Activities:	Questionnaires and interviews
Context:	Everyday life
Expectations:	Attitudes and interests
Learners:	Social constructivism, Attention to cognitive, affective and social dimensions.

Bibliography

Number of times an item in the bibliography is referenced in the text. Numbers for each of the different parts of the paper is given in the table below. See table 4 for explanations of the categories.

Part of paper	Ss	Sv	Ec	Eg	Met.	SEn	SEc	SEl	SEg	SERt	SERr	SERa
Background	0	0	1	11	1	0	0	0	1	9	0	37
Method	0	0	0	0	0	0	0	0	1	0	0	2
Result	0	0	0	0	0	0	0	0	0	0	0	1
Discussion	0	0	0	1	0	0	0	0	0	0	0	8
Conclusion	0	0	0	0	0	0	0	0	0	0	0	0
References	0	0	1	6	1	0	0	0	2	1	0	14

	<1990	1990-1994	1995-1999	>2000
References	1	4	11	9

The two student teachers that have written this exam paper on pupils' interest of science have used a lot of first hand references. We have categorized them as Science Education Research articles (SERa). These articles are all in Swedish and that is probably an important fact, since most students prefer reading in Swedish to English. There is a lot of English literature in their education, but when the choice is theirs, the students choose Swedish literature. They refer to the papers to generate a background that they can rely upon for their own investigation and they also use them in their discussion at the end of their paper.

Paper 2. Air pressure – student's conceptions and explanatory models

Pupils: Conceptions
Domain: Air pressure
Activities: Investigation
Context: Everyday life

Text of paper

Epistemology: Social constructivism
Activities: Practical work, questionnaires and interviews
Context: Everyday life
Expectations: Improvement of model based explanations
Learners: Social constructivism, Attention to cognitive and social dimensions

Bibliography

Number of times an item in the bibliography is referenced in the text. Numbers for each of the different parts of the paper is given in the table below. See table 4 for explanations of the categories.

Part of paper	Ss	Sv	Ec	Eg	Met.	SEn	SEc	SEl	SEg	SERt	SERr	SERa
Background	8	0	0	2	0	0	0	0	2	0	0	8
Method	0	0	0	0	0	0	0	0	0	0	0	2
Result	0	0	0	0	0	0	0	0	0	0	0	1
Discussion	0	0	2	0	0	1	0	0	0	2	0	8
Conclusion	0	0	0	0	0	1	1	0	0	2	0	0
References	8	0	1	2	0	1	1	0	2	4	0	6

	<1990	1990-1994	1995-1999	>2000
References	5	2	10	8

These two students having worked on conceptions of air pressure refer to eight different subject oriented references in their background. They have delved deeper into the subject area before starting the investigation, and they have written a thorough background in their paper. They are also discussing earlier research within the area, which is shown by a number of references to Science Education Research articles (SERa) in the background. They are actively using the references in their discussions, and not only in the background section. They seem to have read the articles in detail, although several of them are in English.

Paper 3. Can the understanding of concepts in science and technology be improved by working with LEGO DACTA?

Pupils: Conceptions, and to make them work
Domain: ICT and ecological processes
Activities: Practical work, investigation
Context: Everyday life

Text of paper

Epistemology: Social constructivism
Activities: Practical work and ICT
Context: Everyday life
Expectations: Skills and understanding of concepts
Learners: Social constructivism, Attention to cognitive, affective and social dimensions

Bibliography

Number of times an item in the bibliography is referenced in the text. Numbers for each of the different parts of the paper is given in the table below. See table 4 for explanations of the categories.

Part of paper	Ss	Sv	Ec	Eg	Met.	SEn	SEc	SEl	SEg	SERt	SERr	SERa
Background	4	0	7	4	0	0	0	0	12	14	4	9
Method	0	0	0	1	0	0	0	0	0	0	0	1
Result	0	0	0	0	0	0	0	0	0	0	0	0
Discussion	1	0	1	1	0	0	0	0	3	4	1	3
Conclusion	0	0	0	0	0	0	0	0	0	0	0	0
References	4	0	3	1	0	0	0	0	6	1	1	4

	<1990	1990-1994	1995-1999	>2000
References	1	3	10	6

These two students have developed and assessed a teaching sequence in the subject *Technology* using computer controlled LEGO. They worked in the area of ecological processes and mechanics constructing a green house and an elevator. Their use of subject oriented literature in the background is moderate. Instead they are focusing on general literature in the area of teaching with the use of computers, coded as SEg, and on curriculum texts (Ec). In the background section they use literature on pupils' conceptions in their areas, but also to some extent in their discussion. The overall impression though, is that they have focused on general educational literature.

Paper 4. Environment education - integrated or a specific subject?

Pupils: Attitudes and motivation of students
Domain: Environmental education
Activities: Investigation
Context: Science literacy

Text of paper

Epistemology: Social constructivism
Activities: Documentation
Context: Science literacy
Expectations: Motivation
Learners: Social constructivism, Attention to cognitive, affective, social and societal dimensions

Bibliography

Number of times an item in the bibliography is referenced in the text. Numbers for each of the different parts of the paper is given in the table below. See table 4 for explanations of the categories.

Part of paper	Ss	Sv	Ec	Eg	Met.	SEn	SEc	SEl	SEg	SERt	SERr	SERa
Background	7	20	22	5	0	0	0	0	31	13	0	9
Method	0	0	5	3	0	0	0	0	0	0	0	0
Result	0	0	0	0	0	0	0	0	0	0	0	0
Discussion	0	3	0	0	0	0	0	0	3	0	0	1
Conclusion	0	0	0	0	0	0	0	0	0	0	0	0
References	4	6	8	6	0	0	0	0	12	2	0	7

	<1990	1990-1994	1995-1999	>2000
References	3	7	23	12

These two students have read several books on environmental issues. They refer extensively to articles/books in general education, where results from science education research are interpreted and discussed. They seem to find these articles/books more accessible. However, they do not use the references in their discussion and this could be because that is difficult with the more general literature they have chosen.

Paper 5. Everyday conceptions or scientific concepts?

Pupils: Conceptions
Domain: Particle model of matter, astronomy, optics
Activities: Investigation
Context: Everyday life

Text of paper

Epistemology: Social constructivism
Activities: Documentation
Context: Everyday life, Current scientific event
Expectations: Knowledge
Learners: Constructivism, Attention to cognitive dimensions

Bibliography

Number of times an item in the bibliography is referenced in the text. Numbers for each of the different parts of the paper is given in the table below. See table 4 for explanations of the categories.

Part	Ss	Sv	Ec	Eg	Met.	SEn	SEc	SEl	SEg	SERt	SERr	SERa
Background	0	0	3	28	1	0	5	2	0	13	2	14
Method	0	0	0	1	0	0	1	0	0	0	0	1
Results	0	0	0	0	0	0	3	0	0	0	0	0
Discussion	0	0	1	0	0	0	1	0	0	0	0	4
Conclusion	0	0	0	1	0	0	0	0	0	0	0	0
References	0	0	3	7	0	0	3	1	0	4	1	2

	<1990	1990-1994	1995-1999	>2000
Ref	2	3	10	6

Pupils use everyday language when talking about everyday phenomena. This group studied how this is covered in the national curriculum. As many of the other groups they chose a few goals from the curriculum and discussed the aim of their exam paper from this angle. They also presented theories of learning using educational and methodological literature where often research in science education is interpreted. The teacher students presented research on students' conceptions in the domains they wanted to study and the questionnaire contained examples from the research reports. They compared their results with the results from those studies.

Paper 6. Pupils' attitudes towards genetic engineering

Pupils: Attitudes, Conceptions
Domain: Genetic engineering
Activities: Investigation
Context: Everyday life, science literacy

Text of paper

Epistemology: Attitudes to genetic engineering
Activities: Documentation
Context: Everyday life, modern technology
Expectations: Using knowledge, Affective goals
Learners: Social Constructivism, Attention to cognitive dimensions.

Bibliography

Number of times an item in the bibliography is referenced in the text. Numbers for each of the different parts of the paper is given in the table below. See table 4 for explanations of the categories.

Part of paper	Ss	Sv	Ec	Eg	Met.	SEn	SEc	SEl	SEg	SERt	SERr	SERa
Background	8	43	9	1	0	0	0	0	1	3	0	3
Method	0	0	0	0	1	0	0	0	0	0	0	0
Result	0	0	0	0	0	0	1	0	0	0	0	0
Discussion	1	1	0	0	0	0	0	0	0	0	0	1
Conclusion	0	0	0	0	0	0	0	0	0	1	0	0
References	5	16	3	0	0	0	0	0	0	0	0	2

	<1990	1990-1994	1995-1999	>2000
Gent Ref	4	1	11	10

In this exam paper about attitudes towards genetic engineering the students started by reading about genetic engineering using literature from biology, genetics and popular presentations of research in this area. They also presented a historical background for the development. They wrote about attitudes and policies towards genetic engineering of different groups in the Swedish society. They mainly referred to journals and the Internet in their bibliography. They did a thorough presentation of the national curriculum concerning genetic engineering. Both national and international research reports about students' attitudes towards genetic engineering were presented. The students used a questionnaire from a national project in their empirical part of the study. They compared their results with the results from this study.

Paper 7. The particle model of matter – a mere detail?

Pupils: Conceptions

Domain: Particle nature of matter

Activities: Investigation

Context: Everyday life, Literacy of science

Text of paper

Epistemology: Social constructivism

Activities: Exercises, Practical work, Lessons, Documentation

Context: Everyday life, Current scientific event, History of science

Expectations: Motivation, Knowledge, Affective goals

Learners: Social constructivism, Constructivism, Attention to cognitive and social dimensions.

Bibliography

Number of times an item in the bibliography is referenced in the text. Numbers for each of the different parts of the paper is given in the table below. See table 4 for explanations of the categories.

	Ss	**Sv**	**Ec**	**Eg**	**Met.**	**SEn**	**SEc**	**SEl**	**SEg**	**SERt**	**SERr**	**SERa**
Background	6	0	6	6	0	3	4	5	0	18	0	18
Method	0	0	0	2	0	0	1	0	0	5	0	0
Results	0	0	0	0	0	0	0	0	0	0	0	2
Discussion	0	0	2	0	0	0	2	0	0	4	0	3
Conclusion	0	0	0	0	0	0	0	0	0	0	0	0
References	6	0	3	3	0	1	7	2	0	9	0	7

Documents	**<1990**	**1990-1994**	**1995-1999**	**>2000**
Part Ref	12	11	12	3

These teacher students started with a presentation of the particle models of matter from a historical point of view. They described the development of the particle model and discussed the nature of science from this perspective. They presented research on students' conceptions of the particle model of matter from national and international studies. They used ideas from these studies in their interviews with students. The empirical part of the work contained planning, implementation, and evaluation of a teaching sequence. The teacher students used reports of research in science education to described theories of learning.

Conclusion and implications

The papers are different but the seven papers in our case study are representative of the different kinds of exam paper produced. The student's can choose to do their exam paper as a research project related to pedagogy or science or math education. In this study we are focusing how students refer to different kinds of literature when they write their exam papers, and discuss questions related to their work as teachers in math or science in secondary school. In almost all the papers the curricula are analysed with a perspective based on the specific research questions.

In the analysis we can see that students are referring to science education research, both indirectly from books like (Sjøberg, 2000), and directly from research articles and doctoral theses. Several students are referring to anthologies, e.g. Welford et al. (1996). The supervisor and choice of subject influence the student. However, we see variations between students having the same supervisor. Students refer to research results and they relate their own results to earlier work in their discussions.

In papers 2, 4 and 6 the students have many references to literature in science. They chose to deepen their knowledge about their subject area before they started to assemble data. This can be related to their choice of subjects. They also studied similar investigations, e.g. attitudes to genetic engineering.

In four of the papers the students studied pupils' conception of scientific concepts or how pupils use their science knowledge to talk about everyday phenomena. In these papers there are many references to reports about pupils' conceptions, and the teacher students often refer to descriptions of theories of learning.

In papers 2, 3 and 7, where the students developed and implemented teaching sequences, they refer to literature of pupils' conceptions and learning from a socio cultural perspective. In these papers, and others too, the teacher students refer to articles/books in general education, where results from science education research are interpreted and discussed. They seem to find these articles/books more accessible. These references are rarely used in the discussion parts of the exam papers and this could be because it is more difficult to relate to general literature in a detailed discussion.

Generally we are encouraged, because our results show that there are influences from science education research results in the investigate exam papers. This might even indicate that students could be inspired by science education research in their future work. However, we have not been able to establish that in our case study. It would be of interest to continue this study and analyse how these students work in their schools, by observation and interviews. We could thereby come closer to answering the questions set out at the beginning; *What are the main subjects of preoccupation of young teachers?* and *In what part can they find answers in science education research or more widely educational research?*

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Appendix A. School and the renewed Teacher Education in Sweden

The Swedish school system

The Swedish public school system comprises compulsory school and various types of voluntary schooling, see table 6. Compulsory school includes compulsory basic school, school for the Saami peoples of northern Sweden, special school (for children with impaired sight, hearing or speech), and compulsory school for mentally handicapped. Voluntary schools comprise upper secondary school, municipal adult education and education for mentally handicapped adults.

Tuition in the state schools is free. Neither pupils nor their parents usually incur any costs for teaching materials, school meals, health care, school transport, etc.

Table 6. Schematic (simplified) view of the Swedish school system and the renewed teacher education

<table>
<tr><th>Age</th><th>Grade</th><th colspan="3"></th><th colspan="2">Renewed teacher education</th></tr>
<tr><td></td><td></td><td colspan="3">Preschool</td><td rowspan="10">Requires a teacher education of at least 3.5 years</td><td rowspan="2"></td></tr>
<tr><td>0-5(6)</td><td>Pre</td><td colspan="3">0y – 3y
3y – 5(6)y 0y – 5(6)y</td></tr>
<tr><td></td><td></td><td colspan="3">Compulsory school</td><td rowspan="9">Requires a teacher education of at least 4.5 years</td></tr>
<tr><td>(6)</td><td>(F)</td><td>Age specific</td><td></td><td></td><td rowspan="8"></td></tr>
<tr><td>7</td><td>1</td><td>“</td><td>Age-integrated</td><td>Age-integrated</td></tr>
<tr><td>8</td><td>2</td><td>“</td><td>(team**)</td><td>(team**)</td></tr>
<tr><td>9</td><td>3</td><td>“</td><td rowspan="6"></td><td rowspan="5"></td></tr>
<tr><td>10</td><td>4</td><td>“</td><td>Age specific</td><td>Age-integrated</td></tr>
<tr><td>11</td><td>5</td><td>“</td><td>“</td><td>(team**)</td></tr>
<tr><td>12</td><td>6</td><td>“</td><td>“</td><td rowspan="4"></td></tr>
<tr><td>13</td><td>7</td><td>“</td><td>“</td><td>Age specific</td></tr>
<tr><td>14</td><td>8</td><td>“</td><td>“</td><td>“</td></tr>
<tr><td>15</td><td>9</td><td>“</td><td>“</td><td>“</td></tr>
<tr><td></td><td></td><td colspan="3">Upper secondary school</td></tr>
<tr><td>16</td><td>Gy1</td><td colspan="3">National and local programs with compulsory and elective courses</td></tr>
<tr><td>17</td><td>Gy2</td><td colspan="3">“</td></tr>
<tr><td>18</td><td>Gy3</td><td colspan="3">“</td></tr>
</table>

* The F grade is formally not part of the compulsory school, but it has to be offered to the child.

** Team - Teachers, pre-school teachers and recreation instructors

The academic year

The academic (school) year normally begins at the end of August and ends early the following June, making a total of some 40 weeks. A school week is five days long, from Monday to Friday. The longest holiday within the academic year is from around 20 December to the beginning of January.

Child care/Pre-school and "pre-school grade"

The majority of children are in pre-school (child care) during the ages 1 – 5 years. The municipalities and some private alternatives organize this, and teams of pre-school teachers run the activities in pre-school. The municipalities have a duty to organise preparatory-school activities (pre-school grade, F) for all children from the year of their sixth birthday up until school entrance. Arrangements vary between the municipalities, but the pre-school grade (F), see Table 6, is normally located in or co-ordinated by an ordinary school. It can also be linked directly to the municipal child-care.

Compulsory school

The nine year compulsory basic school is for all children between the ages of seven and sixteen years. If parents prefer, children may start school at six years of age. See Table 6.

Upper secondary school

Almost all of the pupils attending compulsory basic school continue directly to upper secondary school, and almost all of them complete their upper secondary schooling within three years (1993).

Upper secondary school is divided into 17 three-year national programmes, all of which are intended to provide a broad-based education and confer general eligibility for further studies in higher education. In addition to the national programmes there are also specially designed and individual programmes.

Adult education

Young persons are entitled to enter upper secondary school up to the age of 20. After this they can choose between various forms of municipal adult education. The regular adult education (komvux) programmes comprise both basic adult education corresponding to compulsory basic school, and voluntary education corresponding to the courses offered by upper secondary school.

Universities and colleges

Almost a quarter of all students go on to higher education within three years of leaving upper secondary school (1992). At university and college they can either take individual courses or a specified study programme. Most universities and colleges in Sweden are state run. There are universities and colleges at more than twenty centres around the country.

The language of instruction is usually Swedish, but there are an increasing number of courses given in English, sometimes also in other languages. However, much of the literature studied is in English. Very often, postgraduate education is conducted in English. There are also Masters' programmes in English for foreign students. Grades are generally given on a three-level scale: Pass with Distinction, Pass and Fail.

Studies are organised either in the form of study programmes or single-subject courses, both leading to a degree. Sweden has a system of credit points, where one term of successful full-time studies with a workload of 40 hours per week can yield 20 points, one year 40 points (1 point = 1.5 ECTS credits). A "major" is normally 60 points and includes an exam paper.

The forms of teaching used in Swedish higher education are lectures, seminars, laboratory, excursions and project work. The number of lessons per week varies between different kinds of education. Continuous examinations are held throughout the course, normally through written examinations or seminars with

papers. Students who fail their examinations may repeat them. Normally, students are required to obtain 20 credit points in a course before they can go on to the next level of 20 points in the same subject if they take single-subject courses. Such courses are studied one at a time and students choose courses each semester. Students are required to do an independent project or exam paper of an analytical and problem-solving character at the end of their studies, as a final control of knowledge and ability achieved in the whole programme subject. In general, there is no longer a final oral examination.

Before 1993 there were about 100 general study programmes, established by Parliament and varying in length from 40 to 220 points. Until 1989 the National Board of Universities and Colleges planned the curriculum for the general programmes, but more detailed planning was left to the local programme committees. In 1989 the whole responsibility for curriculum planning was decentralised to the higher education institutions. After 1993 it is also these institutions that decide which programmes and courses to offer and how they should be organised, as long as the degree requirements are met.

For students who have regular jobs, single-subject courses are often offered in the evenings and on a part-time basis, or as distance education courses. Part-time studies are planned to take twice as long time to complete as full-time studies. The single-subject courses have served one of the objectives of the 1977 reform: to make higher education a forum for recurrent education. They also offer a possibility for an individually chosen combination of studies as an alternative to the set study programmes. The students can decide whether they want to study for a full degree or only take courses giving a certificate.

After completion of a full programme the student obtains a degree. The degree is named after the field of studies or the occupation involved, with an official translation into English. The principle for this translation has been, except for a period after 1993, that degrees based on 120-140 points are translated as Bachelor's degrees and degrees based on 160 points or more as Master's degrees. Degrees from shorter programmes than 120 points were earlier translated with 'University Certificate', later with 'University Diploma'. Students may obtain degree certificates in English on request. The degree certificates contain detailed information as to the contents of the degree. Certificates and degrees are issued/awarded by the universities and they need no other authorisation.

Postgraduate Education

The principle in the Swedish system of doctoral studies is that the studies are systematically planned with courses and a doctoral dissertation. It should be possible to complete the doctoral degree after 4 years of full-time study, but the average time taken is around 6 years. Each student is entitled to individual supervision and the dissertation is defended in public with an opponent (external examiner), often from abroad. The dissertation may be written either as a monograph or as a so-called composite dissertation, consisting of a number of published research papers and a summary. It is published and distributed to all universities.

Apart from the doctoral degree, there is a licentiate degree, a research degree with a shorter qualifying period: a minimum of 2 years of courses and a smaller dissertation than the doctoral dissertation. The licentiate dissertation is defended in a seminar with an opponent. This degree was reintroduced in the 1980's starting with the technical faculty, which is the faculty having the most licentiates because of the demand from industry. There was an older kind of licentiate degree before 1972 with other criteria than the ones mentioned above.

Scientific research and teaching after the doctoral degree may lead to the title "docent", after application and evaluation.

Teacher Training

Swedish teacher training has changed in the last few years, and changed again the 1 July 2001, see next section. Students used to be trained to teach all subjects in primary school, junior or intermediate level, or to teach a certain set combination of subjects in secondary school, lower or upper level. In 1988 a new teacher-training programme was introduced, parts of which are common to all teachers in primary and lower secondary school. Teachers were trained for work in **grades 1-7** (3½ years, 140 points) with two different specialisations:

- Swedish and social sciences
- Mathematics and natural sciences (Requires upper secondary Ma, Phy, Che, Bi)

or in **grades 4-9** (4½ years, 180 points) with specialisation in one of five different tracks:

- Swedish and foreign languages
- Social sciences
- Natural sciences (Req upper secondary Ma, Phy, Che, Bi)
- Mathematics and natural sciences (Requires upper secondary Ma, Phy, Che, Bi)
- Practical/artistic subject + another subject

As an alternative it has also been possible for teachers for lower secondary school to study according to what is described below for upper secondary teachers. This has, in practice, only been possible for specialisation towards grades 4-9.

Teacher training for upper secondary school is based on a certain combination of subjects within one field, like mathematics-natural sciences, languages, humanities etc, a total of 4.5-5.5 years (180-200/220 points). Since 1992 it has been possible, in principle, to combine any two subjects within a teacher-training programme. These subjects are studied at the university up to a level giving eligibility for doctoral studies, 1.5 or 2.0 years (60 or 80 points). The subjects are then combined with a one year (40-points) education course (including pedagogy, teaching methods and teaching practice) at a teacher-training institute/faculty.

The 2000 Teacher Education Reform

The teacher education reform that came into effect on July 1, 2001, involves many changes. Instead of eight separate teaching degrees there will be only one, but with varying lengths, see Table 6.

Common basis of knowledge

The diploma awarded upon completion of the renewed teacher education program will show the graduate's specialization and status of qualification. One of the principal ideas of the reform is that all teachers, whether they intend to work in pre-school, in upper secondary school or as physical education teachers, need a common basis of knowledge and general teacher training. Therefore, as much as 60 points, or 1½ years, is the same for all students. There are many options of specialization and new subject areas have been introduced.

Research

All programmes include research preparation and the submitting of an exam paper or completion of a special project. The aim is that students, after completion of the programme, will have eligibility for doctoral studies in the area of educational studies. In connection with the introduction of the renewed teacher education it was suggested that a faculty of Education should be established in Sweden, but the government did not accept this. Thus, there is an ongoing discussion about what doctoral studies in education means in terms of entrance requirements, which faculty it belongs to and so forth.

Flexibility

Flexibility is another key word for the renewed teacher education, with the implication that students are able to easily change their area of specialization by complementary studies. Parts of the new programme are also available to teachers already in the profession, e.g. through distance studies. It is also possible to do practical and pedagogical coursework and training after completed academic studies in relevant subjects of required length, i.e. to enter the teacher education after having completed studies in specific subjects.

The length of studies

The teacher training is now, to an even greater extent than before, taking place in public schools in the municipalities. The length of studies is the same as before in most cases, i.e. 140 credit points (3,5 years) for compulsory school teachers of younger children, 180 credit points for teachers of older children. Former *Pre-school teachers* and *Recreation instructors* will follow a teacher programme that is extended to 140 credit points.

The degree

The official title of the degree is ”Teacher” with the specialization indicated on the diploma. The translation of the degree into English has not been determined yet. Depending on the length of the programme the degree could be translated as ”bachelor” or ”master”.

Forming of the programmes

The universities have formed the programmes differently and therefore, a detailed description is not given here. The content will vary a great deal at the different institutes of higher education. As an example we shortly describe the teacher education at Kristianstad.

The Renewed Teacher Education at Kristianstad

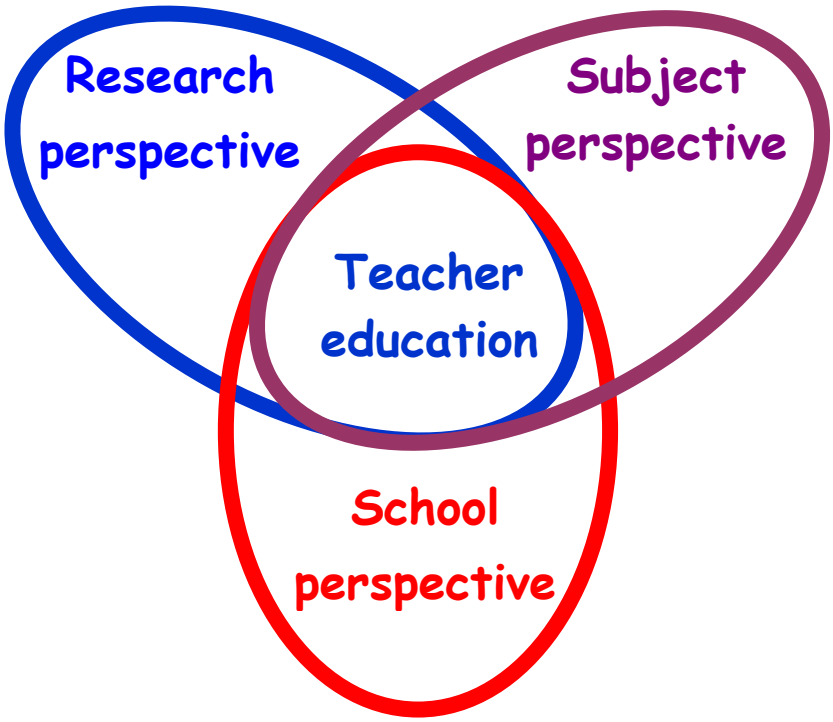
A teacher education for school, subject and research

The teacher education and current research will be closely tied together at Kristianstad. The education is founded on both scientific values and on practical experiences, see Figure 1. The choice of content and teaching methods is based on current national and international research. The general educational studies (60 points) and the elective alignments (1 year, 40 points) and specialisations (½ year, 20 points) can be combined to form ”tracks” through the programme that not only give a *Teachers certificate*, but also prepares for specific post-graduate and doctoral studies. Student teachers aiming to work with older pupils study 180/200 points and choose 2 alignments and 2-3 specialisations. Those aiming to work with younger pupils study 140/160 points and choose 1 alignment and 2-3 specialisations, see Table 6 and Appendix A. Students choose in what order they study the different blocks of the programme. However, they are sometimes limited by prerequisites, e.g. you need to have studied Science at upper secondary in order to follow the Science alignment.

General starting points for the teaching are that

- students by themselves or in group formulate problems
- the problems are related to real life
- students have a great responsibility for their own learning
- students communication (talking and writing) is an important part of the learning process
- presentations, communication and ICT should be natural parts
- there is tutoring, labwork and seminars

Figure 1. Perspectives of the renewed teacher education at Kristianstad



The practical work in schools is integrated in the General educational studies and in the alignments and totals to 30 points, where 20-25 points (weeks) is periods of actual teaching.

An independent project or an exam paper of an analytical and problem-solving character is performed at the end of the programme (10 or 20 points). This work is normally supervised by members of different research groups, e.g. for science the Learning in Science and Mathematics group, LISMA. It can be part of an ongoing research project. To prepare the students for this they are required to go to "research" lectures and seminars during their undergraduate years.

Internet resources

The Swedish National Agency for Education (2001). *The Swedish school system*. http://www.skolverket.se/english/system/index.shtml.

The Swedish National Agency for Higher Education (2001). *Guide to Swedish Higher Education*. http://www.hsv.se/english/higher/Swehigheredu.html

National Agency for Higher Education (2001). *The 2000 Teacher Education Reform*. http://wwweng.hsv.se/en/CollectionServlet/6/13/21.html

Appendix B. Renewed teacher education at Kristianstad, Science

Fall 2001	**Fall 2001**	**Fall 2001**	**Fall 2001**	**Fall 2001**	**Fall 2001**
General Educational studies 1	General Educational studies 1	General Educational studies 1	General Educational studies 1	General Educational studies 1	General Educational studies 1
Spring 2002	**Spring 2002**	**Spring 2002**	**Spring 2002**	**Spring 2002**	**Spring 2002**
Alignment 1 (e.g. *Science**) " "	Alignment 1 " "	Alignment 1 " "	Alignment 1 " "	Alignment 1 " "	Alignment 1 (e.g. *Play-development-learning*)
Fall 2002	**Fall 2002**	**Fall 2002**	**Fall 2002**	**Fall 2002**	**Fall 2002**
Alignment 1 (e.g. *Science**) " "	Alignment 1 " "	Alignment 1 " "	Alignment 1 " "	Alignment 1 " "	Alignment 1 (e.g. *Play-development-learning*)
Spring 2003	**Spring 2003**	**Spring 2003**	**Spring 2003**	**Spring 2003**	**Spring 2003**
Alignment 2 (e.g. *Ma, Bi Swedish*, or something else)	Specialisation 1 " "	General Educational studies 2	General Educational studies 2	General Educational studies 2	General Educational studies 2
Fall 2003	**Fall 2003**	**Fall 2003**	**Fall 2003**	**Fall 2003**	**Fall 2003**
Alignment 2 (e.g. *Ma, Bi, Swedish*, or something else)	General Educational studies 2	Alignment 2 " "	Specialisation 1 " "	Alignment 2 " "	Specialisation 1 (e.g. *Science for kids*) "
Spring 2004	**Spring 2004**	**Spring 2004**	**Spring 2004**	**Spring 2004**	**Spring 2004**
General Educational studies 2	Alignment 2 " "	Alignment 2 " "	Alignment 2 " "	Alignment 2 " "	Specialisation 2 (e.g. *With nature as classroom*)
Fall 2004	**Fall 2004**	**Fall 2004**	**Fall 2004**	**Fall 2004**	**Fall 2004**
Specialisation 1 (e.g. *Physics and Astronomy*)	Alignment 2 " "	Specialisation 1 " "	Alignment 2 " "	General Educational studies 3	General Educational studies 3
Spring 2005	**Spring 2005**	**Spring 2005**	**Spring 2005**	**Spring 2005**	**Spring 2005**
Specialisation 2 (e.g. *With nature as classroom*)	Specialisation 2 " "	Specialisation 2 " "	Specialisation 2 " "	Specialisation 1 " "	
Fall 2005	**Fall 2005**	**Fall 2005**	**Fall 2005**	**Fall 2005**	**Fall 2005**
General Educational studies 3	General Educational studies 3	General Educational studies 3	General Educational studies 3		
Spring 2006	**Spring 2006**	**Spring 2006**	**Spring 2006**	**Spring 2006**	**Spring 2006**
Specialisation 3 Elective for all except *Swedish, Social sciences*	Specialisation 3 Elective for all except *Swedish, Social sciences*	Specialisation 3 Elective for all except *Swedish, Social sciences*	Specialisation 3 Elective for all except *Swedish, Social sciences*		

* The science content is: *From atoms to the molecules of life* 10p, *Energy* 10p, *Everyday chemistry* 5p, *Light and Sound* 5p, *Human body* 5p, *School practice* 5p.