Jennifer Hovis Rösth

Mathematics A in Municipal Adult Education
A Case Study about a Non-Traditional Teaching Approach
The purpose of this project is to describe one teacher's non-traditional approach to teaching Mathematics A in municipal adult education. A case study has been carried out over the course of one semester of teaching, involving classroom observations, formal and informal interviews with the teacher and students, surveys and the collection of teaching materials. Each of the aspects of the teaching approach are described and discussed including “book lessons,” “practical lessons,” examinations and group work. The teacher's and students' comments on the teaching approach are recorded along with my comments. The following two questions are also addressed: What is required of the teacher for the implementation of a non-traditional way of working with Mathematics in adult education? and What is the significance of groups in a non-traditional mathematics environment? The non-traditional teaching approach described in this project was able to be linked to a social-constructivist approach to viewing mathematics teaching and learning. With the help of this project, it can be seen that non-traditional approaches to teaching Mathematics can be implemented in the classroom, even in municipal adult education classrooms.
Abstract

The purpose of this project is to describe one teacher's non-traditional approach to teaching Mathematics A in municipal adult education. A case study has been carried out over the course of one semester of teaching, involving classroom observations, formal and informal interviews with the teacher and students, surveys and the collection of teaching materials. Each of the aspects of the teaching approach are described and discussed including “book lessons,” “practical lessons,” examinations and group work. The teacher's and students' comments on the teaching approach are recorded along with my comments. The following two questions are also addressed: What is required of the teacher for the implementation of a non-traditional way of working with Mathematics in adult education? and What is the significance of groups in a non-traditional mathematics environment? The non-traditional teaching approach described in this project was able to be linked to a social-constructivist approach to viewing mathematics teaching and learning. With the help of this project, it can be seen that non-traditional approaches to teaching Mathematics can be implemented in the classroom, even in municipal adult education classrooms.
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1 Background

The past four years of my life have been spent studying to become an upper secondary school teacher. During this time, I have been student teaching at several different upper secondary schools here in Sweden. The most recent two years of my education have been dedicated to Mathematics. I have had the pleasure of student teaching on three different occasions of between three and five weeks each. During my first two student teaching experiences with Mathematics in adult education, I became acquainted with a Mathematics teacher who at the time began developing and implementing a non-traditional teaching method in his classroom. I became intrigued with this way of teaching and took part in the development process. Upon seeing the success of the teacher and his way of teaching, I immediately wanted to share his ideas with others. When it came time to research and write my degree project, I knew a case study was in order. In this project, I will describe one teacher's approach to teaching Mathematics A in municipal adult education in Sweden.

Due to the fact that I have chosen to write this thesis in English, not all readers are aware of how the Swedish school system works. Due to this, I have chosen to give a thorough introduction and explanation of municipal adult education, the national curriculum and mathematics syllabi. Those readers aware of how the Swedish school system works along with its policies may wish to begin reading on page 11.

The current national curriculum for non-compulsory education, known as Lpf 94, and the national syllabi for Mathematics were reinforced by the implementation of National Examinations, which are examinations created by special committees covering all of the material incorporated in a specific Mathematics course, correct assessments are supplied for teachers assessing the examinations and for everyday use in their classrooms. These examinations have led many teachers to begin examining and questioning their classroom situations and teaching methods. Some teachers have found discrepancies in their teaching methods and the goals set up by the state. Both the curriculum and syllabi are key factors in decisions across the nation to change approaches to teaching. It should be noted that in Sweden there is both a syllabus for Mathematics in general and a specific syllabus for each of the seven Mathematics courses available to students in the non-compulsory school system. All of the syllabi are established by the state and are to be followed nationally, in order to provide equal education to all citizens. To truly understand current classroom situations and teaching methods, a brief background of adult education, the curriculum and syllabi must first be examined. For the purposes of this paper, only the general Mathematics and the Mathematics A syllabi are relevant.

Municipal adult secondary education, known as Komvux, in Sweden “includes basic and upper secondary education, as well as continuing education programs. Komvux was established in 1968 to offer education to adults who lacked the equivalent of compulsory school or upper secondary school” (Skolverket, Adult). Municipal adult education programs are open to persons 20 years of age or older. This is an option that has become increasingly popular in recent years. Municipal adult education uses the same curriculum as all non-compulsory schools in Sweden, Lpf 94. They also use the same syllabi and grading criteria. “Every course has a syllabus stating the objectives to
be achieved. There are also grading criteria for every course stating the required level of achievement for the grades of Pass, Pass with Distinction and Pass with Special Distinction” (Skolverket, Upper). Each course offered has a nationally approved syllabi and grading criteria; there are also local syllabi and grading criteria that are approved by the municipality.

The Curriculum for the non-compulsory school system, Lpf 94, in Sweden discusses the fundamental values and tasks of the school, as well as establishes goals and guidelines for schools to follow. Lpf 94 is the curriculum that applies to upper secondary schools, municipal adult education, the national schools for adults, the upper secondary education for pupils with learning disabilities and education for adults with learning disabilities. Lpf 94 states that “the school has the important task of imparting, instilling and forming in pupils those values on which our [Swedish] society is based” and that “the task of the school is to encourage all pupils to discover their own uniqueness as individuals and thereby participate in social life by giving of their best in responsible freedom” (3).

The main tasks of the non-compulsory school are to impart knowledge and to create the precondition for pupils to acquire and develop their knowledge. [...] Pupils shall also be able to keep their bearings in a complex reality involving vast flows of information and a rapid rate of change. Their ability to find, acquire and use new knowledge thus becomes important. Pupils shall train themselves to think critically, to examine facts and their relationships and to see the consequences of different alternatives. (5-6)

One of the special task goals for the education of adults established in Lpf 94 is to “increase the pupil's ability to understand, critically examine and participate in culture, social and political life, and thereby contribute to the development of a democratic society” (9). Goals that schools shall strive to ensure concerning knowledge include that all pupils “can use their knowledge as a tool to formulate and test assumptions as well as solve problems, reflect over what they have experienced, critically examine and value statements and relationships and solve practical problems and work tasks” along with “develop[ing] the ability to work not only independently but also together with others” (10). Guidelines that have been established for the teacher concerning knowledge include the following:

The teacher shall:
- take as the starting point each individual pupil's needs, preconditions, experiences and thinking,
- organise and carry out the work so that the pupils:
  - develop in accordance with their own preconditions and at the same time are stimulated into using and developing their ability
  - experience that knowledge is meaningful and that their own learning is progressing
  - receive support in their language and communicative development
  - gradually receive more and increasingly independent tasks to perform as well as increasing responsibility,
- in the education create a balance between theoretical and practical knowledge
that supports the learning of pupils. (Skolverket, *Curriculum* 13)

Lpf 94 states responsibilities that schools have in making sure students take responsibility for and influence their education. The schools shall strive to ensure that all pupils “take personal responsibility for their studies and their working environment,” “actively influence over their education” and “strengthen their confidence in their own ability to individually and together with others take initiative, responsibility and influence their own conditions” (15). As can be seen here, the schools and teachers have great responsibility to ensure the proper education of Swedish students. Teachers must be democratic in their teaching approach and stimulate students to take responsibility for their education. Lpf 94 moves the focus from the teachers to the students. In other words, students are required to take a larger responsibility for their education while teachers are to help and guide students in their search for knowledge. The teacher's role has changed from being an educator to being a knowledge guide (Gustafsson and Mouwitz 22). Students are to become more active in the classroom and seek information. This can also be seen in the syllabi and grading criteria for Mathematics.

Mathematics has one general syllabus and a separate more specific syllabus for each of the seven Mathematics courses available in the Swedish non-compulsory school system. The general syllabus for Mathematics describes the aim of the subject, goals to aim for, the structure and nature of the subject along with a brief description of each of the seven Mathematics courses. Mathematics is given a great deal of importance in the Swedish curriculum and thought to be useful in other subject areas as well. "Problem solving, communication, using mathematical models, and the history of mathematical ideas, are four important aspects of the subject that permeate all teaching” (Skolverket, *Mathematics*). The aim of the subject according to the general syllabus is not only to continue the Mathematics education of the compulsory school years, but also to broaden and deepen the subject.

The subject should provide the ability to communicate in the language and symbols of mathematics [...]. The subject also aims at pupils being able to analyse, critically assess and solve problems in order to be able to independently determine their views on issues important both for themselves and society, covering areas such as ethics and the environment. The subject aims at pupils experiencing delight in developing their mathematical creativity, and the ability to solve problems, as well as experience something of the beauty and logic of mathematics. (Skolverket, *Mathematics*)

The general syllabus establishes specific goals for schools in their teaching of Mathematics to students to aim towards ensuring that each student is able to meet the requirements in order to receive a passing grade. Some goals to aim for include:

- develop[ing] their [the students] ability to follow and reason mathematically, as well as present their thoughts orally and in writing
- develop[ing] their ability with the help of mathematics to solve on their own and in groups problems of importance in their chosen study orientation, as well as interpret and evaluate solutions in relation to the original problem
• develop[ing] their ability to work in a project and in group discussions work with the development of concepts, as well as formulate and give their reasons for using different methods for solving problems. (Skolverket, Mathematics)

The Mathematics syllabus takes the focus off simply being able to execute mathematical calculations. This puts Mathematics in broader terms, where students should be able to think and reason mathematically, use a mathematical language, solve problems, work in groups, interpret their results, evaluate solutions and present their findings orally, among many other things.

The Mathematics A course taught in Swedish non-compulsory schools is of great importance. All students studying a national or individual program are required to receive a passing grade in the Mathematics A course. It consists of 100 lesson hours and is generally taught over the course of one full school year, two semesters, with the exception of a couple of national programs, which teach the course in one semester or three semesters. Municipal adult education teaches Mathematics A over the course of one semester. Mathematics A “builds further on mathematics from the compulsory school and provides broader and advanced knowledge in the areas of arithmetic, algebra, geometry, statistics and the theory of functions” (Skolverket, Mathematics A).

Due to the fact that all students are required to study this course, its structure is generally modified to best suit the students' needs and area of study. Different textbooks are used for different national programs. Some textbook series even have a textbook for adult education.

The syllabus for Mathematics A establishes specific goals to be attained upon completion of the course. These goals include specifics pertaining to arithmetic, algebra, geometry, statistics and the theory of functions, the main areas of study, as well as being able to solve mathematical problems in daily life, being able to solve problems with the help of a calculator and seeing the connection between mathematics, daily life and cultures throughout the world. There are, of course, different grading criteria that have to be met for each of the different levels, Pass, Pass with Distinction and Pass with Special Distinction. To achieve a grade of Pass, students must be able to “carry out mathematical reasoning, both orally and in writing,” and “use mathematical terms, symbols and conventions, as well as carry out calculations in such a way that it is possible to follow, understand and examine the thinking expressed” among other things (Skolverket, Mathematics A).

The criteria for Pass with Distinction are similar to those of pass, but require more of the student. Students have to, among other things, “participate in and carry out mathematical reasoning,” “provide mathematical interpretations of situations and events, as well as carry out and present their work with logical reasoning” and “use mathematical terms, symbols and conventions, as well as carry out calculations in such a way that it is easy to follow, understand and examine the thinking they express” (Skolverket, Mathematics A). All of these things have to be done both in writing and orally. Pass with Special Distinction's criteria are also a continuation of those previously mentioned, yet require the most of a student. The criteria include “formulate[ing] and develop[ing] problems, choose[ing] general methods and models for problem solving, as well as demonstrate[ing] clear thinking in correct mathematical language,”
analyse[ing] and interpret[ing] the results from different kinds of mathematical reasoning and problem solving” and “participate[ing] in mathematical discussions and provide[ing] mathematical proof[s], both orally and in writing” (Skolverket, *Mathematics A*).

Since Lpf 94 became effective in February of 1994, it has become more and more visible in upper secondary classrooms across the nation. Teachers are progressing towards the new curriculum and striving towards these new goals. This can be seen in various publications, such as *Nämnaren*, a quarterly magazine dedicated to teachers of Mathematics, and reports from conferences like Matematikbiennalen. Robertson Hörberg's study of 138 teachers, eleven teachers were interviewed and 127 teachers completed a questionnaire, showed the same results. Eighty percent of the teachers in her study said they changed their teaching methods since they started teaching; however, most of the teachers had not changed their teaching approaches drastically. The reasons these teachers gave for changing their teaching methods include personal experiences, students, further education and the new curriculum, Lpf 94 (190). Mathematics is one subject that has had difficulty implementing the new curriculum. Mathematics has a long standing tradition, which many teachers wish to hold on to. Traditional Mathematics lessons are comprised of a lecture, where the teacher explains a new concept, followed by quiet time for the students to individually solve exercises in a textbook. After examining Lpf 94 and the syllabi for Mathematics, it is easy to see that this traditional Mathematics classroom situation clashes with the goals and guidelines established by the state.

The curriculum and syllabi set high standards for teachers and students, but how have these new standards influenced Mathematics education? Have students and teachers lost their desire to learn and teach Mathematics? A report presented by The Swedish National Agency for Education, Skolverket, in 2003 entitled *Lusten att lär – med fokus på matematik*, “The Desire to Learn – Focused on Mathematics”, addresses this issue. A quality control was carried out by a group of education inspectors on the basis of finding out how the desire to learn is aroused and kept alive throughout compulsory school, non-compulsory school and municipal adult education. The influential factors reviewed by the inspectors were the influences on the desire to learn, both positive and negative, seen from a lifelong perspective, as well as what is being done by the school system to arouse and support the desire to learn in students. Due to the fact that the desire to learn depends greatly on the individual and the subject area, the inspectors chose to concentrate their review to the subject of Mathematics (Skolverket, *Lusten* 7).

The education inspectors defined the “desire to learn” as learning that has a positive inner driving force that relies on the ability to individually and together with others seek out and form new knowledge (Skolverket, *Lusten* 9). Many people have had bad experiences with Mathematics. Bad experiences and “blockings” can come from a teacher and bad teaching, study tempo, the character and content of school Mathematics, teaching methods and lack of faith and confidence in one’s own ability (Gustafsson and Mouwitz 94-96). For a few, these experiences lead to feelings of failure, dissociation and even anxiety, fear and panic (Skolverket, *Lusten*; Gustafsson and Mouwitz 93). Many carry these feeling with them to adulthood. Adults with negative experiences of Mathematics easily transfer their feelings to younger generations. This is not a unique
problem for Sweden, but one that is common throughout the world. The desire to learn can be described as a development of an individual’s emotions, intellect and social abilities. People who were asked to describe a situation, in which they felt a desire to learn, often described situations where they both felt and thought. The educational situations in which the inspectors found the most engaged and interested students, which showed a desire to learn, featured space for both feeling and thought, the joy of discovery, involvement and activity on the part of both the students and the teacher. These situations also featured variation in both content and methods of teaching and working. The students worked both individually and in different group constructions. The teacher together with the students reflected over and discussed different ways of thinking and solving mathematical problems. There were even elements of laboratory experiments and inquisitive ways of working (Skolverket, Lusten).

When contents are not found meaningful and students don't understand what they are working with, it is difficult to maintain interest and motivation. The same is true for the opposite, when motivation is high; Mathematics is meaningful and comprehensible, which enforces the desire to learn. Mathematics needs to deal with life outside the classroom. Working solely with Mathematics on a theoretical level contributes to the difficulty many students have in Mathematics. By beginning with the syllabi's descriptions of goals to strive towards and goals to attain, the teacher's and students' own creativity gain more space and the possibility of finding different methods for reaching desired and interesting learning can be attained. The factors that promote a desire to learn and need to be implemented on a higher basis, according to the report, are:

- the need to understand and succeed
- confidence in one's own ability to learn
- the need for school work to be relevant and comprehensible
- the need for variation and flexibility to avoid monotonousness
- class or group discussions and problem solving in groups
- the ability to influence ones studies, both content and evaluation design
- the need for varied forms of feedback
- a good working environment with time and peaceful surroundings
- the teacher's engagement and ability to motivate, inspire and show that knowledge is pleasure. (Skolverket, Lusten 26-36)

With an increased desire to learn on the part of the students, teachers' desire to teach also increases. There are few things that are needed in order to turn a traditional teaching environment into one that promotes a desire to learn. A few of these include more varied teaching methods, relevant and comprehensible content, decreased dominance of textbooks and increased use of varying teaching aids. In this paper, a traditional teaching environment is one in which the teacher begins a lesson by lecturing students on a mathematical concept or method, with little or no dialog with the students. The lessons continue with the students working individually on exercises from their textbook, while the teacher goes around the classroom helping individual students. Examinations in the form of individual written in-class tests are the most common and are generally given at the end of each chapter in the textbook. A non-traditional teaching environment, in turn, includes the factors that promote a desire to learn as mentioned.
earlier and reported by the Swedish National Agency for Education in 2003, in *Lusten att lära*. 
2 Aim

In this thesis, I will describe one teacher's approach to teaching Mathematics A to adults in municipal secondary education in Sweden. This teacher's approach to Mathematics A is non-traditional in the sense that it goes against most views of what can and cannot be implemented in adult education. This is true both for Sweden and countries around the world. Traditional views of adult education dictate that it is close to impossible to implement varied teaching methods into the stress factors surrounding adult education, such as age differences, time factors, specific curriculum and detailed syllabi. Student factors in the form of previous knowledge, blockings, negative experiences and resistance also adds to the difficulty in implementing non-traditional teaching methods into Mathematics classrooms (Gustafsson and Mouwitz 93-97). Mathematics education is traditionally reliant upon a chosen textbook both for content and structure. The stressful situation surrounding adult education has many times been the topic of conversation throughout my teacher education.

“Knowledge is fixed; teachers give knowledge to pupils who store and remember it” (Ball, Lubienski and Mewborn 435). This is a common view of Mathematics knowledge. In studies done by Romberg and Carpenter on the subject of Mathematics, it was found that textbooks are seen as “the authority on knowledge and the guide to learning,” while “many teachers see their job as 'covering the text’” (867). They found further that “mathematics and science were seldom 'taught as scientific inquiry [but rather] presented as what the experts [textbook writers] had found to be true’” (867). Höghielm's study on adult education supported these conclusions. He found that “actual teaching practices [...] run clean contrary to the ideals [...] in that teaching – according to the empirical data collected for this study [Höghielm's study] – has been organised on a 'cramming' basis. In other words, the teachers play the part of living textbooks” (207).

Great importance must also be ascribed to school tradition. Teachers coming, usually, from youth education have learned that it is their job to “teach” and to do so on the terms dictated by their teaching subjects. Teachers are confronted by adults who demand efficiency, added to which they often appreciate the absence of disciplinary problems. What, then, could be more natural than teaching by conveying as many facts as possible? (Höghielm 216)

“Despite its power, rich traditions, and beauty, mathematics is too often encountered in ways that lead to its being misunderstood and unappreciated. Many pupils spend their time in mathematics classrooms where mathematics is no more than a set of arbitrary rules and procedures to be memorized” (Ball, Lubieski and Mewborn 434). Löthman's study on Mathematics education concluded the same results; the dominant characteristic of adult education is distinguished by rule-based teacher led education. This was even appreciated by students, according to her interviews (95). However, Löthman stated that this type of education isn't without risks. One such risk is that students' mathematical creativity could become one-sided and finite (96).
Löthman also concluded, according to the teachers interviewed in her study, that teaching problems often arise because of the fact that adult groups contain such widespread ages and varied previous knowledge depending greatly on ability and previous schooling. Due to the fact that the teachers involved applied a teaching method where the students followed along in a textbook, a common ground was necessary for all of the students. The teachers found it easier if teaching originated from common references supplied by the teacher's subject knowledge. The importance of mathematical rules was emphasized by the teachers in Löthman's study. Teaching could, therefore, be seen as strongly goal oriented and built-up around a decided structure with mathematical rules. The students in Löthman's study considered mathematical problem-solving methods learned in school mathematically important; however, most students had their own methods for solving mathematical problems outside of school (131).

Despite waves of reform, Mathematics education has remained virtually unchanged.

Among the most frequent explanations [for Mathematics education remaining unchanged] are the misrepresentation of mathematics; culturally embedded views of knowledge, learning, and teaching; social organization of schools and teaching; curriculum materials and assessments; and teacher education and professional development. (Ball, Lubienski and Mewborn 435)

**Research Questions**

The teaching approach in this study goes against many of these seemingly unwritten rules or traditions of adult education. The teacher is trying to leave behind and work against many of the traditions of adult education. In this case study, I intend to describe this teacher's approach to teaching Mathematics A to adults and answer the following two questions.

1. What is required of the teacher for the implementation of a non-traditional way of working with Mathematics in adult education?

2. What roll do groups play in a non-traditional mathematics environment?

**Structure of the Thesis**

In chapter three, I will give a description of the methodology used in this case study along with a detailed description of data collection and the analysis process.

In chapter four, I will describe the setting of the case study followed by a detailed description of the Mathematics A model. The chapter concludes with both the students' and the teacher's responses to the teaching model.

In chapter five, I will analyse and discuss the teaching approach along with answering the two research questions. Throughout the chapter, ideas are highlighted with examples from observations and sections of theory in order to better analyse and discuss them. Sections of theory are included in the analysis and discussion as they were not part of the background of the study, but were required during the analysis process.
3 Methodology

In this chapter, I describe the methodology used in this study. I will first discuss case study as the choice of methodology, followed by a short discussion of the selection of study participants. Finally, I will give a description of data collection and the analysis process.

3.1 Case Study

An ethnographic case study, according to Merriam, is an intensive holistic description and analysis of a single unit of a bounded system (18+); the examination of an instance in action (26+). Ethnography is the study of a group's social or cultural way of life (Kullberg). This case study is the description of one teacher's approach to teaching Mathematics to a group of adults. The case then becomes the study of one group's way of interacting in the process of learning Mathematics. Case studies can be descriptive or interpretive. I have chosen to present this case study as a descriptive account of phenomena rather than interpretive. In case studies, the researcher has to be able to handle stressful situations and make snap decisions, be sensitive to all parts concerned and intuitive, be a good communicator, listener and writer, as well as have empathy (Merriam 18+). Being a case study researcher takes a lot of time and care both in the field and during analytical stages. This case study is a richly descriptive product of many long hours of fieldwork, analysis and report writing.

Case studies can be combined with other types of qualitative research for a more in depth understanding of a situation, process or context (Merriam 18+). I have chosen to combine my qualitative research both with other forms of qualitative research, such as formal interviews, and quantitative research, such as questionnaires and a formal evaluation. Descriptions of each of these methods follow. Researchers refer to the mixing of different research methods as triangulation (Kullberg 84; Nesbit 46). Nesbit mentions “findings that have been derived from more than one method of investigation can be viewed with greater confidence and with a greater claim to validity” (46). “The flaws of one method are often the strengths of another, and by combining methods, observers can achieve the best of each, while overcoming their unique differences” (qtd. in Nesbit 46). Kullberg says that it is better to have many questions and ideas when starting a study to make sure that the study doesn't become stagnant but easier to develop and change. However, once a study has begun the main idea or theme shouldn't change.

3.2 Selection of Participants

Case study researchers can have an insider or outsider perspective depending on their relationship to the participants in the study (Kullberg). In this case, I have both an insider and outside perspective. On the one hand, I have gotten to know the teacher in this case and seen him work on previous occasions. I know how he approaches teaching and which methods he prefers to use. On the other hand, I had never met any of the
students before the start of the semester and initiation of this study.

Upon initiating my research project, I contacted the teacher to inquire about making his teaching approach the focus of this project. He consented and the project began. The teacher received an explanatory letter within two weeks of beginning the project explaining the project, as well as its formation. The letter was compliant with the research ethics principles created by the Swedish Research Council. (A copy of the explanatory letter is attached as Appendix A.)

The students in the case study were a group of adults who registered for the Mathematics A class that was offered at the time of my project. They were each given a copy of an explanatory letter within the first two weeks of the course and allowed to change to a different group with a different teacher, which was not involved with this project, if they so chose. There were no participants that chose to change groups for that purpose. The letter was also compliant with the research ethics principles created by the Swedish Research Council. (A copy of the explanatory letter is attached as Appendix B.)

### 3.3 Data Collection

Due to the fact that the researcher is the primary instrument for data collection, the case truly depends on the researcher’s ability to react and interact with the participants. Data collection is the source of information in a case study and, therefore, vitally important. I chose to use several different methods in my collection of data. The main source of data came from observations, both in the classroom and during planning sessions. The planning sessions referred to periodically throughout this report are formal planning sessions in which the observed teacher and one colleague also teaching a Mathematics A course together planned upcoming lessons. Secondly, I used interviews, both formal and informal, with the teacher and students alike. Surveys and the collection of documents were carried out. All of these items along with a well written journal have proven useful in analyzing observations and during interviews. Each of these methods will now be discussed in detail. An overview of data collection can be seem in Figure 1 at the end of this section.

#### 3.3.1 Observations

Classroom observations and observations of planning sessions are the main source of information in this case study. I chose to do my observations in the form of observer-as-participant (Kullberg; Merriam). This means that I was primarily an observer in the classroom, but could move about freely and participate in the different classroom activities, allowing me to observe the teaching approach in its natural setting. After a few lessons, the students became comfortable with me in the classroom and began to accept me as a participant. However, I restrained from taking an active part in any form of teaching. I did on occasion help students solve problems as they worked when the teacher was busy with other students, but tried not to influence the students in any way that could alter the results of this study, a recommendation of Kullberg (98-99). Observations are difficult for an untrained researcher; it is difficult to know what to
observe and what is important. Merriam's advice on this subject includes observing: the physical settings, the participants, activities and interactions, conversations, subtle factors and my own behavior (97-98). Observations at the beginning of this study were very general and unspecific; however, with time and practice, they became more specific and specialized. One specific phenomenon becomes the focus of an entire observation period, in this case an entire lesson (Kullberg). In order to better understand the workings of a group in a mathematics classroom, I focused entire lesson observations on one group of students. On several occasions, I focused my observations entirely on the teacher and his activities in the classroom. Some observations were split up between the teacher and different groups depending on the activities of the lesson.

There were a total of forty-eight lessons during the course of the semester. I was able to observe sixteen lessons, one third of the total. While observing lessons, I generally sat as far forward and off to the side as possible as to best see all of the students’ faces and the teacher. From where I sat, the whiteboard was at times difficult to see and read.

The first planning sessions I observed and took part in were prior to the beginning of the course; that is to say the initial planning session for the entire course. At this point in time, the curriculum and the syllabi were discussed and taken into account while planning the semester, and above all, the first eight weeks of lessons. I attended a total of six formal planning sessions and almost weekly informal planning sessions. I was in constant contact with the teacher to discuss what was happening and going to happen in the classroom.

3.3.2 Interviews

Observations lead to formal and informal interview questions. Formal interviews are used most often for qualitative research as they are generally detailed and can be lengthy at times. Kvale calls the qualitative research interview “a construction site of knowledge” (42). He advises the researcher to receive consent from the interviewee and inform them of the overall purpose and the main features of the design of the interview, along with possible risks and benefits. It should be made known that participation is voluntary and the interviewee had the right to withdraw at any time from the interview (112). Confidentiality issues were also discussed with the interviewee to make sure they knew their identity and any personal or private information revealed during the interview would be unrecognizable in the final report (114).

Within the first two weeks of the semester, I formally interviewed the teacher. I first prepared a semi-structured interview guide with a mix of more and less structured questions. (A copy of interview guide 1 is attached as Appendix C.) The interview lasted about forty-five minutes and was tape-recorded. Within one week of the first interview, the tape was transcribed for further analysis. Tape-recording is recommended by most researchers including Merriam and Kvale. The purpose of the first interview was to find out about the teacher's background, the background of his teaching approach and his intentions for the coming semester. Upon completion of the semester, I formally interviewed the teacher again. He received a copy of the transcription of the first interview to review a couple of weeks in advance. I prepared a second semi-structured interview guide based on the first interview and classroom observations. (A copy of
Six volunteer students were interviewed near the end of the semester. I wanted to explore the students' perspectives on the applied teaching approach and find out formally what they thought about it. I prepared an interview guide with semi-structured questions, which covered all of the different areas of the lessons and allowed for the students to speak freely about the teaching approach. (A copy of the student interview guide is attached as Appendix E.) The semi-structured interview guide allowed for a more open discussion and the possibility for follow-up questions. The first interview acted as a practice interview to analyze the questions and their appropriateness. Upon completing the first interview, I found the questions to be suitable and appropriate, which is why I continued using the same interview guide for the remaining five students. All of the interviews were conducted in privacy, in empty classrooms, and were tape-recorded and transcribed within one week for further analysis.

Many informal interviews were conducted throughout the course of the semester. After each lesson, I discussed classroom occurrences with the teacher to get his response and answer any questions that I may have had. As the students worked in the classroom, I observed how they worked with Mathematics and how they interacted with each other. Occasionally, I would talk to students about how they were solving a problem or how they were interacting. These instances acted as informal interviews, as I recorded what was said and commented on them at a later point in time.

On one occasion, I informally interviewed the head of the school to find out more information about the school and its organization. The interview took place in the educator’s office in privacy; I took notes rather than tape-recording the conversation. The interview lasted twenty-five minutes. On three occasions, I informally interviewed a student teacher who had been working with the teacher during a five week period. We discussed what had happened in and out of the classroom that could be of interest to this case study, as well as her thoughts and reflections on the teaching approach.

### 3.3.3 Surveys

Data collection in this study also took the form of questionnaires at two different times, at the beginning and again at the end of the course. Just before the semester began, I developed a short questionnaire for the purpose of getting to know the students and their backgrounds. During the first lesson, the students were asked to write a short letter to the teacher explaining their mathematical experiences and feelings towards Mathematics; sixteen students wrote a letter to the teacher. During the second lesson, each of the students was given a copy of the first questionnaire, which was comprised of eight questions concerning the students' backgrounds, who they are and their school experience before beginning this Mathematics course. Twenty-one students answered the questionnaire. (The questionnaire is attached as Appendix F.)
At the end of the semester, the teacher and I developed an extensive evaluation, consisting of thirty-seven questions, covering all aspects of the course. The purpose of the evaluation was to get the students' anonymous feelings about the semester and the teaching approach. The teacher needed student reactions to the semester in order to further develop his approach and I wanted to know how the students really felt about the teaching approach. The students each received a copy of the evaluation roughly one week before the end of the semester. They were asked to fill in the evaluation at home and return them to the teacher's mailbox before the end of the semester. Fourteen out of twenty-three students returned completed evaluations. (The evaluation is attacked as Appendix G.)

### 3.3.4 Documents

Kullberg emphasizes the importance of collecting “artifacts,” as she calls them (13, 43). During the course of the semester, I collected a copy of each of the handouts and similar materials that were supplied to the students. This enabled me to analyze in detail the teaching approach. Materials included planning schedules, activity sheets and examinations. All of the sheets were kept in a separate folder in chronological order marked with the date they were handed out or worked with in the classroom. I obtained a copy of the textbook prior to the start of the semester and was able to keep it throughout the writing of this report for further analysis. The textbook will be discussed in detail in chapter 4.2.1.

![Figure 1: Overview of document collection.](image-url)
3.4 Data Analysis

Data analysis is the process of bringing order, structure, and meaning to a mass of collected data. Within qualitative research, analysis consists of a search for general statements about relationships among categories of data. Much of this process consists of organizing data, sorting and coding the initial data set, generating themes and categories, testing the emerging themes and concepts against the data, searching for alternative explanations, and writing the final report. (Nesbit 53)

A detailed journal was kept throughout the semester. Notes were taken during all of the planning sessions, classroom observations, formal interviews and after each of the informal interviews. After each session spent doing fieldwork, my notes were rewritten with more detail and reflections about what had occurred during each of the different sessions. The journal proved useful in creating interview guides and remembering important facts during interviews and classroom observations.

Data analysis has been ongoing throughout the course of my study. As I collected data, I analyzed and reflected upon it. My journal was a source for analysis of observations and interviews. For instance, after transcribing the student interviews, I looked for patterns, themes and consensuses within the students' answers and thoughts about the teaching approach, which lead to informal interviews with other students during classroom observations and questions in the final interview with the teacher. The transcription from the first teacher interview was reviewed several times throughout the course of the semester and became very helpful in analyzing observations and developing the final interview guide.

The questionnaires were compiled within a week of their collection and reviewed and reflected upon several times. I was able to get to know the students much quicker than anticipated with the help of the first questionnaire. After only a few observation sessions, I knew the students well enough to really observe them and record their actions and transactions for further analysis concerning the teaching approach. Conclusions could be made about each of the different aspects of the approach with the help of the evaluation.

The collection of all of the different documents and materials used as teaching aids throughout the semester were kept in a separate folder in chronological order, as mentioned earlier. This allowed for continual analysis throughout the semester and a broader analysis of teaching aids that could be compared from the beginning of the semester to the end.
4 The Case

This chapter describes in detail the workings of the case, beginning with the background factors of the case, for example information about Mathematics A, the students and the teacher. Following is a description of the Mathematics A model of teaching, including the goals and intentions of the course and descriptions of each of the different elements utilized in the teaching process. Finally, the responses to the Mathematics A model from the students and the teacher are given.

4.1 The Setting

In this section, I consider the background elements of this case study. First, I will describe the school where the study took place followed by a detailed description of Mathematics A. I will then proceed to give a more detailed description of the teacher and the students taking part in the Mathematics A course during this study.

4.1.1 The School

The school is located in a medium sized city of approximately 100,000 citizens in the southern half of Sweden, and is one among several adult education centers, but unique in many ways. It is a school which has expanded throughout the southern half of Sweden in the past fifty years. The first school of its kind was founded in the 1950’s by a group of university professors wishing to share their knowledge with people outside the walls of the university. Teaching took the form of study circles and focused on educating adults. The school was unique both then and now due to the fact that it is an adult educational association not connected to any private organization; it is a private school connected to the municipality, in other words a “private state school.” The school quickly expanded both “at home” and throughout the southern half of Sweden.

This school was formed in the early 1990's. In 1997, reorganization of adult education took place on a national level. Non-compulsory adult education began focusing on the unemployed and those needing a year off work. These adults were guaranteed admission if they wished to complete their non-compulsory upper secondary education. In 2002, the school gained “Komvux” status, municipal adult education status (see chapter 1 for a more detailed description of “Komvux”). This means that the municipality buys adult education places, which entitles the school to negotiate on how many students they can or want to admit.

Today, the school is entitled to roughly 120,000 high school credit hours, which is approximately 300 students varying between full-time students, part-time students and those only studying a course or so. Roughly ten percent drop-out before receiving a grade and approximately 250 students receive final grades each semester. At this school, the teachers are hand-picked by the head of the school, who is also a teacher; there are roughly twenty teachers teaching municipal adult education at this school. The teachers pride themselves in their open-mindedness and refuse to concede to obstacles; anything is possible. They focus on creating an environment in which both the students and the
teachers can feel secure in themselves and their knowledge. Students as individuals with individual needs are the focus of all teaching that takes place and both student study plans and teaching methods are adjusted thereafter. In other words, this school has been working in a way that agrees with the current national curriculum, Lpf 94, since its founding.

Mathematics A lessons took place in two classrooms. The classroom in this study was short and wide. The students’ tables were only two rows deep but seven tables wide; there was room for two students at each table. There are even a few tables at the ends of the two rows facing the center of the room rather than the whiteboard. The whiteboard in this particular classroom was small for a Mathematics classroom; it was one meter wide and one meter twenty centimeters high, while an average whiteboard is three meters wide and one meter twenty centimeters high.

### 4.1.2 Mathematics A

Mathematics A is the first and most basic Mathematics course offered at the non-compulsory upper secondary level. It is a summation course of all Mathematics offered below the non-compulsory level, yet broader and more advanced. As mentioned earlier, a passing grade in Mathematics A is required by all students studying at the non-compulsory level in order to receive final grades. The course is 100 credit hours and taught over the course of one semester at municipal adult education. The areas focused on in Mathematics A are arithmetic, algebra, geometry, statistics and the theory of equations and functions. The textbook used for this course will be described in detail in chapter 4.2.1.

At this school, there are three Mathematics teachers, of which two teach Mathematics A. During the semester of this study, there were two Mathematics A classes; each class was taught by a different teacher. Both of these two teachers also teach other Mathematics classes and one of the teachers teaches courses in different subject areas. The Mathematics A classes were conducted parallel to each other, in other words they were both taught at the same time and with the same schedule. At this school, Mathematics A consists of three ninety minute lessons a week. The three lessons were held Monday and Wednesday mornings and Thursday afternoons during this study. Due to the fact that municipal adult education is a non-compulsory upper secondary education, attendance cannot be made mandatory, only its importance emphasized. This can lead to problems both for the teachers and the students and will be discussed in chapters 4.3.2 and 5.

### 4.1.3 The Teacher

I will now and for the rest of this report refer to the teacher as Peter. At the beginning of the semester, Peter was interviewed about his personal and professional backgrounds, as well as about the Mathematics A course being observed. At the time of this study, Peter was in his early 50's and had been working as a teacher for less than ten years. He began his career in construction, but tired of it in the 1980's. Peter began searching for work that was more socially oriented. He became a primary school teacher, grades four through seven, and took a job as a substitute for one semester in a primary school. He realized that he wasn’t meant to be a teacher for small children and looked for work
elsewhere. Some time later, he received the opportunity to substitute one week for a group of adults between the ages of twenty and sixty in a town near his home. Peter then realized that he was better suited as a teacher for adults than for children.

After some time off work, Peter began teaching music classes; Peter is passionate about music. His music classes were held at the school described earlier. He went to the head of the school and asked if there were any available openings to teach Mathematics or English. There was an opening for a Mathematics teacher at the time, but only one Mathematics A course, roughly twenty percent of a full-time job. He took the job and enjoyed it. The following semesters he increased his hours and expanded his job to include Mathematics B and eventually Mathematics C. Currently, Peter is employed eighty percent of a full-time job and teaches Mathematics A, B and C. When asked what he enjoys the most about teaching, Peter replied:

The best part is when I notice that people are getting something out of what I am trying to get across and when I notice that people understand.

Peter has not formally studied Mathematics at college more than that which was required for his primary school teacher’s education. In order to be able to teach Mathematics B and C, he had to study the courses on his own and, at times, even learn new mathematical concepts from scratch. His mathematical abilities are limited to that which he teaches, but he is always interested in learning new things, even from his students. Due to Peter's background, he approaches things practically and prefers doing things hands-on. When describing his own learning method, he explains the need to be able to see and examine things rather than just hear and think about them theoretically. This means that when Peter teaches, his lessons become practical and based on everyday occurrences, which he and his students can refer to. This makes Peter’s lessons interesting; and Peter a candidate to experiment with different teaching methods in order to find one that better suits different individuals’ needs.

In the beginning, I thought about Math from practical reality. I applied Math to reality when I explained, mostly because it was what I found most interesting with Math. I am a practical mathematician. I always try to find my own perspective on everything that I teach complementing with things from the book.

When Peter began teaching Mathematics, his approach was based on reality and practical examples, which he and his students could relate to. However, over time, he felt that he began losing his edge due to the fact that he was working as a teacher rather than working practically. He felt his teaching methods becoming more traditional and was uncomfortable with that. At this point Peter realized that he needed to change his approach to teaching Mathematics before it was too late, yet he wasn't sure where to begin, but knew it needed to be done. Peter had a few ideas including things like group
work and more practical examples.

There is no pedagogy that is generally good for everyone. The more senses you are able to use, the higher the odds are that it suits more people compared to just having abstract pictures of symbols.

Det finns inget pedagogik som är generellt bra för alla. […] Om man utnyttjar fler sinnen man har, finns det större sannolikhet att det passar fler än om man bara har bilder av abstrakta tecken.

Peter began working with his ideas and talking to other teachers and student teachers. After a semester of reflecting and planning, he began implementing his ideas in his classroom. His first attempt didn't go as planned, but he didn't give up. He tried again the following semester after making a few adjustments. This case study describes his third semester and attempt at a new teaching model based on group work and with less focus on a textbook.

### 4.1.4 The Students

The students signed up to study Mathematics A the semester of this study were a total of twenty-six. There were twenty-one at the beginning of the semester; this number increased to a total of twenty-six and then decreased again for various reasons to twenty-three students completing the course. For the majority of the semester there were twenty-six active students. The twenty-one students present at the second lesson filled in a questionnaire pertaining to their backgrounds, both social and mathematical. The students’ ages varied, but not greatly. Most of the students were between the ages of twenty and twenty-five, only a few were older, see Figure 2. The age distribution of the students in this study was representative of the age distribution of the entire school. Due to the young age of most of the students, it hasn’t been that long since they last sat in a classroom for instruction. Seventeen of the twenty-one students had studied for one reason or another within the previous four years of this study.

Students sign up to study Mathematics A for various reasons. The twenty-one students present at the second lesson gave their reasons for studying to be: to raise their current grade in order to apply to a tertiary level of education (10), to receive a grade in Mathematics A in order to apply to a tertiary level of education (4), to receive a grade in the required subjects of non-compulsory education (1), to learn mathematics (4) and because they like Mathematics (2). From these student answers, it can be seen that the majority of the students studied Mathematics A in order to raise or establish a grade in order to apply for further education. This can be a bit of a problem when not all students are in the same position from the start of the course.

Two of the twenty-one students had never studied Mathematics A before. This means that they were at a disadvantage from day one, as their knowledge of Mathematics was not on the same level as those who had studied on previous occasions. Six students had studied Mathematics A within the past two years at municipal adult education, giving them the best advantage; and most of the remaining thirteen students had studied Mathematics A at an upper secondary school. These differences create difficulties for the teacher when planning and teaching lessons as student expectations are extremely
varied, from one student never receiving any formal Mathematics education to students who studied as most recent as the previous semester.

During the first lesson, the students were asked to write a letter to the teacher explaining their mathematical experience. The letter was designed openly allowing the students to write what and how they felt focusing on the subject of Mathematics. To get the students started, several “help questions” were provided:

- How much do you enjoy Mathematics?
- Are any particular emotions evoked when you think about Mathematics or when you enter a Mathematics classroom?
- Do you think of anything in particular when you think of Mathematics?
- How have you previously worked with Mathematics?
- How do you prefer to work with Mathematics?
- What are your expectations of a Mathematics course? What are your expectations of this Mathematics course?

In response to the first question, *How much do you enjoy Mathematics?*, the students gave varied answers. Answers included not enjoying Mathematics at all, being indifferent to it and finding it fun occasionally. Some students were indifferent to Mathematics, while others understood the importance of it, which could depend greatly on their mathematical backgrounds. The students have very different backgrounds and feelings towards Mathematics. Many students have feelings of anxiety and nervousness when they think about Mathematics, while others have a tendency to feel unintelligent and would rather be somewhere other than in a Mathematics classroom. A few students responded that they enjoy Mathematics and have only positive feeling towards learning Mathematics.
Students don’t seem to be fond of Mathematics and don’t associate much of anything positive with Mathematics. Muscle cramps, illogical thinking and a feeling of being unworthy are signs of bad experiences with Mathematics. Memorization, complicated steps, digits and time factors are all things associated with mathematics; yet they do not evoke positive memories or feelings. These negative feelings would not make a student yearn to enter a Mathematics classroom. Only one genuinely positive comment came from a student, while three other students found Mathematics useful in one way or another.

Due to the fact that Mathematics is generally taught in a very traditional way, the assumption can be drawn that most of the students have had similar experiences with only small variations. According to the students, some traditional Mathematics lessons include a teacher led lecture followed by independent student work with exercises in a textbook, while other lessons are dedicated primarily to independent student work with textbook exercises. One student experienced an alternative teaching method, which included games and problem solving exercises. One student had not received much formal Mathematics education, but rather learned Mathematics at home through everyday use. Students seem to either enjoy traditional Mathematics lessons or they don't. Many students have never experienced anything other than traditional Mathematics lessons and don’t know what to expect of alternative lessons, and therefore, could be afraid to try something new when they have negative feelings towards Mathematics. What is meant by alternative lessons according to the students who answered in this way are for example lessons that include: problem solving exercises, games, experiments and group or class discussions.

Many of the students are solely interested in achieving a high grade in order to apply to a tertiary level of education, yet many also wished to learn new things and even be able to remember their new found knowledge for years to come. Four of the students wrote that they wanted to learn Mathematics from the ground up in order to remember and be able to use their mathematical knowledge in the future.

The students signed-up to study this Mathematics A course are varied both in their backgrounds, social and mathematical, and their reasons for studying Mathematics. Yet they seem to have a few things in common, the methods the students have been exposed to while learning Mathematics, the methods they prefer when learning Mathematics and even what they hope to get out of the course.
4.2 The Mathematics A Model

In this section, I will describe in detail the teaching model used by Peter in his classroom including a description of Mathematics A and each of the individual sections of the course.

4.2.1 An Introduction to Mathematics A

Mathematics A is a summation of all Mathematics courses offered below the non-compulsory level, yet broader and more advanced than its predecessors. As mentioned earlier, a passing grade in Mathematics A is required by all students studying at the non-compulsory level in order to receive final grades. The course is 100 credit hours and taught over the course of one semester in municipal adult education. Arithmetic, algebra, geometry, statistics and the theory of equations and functions are focused on in Mathematics A.

The textbook used for the Mathematics A course in this study is entitled *Matematik 3000, KomVux - A kurs*, “Mathematics 3000, Municipal Adult Education – Course A.” This is a popular Mathematics textbook series in Sweden. The series includes textbooks for each of the seven different Mathematics courses and even special textbooks for many of the different national programs in non-compulsory education. In the book’s introduction, it is stated that the textbook series focuses on knowledge, comprehension and problem-solving (Björk, Brolin and Munther 3). This book is just over four hundred pages and has a total of six chapters. The chapters are entitled: Working with Numbers, Percent, Statistics, Equations and Formulas, Geometry and Graphs and Functions.

Each chapter is designed in a similar fashion; first there is a page long study guide. This is followed by several sections of theory, which gives the students a chance to understand and discover Mathematics (3). After each theory section follows several solved exercises printed in blue. After the solved exercises, a longer section with unsolved exercises can be found. This section starts with a few exercises entitle “Can You Solve These?” There are then three subsections with exercises divided into A, B and C representing the different achievable grade levels, Pass, Pass with Distinction, Pass with Special Distinction. A few of the exercises are marked with the symbol (L), which means that they are learning exercises and a solution can be found in the back of the book. Throughout each chapter, there are one or more practice tests. If the students don’t do well on the practice tests, repetition exercises can be found at the back of the book. At the end of each chapter there is a short section of problem solving exercises, a section entitled “Working Without a Calculator,” a short summary of the chapter’s theory and a longer section of mixed exercises (A, B and C exercises). The textbook also includes short sections, often one page long, with Mathematics history. An answer key can be found at the very end of the textbook.
4.2.2 Goals and Intentions

The Mathematics A model designed by Peter is unique. Here is a presentation of Peter’s intentions on how the model is built-up and how it is designed to work. Also included are his goals and ambitions for this specific semester.

The first planning session of the semester was intended to give the entire semester an overall layout and more specific scheduling for the first part of the semester. This planning period took place before the school semester started and both Peter and the other Mathematics A teacher were present, as the schedule and teaching content of Mathematics A are the same for both teachers. The planning session started with a fairly long discussion about the curriculum documents and both the general Mathematics syllabus and the Mathematics A syllabus. The goals established for the students, which must be achieved upon completion of the course, were of much controversy. Due to the fact that there is a large number of varying goals to be achieved, a discussion was needed to sort through them. The debate about adult education is returned to once again; the curriculum and syllabi are designed for courses taught in upper secondary schools and are, in most cases, given a considerably larger amount of time, generally one full school year. It seems nearly impossible to fulfill each of the goals without losing track of what is really important in a Mathematics course, knowledge and comprehension. Therefore, several questions must be asked: Are all of the goals equally important? Does each of the goals have to be fulfilled for a student to receive a passing grade? If not, which of the goals have to be met and, therefore, prioritized? What is the best way to fulfill as many goals as possible?

Due to Peter’s non-traditional view of Mathematics teaching, he was even forced to ask himself several other questions. How far from the textbook is it possible to deviate without missing any of the goals? Is it possible to completely leave the textbook and still fulfill the goals and guidelines established for the course? Peter doesn't like the fact that Mathematics teachers are so reliant on textbooks. He would prefer to teach without a textbook most of the time, yet realizes his own limitations at this point in his career, but would like to work towards leaving textbooks behind him. From his own experiences both as a student and a teacher, he realizes the importance a textbook has for students and their need and want to have a textbook in their possession while studying Mathematics. Peter feels that the students should have a textbook, but more for home use and practice than drilling in routine exercises in the classroom.

The first planning session ended with a rough schedule of events for the entire semester, sixteen weeks, and a set schedule for the first nine weeks of the semester. One of the first nine weeks was spring break, which meant that there were no lessons that week. The tenth week of the semester was Easter break, which made for a natural division of the semester. The second half of the semester was seven weeks only interrupted by the occasional holiday, study day or theme day, which pop-up throughout the course of the semester. The first eight school weeks were divided among three chapters in the textbook. Three weeks would be devoted to chapter one, Working with Numbers; two weeks would go to chapter two, Percent; and the three weeks before Easter would go to chapter four, Equations and Formulas. After Easter, lessons would continue with chapter five, Geometry, and chapter six, Graphs and Functions.
Three lessons were scheduled per week, of which two lessons would be “book lessons” and one “practical lesson.” Each of these two types of lessons will be described in detail later in this chapter. The activities for “book lessons” were established and a list of possible activities was made for the “practical lessons.” The focus of Peter's teaching model is group work. He believes that students should not sit by themselves and work through a textbook. Students should sit together in small groups and work through problems to truly understand and get the most out of them; therefore, nearly all classroom activities were planned to be carried out in groups. Peter's ideas about group work will also be described in more detail later in this chapter. The schedule was finalized by making copies for the students and adding a short introductory letter to the students describing how to work with the textbook during “book lessons.”

The letter to the students read as follows:

**How we work with the Math book**

1. When starting a new theory section, begin by reading through the section in the book, think about what is said, take notes and write down anything you don’t understand.
2. Discuss in your group the things you don’t understand. Before you begin working with the exercises, everyone in the groups should understand.
3. Calculate the selected exercises together in your group.
4. Upon completion of the selected exercises, go on to the next section of theory.

The rest of the exercises and sections in the book not taken up in class should be calculated at home or during math workshops. Take advantage of the possibility to contact your group members if you run into problems. It is important to write down any problems that arise while working and to bring them up in your group during the following lesson.

Apart from this book based work, we will be working once a week with other mathematics problems where other ways of working will be applied. Your active participation in these lessons will also be taken into account.

Examinations and assessments occur throughout the entirety of the course, in group discussions, short written exercises to be handed in and “regular” written tests. Furthermore, oral examinations, reviews, a national examination during the second half of the semester, lab experiments and group activities will also count towards your final grade. (A copy of the original text is attached as Appendix H.)

Peter generally doesn't set specific goals for himself. However, he does have a few goals and ambitions for this semester. He wants the course to be rewarding for his students and to give good results. Peter is interested in making sure his teaching approach develops in the right direction and that he is able to keep developing it for the better. He hopes to create a certain stability and structure in his model to make working with this model easier in the future. This is what Peter had to say about his teaching approach.
It isn't just group work; it is working practically, working with labs. But, it is a long process. It demands that I am very clear and exact and know exactly how everything is to be. It is a change. It should be natural that you work with Math in the same way you work with other subjects, more labs, more openness and more group work. I believe that above all there is support in the curriculum for working in different ways.

The schedule for chapter one is attached as Appendix I to give the reader an overview and idea of how a chapter was typically dealt with. The schedule list each lesson time and the activities of each lesson including exercises to work with in class and the date of examinations.

4.2.3 Group Work

Group work is the most important part of Peter's teaching approach. He believes in the saying “two heads are better than one.” From his experience as a student and as a teacher he realizes that Mathematics is not an easy subject to learn and understand. Mathematics, like most subjects, becomes easier to understand with help. Peter decided that students should sit in groups during as many lessons as possible in order to be able to make use of other students' knowledge.

There are many different factors that have to be taken into consideration, which causes teachers to avoid group work. Peter was no different. He has had tremendous amounts of difficulty deciding on how to group his students. He tried different strategies in each of the previous semesters in which he implemented his new model, allowing the students divide themselves into groups, ability grouping and mixed grouping, but with little success. During the planning session before the semester started, Peter had to come up with a plan on how to divide his new students into groups. Due to the fact that he didn't yet know who his new students were or their abilities, he was forced to ponder the idea until school started and he was able to meet his students on the first day of class.

A total of thirty-five students were present at the Mathematics A introduction, sixteen men and eighteen women. Three students had called in their absence. Both Peter and his colleague were present at the introduction and decided then that they would just divide the class in the middle of the room. Half of the room went with the other teacher into an adjoining room, while the rest of the class remained seated in Peter's classroom. The absent students and any student who showed up late would be divided between the two teachers' classrooms. Any student preferring one teacher over the other was also welcome to choose a classroom, no questions asked. Peter ended up with twenty students, seven men and thirteen women. As mentioned earlier, this number rose to a total of twenty-six students before landing again at twenty-three students receiving final grades.
Peter decided to try to build groups of students who could meet outside the classroom during school hours. In other words, each group would consist of three to four students who were free at the same time during the day. He asked each of the students to write their names on an empty schedule when they were free from classes. After the students had written their names on the schedule, Peter got to work trying to divide his students into groups. This method proved more difficult than he had anticipated. Only one or two groups of four students each were able to be formed. Peter decided to just divide the students into groups and let them get to know each other after finding out that virtually none of the students had met before entering his classroom.

It was decided that after roughly four weeks of work in these original groups, a discussion with the students about the groups would be initiated, in order to find out how the groups were working out and when the students would like to change groups. After roughly six weeks of lessons, Peter made new groups. At this point, he rearranged the groups so that for the most part everyone was randomly placed in a new group. Two students were given special treatment in designing new groups. That is to say, they were placed in a group based on ability, in other words the students who had not previously studied Mathematics A and required more help. The students were constantly encouraged to work in groups outside the classroom, even if they weren't able to meet with their “classroom” groups. The importance and value of group work was stressed throughout the course.

4.2.4 Book Lessons

Book lessons were similar to traditional Mathematics lessons with the exception of group work. The students were given a schedule for each new chapter they were about to start. The schedules included the name of the chapter in question and a detailed list of the days designated to the particular chapter and the date of the examination. Each week was divided into three sections with room for each of the three lessons of the week. Each lesson was explained in detail including which pages of theory the lesson concerned and which exercises were to be calculated in class in groups. The theory was supposed to be read through at home and notes taken as well as any questions or problems that arose during the reading of the theory written down in order to be discussed in groups before calculation began, as mentioned in chapter 4.2.2.

Many book lessons contained a teacher led lecture. At the beginning of the semester, there were few lectures; and if there was a lecture, it was held in the middle of a lesson or towards the end allowing the students to work with the theory and exercises first. As the semester progressed, so did the lectures. They became more frequent and were often held at the beginning of a lesson. The lectures even became lengthier with time. The students seemed to enjoy the lectures and often asked for more and longer lectures with more examples, even though Peter was opposed to having so many at the beginning of the semester. He realized how important the students found lectures and abided to their wishes by adding more.
After the lectures, the students sat in their groups and calculated the selected exercises. During different chapters and sections of theory, different teaching aids were retrieved from a cabinet in the classroom in order to better illustrate examples. These teaching aids included different three-dimensional wooden shapes, tape measures, scales for weighing objects, wooden squares with a grid of holes used to represent the coordinate system where nails could be placed in the holes to create equations, etc. The students were encouraged to use the teaching aids as much and as often as possible.

The types of exercises selected from the textbook to be worked with in-class were generally typical of any Mathematics textbook. The exercises were selected from each of the three different categories, A, B and C, representing the different grade levels, in order to satisfy everyone needs. Groups were encouraged to pick out further exercises at the level that best suited them. A couple of exercises selected from Chapter one, Working with Numbers, subsection, Negative Numbers can be found in Appendix J.

Generally, the students would work diligently for most of the lesson time. However, near the end of the lessons, some students would get restless and talkative. Depending on how much time was left in the lesson, Peter would step in and advise the students to get back on-task. If there were only a few minutes remaining, he would let the chatter seemingly slip by. If groups would happen to get off-task early in a lesson, Peter would make his presence known to the group by asking if they had encountered trouble or needed help with anything. This generally helped an off-task group back on-task. Occasionally, he would even find different and more advanced problems for groups that had difficulty staying on-task.

Many students seemed to enjoy working with exercises from the textbook in groups. Many commented on how much easier it was to understand Mathematics and get help than it had been in previous courses while working individually. There were only a couple students who were persistent in working individually or not coming to class. After getting to know these couple of students by being in the classroom, taking part in lessons and observing, I came to realize that these were the students with the worst experiences with Mathematics. They were the students who least liked Mathematics and had the most fear, anxiety and nervousness towards Mathematics. In general, book lessons where productive for most students. Peter spent his time walking around the room helping groups and occasionally individual students with problems or finding more advanced problems for groups to work with.

4.2.5 Practical Lessons

Peter has always been more practical than theoretical in his learning and teaching of Mathematics; therefore, it was quite natural that he would develop his own teaching approach that includes more practical elements. Peter had searched for alternatives to traditional teaching methods and activities. This is when Peter became serious about developing his approach. He bought a binder and started collecting all of the different activity sheets he came across. Today he has several binders with many activities sorted into categories in order to be able to find them. The activities are a never ending collection from many different sources.
Of the three Mathematics A lessons each week, it was decided that one lesson would be devoted to other activities where different ways of working could be applied. Peter had many ideas of what these practical lessons should be devoted to. The most obvious activities for such lessons would be working with something related to the present chapter in the book. However, Peter also believed in working with different areas that students generally had problems with, for example working with multiplication and division tables.

During the first planning sessions, Peter couldn't decide which activities would be used during the first eight weeks of lessons, but rather made a list of possible activities to organize and check through in order to have different activities prepared. Depending on the situation and the students, he could pick-out an activity that suited the lesson's needs. Examples of the different activities with explanations used during these practical lessons throughout the semester follow.

- European Kangaroo Competition – A yearly competition for students of all ages. Originally started in Australia, and spread throughout the rest of the world. Peter uses old competition exercises to strengthen and sharpen his students' knowledge and awareness of Mathematics. (For more information see Nämnaren's web site at http://ncm.gu.se/index.php?name=kanguru-start.)
- "Krister Activities" - Activities whose origin began with a former secondary school Mathematics and Science teacher. Some of these activities can be found in the teacher's guide to the Mathematics 3000 textbook series. (Two activities can be found in Appendix K and L)
- Newspaper Math – Mathematics can be found everywhere. Peter noticed that the daily newspaper contained considerable amounts of mathematics. He began collecting articles and entire newspapers to use during practical lessons.
- Subject Integration – Mathematics isn't a subject by itself. It is easily integrated with many other subjects. Peter has activities involving music, law, social sciences and many other subject areas, not forgetting the most obvious, natural sciences. (See Appendix M)
- Working without a Calculator – Today's students have become reliant on calculators. Peter believes in allowing his students to use calculators during lessons and on tests. However, he feels that being able to calculate simple Mathematics in your head is not something that should be ignored. He has many different exercises to help students practice and strengthen their abilities.

The practical lessons seemed to be appreciated by most students. They enjoyed leaving the book behind them for a lesson and working with something else. However, there was a continuous debate on whether or not time allowed such activities. That is to say, if they would be able to finish the textbook chapters and exercises before the end of the semester. The Mathematics students in this case have a need to calculate exercises in a textbook in order to have a feeling of mathematics knowledge. They have a desire to calculate as many exercises as possible in as short a period of time as possible. This is something Peter doesn't like and would like to get rid of in his students. He feels that a person can learn just as much Mathematics from one good exercise as from one hundred
mediocre exercises. However, weaning students off of their Mathematics textbooks is a long process; and therefore, understandable that Peter met with some debate on this subject.

4.2.6 Examinations

Examinations occur in many different forms in Peter's classroom. He uses traditional individual in-class written examinations at the end of most chapters, but also take-home examinations, small exercises to be handed in and group examinations. Accordingly, group work and active participation in the classroom are also factors that are averaged into the final grades of his students. Peter's traditional individual in-class written examinations are not so traditional at times. He doesn't feel that a student necessarily understands a mathematical concept just because they can calculate a simple problem. He feels that being able to explain how to solve a problem is much more interesting and important. Therefore, many of the questions on his examinations are in the form of “explain how,” where students have to explain in words and with examples how to go about solving a problem.

Here are a few examples of typical “explain how” questions from Peter's examinations.

<table>
<thead>
<tr>
<th>Explain in your own words and with number examples. Your written explanation is more important than your number example.</th>
<th>Förklara med ord och visa med egna sifferexempel. De skriftliga förklaringar är viktigare än sifferexemplen.</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you need to do to be able to add two fractions with different denominators?</td>
<td>Vad behöver du göra för att kunna addera två bråk med olika nämnare?</td>
</tr>
<tr>
<td>What are the advantages of calculating with the rate of change rather than with percent, %. Explain with as much detail as possible.</td>
<td>Vilka fördelar är det att räkna med förändringsfaktorn i stället för procent, %. Förklara så utförligt som du kan.</td>
</tr>
<tr>
<td>a) Explain the difference between simplifying and solving a problem. b) What kind of problems can be simplified and what kind can be solved? Motivate your answer!</td>
<td>a) Förklara skillnad mellan att förenkla en uppgift och att lösa en uppgift. b) Vilka sorts uppgifter går att förenkla och vilka går att lösa? Motivera!</td>
</tr>
</tbody>
</table>

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Peter's examinations generally included the traditional “calculate” questions as well. However, a grade higher than Pass could not be achieved by only answering those types of questions. Peter spends considerable amounts of time during lessons discussing with students how important it is to understand how and why an exercise is solved a certain way. He is also open for student suggestions for solving problems that deviate from textbook explanations. Peter's students should be well prepared to take his examinations; however, the first examination is always a struggle for the students. Being able to explain a solution is something that his students become very good at and many even enjoy taking his examinations by the end of the semester.

The students' final grades were based on a total of five chapters of work throughout the course of the semester. Three of the chapters were tested with traditional individual written in-class examinations. One chapter was tested in two parts, the first part was a traditional individual written in-class examination and the second part was a group examination. The students were given the choice of a take-home examination or a traditional individual written in-class examination for one chapter. The difference between the two examinations was that take-home test could only give a grade as high as Pass with Distinction. To receive a Pass with Special Distinction, the students were required to take the in-class examination. Near the end of the semester, the students were also given a National Examination. The National Examination should be completed by all non-compulsory students; however, municipal adult education is an exception due to the fact that the examinations are held nationally once a year, in the spring. Adults can study Mathematics A during the autumn semester when no National Examination is given, which means the examination cannot be required as part of their final grade. The school where this study was conducted has recently begun including National Examinations in their courses as part of the students' grades.

Through my observations and experience in Mathematics classrooms, I have found that a great deal of importance is placed on examinations. This is not untrue for Peter's classroom. Students' grades are based for the most part on examination results, yet can be increased by performing well in other classroom activities. The point has not been reached where inactivity in the classroom or lack of participation in group activities can influence a student's grade.

4.2.7 Mathematics Workshops

Mathematics workshops are something that Peter and his colleagues believe strongly in. The school introduced workshops some years ago and have only expanded them since then. Workshops are time set aside during the school week for students to get extra help with Mathematics, extra help with homework or calculating textbook exercises. At the beginning of each semester, the three Mathematics teachers check their schedules for available time. They generally set aside one to three lesson times each week to host a workshop. During these times, the available teacher can be found in a classroom where any Mathematics student is welcome to come, work and get help when needed. Obviously, the more workshops that are available to students, the more help they can get.
During the semester of this study, there were six Mathematics workshop times set aside each week. Peter hosted two workshops, while his two Mathematics colleagues hosted one and three respectively. For the students studying Mathematics A, there was never a problem with which teacher was hosting a workshop. All of the teachers are knowledgeable in Mathematics A. This is not true for all of the upper level Mathematics courses. The workshops were voluntary for the students, which means that most students utilized them just before examinations rather than continuously.
4.3Responses to the Mathematics A Model

In this section, I will give an account of the students' reactions and comments along with the teacher's reactions and comments to the Mathematics A model.

4.3.1 The Students' Comments on the Mathematics A Model

Through observations and short informal interviews during lessons, I was able to get an idea of what the students thought of Peter's approach to teaching Mathematics A. However, in order to discuss the students' thoughts and feeling towards the approach, the students filled-out an evaluation and six students, two boys and four girls, were interviewed. The students' names have been changed to protect their identity.

In General

The students were generally satisfied with the Mathematics A course as a whole. They tended to think that the tempo of the course was high, which made it difficult to manage at times, but in general the course was acceptable. Several of the students commented that the course was fun. On the course evaluation, half of the students considered the course “good” while the other half considered it “very good.” The course met most of the students’ expectations.

Book Lessons

In response to questions about the book lessons, the students were generally positive. They found the lectures to be good or very good and for the most part meaningful. At times the lectures were too long, had too high of a tempo, were too detailed or too short, but each lecture was different and not everyone could be happy all of the time. Few students thought that there were too many lectures. Many students found the lectures more interesting and comprehensible when they contained practical examples.

Examinations

The “explain how” questions of the examinations gave mixed responses, from very difficult to easy. Many students found them rather difficult at the beginning of the semester, but got used to them and enjoyed them towards the end of the semester. They began realizing the value in being able to explain how a mathematical element worked rather than just being able to calculate something based on a rule from a textbook. They were also able to realize the value of attending class.

When you understand, you can do the problems [“explain how” questions]. If you have been in class and done the exercises we've had, then I think that everyone can do them. (Billy)

You have to think and understand why you do something in a certain way, not just come and say that's how it is. You have to really understand why and I think that is good because I haven't done that before. (Fillippa)

När man förstår kan man räkna dem [förklara uppgifter]. Har man varit i klassen och räknat de uppgifter man har haft, då tror jag alla klara dem. (Billy)

Man måste tänka efter och förstå varför man gör på ett visst sätt inte bara komma dit och säga att det är så. [...] Man måste verkligen förstå varför, och det tycker jag är bra för det
The students found the examination forms acceptable and in compliance with their expectations of the course along with the goals and intentions of the course. Here is a summary of the students’ examination results including their final grades. The number of students not passing each test is left out of the table.

<table>
<thead>
<tr>
<th>Chapter from Textbook or Examination</th>
<th>Working with Numbers</th>
<th>Percent</th>
<th>Equations</th>
<th>Geometry</th>
<th>Functions</th>
<th>National Exam</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Students</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>18</td>
<td>19</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>PSD</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>PD</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>P</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1: Student examinations results including final grades. PSD stands for Pass with Special Distinction, PD for Pass with Distinction and P for Pass.

**Practical Lessons**

The practical lessons received mixed comments. Many of the students enjoyed the practical lessons and working with Mathematics outside the textbook. However, there were a few students who were weary of leaving the book behind them once a week, due to the fact that they were concerned about finishing the course by the end of the semester. Even though some students were hesitant to the practical lessons, most of them were able to understand their value, find them meaningful and learn new Mathematical concepts or applications for their Mathematical knowledge. One interviewed student was a bit disappointed with the practical lessons. She had high ambitions for these lessons and had hoped that there would have been more lessons with more engaging activities.

I learned a bunch actually. You have to stop and think a bit. (Charlie)

You don't have to work in the book; you can work more independent. You have to use previous knowledge. (Diana)

I wanted to work more with my hands, work more with other examples. (Fillippa)

Jag har lärt mig en del faktiskt. Man tänker till lite. (Charlie)

Då slipper man jobba i boken. Man får jobba mer självständig. Man måste ta fram de andra kunskaper man har sedan tidigare. (Diana)

[Jag ville] jobba mer med händerna, jobba med andra exempel. (Fillippa)
Group Work

Group work was also met with mixed feeling from the students. Most students have experience with Mathematics and have taught themselves how to manage a course; often this coping mechanism results in focused individual work. However, from the results of the students Mathematics letters to the teacher from the beginning of the semester, many of these students hadn't succeeded in Mathematics before nor had they had pleasant experiences. Working in groups was a new experience in a Mathematical classroom for most of the students. This student sums up the remarks of the interviewed students best.

When you work in a group, there are more people who can help out. You can get more opinions when you are stuck on a problem. One person maybe says one part and then another person says a part and suddenly you have learned something. But sometimes it isn't always so good to work in a group, like when you want to concentrate on something and the others aren't on the same problem.

(Diana)

Most students found that working in groups worked well in a mathematics classroom, yet would prefer to limit group work to one or two lessons per week rather than every lesson. The students felt they needed time to concentrate at their own level occasionally. Working in groups has meant different things to different students. Many have had good experiences, but some have not been as successful. A few students were unable to find harmony in their groups, which made for uneasy experiences. A couple students had trouble working in their groups due to the fact that their mathematical abilities were not as high as other group members'. After the groups were reconstructed, students encountering the most difficulty were placed in the same group allowing them to learn Mathematics at their own pace. These students began enjoying Mathematics again and their grades rose.

4.3.2 The Teacher's Comments on the Mathematics A Model

The focus of the second interview with Peter was on evaluating the course. Conclusions could be drawn from observations and informal interviews, which were reinforced upon formally interviewing Peter the second time. What are Peter's thoughts after over five months of work?

In General

I am not really satisfied with the semester. If I look at the students' evaluations, then I am very happy. If I look at how the students have enjoyed Math, then I am happy. That's the most important part.

(Jag är inte så jättenöjd med den [terminen, kursen] [...] Ser jag utvärderingarna så är jag väldigt nöjd. Ser jag hur de har gillat matte då är jag nöjd. Det är det som är det väsentliga.)
Peter had mixed feelings about the semester. He wasn't really pleased with the overall picture of the semester, yet the students seem satisfied to him, which raised his spirits. He questioned his ambitions, if they were too high or if he was just not able to live up to them. He reflected on the fact that he had not lived up to his full potential during a portion of the semester.

What I am unhappy with is that there has been so much absence. That is something that has made our work more difficult. The students have a general press from other subjects and it becomes a lot all at once. That has resulted in not everyone working as hard as I had hoped.

The fact that students come and go as they please upsets Peter. There is little or no consideration for his hard work, or that of the other students. Absence is a major problem in all adult education classes, not just Peter's. Peter feels that when students are absent they fall behind in their mathematical development as well as disrupt the learning process for other students. He cannot plan or carry out lessons the way in which he would like, due to the fact that his students are often absent. Discipline measures are not something that teachers generally want to have to implement and enforce in their classrooms, especially not teachers of adults. Peter seems to see this as a last resort in trying to get his students to realize the value and importance of attending lessons. Peter is afraid that he may have to implement some form of discipline measure in the near future to make the students realize the importance of attending lessons.

Peter experienced some difficulty with his class about half way through the semester; this problem was new for him. His students were extremely unmotivated and spent most of their time in class talking about other things. Eventually, Peter and his students worked through the problem and the second half of the semester went better. He learned a lot from this experience and believes that the next few years of teaching will be to classes with a similar make-up, younger adults. Younger students are not as mature and responsible as the older students Peter is used to working with.

**Book Lessons**

Peter seemed relatively pleased with his book lessons. He realized after a few weeks, the students craved lectures and began implementing more. After awhile, the lectures became lengthier, which Peter was aware of and many times paused to ask if he should continue lecturing or if the students would like to begin working. Often, the students chose a longer lecture. However, he only continued while he had a dialogue with the students. He wanted the students to ask questions; if the students didn’t ask questions, Peter stopped lecturing.
Examinations
A problem Peter could see with this semester was his reliance on test results for final grades. Due to the problem with absence, Peter had difficulty being able to establish a grade for many students due to the fact that they were not present to take part in classroom activities. They generally didn't do anything to compensate for their absence either. This meant that the students’ grades had to be based on the material Peter had, written individual examinations.

This semester there has been a tendency to rely too much on test results. I don't like that. The students have to understand the importance of attending lessons. It is very important. But, when they come and go, back and forth, I lose control and their grades become based too much on tests.

Practical Lessons
Peter enjoys his practical lessons and would like to implement more of them in the future. However, he realizes that when scheduled lessons have to be cancelled and time becomes a stress-factor, his practical lessons are often the first to suffer and disappear. There are numerous reasons why the practical lessons got lost in the process; all of the factors of adult education, as mentioned in chapter 2, play their own part. Peter realizes that his practical lessons disappeared more and more over the course of the semester, but isn't sure what to do about it. However, he was very happy about his efforts during the Geometry chapter. Many lessons, both book and practical, turned into practical lessons. Everyday he had new activities for his students who constantly worked with teaching aids from the cabinet in the classroom or wandered about the school looking for different shapes to examine and so on.

Peter knows his practical lessons and group activities need more space in his teaching approach and this is something that he has to work with and develop. It is clear to see that Peter sees his strengths and weaknesses. He is critical to everything he does, yet is able to see the positive sides as well.

Group Work
Practical lessons and group work go hand-in-hand in Peter's teaching approach. Mathematical discussions are important to Peter, which is why group work is such a central part of his teaching model. He realizes the importance of mathematical conversations and would prefer his students to work in groups throughout each lesson, even outside the classroom.

I think that we can do a lot of practical things, like difficult problems that the students can sit and work with in groups. They could sit and work an entire lesson, have group discussions and so on. Once again we have to leave the book behind us.
Jag tycker att man kan göra mycket speciellt som svåra uppgifter som de kan sitta och grubbla på gruppvis. [...] Man skulle sitta och jobba med dem hela lektionen, diskussioner mellan grupper och så. Återigen måste man kasta boken över axeln.

Peter's goal is to work more with groups on exercises and problems outside the book. He would like to leave the book outside the classroom, as something the students work with at home, and introduce more involved problem solving activities, as well as laboratory experiments and other hands-on activities. Peter is not completely satisfied with the semester, but realizes that he is in the middle of a long developmental process, which is making progress in the right direction.
5 Analysis and Discussion

In this chapter, I will analyse and discuss the strengths and weaknesses of this teaching approach, along with my own personal reflections. I will also discuss the two main questions of this essay.

In General
Overall, Peter's teaching approach seems to be making progress. However, it is in the early stages of development, which means there are still a great many issues that need to be addressed and worked through. The students' responses in both the interviews and evaluations were expected; they coincided with classroom observations and informal interview responses. Peter seems to be aware of his strengths and weaknesses, which allows him to continue developing his approach.

Organization is an important factor in any classroom. Peter is aware of the need for organization yet seems to have a continuous problem with it. The first half of the semester was well planned with the exception of exact activities for each of the practical lessons. However, with time, new schedules weren’t always ready in time to start a new chapter and practical lessons weren’t planned. Students were left wondering which pages of theory to read for coming lessons, which exercises to calculate and when examinations were scheduled. No chapter was ever completely without a schedule, but a couple chapters were started and well under way before proper schedules were completed and handed-out to students. Peter had at times problems with keeping papers organized, knowing where handouts and examinations were when students or I asked for copies of them. Organization is something that needs to be considered.

Attendance is a continuous problem in municipal adult education. Most of the students are unable to commit to their studies full-time, due to various reasons such as: work or small children to care for. Due to the fact that municipal adult education is a continuation of non-compulsory upper secondary education, attendance cannot be made mandatory, only its importance emphasized. This has a tendency to lead to conflicts between students and teachers, and problems for teachers concerning planning and the execution of lessons. The students are adults and entered voluntarily an adult education facility; therefore, they cannot be forced to attend or be reprimanded for not attending. Peter has mixed feelings about attendance and is not sure what to do about it. I believe that attendance is one aspect holding Peter's approach from developing and being executed to its full capacity.

Book Lessons
Lectures were a subject of discussion at the beginning of the semester. Peter was unsure of how many lectures his lessons should have. He was even unsure if he should lecture at all. The semester started with few lectures that were typically held in the middle or towards the end of lessons. However, with time, the students began showing their enthusiasm for lectures and asked for more of them. Peter increased his lectures in both amount and length. Peter always tried to start a dialogue with the students during his lectures to keep them involved. He wanted his students involved in their learning process and to ask questions to steer his lectures in a direction better suited to his students' needs. However, I felt that as Peter’s lectures increased, the amount of time
and focus on group work and leaving the book behind decreased. By the end of the semester, it was beginning to be difficult to find Peter’s original intentions in his classroom. When confronted with the issue, Peter seemed aware of the problem, but unsure of what to do. He was concerned about the students’ well-being and wanted to make them as happy as possible without compromising his approach. Lectures will remain a central issue in the development process of Peter’s approach.

There were many book lessons during the course of the semester but a few stand out in my memory and notes as being special in some way. One particularly interesting lesson occurred just after a long weekend. The students had received a handout to do as homework for the next lesson (see Appendix N). The object of the handout was to determine how many glasses weigh as much as one bottle. One of the seventeen students present at the lesson had solved the problem. Peter had already decided to discuss the exercise with the students on the whiteboard before he knew that only one student had solved the problem. Peter went through the exercise two times showing two different ways of solving the exercise while trying to keep a dialogue going with the students. Only four or five students actually took an active part in the dialogue. Two students complained that the exercise was too difficult, they shouldn’t have to learn things like this and that they shouldn’t be tested on problems of this sort. The students wanted an easier way of solving problems of this nature even though they had already spent three weeks working with the present chapter and were going to have an examination during the next lesson. The actions of the students surprised me when I considered their ages. This was not an isolated incident.

I found the Geometry chapter, especially in the beginning, to be the essence of Peter’s ambitions and his teaching approach. The lessons were practical, where the students spent their time working with real everyday objects and applying their new “book” knowledge while examining them. This is the direction Peter’s approach is going in; this is what he is working towards, practical lessons based on everyday occurrences.

The first Geometry lesson began with Peter telling the students to close their books and forget about them for awhile. Peter lectured for a very short time about the basics of geometry, how to calculate the circumference and area of rectangles, parallelograms, rhombuses, trapezoids and triangles as well as changing between units. Most of what was discussed during the lecture was knowledge students had from previous Mathematics courses. The lecture was a good dialogue between the students and Peter, compared to many earlier lectures. After the lecture, the students were instructed to, in their groups, go around the classroom and locate the different shapes they had just discussed. Upon locating a shape, they were to calculate the circumference and area of the shape as well as change the original measurement units twice, once to larger units and once to smaller units. Towards the end of the lesson, the groups who had completed the task were encouraged to begin discussing how to calculate the circumference and area of circles.

The second Geometry lesson started with a review of the activities of the previous lesson. Results were recorded on the whiteboard and discussed by the whole class. The lesson continued with an explanation of why circumference and area are calculated the way they are with practical examples. Peter also discussed with the students pie, π,
followed by how to calculate the circumference and area of circles. Again, in their
groups, the students were to go around the classroom locating circles and calculating the
circumference and area of them. Towards the end of the lesson a couple groups
presented their results to the rest of the class.

The third Geometry lesson was a practical lesson, where the students in their groups
worked with an exercise called “The Hockey Puck.” The exercise is one of Peter’s
“Krister activities.” In this activity, each group of students is to either examine a hockey
puck or another cylindrical object. The activity includes calculating how far the hockey
puck would have rolled after one hundred revolutions, how many revolutions the hockey
puck has made after traveling a distance of 1.5 km, estimating and calculating the area
of the hockey puck's top, its side and its volume along with other similar exercises. (A
copy of the original activity is attached as Appendix O). The rest of the Geometry
lessons were a bit less practical than the first three, but for the most part the students
worked in their groups, on-task and engaged. The chapter ended with the option of a
take-home examination or an in-class examination.

Examinations
The examinations given during the semester were for the most part traditional
examinations, with the exception of two examinations, a two-part examination and a
take-home examination. The examination which was divided into two parts, one
individual part and one group part did not meet my expectations. I thought that the
group part of the examination would count towards the students’ grades, but it didn’t. In
my opinion, this sent the wrong message to the students about the importance of group
work in this course. Peter’s approach to teaching didn’t hold true during this
examination.

The take-home examination was another good start in the right direction; however, the
downfall was in order for a student to receive the highest grade, he or she was forced to
take a traditional in-class individual written examination. I believe in the future Peter
will be able to develop a take-home examination that allows for all possible grades to be
achieved and that there will be other examination forms that count towards the students’
final grades. It is important for Peter to find a balance between traditional and non-
traditional examinations.

Group work is essential in Peter's teaching model, yet it doesn't seem to have any
influence on students' grades. In order for the students to understand the importance of
working in groups, attending class and participating in activities, their grades need to be
based on more than traditional examination, even if that means a student will receive a
lower grade due to the fact that he or she did not attend class or participate in classroom
activities. The curriculum and especially the syllabi reinforce this idea; support for
Peter's teaching approach and views on examinations and grades is found in these
documents, which helps create a desired balance.

Practical Lessons
A reoccurring factor throughout the semester was the issue of time. When time became
a problem, the practical lessons suffered more than the book lessons. On occasion,
lessons would have to be canceled at the last minute due to teacher conferences,
unplanned theme days or one of numerous other reasons. When a Mathematics A lesson had to be canceled, the schedule would need to be rearranged and the practical lessons most often disappeared. This was most unfortunate. It showed the students that the practical lessons weren't as important as the book lessons; the opposite message Peter wanted to send to his students.

Another issue with the practical lessons was that they were not always as well thought out as other lessons. Some of the practical lessons seemed to come up too quickly for Peter to react and find the most suitable activity for a specific lesson. This is something that is common at the beginning of something new and will most likely disappear with time and experience. However, it is unfortunate none the less.

There were several practical lessons that stood out in my memory like the book lessons. One of which was a lesson close to the beginning of the semester; students worked with old European Kangaroo Competition exercises, which were met with enthusiasm (see chapter 4.2.5 for a description of the exercises). Many of the exercises were difficult, yet interesting and meaningful to the students. Many students didn’t feel that the exercises had anything to do with Mathematics, while others found it interesting to see and understand how Mathematics can be found in the most unexpected places. The students seemed to enjoy these kinds of exercises, which is a good reason to implement more.

Problems from reality, subjects like inheritance law and music were good examples when dealing with fractions for the students to work with (see Appendix M). The music exercises were a bit difficult for many students as they were not musically inclined. However, most of the students found the exercises dealing with law interesting and, therefore, easy. I think more exercises of this nature should be found and put to use in the classroom. The students seemed to respond to reality based problems that they have or could easily run into in everyday life.

Another good example of reality based problems was the first real lesson of the semester. The students were assigned to come up with at least two of their own mathematical problems dealing with everyday things, similar to this example:

I went to the store with 120 SEK and bought 50g mushrooms for 49.90 SEK/hg, milk for 7.50 and 2 boxes of cereal for 21.70 a piece. I had a coupon for 10 SEK rebate with the purchase of 2 boxes of cereal. How much money did I go home with?

The students found these problems meaningful, comprehensible and fun. A great deal of time was spent on the students’ problems and the students seem to learn a lot. More lessons of this nature need to be implemented into Peter's planning. These lessons highlight his approach.
Group Work and its roll in a non-traditional mathematics environment

Group work was the focus of nearly all lessons as it is the basis of Peter's teaching approach. Many of the students seemed to enjoy being able to work in groups. However, a few of the students preferred working individually. This meant that if Peter asked the students if they preferred to work in groups or individually during a lesson, they generally wanted to work individually. However, most often when the students were able to work individually, they still wanted to be able to work with their neighbor. In other words, the students didn’t want to sit in groups and work, but rather sit by themselves and work with their neighbor. At first I was confused by this phenomenon; however, it didn’t take long for me to realize that the students wanted to work in groups, just not their assigned groups; they wanted to work with their friends. On a few occasions, the students were allowed to work with their friends, but often this led to time off-task.

From my observations and from student interviews, I have found that how a group is designed is one of the most important factors in ensuring a group’s success. During classroom observations, I would occasionally walk around the room and help when needed. Many of the students asking for help were individual students, not whole groups. This meant that the groups were not working on the same exercise; they were not working as a group, but as individuals who just happened to be sitting next to each other. Often students preferred asking the teacher for help rather than their fellow group members. Many of the groups were made-up of students with very different abilities. At times, Peter's group constellations were not effective.

Factors that affect a group are size, outside pressure, solidarity, self-confidence, self-awareness, status within the group, age and phase of development (Åberg 18). Other factors that effect Peter's groups include attendance, social and mathematical backgrounds, previous knowledge and previous experiences. As the leader, or teacher in this case, of a group, one needs knowledge about group dynamics, that is to say, what happens in a group, what different members do, how they behave and the consequences of members' actions towards each other (Nilsson 14). A “we feeling,” a feeling of togetherness, generally forms when a group’s members become acquainted, come closer together and standards on how to behave in the group are established (9). According to Sjögren, a group's size is of great importance for the success of the group. A smaller group of four members is ideal and optimal for open discussions where all of the members have the opportunity to speak. Few members, such as four, force all of the individual members into focus making everyone’s efforts count (101-105).

The teacher creates feelings of security and balance in the classroom. It is important for the teacher to have clear and concrete goals before entering the classroom, in order to more easily create these feelings of security and balance (Nilsson 104). The teacher is also responsible for motivating his or her students, which leads to increased responsibility, self-realization and fulfillment in the students (37-41). Group work requires more time, planning, resources and structure on the part of the teacher, which is not always available (Sjögren 204). It can also be difficult for the teacher to determine the different group members' efforts when deciding the students' grades.
Sjögren recommends putting extra time and effort into building effective groups. More active students should be placed together in groups, while less active students should be placed in groups together. In this way, less active students are able to increase their self-confidence and become more active over time. Where and how to place groups in a classroom is also important. Most activity occurs while students are sitting in a circular form rather than next to each other (105-113).

Peter needs to develop a model for building groups. All of these factors need to come into play. Two students also had ideas on how to improve the success of groups in the future.

Determine groups based on how smart we are. (Fillippa)

Maybe you could take a group aside and teach them based on how smart the group is. (Charlie)

Due to the fact that Mathematics A is the lowest level Mathematics offered in non-compulsory schooling, most students studying it have just started studying at municipal adult education. This means that most often the students are unacquainted with other students in the classroom, as was the case during this semester. When the teacher has never met the students and the students have never met each other, it is difficult to build groups. Random groups are probably most appropriate at the beginning of a course. However, after the students and teacher have gotten to know one another, more effective groups can be formed.

One idea on how to break Peter's students into groups is based on attendance, activity and ability. Students who regularly attend lessons should not be punished by being put with a group of students who generally don't show-up for class. Students with high attendance rates should, therefore, be prioritized in groups of at least three students. Not all of the four students in a group need to have high attendance rates; three students make for a functioning group. Once attendance is accounted for, the students' abilities and activity need to be weighed. Hopefully, once all of these factors have been considered, the students will be divided into effective groups. Some students will need special treatment as harmony within the classroom and within the groups also needs to be established. This is not a final model for dividing Peter's students into groups; this is simply one idea. Peter will have to work with different ideas and possibilities to find a model that works best for him in his classroom.

What is required of the teacher for the implementation of a non-traditional way of working with Mathematics in adult education?

There are many factors that have to be taken into consideration when implementing such a non-traditional teaching approach, while others have to be explored on a trial-and-error basis. What is most necessary for such a model to be implemented is a “reflective practitioner.” Reflective practice means “developing the skills of sharpening attention to what is going on in the classroom, noticing and recording significant events and 'working' on them in order to learn as much as possible about children's learning and the
role of the teacher” (Lerman 52). It was Donald Schön, a philosopher, who first brought reflection into the understanding of what professionals do.

The practitioner allows himself to experience surprise, puzzlement, or confusion in a situation which he finds uncertain or unique. He reflects on the phenomenon before him, and on the prior understandings which have been implicit in his behavior. He carries out an experiment which serves to generate both a new understanding of the phenomenon and a change in the situation. (Schön 68)

Reflection-in-action, or thinking on your feet, is one of Schön's most prominent ideas. Schön describes knowledge-in-action: as something that “can be seen as consisting of strategies of action, understanding or phenomena, ways of framing the problematic situations encountered in day-to-day experience” (qtd in Lerman 62). A teacher must first begin reflecting over his or her action in order to find a need or desire to develop his or her teaching method. Ekenberg states several characteristics common among teachers who desire to develop their teaching methods. These characteristics include a desire for more knowledge in the areas of theme work, process focused methodology, verbal communication, drama in education and the use of computers among others (208).

Ekenberg mentions the importance of reflection in the development process as well. She advises reflecting practitioners to not settle with verbal reflection, but to record one's thoughts and ideas as they become more real when they are visible. Recording thoughts and ideas also help to establish distance in order to evaluate goals and methods. When ideas are written, it is possible to consider, rearrange and change them more easily (213). Peter has obviously become a reflecting practitioner. He has become aware of his classroom situation and begun revising and changing it for the better. What he is currently lacking is knowledge about group dynamics, as functioning groups are essential for the success of his teaching approach. Recording thoughts and ideas to ease the development process has not been one of Peter's strengths. His organization skills are lacking, yet progressively getting better. His goal for the following semester is to have a well thought out plan for the entire semester including goals, grading criteria, back-up plans and clear classroom procedures before entering the classroom for the first lesson.

*Non-traditional teaching approaches in practice*

Peter is not alone in implementing a new teaching approach; educators of students of all ages, mostly primary and secondary school teachers, are studying and implementing non-traditional ways of working with Mathematics in their classrooms. Boaler found in a study conducted at two schools in England presented in 1997 that students who experienced practical Mathematics were more likely to succeed than those experiencing traditional Mathematics. This was contrary to popular belief. “Within mathematics education there is an established concern that many people are unable to use the mathematics they learn at school in situations outside the classroom context” (2). "The UK's official body of mathematics inspectors reported in 1994 that most of the mathematics teaching they saw in the upper secondary years involved listening to the teacher and then working through exercises,” traditional Mathematics in other words (39). These students regarded Mathematics as rule-bound. They rarely tried to interpret
problems, but rather looked for clues in the problems as they had been taught. In the non-traditional school Boaler studied, Mathematics learning was not based on procedures, but rather activities and projects were the students found the need for certain mathematical techniques, which they then learned.

The students at [the non-traditional school] showed that they were flexible and adaptable in their use of mathematics, probably because they understood enough about the methods they were using to utilize them in different situations. The students at [the traditional school] had developed a broad knowledge of mathematical facts, rules and procedures that they demonstrated in their textbook questions, but they found it difficult remembering these methods to base decisions on when or how to use them or adapt them. (81)

Drath, a middle school teacher, described his teaching approach to Mathematics in a recent issue of Nämnaren. He has begun implementing teaching methods common to natural science subjects in his Mathematics classroom. Drath's students work in pairs each lesson and begin lessons with “mathematical discussions.” He presents a problem to the class and the students, in pairs, try to solve the problem aloud. Occasionally, the students present their solutions to the rest of the class. The remaining lesson time is generally dedicated to calculating textbook exercises or other activities, which Drath has prepared. His students are continuously encouraged to work in their pairs and not complete all of the textbook exercises, only a select few. Drath has also implemented “explain how” questions on his examinations, as thought and reflection are prioritized higher than simple calculations. Drath's approach has many of the same features as Peter's approach even though they teach at different age levels.

Conclusion
Due to the fact that there are rarely direct possibilities to become aware of mathematics in the world around us, mathematical experience is considered to exist anywhere other than the classroom. It is not surprising that it often results in incomplete knowledge and ritualized forms (Jaworski, Undervisa 10). Jaworski studies Mathematics through a constructivist and even social-constructivist point-of-view. “Socio-cultural theorists view learning as integration into a community of practice [...] in which social actions are identified [...] and classroom activities designed” (Jaworski, Constructivism). In other words, knowledge is something that is actively constructed by the learner and learning is a process based on the learner's experience of the world. Social-constructivism can better be described in these five key points:

1. Knowing is an action participated in by the learner. Knowledge is not received from an external source.
2. Learning is a process of comparing new experience with knowledge constructed from previous experience, resulting in the reinforcing or adaptation of that knowledge.
3. Social interactions within the learning environment are an essential part of this experience and contribute fundamentally to individual knowledge construction.
4. Shared meanings develop through negotiation in the learning environment, leading to the development of common or 'taken-as-shared' knowledge.
5. Learning takes place within some socio-cultural setting - a 'community of practice' in which we can think of social actions as well as social interactions. (Jaworski, Constructivism)

Through discussion or argument, the participants [students] negotiate new positions which leads to shared meanings developing. Such negotiation is not bargaining, but a genuine offering of individual perspectives and meanings for consideration by others. It involves making an effort to listen to and understand other perspectives. (Jaworski, Constructivism)

While reading Jaworski's research on social-constructivism in Mathematics, I am reminded of Peter's classroom and his teaching approach. Peter's students discuss and negotiate new mathematical knowledge combining different experiences, which leaves them with broader perspectives than they would have otherwise encountered. Social interaction, most often in the form of group work, is a key feature in Peter's approach, which requires his students to take a more active part in acquiring knowledge.

Jaworski's takes her research in Mathematics a step farther by breaking Mathematics teaching down into three main parts, Management of Learning, Sensitivity to Students and Mathematical challenge, which she calls The Teaching Triad.

Management of learning is manifested in a set of teaching strategies and beliefs about teaching which influence the prevailing classroom atmosphere and the way in which lessons are conducted. Sensitivity to students is inherent in the teacher-student relationship and the teacher's knowledge of individual students and influences the way in which the teacher interacts with, and challenges, students. Mathematical challenge arises from the teacher's own epistemological standpoint and the way in which she offers mathematics to her students depending on their individual needs and levels of progress. (Jaworski, Investigating 107-108)

Peter's approach to teaching Mathematics includes each of these three parts. He manages learning by developing his approach and planning lessons thereafter. In the mean time, he takes into consideration his students. He plans lessons with their best interests in mind and changes lessons to better suit their needs, for example adding more lectures that students find necessary. He also keeps in mind how the students interact in and out of the classroom. Peter encourages group work outside the classroom and tries to form well-functioning groups inside the classroom to help students better understand Mathematics. The mathematical challenge in Peter's classroom is how he presents Mathematics to his students. Mathematical concepts are presented to students in different ways to best suits individual needs and knowledge levels, for example Peter gives different solutions to a problem allowing more students to understand as well as challenging more advanced groups of students with problems at a more advanced knowledge level.

As shown in this paper's description of one teacher's work with Mathematics A, it is possible to implement non-traditional teaching methods in a mathematics classroom, but it requires a great deal of work. Peter's approach to teaching Mathematics A in municipal adult education is quite unique. Most teachers implementing non-traditional
approaches in their classrooms are primary or secondary school teachers, while most adult education teacher shy away from non-traditional approaches. Peter's approach is an example of a work in progress, yet shows that it is possible to implement non-traditional methods in adult education. As discussed in chapter 1, a successful non-traditional classroom that promotes the desire to learn should, according to Skolverkets report, include as many of the following aspects as possible:

- the need to understand and succeed
- confidence in one's own ability to learn
- the need for school work to be relevant and comprehensible
- the need for variation and flexibility to avoid monotonousness
- class or group discussions and problem solving in groups
- the ability to influence ones studies, both content and evaluation design
- the need for varied forms of feedback
- a good working environment with time and peaceful surroundings
- the teacher's engagement and ability to motivate, inspire and show that knowledge is pleasure. (Skolverket, Lusten 26-36)

Peter's classroom already includes many of these elements and he is continuously working to fulfill the remaining elements in order to create the best possible working environment for his students and himself. Peter is a reflective practitioner with a social-constructivist view of Mathematics and with goals and ambitions for the future.
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*Fallstudie om en lärares arbete med Matematik A på KomVux*

**Bakgrund**

**Undersökningens uppläggning**

**Villkor för deltagande**

Du får gärna ta kontakt med mig eller min handledare om du undrar över något. Tack på förhand!

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En undersökning om en lärares arbete med Matematik A på KomVux

Bakgrund

Undersökningens uppläggning

Villkor för deltagande
Ditt deltagande är frivilligt och du har rätt att avbryta din medverkan när som helst. Dina uppgifter kommer då inte att finnas med i undersökningens resultat.

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Appendix C – Interview Guide for Teacher Interview 1

Linköpings Universitet
Lärareprogrammet
Jennifer Hovis

Intervju frågor – Lärare intervju 1
Början på terminen

Inledning
Vad heter du?
Hur gammal är du?
Vad har du för utbildning?
Hur länge har du jobbat som lärare?
Hur länge har du jobbat här?
Hur ser din tjänst ut? %, ämne, kurser, extra tjänster
Vad tycker du är det bästa med att jobba som lärare?
Vilka elever undervisar du helst? Grundskolan, gymnasiet, vuxna

Matematik A
Undervisningen
Hur ser undervisningen i matematik A ut?
Hur kom du på idéen?
Varför behövdes förändringen?
Hur reagerade dina kollegor/skolledning när du ville förändra undervisningen?
Har du fått några extra resurser?
Varför ser undervisningen ut så?
Hur planerar du lektionerna? Läroplanen, kursplanen, boken...

Eleverna
Hur reagerade eleverna med den nya metoden?
Har du sett/märkt någon skillnad/förändring i elever? motivation, inställning, betyg...

Första försöket
Hur fungerade undervisningen första gången?
Hur har du utvecklat metoden sedan dess?

Framtiden – denna termin
Vad har du för förväntningar för denna termin?
Provar du något nytt nu?
Vad hoppas du fungerar bättre denna termin?
Vad hoppas du fungerar bättre som du har förändrat/utvecklat sedan sist?
Vad är ditt största/mest viktigt mål för denna termin?
Appendix D – Interview Guide for Teacher Interview 2

Linköpings Universitet
Lärareprogrammet
Jennifer Hovis

Intervju frågor – Lärare intervju 2

Slutet av terminen

Allmänt:
Hur tycker du att terminen har gått i matte A?
   Har den gått som du trodde att det skulle gå?
Har du uppfyllt dina mål? (s.8)
   Det ska känna bra
   Det ska vara givande
   Det ska vara en bra upplägg
   Det ska funka bra i grupperna
   Det ska hålla genom hela terminen
Har terminen gett dig någonting?
Har det blivit mer laborativt, mer öppet och mer gruppvis? (s.8)
Hur tycker du att eleverna har uppskattat kursen?
Hur gick det med krisen kring sportlov när du hade funderingar på att lägga av med grupperbete?

Föreläsningarna:
Hur har det gått med föreläsningarna?
   Du var lite kluven tidigare om hur mycket föreläsning skulle finnas med i undervisningen.
Finns det någon skillnad mellan början och slutet av terminen? (längd, antal, uppskattningen...)

Grupperna:
Hur har grupparbetet fungerat tycker du?
Har ni hittat en modell för hur ni ändrar grupperna? (s.6)
Har det blivit mer gruppvis? (se tidigare och s.8)

Specialektionerna:
Har speciallektionerna fungerat som du trodde/önskad?
Har du fått extra tid som resurs för utvecklingen av denna undervisningssätt? (s.6)
Har du infört tidningsmatte i undervisningen? (s.8)
Har ni jobbat med:
   huvudräkning
   provräkningar (s.4)
   kängurutävling
Är det något mer du skulle vilja ha jobbat med (eller införa) på speciallektionerna?
Har det blivit mer laborativt? (se tidigare och s.8)

Övrigt:
Hur ser din framtid ut? Kommer du att fortsätta med denna undervisningsmodell?
Har du något att tillägga?
Appendix E – Interview Guide for Student Interviews

Linköpings Universitet
Lärareprogrammet
Jennifer Hovis

Intervju frågor – Elev intervjuer
Mitten mot slutet av terminen

Generellt:
Vad tycker du om denna matte A kurs i sin helhet?
Vad tycker du om föreläsningarna?
   Tidsmässig, innehållsmässig, ...?
Hur tycker du att proven har varit?

Grupparbete:
Hur fungerar grupparbete tycker du?
Får du hjälp av andra gruppmedlemmar när du inte förstår?
Har du fått hjälp av någon annan gruppmedlem när dem inte förstått?
Trivs du i nuvarande grupp?
   Den förra gruppen?
Är det något aspekt du skulle vilja ändra när det gäller grupparbete?

"speciallektioner":
Vad tycker du om ”speciallektionerna”?
   Lär du dig någonting? Vad?
   Är uppgifterna relevanta, intressanta, hjälpsamma...?
Vilken lektion/aktivitet har du tyckte bäst om? Varför?
Vilken lektion/aktivitet har du tyckte minst om? Varför?
Finns det något du skulle vilja jobba med på en speciallektion?

Övrigt:
Har du något att tillägga?
**Appendix F– Questionnaire, Student Backgrounds**

Hej!

Tack för att du tar dig tid att svara på några frågor! Jag är intresserad av att få en bild av din bakgrund när det gäller utbildning och erfarenheter av matematik. Jag gör detta för att ta reda på klassens profil. All information kommer att behandlas konfidentiellt.

Tack för din medverkan!

Jennifer

<table>
<thead>
<tr>
<th>Ålder:</th>
<th>16-25</th>
<th>26-35</th>
<th>36-45</th>
<th>46-55</th>
<th>56-65</th>
<th>66+</th>
</tr>
</thead>
</table>

Familjesituation: (ex: singel, sambo, gift, skild, har barn)

Vad har du för tidigare utbildning?

När läste du senast eller när satt du senast i skolbänken? (vilket år?)

Har du läst på KomVux tidigare? När?

Har du läst *Matematik A* tidigare? Var och När?

Vilka är dina framtida planer? Alltså varför läser du på KomVux?

Vilka är dina framtida matematikplaner? Alltså, varför läser du Matematik A?

Övriga kommentarer eller frågor:
Utvärdering: Matematik A


Tack på förhand för din aktiva medverkan.

Allmänt:
Hur tycker du att kursen har varit i sin helhet?

<table>
<thead>
<tr>
<th>Välilt Dålig</th>
<th>Dålig</th>
<th>Bra</th>
<th>Välilt Bra</th>
</tr>
</thead>
</table>

Hur har kursen varit jämfört med dina förväntningar?

<table>
<thead>
<tr>
<th>Uppfylt alla mina förväntningar</th>
<th>Uppfylt många av mina förväntningar</th>
<th>Uppfylt några av mina förväntningar</th>
<th>Uppfylt inga av mina förväntningar</th>
</tr>
</thead>
</table>

Föreläsningarna:
Hur tycker du att föreläsningarna har varit?

<table>
<thead>
<tr>
<th>Välilt Dåliga</th>
<th>Dåliga</th>
<th>Bra</th>
<th>Välilt Bra</th>
</tr>
</thead>
</table>

Hur har föreläsningarna varit tidsmässigt?

<table>
<thead>
<tr>
<th>För långa</th>
<th>Lagom långa</th>
<th>Lagom korta</th>
<th>För korta</th>
</tr>
</thead>
</table>

Hur har föreläsningarna varit innehållsmässigt?

<table>
<thead>
<tr>
<th>Meningslösa</th>
<th>Lite givande</th>
<th>Givande</th>
<th>Mycket givande</th>
</tr>
</thead>
</table>

Hur har föreläsningarna varit i antal?

<table>
<thead>
<tr>
<th>För många</th>
<th>Många</th>
<th>Få</th>
<th>För få</th>
</tr>
</thead>
</table>

Tycker du att det har gett mer när föreläsningarna har innehållit praktiska exempel och konkret material?

<table>
<thead>
<tr>
<th>Stämmer helt</th>
<th>Stämmer delvis</th>
<th>Stämmer dåligt</th>
<th>Stämmer inte alls</th>
</tr>
</thead>
</table>

Grupparbete:
Hur tycker du att grupparbetet har fungerat?

<table>
<thead>
<tr>
<th>Välilt Bra</th>
<th>Bra</th>
<th>Dåligt</th>
<th>Välilt Dåligt</th>
</tr>
</thead>
</table>

Skulle du vilja haft gruppinlämningsuppgifter?

| Ja | Nej |
### Skulle du vilja haft gruppredovisningar?

<table>
<thead>
<tr>
<th>Ja</th>
<th>Nej</th>
</tr>
</thead>
</table>

**Hur har nivåskillnader i grupperna varit? Första gruppen**

<table>
<thead>
<tr>
<th>Stämmer helt överens</th>
<th>Stämmer bra</th>
<th>Stämmer dålig</th>
<th>Stämmer inte alls</th>
<th>Saknat grupp</th>
</tr>
</thead>
</table>

**Hur har nivåskillnader i grupperna varit? Andra gruppen**

<table>
<thead>
<tr>
<th>Stämmer helt överens</th>
<th>Stämmer bra</th>
<th>Stämmer dålig</th>
<th>Stämmer inte alls</th>
<th>Saknat grupp</th>
</tr>
</thead>
</table>

**Hur ofta vill du jobba i grupp helst?**

<table>
<thead>
<tr>
<th>Alltid</th>
<th>Någon gång per vecka</th>
<th>Någon gång ibland</th>
<th>Aldrig</th>
</tr>
</thead>
</table>

**Speciallektionerna – onsdagarne:**

**Hur tycker du att speciallektionerna har varit?**

<table>
<thead>
<tr>
<th>Väldigt dåliga</th>
<th>Dåliga</th>
<th>Bra</th>
<th>Väldigt bra</th>
</tr>
</thead>
</table>

**Hur mycket har du lärt dig på dessa lektioner?**

<table>
<thead>
<tr>
<th>Väldigt mycket</th>
<th>Mycket</th>
<th>Lite</th>
<th>Väldigt lite</th>
</tr>
</thead>
</table>

**Har speciallektionerna varit givande?**

<table>
<thead>
<tr>
<th>Inte alls</th>
<th>Lite</th>
<th>Mycket</th>
<th>Väldigt mycket</th>
</tr>
</thead>
</table>

**Tycker du att det har gett mer när du har jobbat med praktiska exempel och konkret material?**

<table>
<thead>
<tr>
<th>Stämmer helt</th>
<th>Stämmer delvis</th>
<th>Stämmer dåligt</th>
<th>Stämmer inte alls</th>
</tr>
</thead>
</table>

**Prov:**

**Hur tycker du att proven har varit?**

<table>
<thead>
<tr>
<th>Väldigt bra</th>
<th>Bra</th>
<th>Dåliga</th>
<th>Väldigt dåliga</th>
</tr>
</thead>
</table>

**Hur tycker du att kunskapsnivån på proven har varit?**

<table>
<thead>
<tr>
<th>Väldigt svår</th>
<th>Svår</th>
<th>Lätt</th>
<th>Väldigt lätt</th>
</tr>
</thead>
</table>

**Vad har du tyckte om förståelse frågorerna, till exempel förklara något med ord?**

<table>
<thead>
<tr>
<th>Väldigt svåra</th>
<th>Svåra</th>
<th>Lätta</th>
<th>Väldigt lätta</th>
</tr>
</thead>
</table>

**Tycker du att examinationsformerna har varit bra?**

<table>
<thead>
<tr>
<th>Håller helt med</th>
<th>Håller med</th>
<th>Håller lite med</th>
<th>Håller inte alls med</th>
</tr>
</thead>
</table>

**Hur tycker du att examinationsformerna har stämt med kursens upplägg?**

<table>
<thead>
<tr>
<th>Stämmer helt överens</th>
<th>Stämmer mycket överens</th>
<th>Stämmer lite överens</th>
<th>Stämmer inte alls överens</th>
</tr>
</thead>
</table>

64
Öppna frågor: använd gärna baksidan!
Berätta hur du har upplevt kursen.
Har du känt dig trygg i klassen? Förklara.
Har du vågat ställa frågor under föreläsningarna? Förklara.
Har du känt dig trygg i grupperna? Förklara.
Har du kunnat fråga efter hjälp i grupperna? Förklara.
Hur ska grupperna byggas upp anser du?
Finns det något du skulle vilja ändra när det gäller grupparbete?
Berätta om hur du har upplevt grupparbete, både för- och nackdelar.
Vad skulle du vilja ha jobbat mer med på speciallektionerna? Varför?
Finns det något arbetssätt som du skulle vilja ha jobbat med på en speciallektion? Varför?
Berätta om hur du har upplevt speciallektionerna, både för- och nackdelar.
Vilken/vilka provformer skulle du vilja haft på denna matematikkurs?
Om du har haft rädsla eller prestationsängest inför matematik, har det på något sätt förändrats under kursens gång? Förklara.
Vad anser du skulle förändras till nästa termin?
Förslag på något nytt som borde prövas:
Övriga kommentarer:
Appendix H – Original Letter to Students from Teacher

Planering: Matematik A vårtermin 2005

Hur vi går tillväga när vi arbetar med matte boken:

- Vid varje förklaringsmoment så läser du, funderar och tar upp det du själv inte förstår.
- Diskutera i gruppen de frågorna som kommit fram. Innan ni börjar räkna, se till att alla greppar momenten.
- Gör utvalda uppgifter gemensamt.
- Gå sen vidare till nästa förklaringsmoment.


Förutom denna arbetsgång baserad på boken så kommer vi en gång i veckan att arbeta med andra matematikuppgifter där också andra arbetsmetoder kommer att tillämpas. Ditt aktiva deltagande i dessa kommer också att bedömas.

Examinationer och bedömningar sker dels genom de löpande diskussioner som förs i gruppen, dels genom skriftliga små provuppgifter och dels genom ”vanliga” prov. Dessutom genom muntliga examinationer och genomgångar samt ett nationellt prov under terminens andra hälft. Samt genom laborationer och andra gruppövningar.
Appendix I – Example of a Typical Schedule

Matematik A: Kapitel 1 – Att arbeta med tal

Tal som ni räknar gemensamt på lektionerna vid följande tillfällen:

v.4

måndag lektion 1 – negativa tal

Läs sidorna 12, 14-16 innan lektionen

<table>
<thead>
<tr>
<th>Övningar</th>
<th>1109 a,b</th>
<th>1110 b,c,d</th>
<th>1111 b</th>
<th>1112 a,b</th>
<th>1113</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1114 a,b</td>
<td>1116 a,b,1118</td>
<td>1119</td>
<td>1130 a,b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1132</td>
<td>1134 a,b</td>
<td>1135 a,b</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

onsdag lektion 2: speciallektion

 torsdag lektion 3 – negativa tal

Läs sidorna 18-19, 22-24 innan lektionen

<table>
<thead>
<tr>
<th>Övningar</th>
<th>1142 a-d</th>
<th>1143 a-d</th>
<th>1145 a,b</th>
<th>1146 a,b</th>
<th>1147 a,b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1149a-d</td>
<td>1160 a-d</td>
<td>1161 b,b</td>
<td>1163 a,b</td>
<td>1164 a,c</td>
</tr>
<tr>
<td></td>
<td>1165 a,b</td>
<td>1166</td>
<td>1167 a,b</td>
<td>1169 a,b</td>
<td></td>
</tr>
</tbody>
</table>

v.5

måndag: studiedag

onsdag lektion 5: speciallektion

torsdag lektion 6 – bråk

Läs sidorna 30-31, 33, 35-36 innan lektionen

<table>
<thead>
<tr>
<th>Övningar</th>
<th>1239 a,b</th>
<th>1241</th>
<th>1242</th>
<th>1244 b,c</th>
<th>1246 b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1248 a</td>
<td>1249</td>
<td>1251 a-c</td>
<td>1252</td>
<td>1257 a-c</td>
</tr>
<tr>
<td></td>
<td>1260 a,b</td>
<td>1262</td>
<td>1264</td>
<td>1266 a,b</td>
<td>1271 a-c</td>
</tr>
<tr>
<td></td>
<td>1272 a-c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

v.6

måndag lektion 7 – avrundning och överslagsräkning

Läs sidorna 38-40, 42-43, 44 innan lektionen

<table>
<thead>
<tr>
<th>Övningar</th>
<th>1335 a</th>
<th>1336 a</th>
<th>1337 a</th>
<th>1338 a</th>
<th>1341</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1342</td>
<td>1343</td>
<td>1344</td>
<td>1346</td>
<td></td>
</tr>
</tbody>
</table>

onsdag lektion 8: speciallektion

torsdag lektion 9: prov på kapitel 1

Lycka till!
### Appendix J – Examples of Selected Textbook Exercises

Selected from Chapter One, Working with Numbers, subsection Negative Numbers

<table>
<thead>
<tr>
<th>A 1130</th>
<th>Skriv talen i storleksordning med det minsta först.</th>
<th>A 1130</th>
<th>Write the numbers in order starting with the smallest.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 12, 17, 13, 19</td>
<td>a) 12, 17, 13, 19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) 6, 10, −2, 4</td>
<td>b) 6, 10, −2, 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A 1134</th>
<th>On the game show “Jeopardy!” on TV4, every question is worth a certain amount money. A correct answer earns money, while an incorrect answer loses money. Malena has a total of −400 SEK. She answers a question worth 700 SEK. How much money does she have if she</th>
<th>A 1134</th>
<th>I frågeprogrammet “Jeopardy!” i TV4 är varje fråga värd en summa pengar. Svarar man rätt för man summan, svara man fel förlorar man den. Malena har i sin “pott” −400 kr. Hon besvarar en fråga värd 700 kr. Hur mycket har hon i “potten” om hon</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) answers correctly</td>
<td>a) svarar rätt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) answers incorrectly?</td>
<td>b) svarar fel?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B 1135</th>
<th>The temperature is falling at a rate of 3°C per hour. How long will it take for the temperature to fall from</th>
<th>B 1135</th>
<th>Temperaturen faller med hastigheten 3°C per timme. Hur länge dröjer det innan den faller från</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) −2°C to −14°C</td>
<td>a) −2°C till −14°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) 5°C to −10°C?</td>
<td>b) 5°C till −10°C?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B 1165</th>
<th>Calculate</th>
<th>B 1165</th>
<th>Beräkna</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) (−2) · (−3) · (−4)</td>
<td>a) (−2) · (−3) · (−4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) (−3) · 7 + (−4) · (−5)</td>
<td>b) (−3) · 7 + (−4) · (−5)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C 1147</th>
<th>What number should be in the empty box? (L)</th>
<th>C 1147</th>
<th>Vilket tal ska stå i den tomma rutan? (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 21 + □ = 5</td>
<td>a) 21 + □ = 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) 12 − □ = 30</td>
<td>b) 12 − □ = 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) −42 + □ = 37</td>
<td>c) −42 + □ = 37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) −15 − □ = 24</td>
<td>d) −15 − □ = 24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C 1169</th>
<th>You are given the numbers 3, −2, 0, 1, −1, −4, 2. Which two numbers give</th>
<th>C 1169</th>
<th>Du har talen 3, −2, 0, 1, −1, −4, 2. Vilka två tal ger den</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) the largest product</td>
<td>a) största produkten</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) the smallest product? (L)</td>
<td>b) minsta produkten? (L)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ekvationer

I denna aktivitet ska du fundera ut vad som ska stå i de tomma rutorna. Räknesättet är addition. Deluppgift a) visar hur du ska gå tillväga. Rita av figurerna i ditt räknehäfte och fyll i de tomma rutorna.

- Fundera ut vilka tal som ska stå i de tomma rutorna. Redovisa med en figur med ifyllda tal.

\[
\begin{array}{c}
\text{a) } & 7 & 13 \\
& 20 \\
\text{b) } & 5 & 14 \\
& 25 \\
\text{c) } & 12 & 24 \\
& 100 \\
\text{d) } & 4 & 7 \\
& 11 \\
\end{array}
\]

Uppgifterna 1 c) och d) är inte helt enkla, kanske fick du pröva med flera olika tal i översta raden innan du hittade det rätta. Du ska nu få lösa liknande problem genom att ställa upp en ekvation och lösa den.

Lös uppgifterna nedan genom att arbeta efter följande schema.
- Kalla det okända talet i övre raden för \(x\).
- Bilda uttryck i rutorna under och förenkla där det är möjligt.
- När du nått bottentalet kan du ställa upp en ekvation och lösa den.
- Kontrollera att din lösning är riktig.

\[
\begin{align*}
\text{Lösning:} & \\
12 + x + x + 5 &= 23 \\
2x + 17 &= 23 \\
2x &= 6 \\
x &= 3
\end{align*}
\]

\[
\begin{array}{c}
\text{a) } & 8 & 5 \\
& 62 \\
\text{b) } & 17 & 8 \\
& 77 \\
\text{c) } & 2x & 14 & 20 \\
& x + 60 \\
\text{d) } & 24 & 5x & 13 \\
& 67 - 5x \\
\end{array}
\]
Input – Output

I den här aktiviteten kan “x” anta olika värden. Man säger att “x” är en variabel. De tal som man tilldelar “x” står till vänster i figurerna.

I mitten finns en maskin, en formel, som skapar nya tal som står till höger i figuren.

Uppgiften i den här aktiviteten är att rita av figurerna och fylla i de tomma rutorna med tal eller formel.

1. 

2. 

3. 

4. Rita tre egna figurer efter mönster ovan och låt en kamrat lösa uppgiften
Bråkräkning i praktiken

Hur ser den arvsmässiga fördelningen ut mellan helsyskon och halvsysson enligt de två exemplen? Hur mycket får helsyskonen var respektive tillsammans på ett arv på 600 000?


Hur många dricksglas väger jämnt med en flaska?
Appendix O – The Hockey Puck

Pucken

- Hur lång sträcka har pucken rullat då den har rullat 100 varv?

- Hur många varv har den rullat då den har rullat sträckan 1,5km?

- Rita av puckens cirkelformade bottenyta i naturlig storlek. Rita en kvadrat med area 1 cm² bredvid cirkeln. Gör en uppskattning av cirkelns area. Beräkna cirkelns area.

- Skriv upp de former du behöver för att beräkna puckens volym, mantelarea och total begränsningsarea.

- Rita mantelytan som en rektangel i naturlig storlek. Gör en uppskattning av mantelytans area. Beräkna mantelytans area.

- Gör en uppskattning av puckens volym. Beräkna puckens volym.

- Beräkna hur många procent mantelyta utgör av den totala begränsningsytan. Ange en formel (så enkel som möjligt) för att beräkningen av a).

- Vilket är förhållandet mellan radien och höjden i en cylinder där bottenytan och mantelytan har lika stor area?

Material: Ishockeypuck