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A top down approach to learn basic electronics

Abstract

Introduction

This projects' aim is to restructure the way students learn basic analogue electronics. The objective is to organize the course with a top-down structure to enhance the students' motivation to learn electronic design and give them a more holistic view on the subject. Another objective of the project is to change the usual final written test to a continuous examination in order to give more feedback to the student and for the student to gain a deeper understanding of the subject. The student will also be more engaged in his or her own learning. The holistic view of this course is supposed to give a better base for learning.

Background

Traditionally a basic course in analogue electronics is organized in a bottom-up way. The course is usually starting with elementary solid state physics to explain the function of semiconductor components as diodes and transistors. The use of transistors for voltage amplification is illustrated with exercises and students learn how to analyse different kinds of amplifier configurations. Sometimes they even learn how to synthesize or design an amplifier to satisfy a given specification. Later in the course students will learn about integrated amplifiers such as operational amplifiers that also could be used to build voltage amplifiers. To be able to assess the students knowledge there is usually a written examination at the end of the course. Often the final test consists of a set of typical exercises. The workload for the students (especially if there are parallel courses with higher priority earlier in the course) tends to concentrate the studying to the days before the exam. Studying of older examination papers and other cue-seeking to find out what kind of assignments that usually are emphasized on the test tend to drive the student into a learning strategy that do not encourage a deep and durable learning. The major problem with a traditional course is that the students are to passive and there is to little focus toward the students learning process.

Approach

The course will be planned in a top-down way to give a more holistic view. This means that the starting point will be system aspects of analogue electronic systems and design with integrated operational amplifiers. This is an easier way

to design amplifiers than using discrete transistor circuits. The students could by this organisation start to design practical circuits much earlier in the course. With interesting design problems the students' motivation could be enhanced. As an example one of the first design problems in the course could be: "Given a microphone and a loudspeaker, build amplifiers so there will be sound from the loudspeaker when you are talking into the microphone". Most students of today have no earlier experience of using electronic components. More seldom there are students who have been building electronic project as a hobby. Computers and computer games seem to interest young boys and girls more than to bring electronic devices to pieces and inspect the electronic components. This top-down approach of the course would motivate the students to learn about electronic components at the same time as they get practical experience with measurement instruments and learning electronics by doing electronics. The basic component level with transistor amplifiers will be covered with design problems later in the course when the students are more accustomed to the design and use of voltage amplifiers. There will be traditional teacher centred lessons in the course but there will also be student centred group activities in the course. There will of course be laboratory resources available for the students but the students plan their lab exercises by themselves, teachers are available as a resource for the students. The driving force for the students' learning will be two or three design projects. The main goal of these design projects is not if their construction work well or not (nearly anyone could assemble a functioning electronic kit with some instructions). The main goal is of course the knowledge the students will possess after the course. It is our intention that it is the students themselves that should be more responsible to show that they are fulfilling the objectives of the course with the starting point from the design projects. Students will have to be more conscious about their own learning and examination.

Assessment

The way the students in a course are examined will of course influence the students' way of learning. A traditional written exam at the end of the course will not fit very well into this new course. There is also a need to enhance the quality of the learning with the goal that more students will pass the exam. The following principles will be applied in the examination procedure:

- There will be a more distributed form of assessment with the possibilities to give more feedback than usual to the students. By this way the student can be given a second chance to complete the parts where they are failing during the course instead of doing a wholly new examination several months after the course is concluded, which is the usual procedure when students fail in a final written exam.
- Examination will be diversified, i.e. there will be different kind of examination types. We are planning to have a combination of written examination, papers and reports writ-ten by the student combined with oral tests and oral presentations in peer groups.

- The examination should develop the students' ability to fulfil the main objectives in the education such as critical thinking and improve on oral and written presentations.

Evaluation

Another aspect of assessment is to evaluate the course itself and find out if this is a more effective way of learning and if it gives a deeper understanding than traditional courses. This is not an easy task because the emphasis will be on other knowledge and skills than in a traditional course. The project is planned to be evaluated with enquiries and interviews with the students and teachers in the course. Experts on evaluation of pedagogical projects will be engaged in this procedure.

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KUNGL TEKNISKA HÖGSKOLAN

Royal Institute of Technology
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A top-down approach to learn basic electronics

Bengt Molin

Final report September 2002

The project has been supported by the Swedish Council for the Renewal of Higher Education.

Abstract

Traditionally a basic course in analogue electronics is organized in a bottom-up way. The course is usually starting with elementary solid state physics to explain the function of semiconductor components as diodes and transistors. The use of transistors for voltage amplification is illustrated with exercises. Students learn how to analyse different kinds of amplifier configurations with the transistor. Sometimes they even learn how to synthesize or design an amplifier to satisfy a given specification. Later in the course students will learn about integrated amplifiers such as operational amplifiers and how they could be used to build voltage amplifiers.

In this project we have restructured the way students learn basic analogue electronics. The new course is organized with a top-down structure to enhance the student's motivation to learn electronic design and to obtain a more holistic view. This means that the starting point is a system aspect of analogue electronic systems and design with integrated operational amplifiers. This is an easier way to design amplifiers than using discrete transistor circuits. The students could by this organization start to design practical circuits much earlier in the course. With interesting design problems the student's motivation is enhanced. This top-down approach of the course motivates the students to learn about electronic components at the same time as they get practical experience with measurement instruments and are learning electronics by doing electronics.

We have also changed the usual final written test to several examinations during the course in order to give more feedback to the student. The examinations are also planned so the student will gain a deeper understanding of the subject.

The evaluation of the project shows that the traditional course can be replaced with this top-down structure. The students are more motivated and engaged in their learning but it could also lead to more workload.

Contents

Preface

The project *A top-down approach to learn basic electronics* was carried out during the academic year 2001/2002 at the Department of Applied Information Technology at the Royal Institute of Technology (KTH) in Kista, Stockholm. The course this project is dealing with is Analogue Electronics that is given during the first half of the spring semester. This project has emanated out from changes and experiments that have been tested during a couple of years prior to this project.

First of all I wish to thank all students from this year and earlier year who has been exposed to our pedagogical experiments. There have been many discussions that also have enriched the teachers involved in this course.

My colleagues, Jan Andersson, Bengt-Åke Larsson and Anders Lindfors, have been part of this project and helped me to develop this new course. Without their support and encouragement I would not have dared to take this step.

I also want to thank Mats Nyberg from KTH Learning Lab who has helped me with the evaluation of this project.

Kista September 2002

Bengt Molin

Project leader

1 Background

The origin of this project was the dissatisfaction we felt about the traditional course examination. With traditional course is here meant a course where the teachers present the course contents with lectures and lessons. The assessment of the students is normally a final written exam. Many students are queseekers and do most of the studying the days immediately before the exam with the help of older examination papers to see what the examinator usually emphasize on this exam. The way the students are assessed tends to gain a surface approach to learning. I can give a little example that I experienced a couple of years ago: Students who do not pass the final written exam have the possibility to try again a couple of months after the course is finished. In such an exam I had two students who were very near the limit to pass the exam. One of the problems given at the exam was a kind of oscillator and the assignment was to calculate the oscillation frequency. One of the students had memorized the formula and could calculate the frequency and passed the exam. The other student did not remember the formula and could not calculate the frequency and did not pass the exam. He had although made some comments in his paper that showed that he might have understood why the oscillator did oscillate. The comments were not complete so he was not able to derive the formula. My reflection when I examined those students was that I suspected that also the first student, who passed, would fail to describe the principle of how the oscillator worked. To know why the oscillator works is of course more valuable knowledge then just to know a formula. This was naturally an example of a bad formulation of the problem but this kind of examination often tends to be in a way that encourages a surface approach to learning.

The concept of surface and deep learning is well known from literature about learning. In the book *Understanding Learning and Teaching* (Prosser & Trigwell, 1999) it is described in this way:

"In a deep approach students aim to understand ideas and seek meanings. They have an intrinsic interest in the task and an expectation of enjoyment in carrying it out. They adopt strategies that help satisfy their curiosity, such as making the task coherent with their own experience; relating and distinguishing evidence and argument; looking for patterns and underlying principles; integrating the task with existing awareness, seeing the parts of a task as making up the whole; theorizing about it; forming hypothesis; and relating what they understand from other parts of the same subject, and from different subjects. Overall they have a focus on the meaning in the argument, the message, or the relationships, but they are aware that the meanings are carried by the words, the text, or the formulae

In a surface approach, students see tasks as external impositions and they have the intention to cope with these requirements. They are instrumentally and pragmatically motivated and seek to meet the demands of the task with minimum effort. They adopt strategies which include a focus on unrelated parts of the task; separate treatment of related parts (such as on principles and examples); a focus on what are seen as essentials (factual data and their symbolic representations); the reproduction of the essentials as accurate as possible; and rote memorizing information for assessment purposes rather than understanding. Overall they would appear to be involved in study without reflection on purpose or strategy, with the focus of that study being on the words, the text, or the formulae."

It has to be pointed out that whether a student takes on a surface approach or a deeper approach depends on the circumstances. In many cases a surface approach could be a successful way to pass an exam. In our project one of the goals is to change the examination so the students will have to switch to a deeper approach to learning.

Usually a course in analogue electronics is starting with elementary solid state physics to explain the function of semiconductor components such as diodes and transistors. The use of transistors for voltage amplification is illustrated with exercises and students learn how to analyse different kinds of amplifier configurations. Sometimes they even learn how to synthesize or design an amplifier to satisfy a given specification. Later in the course students will learn about integrated amplifiers such as operational amplifiers which also could be used to build voltage amplifiers. When the course is given in this way some students have difficulties to understand the practical use of the components at the same time as their physical function are theoretically difficult to understand. The course tends to start at a high theoretical level and make it difficult for some of the students to assimilate the contents of the course. The main examination is at the end of the course with small possibilities to give feedback and correct mistakes in the students learning.

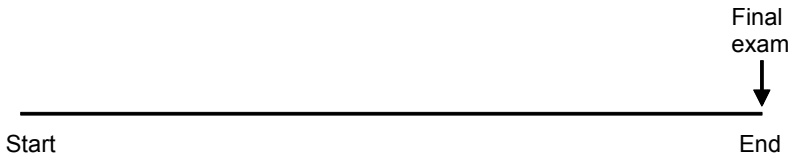


Figure 1 Timeline for the traditional course

In this project we have restructured the way students learn basic analogue electronics. The new course is organized with a top-down structure to enhance the student's motivation to learn electronic design. We have also changed the usual final written test into a continuous examination in order to give more feedback to the student and for the student to gain a deeper understanding of the subject.

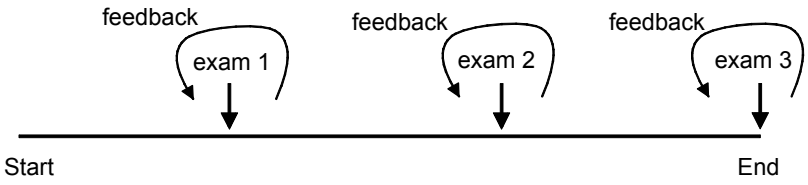


Figure 2 Timeline for the new course

Before we started this project we have had some experience from other courses based on the ideas of project based learning and problem based learning. Therefore it was natural to strive towards a more student centred method when we first started to change this course. We have found some inspiration in following books: *Improving the Quality of Student Learning* (Gibbs, 1992) which focuses on strategies for fostering a deep approach to learning and *Assessing Student Centred Courses* (Gibbs, 1995) which focuses on problems faced by student centred assessment and group assessment. Both books by Gibbs contains many case studies which have inspired us in planning our own courses. The book *Learning in Groups* (Jaques, 1991) describes among other things theories and research about group behavior, communication and learning in groups and evaluation of groups. Another book that also could be recommended is the book *Learning to Teach in Higher Education* (Ramsden, 1992), which is very interesting reading about learning and teaching, and how to design courses for learning.

The idea of "learning by doing" is well known. Many courses in engineering educational programmes are project based. Well known is Aalborg University that has a long experience of integrating engineering practice into curriculum (Fink, 1999). There are also some reports on

the idea of top-down design in electronic courses: Franca (1994) reports of a course in Integrated circuits that has been restructured into a top-down approach. In this case the course is given in the final year for the electrical engineering students. In a basic course Franklin and Noakes (1995) report on a computer based learning approach to teach digital design in a top-down way. They use a design analysis that the student would complete and in doing so gain the motivation to learn more by relating the theory to the activities in practical digital design.

2 The new course

In the following text I will describe the new course, how it is organized and the ideas we have about learning. The description will depend on the content in this course but it is my conviction that the ideas could be applied in other disciplines as well.

About one month before the course started I had a lecture to tell the students about this project and to inform the students about my thoughts about learning in this course. We also formed a reference group with nine students. The reference group had two meetings before and during the course, which helped me in my course planning and to determine the examination form.

2.1 Objectives

The goals of the course Analogue Electronics are to give knowledge about the most common electronic components (diodes, transistors), how they are used and to learn to calculate properties of electronic systems with these components. More specific the course contents RC-filter and Bode-diagrams, semiconductor components and their function, switches and amplifiers with transistors, operational amplifiers, feedback and stability problems, power amplifiers and oscillators. The students should also develop skill in using simulation software.

A course in Electrical Circuits is prerequisite to the course in Analogue Electronics.

2.2 Organization

The new course has been planned in a top-down way to give a more holistic view. This means that the starting point is the use of amplifiers and system aspect of analogue electronic systems. We also start to design with integrated operational amplifiers. This is an easier way to design amplifiers than using discrete transistor circuits. The students could by this organization start to design practical circuits much earlier in the course. With interesting design problems the students' motivation is enhanced. This top-down approach of the course motivate the students to learn about electronic components at the same time as they get practical experience with measurement instruments and learning electronics by doing electronics.

The course in Analogue Electronics is worth four credit points according to the Swedish credit system. This correspond with four weeks full time study. The students are usually studying more than one course at the same period. The course Analogue Electronics is given at the same time as the students have courses in mathematics and programming over a time period of about three months.

There have been 75 students registered on the course this year. We have during past years had a tendency with decreasing number of applicants to this study programme. A consequence of this is that the students do not have to compete to take a place and that everyone that fulfils the demands could start the programme disregarding their prior mark level.

The whole group has been divided into three classes with approximately twenty-five students in each class. Each class has been divided into four smaller groups.

This four-week course in Analogue Electronics has been organized in this way (student time):

- 14 hours lecturing in large group (75 students)
- 22 hours lecturing in class (25 students)
- 12 hours in laboratory
- 10 hours in small groups (6-7 students)

We have been three teachers involved in the course. I have been lecturing in large groups. All three teachers have been lecturing in class, been tutoring group meetings and been lab instructors. With all this student contacts we get to know the students rather well.

We have a system to evaluate the cost for a course. The economical resources given for the course is fixed. As responsible for the course I could choose how to divide the resources between lecturing, lab exercises and group activities as long as the total sum is constant.

Lectures

We have ordinary lectures in the course, both in large groups and smaller classes. The purpose of lecturing in large groups is to introduce the students into the subject and to give some theoretical background. It has also given me, as responsible for the course, a chance to meet all students in the course and explain what we expect from them. Lectures in class have been more of problem solving and theoretical explanations. It is also easier to have a dialogue with the students in smaller groups.

Lab exercises

We do not have any pre-written lab exercises. The students have to plan by themselves what to do in lab. To be effective at lab time they have to prepare their lab with simulations, to confirm that the design is right, and to wire their design on breadboard. When there is no scheduled lab the laboratory is available for students in their free time if they want to prepare the lab. The resources available in lab are two soldering stations and sixteen lab stations with computer and measuring instruments (generator, multimeter and oscilloscope). The teacher's role at lab is to be available as consultant for students who have problems with the design and to guide students with measurement problems and faultfinding.

Group meetings

The purpose of the group meetings is that the students will be able to find a solution to the design problems given in the course and to prepare their session in the laboratory. The group meetings, which are about two hours long, follow this form:

- Understanding the problem. Is there anything that is unclear and has to be clarified?
- Brainstorming. The students associate freely about the problem without discussing. One of the students puts the words down on the whiteboard.
- Evaluating the brainstorming. The students organize their notes from the brainstorming, sorting out all that is irrelevant and writing down what is important and relevant to the problem.
- Solving the problem or planning how to solve the problem.

The teacher's role at the group meeting is to tutor the group, not lecturing. The students themselves take care of the meeting and the teacher should not interfere with the meeting unless the students are to far away from the goal. The teacher could also help to clarify or explain things on the request from students if it is needed. The groups have been formed by simply dividing the class into four groups without any possibility for the student to choose group.

2.3 The course and examination

System level – first problem

You are given a microphone and a loudspeaker. Your task is to design some electronic equipment so there will be sound in the loudspeaker while you are talking into the microphone. This was the first assignment and it was given at the first lecture in the course. This will of course raise many questions to students that never before have been in contact with electronic components. They have however, when they start this course, knowledge about how to calculate voltage and currents in electrical circuits for both direct and alternating currents. We have only four hours reserved in the laboratory for this so we suggest the students to use an integrated power amplifier to which we have a printed circuit board available. It is therefore a kind of do-it-yourself kit but there is no instruction available except the datasheet of the integrated power amplifier. They also have to design a preamplifier using an operational amplifier. The preamplifier is built on a breadboard.

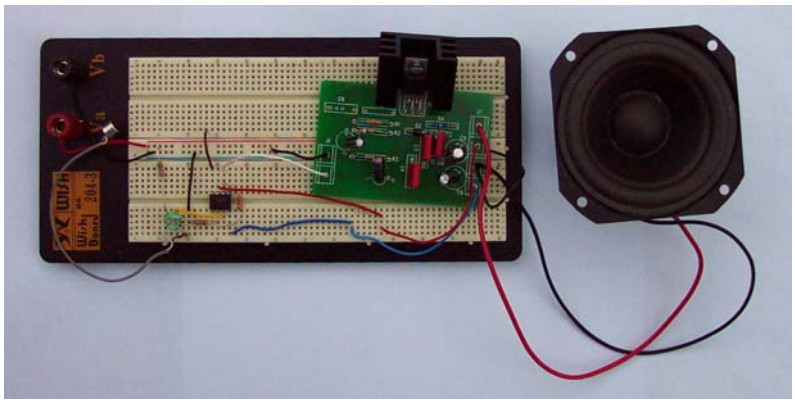


Figure 3 Microphone, preamplifier, integrated power amplifier and loudspeaker

The purpose of this assignment is that the students will be acquainted with resistors, capacitors and integrated circuits datasheet. They will also have to calculate values of components to get the right gain, impedance levels and frequency range.

Examination, part one (X1)

The first examination in the course is a written exam. It focuses on system properties of amplifiers and how to calculate frequency behaviour on filter consisting of resistors and capacitors. Students who fail in this examination have to discuss why they failed with their teacher and thereafter make a new attempt within a couple of days. This examination is given when the course has been going on only a few weeks. The purpose is that we want to be sure that the students have understood some basic concepts. The teachers also get a personal contact with students that have problem to pass this part of the exam.

Use of operational amplifiers – second problem

This assignment with the microphone and loudspeaker is then further developed into this problem:

Develop a simple public address system (PA-system). As an example your teacher could sit in his working room and talk so it will be heard in the laboratory. The distance from microphone to loudspeaker is about 100 meters. There should also be possible to send an attention signal, a simple beep with the frequency 440 Hz would do.

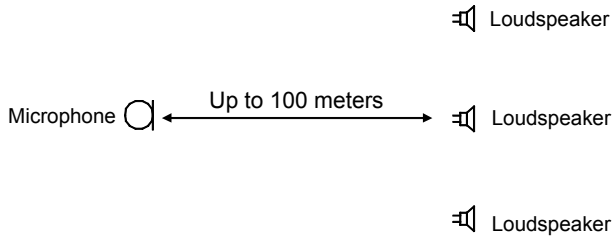


Figure 4 Public address system

This problem leads to different kind of amplifiers designed with operational amplifiers and most of the objectives in this part of the course could be completed with this assign. A functional system should be demonstrated on the second lab exercise in the course.

Examination, part two (X2)

The examination X2 is a portfolio describing all the amplifiers they have designed for the PA-system. It should also show that they could apply the theories from the book on their own design. Calculation should be confirmed with simulations and measurements. The students' portfolios are handed in and after a couple of days, when the teacher has read the portfolio, there is a meeting with the student and the teacher. The examining teacher asks question about the portfolio to make sure that it is the students own work and that the student can explain what and why he or she has done it that way. If the student fails on some part he/she has the opportunity to complete the examination within a few days.

Component level

At the end of the course it is time to learn about the semiconductor components such as transistors and diodes. This is the most difficult part of the course. By this time the students are well oriented about what amplification means and how to build amplifiers with operational amplifiers. At this component level the students are supposed to understand transistors and how to use them to build amplifiers and switches. Internally in an operational amplifier there is transistors so the students also gain a deeper understanding of the operational amplifier.

Examination, part three (X3)

This last examination in the course consists of a set of hand-in assignments, which the students solve by themselves or with other students. The solutions have to be handed in with a personal copy from each student. There is also an assignment to design and build an amplifier with certain properties, different for each student in the small group. This design has to be presented oral in the presence of the group. The examining teacher and the students in the group can ask questions about the design.

Total mark

The student's total mark in the course is depending on all three examinations. To pass the whole course all three examinations must be approved. We have had 75 students registered on the course when it started this year. At the end of the course 83% have passed the examination. We have graded marks with the levels 3, 4 and 5. Out of the 75 registered students 42 students achieved mark 3, 20 students achieved mark 4 and none of the students achieved the highest level 5. Among those who failed to pass the course there were students who has dropped out from the study programme during the course.

3 Evaluation

We have changed the examination form for all our students in the course Analogue Electronics. This means that we do not have a control group that could directly be compared with this new course. It is also a difficult task to evaluate if the quality of the students knowledge is better than in the traditional course. It is e.g. not possible to take one of the old written examinations and compare the result with the results from the students the year before because this years students are not trained to perform well in that kind of examination. A more interesting way to assess the students knowledge would be to evaluate how well they would manage to solve engineering problems within this discipline e.g. one year after they finished the course. It has not been possible to do this kind of evaluation so after some discussion we decided to evaluate this course (Analogue Electronics) from the students view and compare it to another course (Electrical Circuits), which was held in a traditional form just before they started Analogue Electronics.

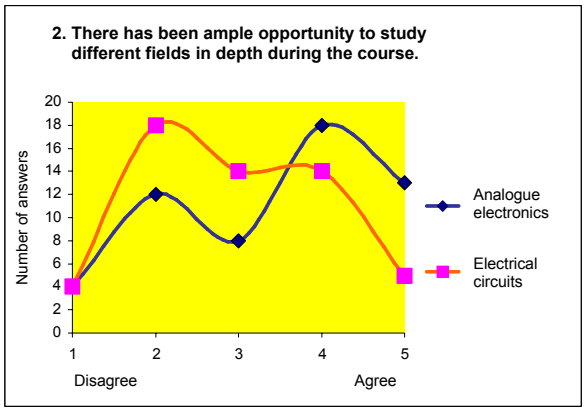
3.1 KTH Learning Lab enquiry

At the end of the course Analogue Electronics all students was invited to answer an enquiry. The students had to grade how much they agreed or disagreed with thirty statements for both courses (Analogue Electronics and Electrical Circuits). Immediately after the enquiry four groups of students was randomly selected and interviewed about the enquiry and the courses. In this report I will publish some of the questions where we have had the largest and most interesting differences between the courses. The enquiry and the interviews was done by Mats Nyberg at KTH Learning Lab. The full result of the enquiry is published in a separate report (Nyberg, 2002).

The questions were formulated to test the student's attitude towards deep learning, course objectives and motivation.

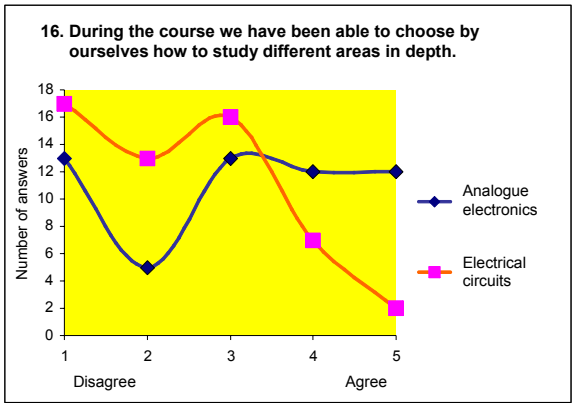
Questions about deep learning

We wanted the students to obtain a deeper approach towards learning in the course Analogue Electronics than in normal courses. With this question (se statement 2 in figure at right) we wanted to test if the students feel that they have possibilities to enter deeply into different fields during the course. The answers show that more students in the course Analogue Electronics than in the

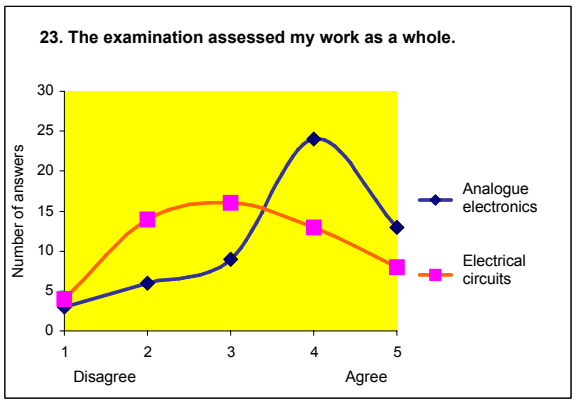


course Electrical Circuits agree with this statement but there is also a group that disagree with the statement. The students are not indifferent, they take up a definite position either in favour or against the concept in Analogue Electronics.

This is a statement with a very interesting answer (statement 16). Most of the students agree that there has been much more freedom of choice in Analogue Electronics. It is remarkable that there is a small group in Analogue Electronics that strongly disagree with the statement. It might be the same group that have a different opinion also in other answers (se statement 3, 29 and 30). It might be interpreted that those students have not understood what to do and do not feel comfortable with the course.

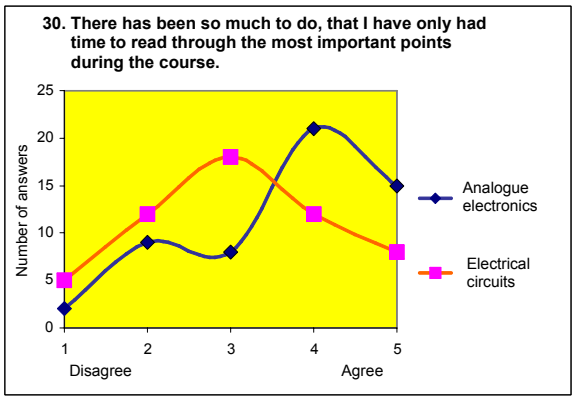


One purpose with changing the examination was to check on the students ability to master the subject in a more engineering way instead of controlling whether they could memorize formulas and solve typical schoolbook exercises. We also wanted a more holistic way to assess the students in the course. The answer of this question (statement 23) show that most of the students agree with the statement that we assess their entirely work in the course.



One drawback into helping the students into deep learning is the lack of time. The students have other demanding courses in the same time period as our course. From the answers on statement 30 it is obvious that the students have had to much to do during the course.

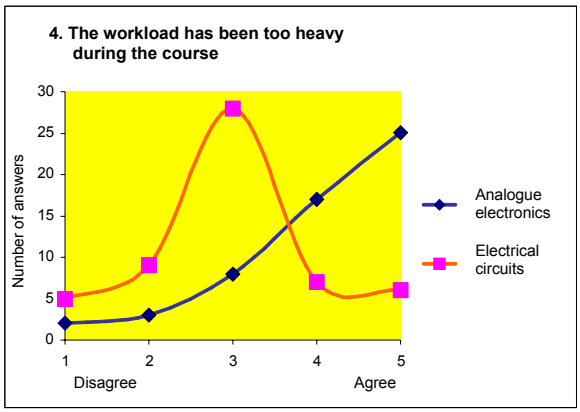
It has been options for the students to choose which mark level they want to apply for. After the course is finished we could notice that many students have been satisfied that they have passed the course and that they do not spend time to raise their marks.



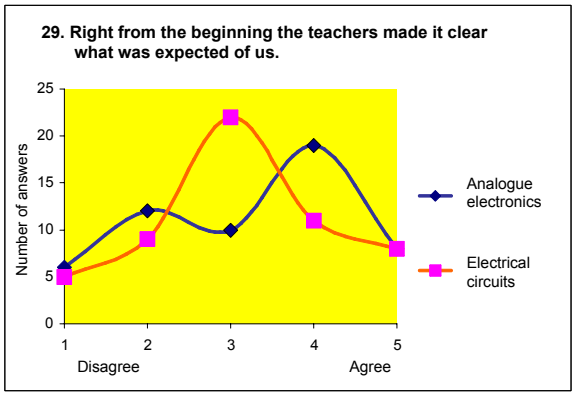
We could say that the students have had possibilities to enter deeply into different fields in the course but the lack of time made it impossible for many students do that in reality.

Questions about course objectives

Another aspect to the students feeling that they do not have enough time is that the course might be overloaded. The students' opinion on the workload in the course is so clear (se statement 4 in the figure at right) that we have to consider if we should reduce the contents of the course or change the examinations so it takes less time.



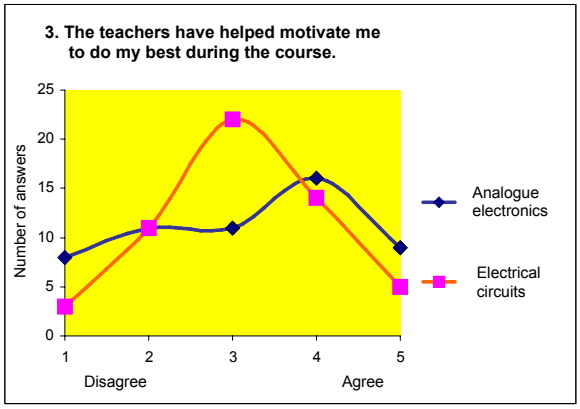
Another interesting topic is whether the students are aware of the goals in the course and what we expect them to do. A majority of the students agree with the statement 29 (se figure at right) but there is also a group of students that disagree with the statement. We seem for some reasons to have managed to split the group in an undesirable way.



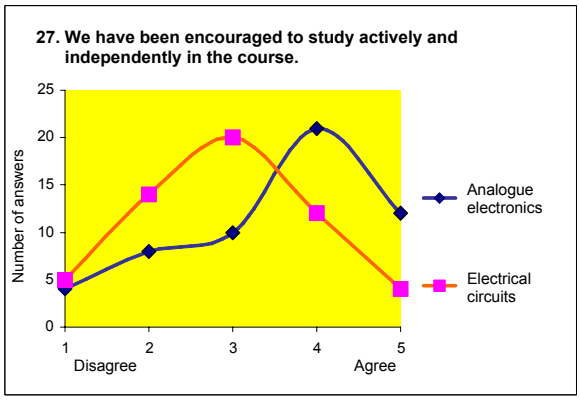
In some of our assignments we do not want to say exactly what the students have to do. We would like the students to find their own way to fulfil the goals of the course. This could have frustrated some students. We might have to make our course objectives more clear.

Questions about motivation

The tendency of splitting the group could also be seen in some of our questions about motivation (statement 3). If the students were not aware of what we expected from them they would of course be disappointed and less motivated to do their best. A consolation for us is that the humps in the figure representing students that agree with statements 3 and 29 are bigger than for the students that disagree.



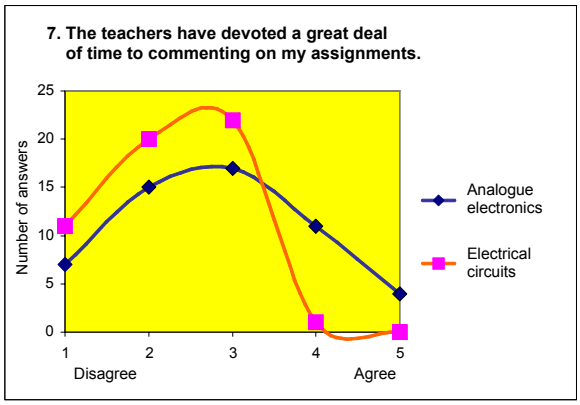
Most of the students agree with the statement that they have been encouraged to study actively and independently in the course (statement 27). This is of course positive and what we wanted.



When we reorganized this course in Analogue Electronics we wanted to give more feedback to the students. Students that do not fulfil our demands have the possibility to complete that part in their examination. Stu-

dents who do not pass a final written examination in a normal course have to make a new examination in a couple of months. We could say that we have included this re-examination into the course.

The students' answers of the statement 7 at the figure to the right verify in some extent that we have succeeded in giving better feedback, but we could make it better.



3.2 Course evaluation

We have also done an enquiry, as we always do as part of the course assessment, about the students' opinion about the course, design problems, lectures and group meetings. This enquiry confirms some results from the KTH Learning Labs enquiry that most of the students (approximately 75 %) are satisfied or very satisfied with the course and the rest (approximately 25%) are not satisfied with the course.

4 Conclusion

We have succeeded in making a course in analogue electronics with a top-down structure and with alternative examination. From real world problems we have made the course contents interesting and well integrated with the examination in the course. Most of the students have been very positive to the approach of learning that have been introduced in this course. Some students are critical and want everything to be as usual. The main problem is the workload that has been to high in the course. The positive attitude from the students inspires us to develop this concept further in the future.

We hope the results in this course could inspire other teachers to start thinking if this could be a possible way to change courses even in other disciplines than electronics.

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a top-down approach to learn basic electronics

EN UTVÄRDERING AV HSV-PROJEKT 012/2000

Mats Nyberg
KTH LEARNING LAB

KTH

a top-down approach to learn basic electronics

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KTH Learning Lab

Denna utvärdering är genomförd av Mats Nyberg vid KTH Learning Lab.

Studien, som genomfördes under våren 2002, är en del av projektet ”A top-down approach to learn basic electronics” som finansierats av Rådet för högskoleutbildning, projektnummer 012/2000.

Projekt- och undersökningsledare: Mats Nyberg, KTH Learning Lab.

Speciellt tack till:
Helge Strömdahl, universitetslektor, KTH Learning Lab, för stöd i frågor om undervisningsmetodik och Jan Enger på KTH, institutionen för matematisk statistik, för goda råd om grafisk presentationsteknik.

PROJEKTBESKRIVNING

Denna projektbeskrivning är ett redigerat utdrag från projektets slutrapport.

The project
A top-down approach to learn basic electronics was carried out during the academic year 2001/2002 at the Department of Applied Information Technology at the Royal Institute of Technology in Kista, Stockholm. The course this project is dealing with is Analogue Electronics that is given during the first half of the spring semester. This project has emanated from changes and experiments that have been tested for a couple of years prior to this project.

Traditionally
a basic course in analogue electronics is organized in a bottom-up way. The course is usually starting with elementary solid state physics to explain the function of semiconductor components, such as diodes and transistors. The use of transistors for voltage amplification is illustrated with exercises. Students learn how to analyse different kinds of amplifier configurations with the transistor. Sometimes they even learn how to synthesize or design an amplifier to satisfy a given specification. Later in the course students will learn about integrated amplifiers such as operational amplifiers and how they could be used to build voltage amplifiers.

In this project
we have restructured the way students learn basic analogue electronics. The new course is organized with a top-down structure to enhance the student's motivation to learn electronic design and to obtain a more holistic view. This means that the starting point is system aspect of analogue electronic systems and design with integrated operational amplifiers. This is an easier way to design amplifiers than using discrete transistor circuits. The students could, by this organization, start to design their own practical circuits much earlier in the course. With interesting design problems the student's motivation is enhanced. This top-down approach of the course motivate the students to learn about electronic components at the same time as they get practical experience with measurement instruments -learning electronics by doing electronics.

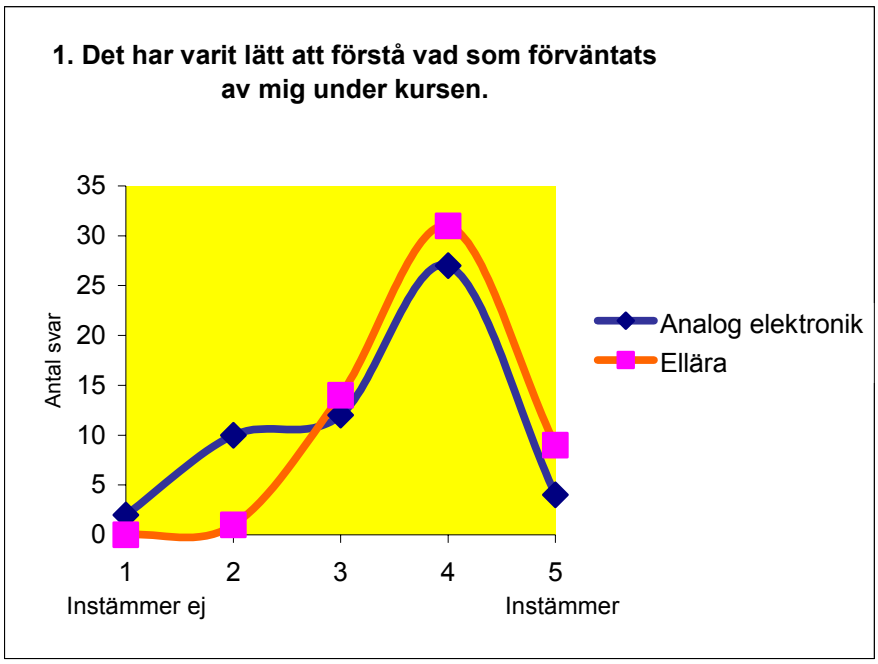
The evaluation
of the project aims to show if the traditional course may be replaced with this top-down structure. Did the students become more motivated and engaged in their learning?
We have changed the examination form for all our students in the course Analogue electronics. This means that we do not have a control group that could be compared directly with this new course. It is also a difficult task to evaluate if the quality of student knowledge is better than in the traditional course. It is e.g. not possible to take just one of the old written examinations and compare the result with the results from the students the year before. Probably our students this year would not do nearly as well, because they are not trained to perform well in that kind of examination. A more interesting way to assess the student knowledge would be to evaluate how well they could manage to solve engineering problems within this discipline e.g. one year after they finished the course. It has not been possible to do this kind of evaluation, either so after some discussion we decided to evaluate this course (Analogue electronics) from the students view and compare it to another course (Electrical circuits), which was taught in a traditional form just before they started Analogue electronics.

At the end
of the course Analogue electronics all students was invited to answer an enquiry. The students had to grade how much they agreed or disagreed with thirty statements for both courses (Analogue electronics and Electrical circuits). Immediately after the enquiry four groups of students were randomely selected and interviewed about the enquiry and the courses.
The enquiry and the interviews were done by Mats Nyberg at KTH Learning Lab.
The questions were formulated to test the student attitude towards deep learning, course objectives and motivation.

KOMMENTAR FRÅN LEARNING LAB

beträffande den grafiska presentationen av utvärderingen:
Undersökningsmaterialet är mätt på en diskret skala som redovisas i punkter på tabellernas kurvor. För åskådlighetens skull har vi valt att redovisa materialet med hjälp av en mjuk graf, eftersom man kan tänka sig en subjektivt kontinuerlig skala, dold bakom de avgivna svarens diskreta värden. Vi frågar ju efter studenternas personliga uppfattningar, relativt ett antal frågor.
Man bör därför inte dra alltför långtgående slutsatser av själva formen på kurvorna.

I anslutning till tabellmaterialet finns även undersökningsledarens personliga kommentarer och förslag på möjlig tolkning av materialet.



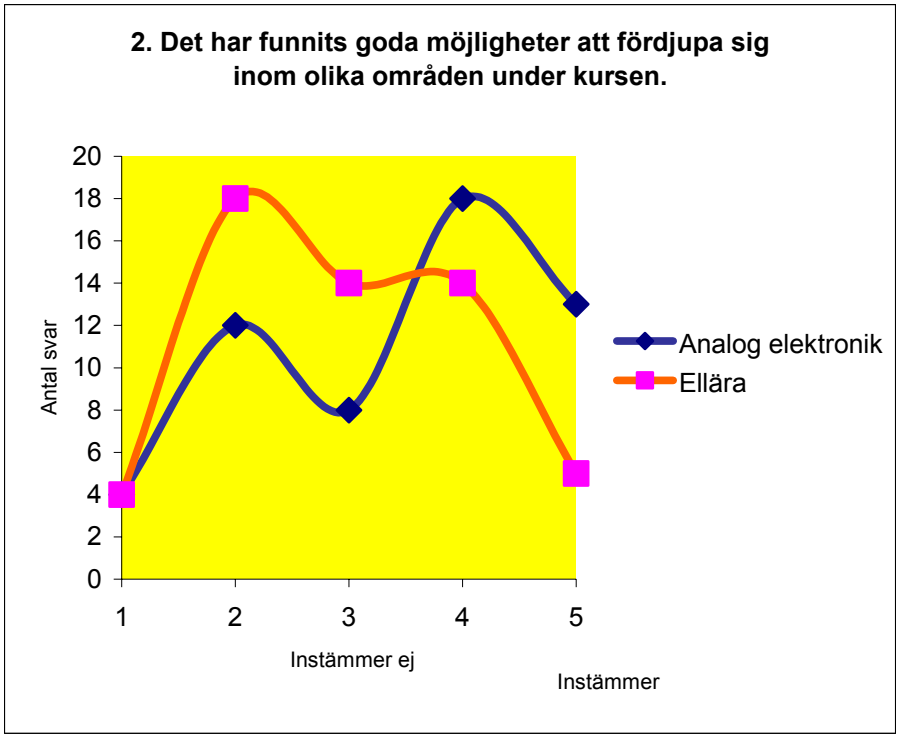
Medelvärde för Analog elektronik:	3, 38
Medelvärde för Ellära:	3, 87
Differens i medelvärde (A.e. - E.)	- 0, 49

Intervjusvar:

- Olika lärare ställer olika krav.
- Stor skillnad mellan lärare, större än mellan kurserna.
- Ae: Tydlig plan upplagd.
- Ae: Svårt att veta vad som krävs.
- Ae: Omöjligt att få överblick.
- Ae: Jag såg aldrig helheten.
- Ae: För lite förkunskaper gjorde resan skumpig.
- Ae: Jag tror att djupare insikt var målet.
- E: Bara klara tentan.
- E: Lätt att se vad som krävs, svårt att göra något extra.
- E: Tentan är målet.

Kommentar från undersökningsledaren:

- Bakom skillnaden i medelvärde ligger de 12 studenter som anser att det inte varit lätt att förstå vad som förväntats av dem under kursen: Analog elektronik. Motsvarande siffra för ellära är 0.
- Kan tolkas så att ett fåtal speciella studenter, förmodligen med merakonventionella förväntningar, har ovanligt stora svårigheter att förstå förväntningarna under Analog elektronik, en kurs med ovanlig examination, utan traditionell sluttentamen. I övrigt följer kurvorna varandra väl.
- Ingen av de tillfrågade hade däremot svårigheter att förstå förväntningarna på den mer traditionella kursen i Ellära.



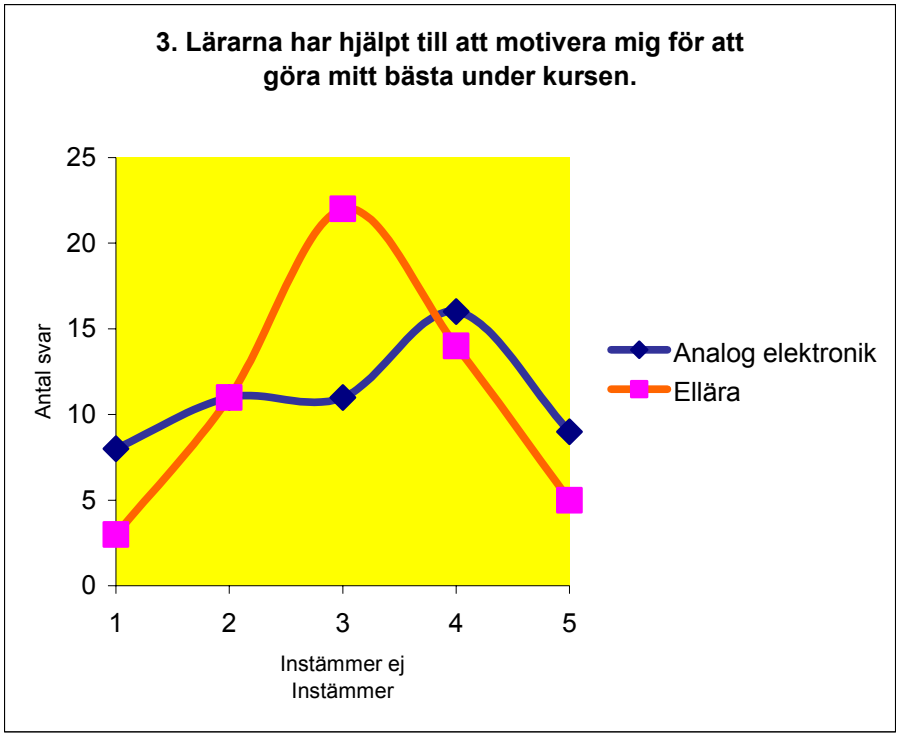
Medelvärde för Analog elektronik:	3, 43
Medelvärde för Ellära:	2, 96
Differens i medelvärde (A.e. – E.)	0, 47

Intervjusvar:

- Det bestämmer man väl själv.
- Analog elektronik var rätt djup, Elläran behövde fördjupas men tiden saknades.
- Det är bara jag som bestämmer vad jag vill satsa på.
- Ae: Möjligheterna fanns men inte tiden.
- Ae: Brist på tid.
- Ae: Det fanns ju annat att göra också.
- Ae: Man väljer ju sin egen examination och försöker klara den.
- Ae: Jag bestämmer ju min egen nivå och följer bara den.
- E: Fanns inget behov av fördjupning.
- E: Vadå, räkna mer eller…?

Kommentar från undersökningsledaren:

- Större skillnad i materialet än vad medelvärdet antyder. Kurvorna för båda kurserna har dubbla pucklar. Se speciellt kurvan för Analog elektronik.
- Kan tolkas så att studentgruppen har polariserats i denna fråga. Vissa studenter anser att det har funnits bättre möjligheter till fördjupning, andra däremot att möjligheterna tvärtom varit sämre. Endast 8 studenter på kursen i Analog elektronik har svarat ”varken eller”.
- Slutsatsen är att ingen är likgiltig till det nya upplägget, man tar ställning för eller emot.



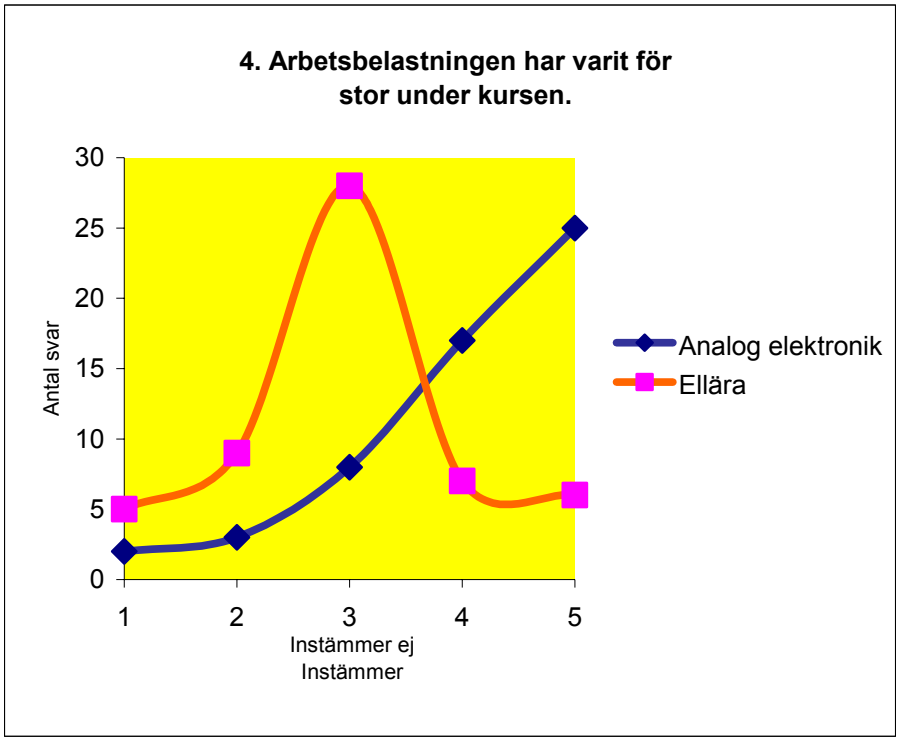
Medelvärde för Analog elektronik:	3, 13
Medelvärde för Ellära:	3, 13
Differens i medelvärde (A.e. – E.)	0, 00

Intervjusvar:

- Individuellt, beror på läraren.
- Det blir 1-1 mellan kurserna.
- Ae: En svårare och mer spännande kurs.
- Ae: Kräver större engagemang, mer motiverande.
- Ae: Belönar individuella prestationer.
- Ae: Svårt att förstå vad som förväntas.
- Ae: Förvirrande kurs, sänker ambitionsnivån.
- Ae: Hade fullt upp med att hinna med.
- E: Det var bara att kunna räkna, inte speciellt motiverande.
- E: Bra att veta vad man hade för mål.
- E: Tydligare mål. Bättre motivation.

Kommentar från undersökningsledaren:

- Här följer kurvan för kursen i Ellära normalfördelningskurvan, medan kurvan för Analog elektronik åter visar upp en tydlig dubbelpuckel.
- Dubbelpuckeln antyder att en del studenter upplever att de får betydligt större motivation medan en annan grupp anser det motsatta, att det motiverande stödet har blivit mindre. Uppfattningarna är alltså polariserade, vilket är intressant; man har en klar uppfattning i frågan.



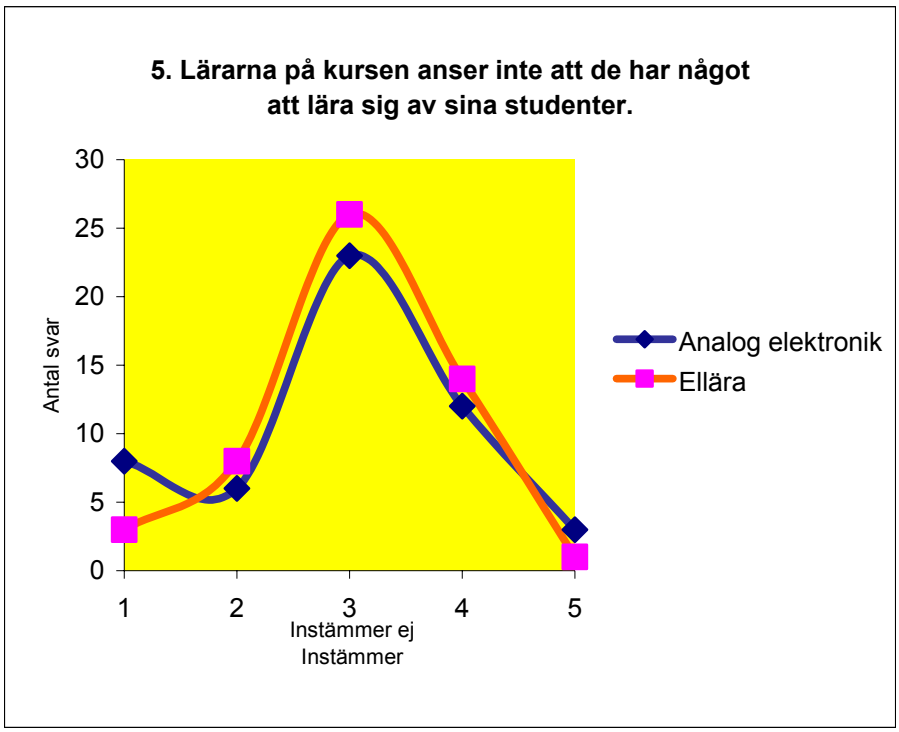
Medelvärde för Analog elektronik:	4, 09
Medelvärde för Ellära:	3, 00
Differens i medelvärde (A.e. – E.)	1, 09

Intervjusvar:

- Ae: Absolut för mycket att göra (alla är överens)
- E: Inte speciellt betungande (alla är överens)

Kommentar från undersökningsledaren:

- Ett mycket entydigt resultat. Kurvorna bekräftas dessutom och understryks av de muntliga intervjusvaren. De flesta studenter var fullständigt överens om att det har varit för stor arbetsbelastning under kursen i Analog elektronik. Ett fåtal anser att så var fallet med kursen i Ellära.



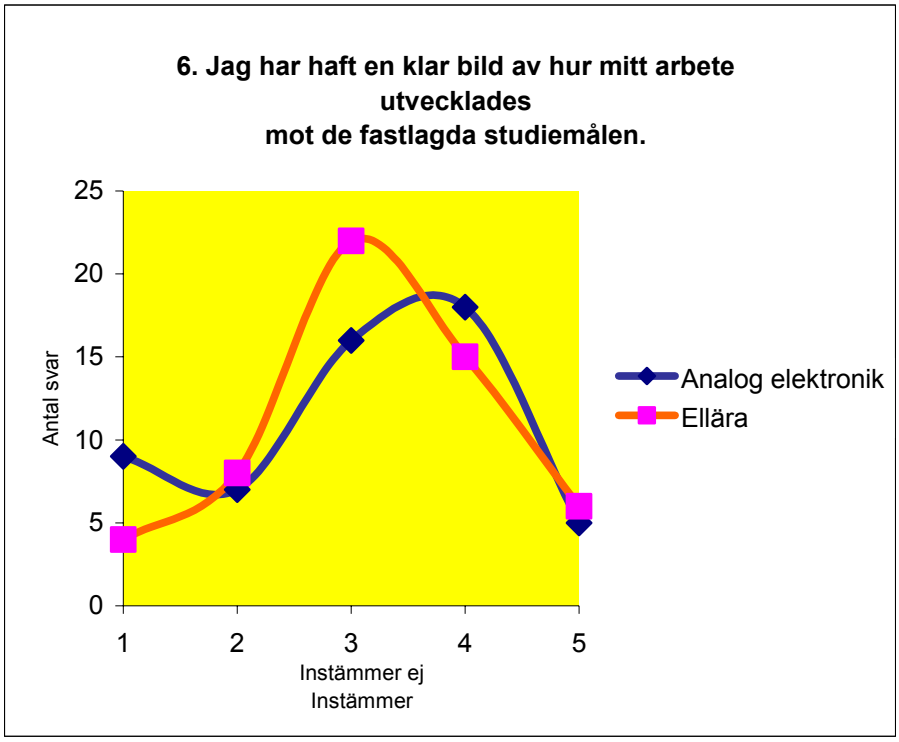
Medelvärde för Analog elektronik:	2, 85
Medelvärde för Ellära:	3, 04
Differens i medelvärde (A.e. – E.)	- 0, 19

Intervjusvar:

- Svår fråga.
- Jag förstår inte.
- Olika för olika lärare.
- Beroende på läraren.
- Hänger inte samman med kursens upplägg, lärarberoende.
- Ae: Vi har inte haft möjlighet att påverka kursen.
- Ae: Ett enda stort experiment som vi inte kunnat påverka.

Kommentar från undersökningsledaren:

- Försumbar skillnad, så liten att den kan härledas ner till enskild lärares insats.
- Den lilla uppåtgående svansen för ”instämmer ej” för Analog elektronik kan sannolikt förklaras av de som svarat ”instämmer ej” på fråga 1.



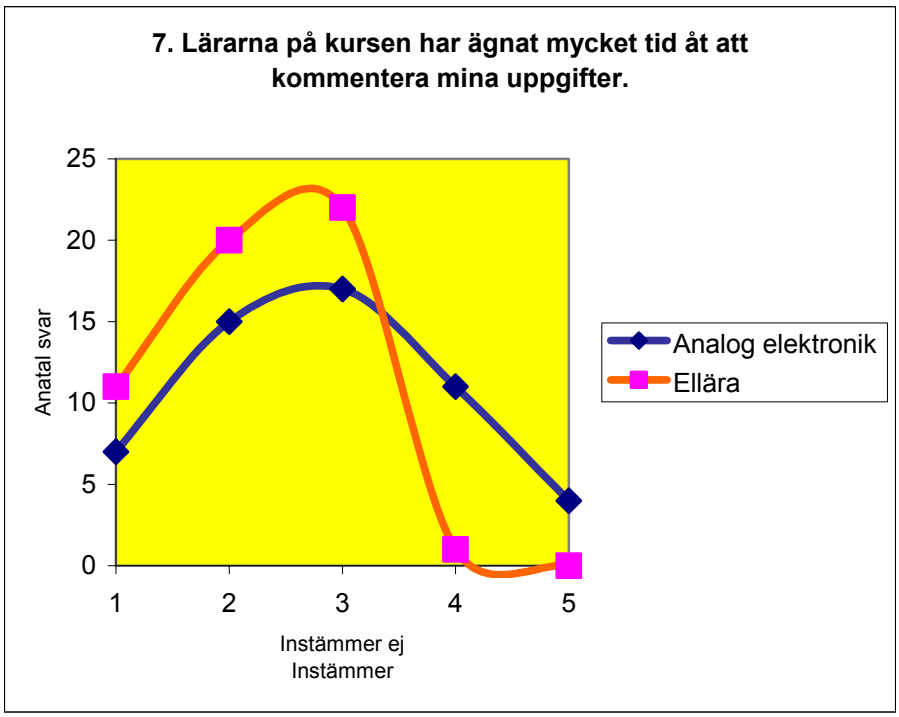
Medelvärde för Analog elektronik:	3, 05
Medelvärde för Ellära:	3, 20
Differens i medelvärde (A.e. – E.)	0, 15

Intervjusvar:

- Hänger ihop med läraren, inte med kursen.
- Lättare att förstå på Elläran än på Analog elektronik.
- För mycket trixande, improvisation och hopplock på Analog elektronik.
- Ingen större skillnad mellan kurserna.
- Ae: Tydlig målsättning redan från start.
- Ae: Lättare att stämma av mot sina egna studiemål.
- E: Lättare att plugga mot en tenta som man vet hur den blir.
- E: Vi fick mer och tydligare information på ellära.

Kommentar från undersökningsledaren:

- Se fråga 5.



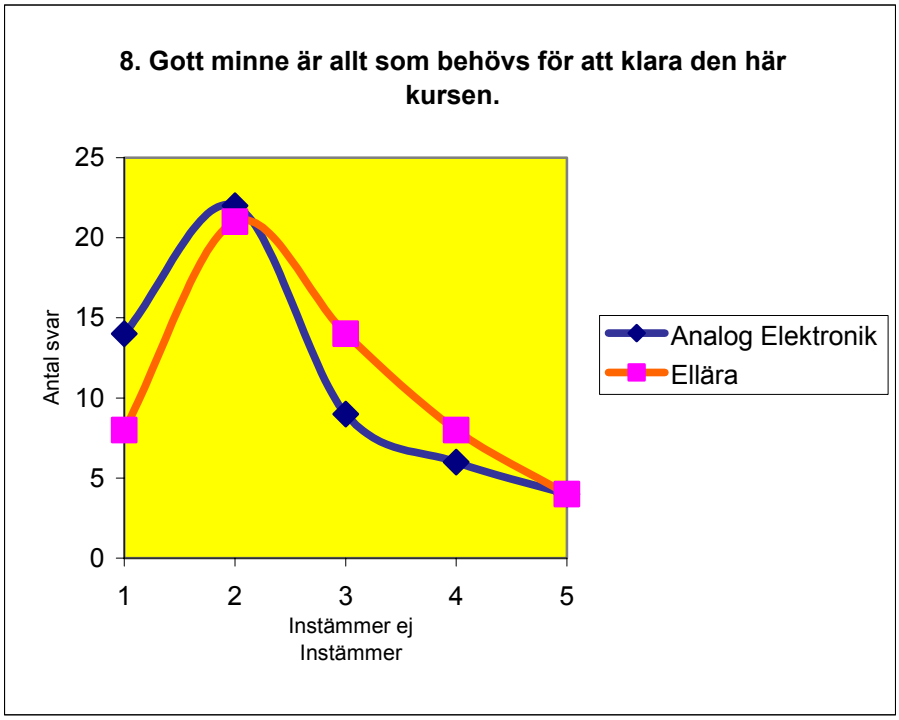
Medelvärde för Analog elektronik:	2, 81
Medelvärde för Ellära:	2, 24
Differens i medelvärde (A.e. – E.)	0, 57

Intervjusvar:

- Det har varit lika illa på båda kurserna.
- Jag tycker att det har varit för lite på båda kurserna.
- För lite tid till individuella genomgångar.
- Helt och hållet kopplat till läraren.
- Klart bättre på Analog elektronik.
- Tydligare respons på Ellära.

Kommentar från undersökningsledaren:

- Ett i stort sett normalfördelat svar för Analog elektronik men en tydlig negativ förskjutning för Ellära.



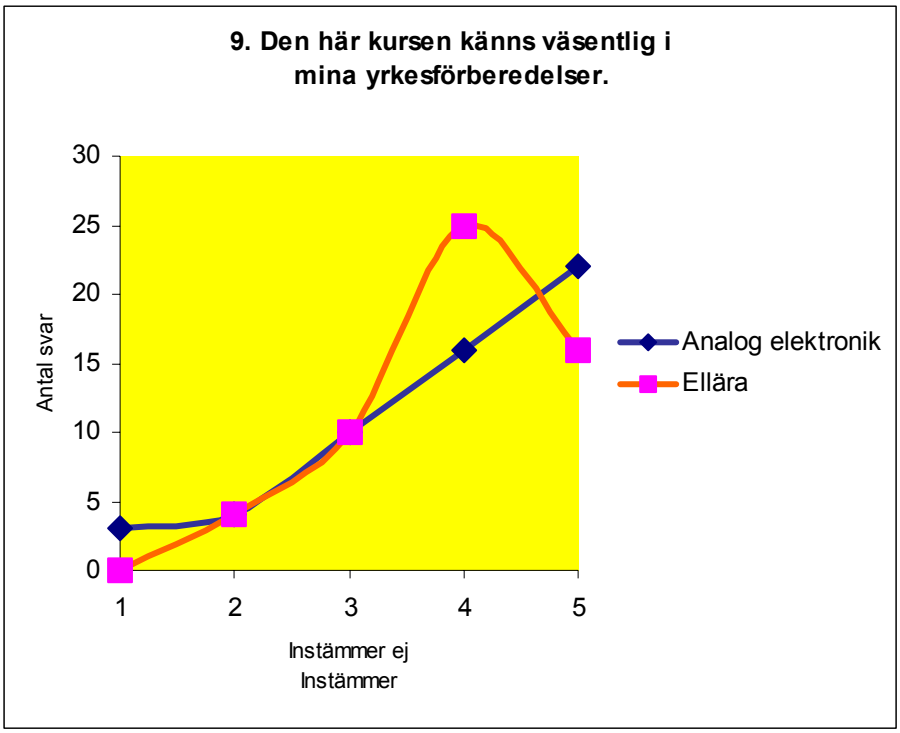
Medelvärde för Analog elektronik:	2, 35
Medelvärde för Ellära:	2, 62
Differens i medelvärde (A.e. – E.)	- 0, 27

Intervjusvar:

- Förstår inte frågan riktigt.
- E: Kräver mer av minnet än Analog elektronik.
- E: Vi räknade mycket så det är ju en form av problemlösning.
- E: Minnet räcker inte långt, man måste kunna räkna.
- Ae: Kräver mer problemlösning och konstruktionskunnande.
- Ae: Det hjälper inte att komma ihåg vad som står i böckerna.

Kommentar från undersökningsledaren:

- Förvånansvärt liten skillnad mellan kurvorna. Kan antyda att frågan var svårare att tolka än vad vi förmodade. Svaren på andra frågor visar att man ansåg/insåg att det var stor skillnad mellan kurserna. Vår slutsats är att frågan var oklart formulerad.



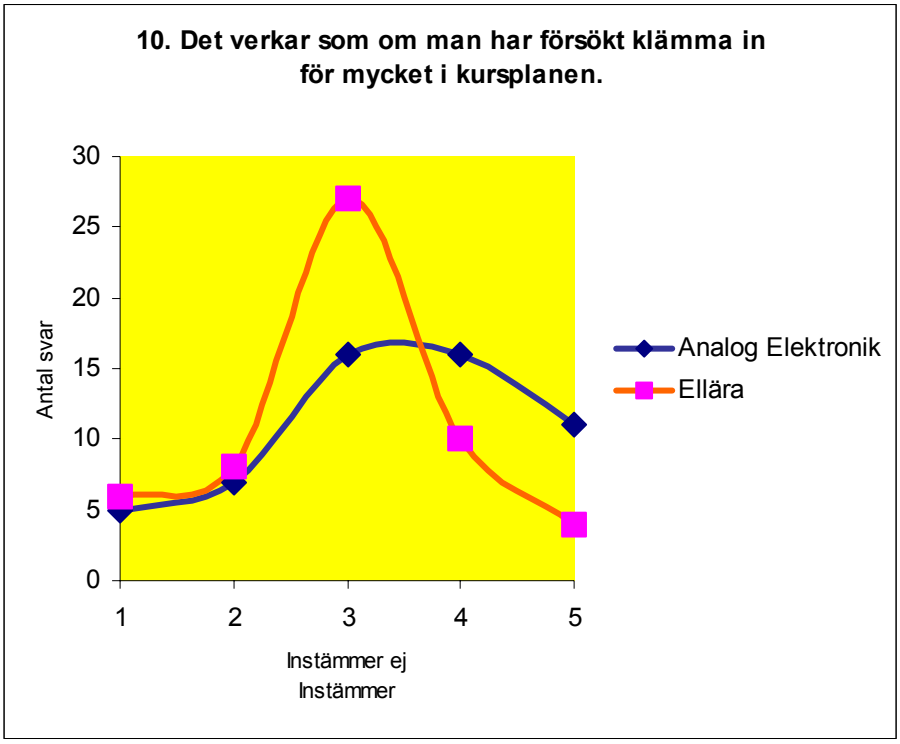
Medelvärde för Analog elektronik:	3, 91
Medelvärde för Ellära:	3, 96
Differens i medelvärde (A.e. – E.)	- 0, 05

Intervjusvar:

- Ae. En smal kurs.
- Ae: Bara för de som vill ha jobb på Ericsson.
- Ae: Skapar motivation.
- Ae: Spännande med konstruktion och problemlösning.
- Ae: Känns verklighetsanpassad.
- Ae: Mycket skrik för lite ull sa käringen som klippte grisen.
- E: Grundläggande kurs, borde fått större utrymme.
- E: Borde haft samma upplägg som Ae.
- E: Är grundläggande men känns för allmän och bred.
- E: Grunden till allt. Kan man inte detta kan man inget.

Kommentar från undersökningsledaren:

- Näraliggande medelvärden men ändå intressant variation.
- Fler ”instämmer starkt” på Analog elektronik, samtidigt som en liten grupp inte instämmer alls, på samma kurs. Kan ses som ett svagt eko av dubbelpucklarna på fråga 2 och 3.
- Sammanfattningsvis anser man att båda kurserna är väsentliga men olika personer har olika favoritkurser.



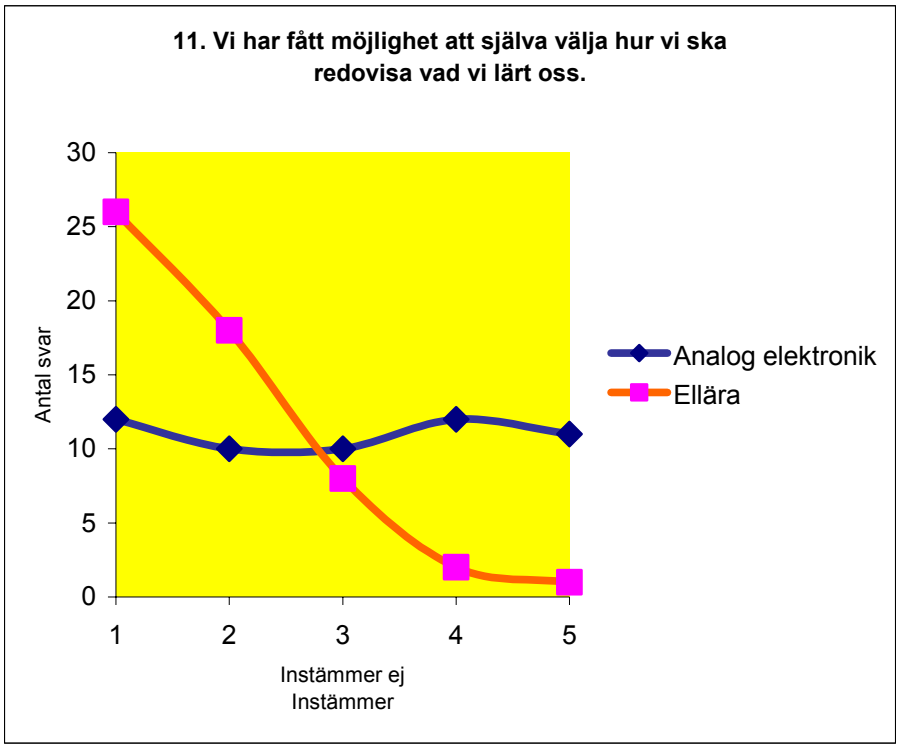
Medelvärde för Analog elektronik:	3, 38
Medelvärde för Ellära:	2, 96
Differens i medelvärde (A.e. – E.)	0, 42

Intervjusvar:

- Ingen större skillnad mellan kurserna.
- Ae: Alldeles för mycket. 8-poängskurs.
- Ae: Inte för mycket men för djupt, för grundligt.
- Ae: Ingen koppling mellan böcker och uppgifter.
- E: Inte alls, det var lugnt.
- E: Lagom mängd men lite ytligt.
- E: Det räckte med att skumma böckerna.

Kommentar från undersökningsledaren:

- Detta skall tolkas så att Ellära var som väntat medan de flesta upplevde Analog elektronik som späckad med innehåll och prestationskrav.



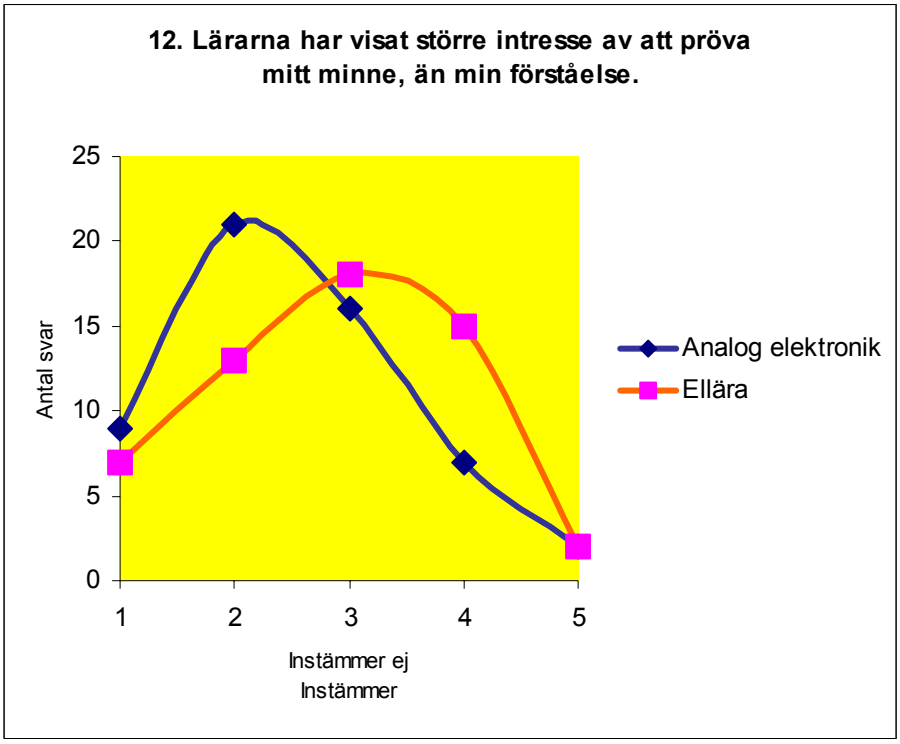
Medelvärde för Analog elektronik:	3, 00
Medelvärde för Ellära:	1, 75
Differens i medelvärde (A.e. – E.)	1, 25

Intervjusvar:

- En kombination av båda kursernas examination hade varit bättre.
- Stor skillnad mellan lärarnas sätt att bedöma oss, större än mellan kurserna.
- Ae: Vi gjorde en enkät, elläran har vi ingen möjlighet att påverka.
- Ae: Jag tror inte enkäten påverkade examinationen.
- Ae: Det känns som om vi gått miste om något, i och med att vi inte bedömts som vanligt.
- Ae: Enkäten var bara ett spel för galleriet.
- Ae. Det känns otillfredsställande att styra sig själv.
- Ae. Vad vet vi om ämnet innan vi läst det.
- E: Det är tryggare med vanliga tentor.

Kommentar från undersökningsledaren:

- Ett tydligt resultat. Man får inte välja redovisningsform på Ellära medan det går att påverka på Analog elektronik. Förvånande dock att vissa trots allt anser att man inte fått välja redovisningsform trots att detta ju var en uttalad grundtanke under Analog Elektronik.
- Det finns en risk att frågan istället har uppfattats som en fråga om ”hur bra” man har tyckt att de olika redovisningsformerna har varit.



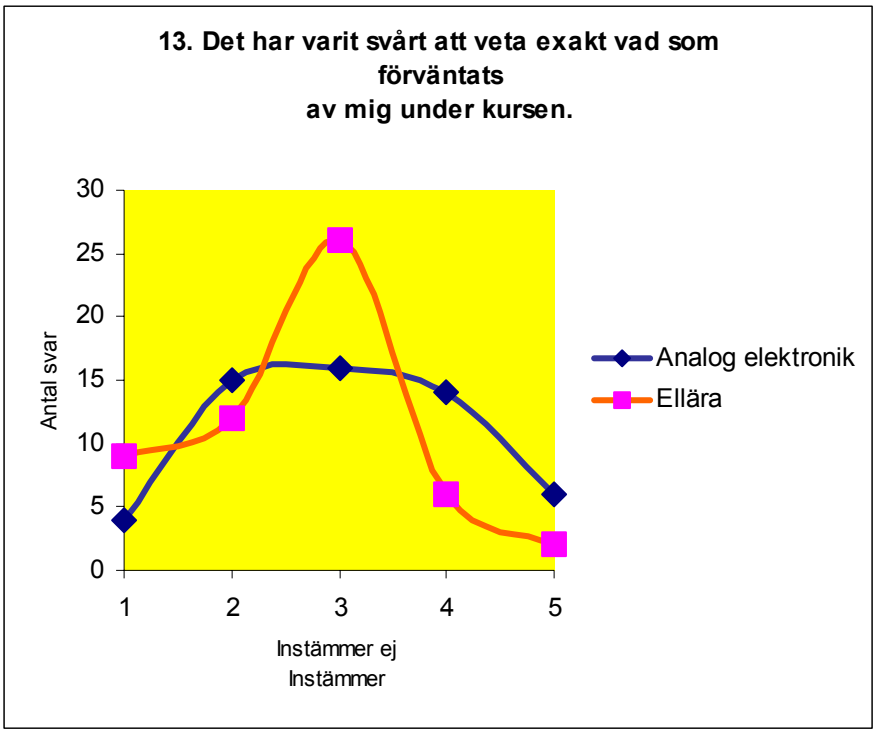
Medelvärde för Analog elektronik:	2, 49
Medelvärde för Ellära:	2, 85
Differens i medelvärde (A.e. – E.)	- 0, 36

Intervjusvar:

- Förstår inte riktigt frågan.
- Ellära handlar om råplugg, Analog elektronik om problemlösning i mörker.
- E: Det räcker gott att ha bra minne på Ellära.
- Ae: Det hjälper inte att plugga in fakta på Analog elektronik.

Kommentar från undersökningsledaren:

- En komplicerat formulerad fråga som ändå ger en tydlig fingervisning. Studenterna håller med om att Ellära handlar mer om gott minne än vad Analog elektronik gör. Skillnaden hade sannolikt varit ännu större om vi använt en rakare och enklare frågeformulering.



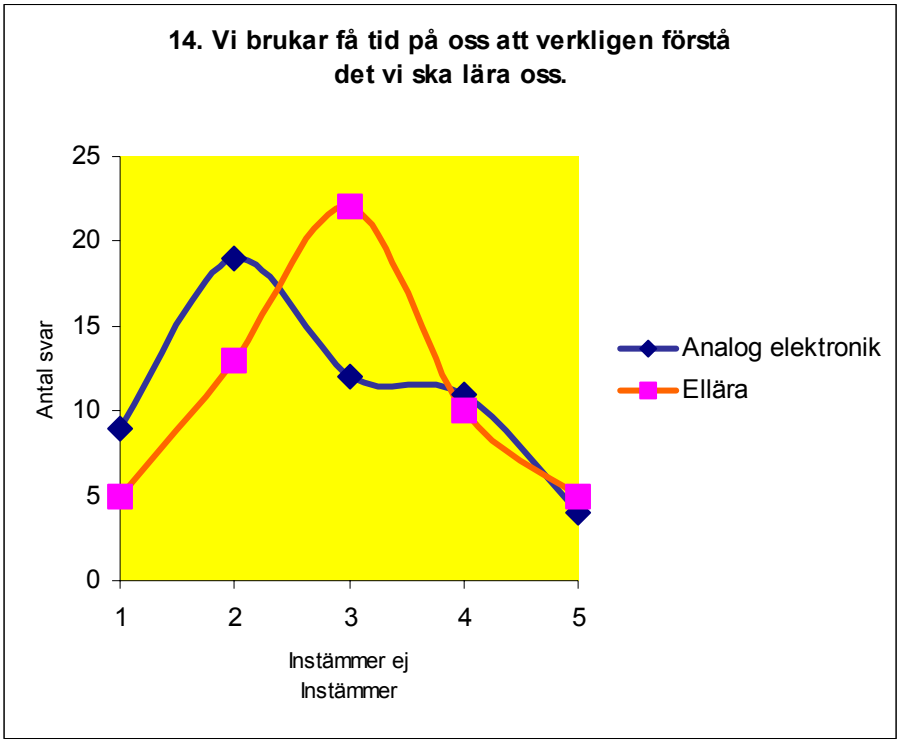
Medelvärde för Analog elektronik:	3, 05
Medelvärde för Ellära:	2, 64
Differens i medelvärde (A.e. – E.)	0, 41

Intervjusvar:

- Se fråga 1.

Kommentar från undersökningsledaren:

- Elläras kurva motsvarar det förväntade, en del tycker si, andra så och de flesta varken eller. Analog elektroniks kurva är mkt intressant och visar upp en antydan till dubbelpuckel. Gruppen polariseras, lika många instämmer som de som inte instämmer. Upplägget passar vissa bättre än det traditionella upplägget men passar andra betydligt sämre än det traditionella upplägget.
- Intressant är att jämföra med fråga 1 som är tydligt besläktad men ger ett annat resultat.
- Det antyder att det är lättare att ta ställning till kritik, som i denna fråga, än till ett positivt påstående, som i fråga 1.



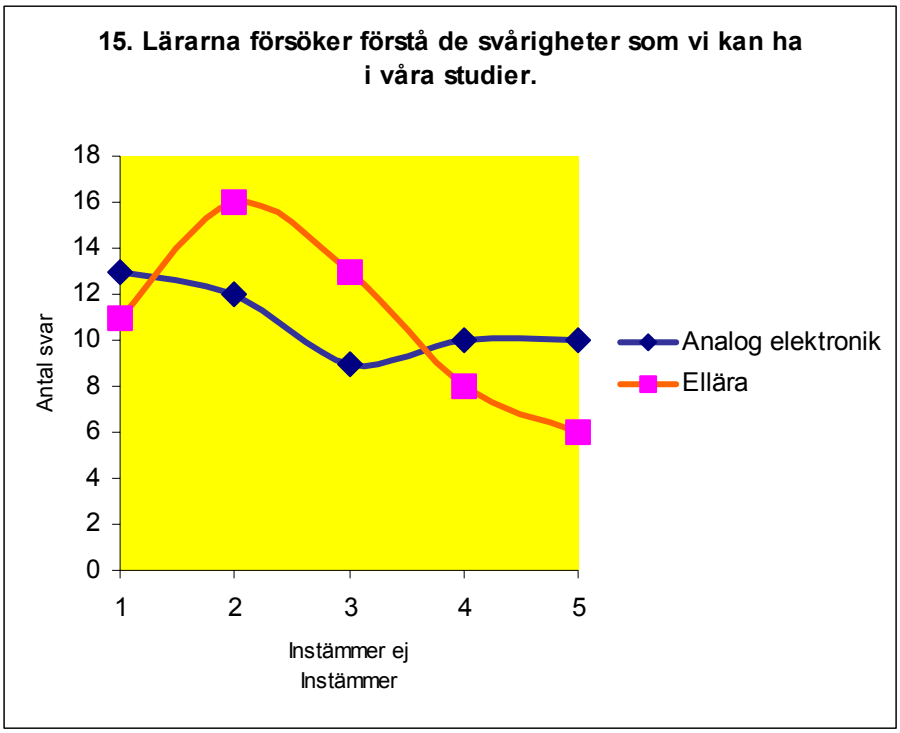
Medelvärde för Analog elektronik:	2, 67
Medelvärde för Ellära:	..2, 95
Differens i medelvärde (A.e. – E.)	- 0, 28

Intervjusvar:

- E: Ja.
- E: Det är mycket lugnare på Elläran.
- Ae: Det finns inte tid avsatt för egen planering.
- Ae: Hinner inte tänka efter.
- Ae: För hård tidspress.
- Ae: Det går inte att pressa in en 8-poängskurs på 4 poängs tid.
- Ae: Nej, tiden räcker inte till.

Kommentar från undersökningsledaren:

- Fler ansåg det svårt att hinna med under Analog elektronik än under Elläran. Jämför även med fråga 4 och 10.



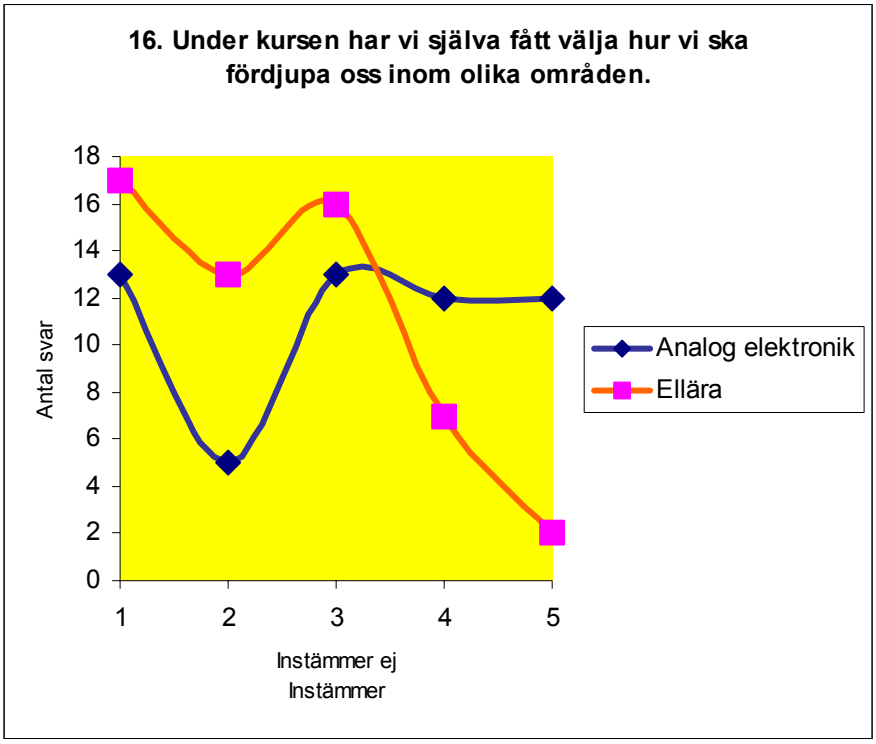
Medelvärde för Analog elektronik:	2, 80
Medelvärde för Ellära:	2, 66
Differens i medelvärde (A.e. – E.)	0, 14

Intervjusvar:

- Helt och hållet beroende på läraren.
- Ingen tid över för detta.
- Dålig planering innebär tidsbrist.
- Man vågar inte säga vad man tycker. Kan påverka bedömningen av mitt jobb.
- Det finns inget utrymme för att diskutera detta.

Kommentar från undersökningsledaren:

- Antyder att lärarna visar anmärkningsvärt lite förståelse under Elläran medan den originella dubbelpuckeln åter uppträder för Analog Elektronik. De flesta väljer att instämma eller inte instämma, färre väljer lagom-läget i mitten.



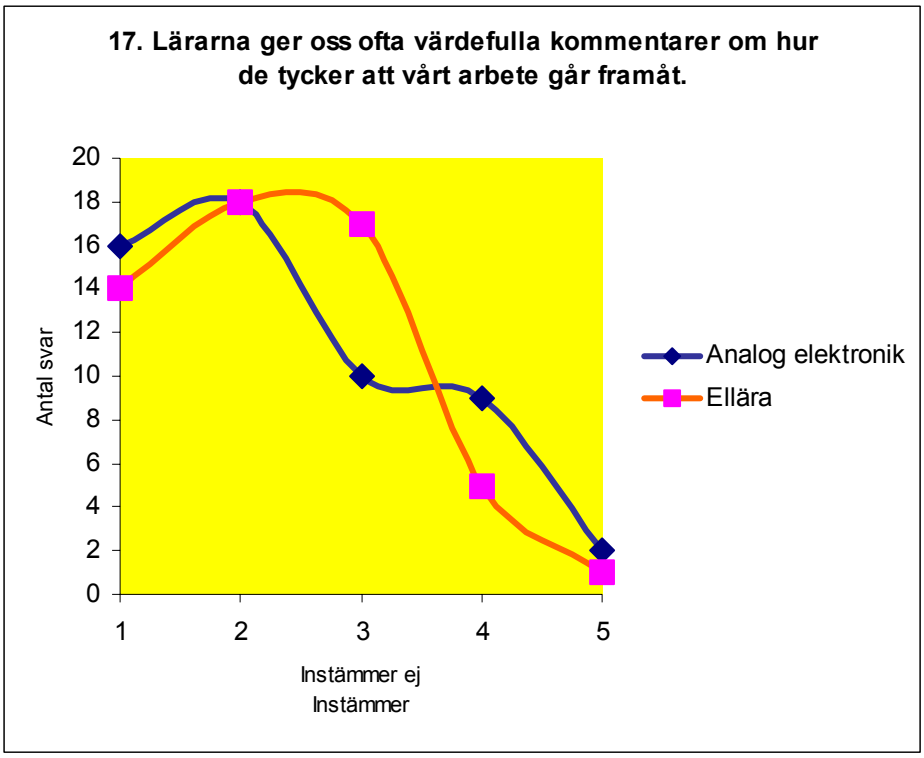
Medelvärde för Analog elektronik:	3, 09
Medelvärde för Ellära:	2, 35
Differens i medelvärde (A.e. – E.)	0, 74

Intervjusvar:

- Tiden räcker inte till.
- Tiden tar slut.
- Det räcker inte med att vilja när det är så mycket att göra.
- Ae: Finns inte tid över till fördjupning.
- Ae: Man gör det som krävs för att uppnå det förutbestämda målet.
- Ae: Det känns inte som om extra engagemang lönar sig.
- E: Förstår inte frågan.
- E: Det krävs ingen fördjupning för att nå bra resultat.

Kommentar från undersökningsledaren:

- En av de intressantaste kurvorna. Visar tydligt skillnaden i uppfattning mellan kurserna.
- De flesta håller med om den stora valfriheten på Analog Elektronik och man är överens om att den saknas under Elläran. Anmärkningsvärd är även den lilla grupp som definitivt inte håller med om valfriheten under Analog Elektronik. Det är samma grupp som genom hela undersökningen har redovisat en annorlunda uppfattning. Detta kan tolkas som att man faktiskt inte riktigt har förstått upplägget och förmått ta det till sig.



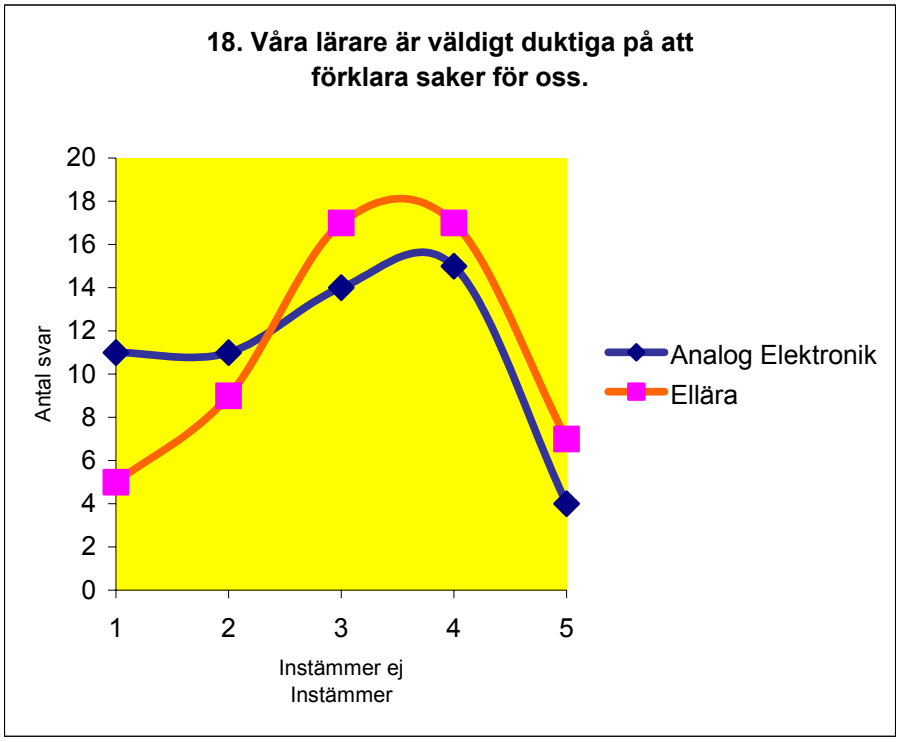
Medelvärde för Analog elektronik:	2, 33
Medelvärde för Ellära:	2, 29
Differens i medelvärde (A.e. – E.)	0, 04

Intervjusvar:

- För lite kommentarer över huvud taget.
- Finns inte tid att kommentera enskilda elevers insatser.
- Ae: Stor skillnad, mycket mer kommentarer på Analog elektronik.
- E Inga kommentarer alls på Ellära.
- Beroende på lärare, inte på upplägget.

Kommentar från undersökningsledaren:

- Kurvorna följer varandra väl. Medelvärdet stämmer. Men vi ser ändå den typiska dubbelpuckeln för Analog Elektronik, medan Elläran visar upp en graf med mer förväntad karaktär, d.v.s. de flesta svaren centrerade kring mittvärdet. Detta understryker än en gång att modellen under Analog Elektronik passa vissa mycket bra och andra mycket sämre medan den mer traditionella metodiken under Ellära passar de flesta lagom bra.



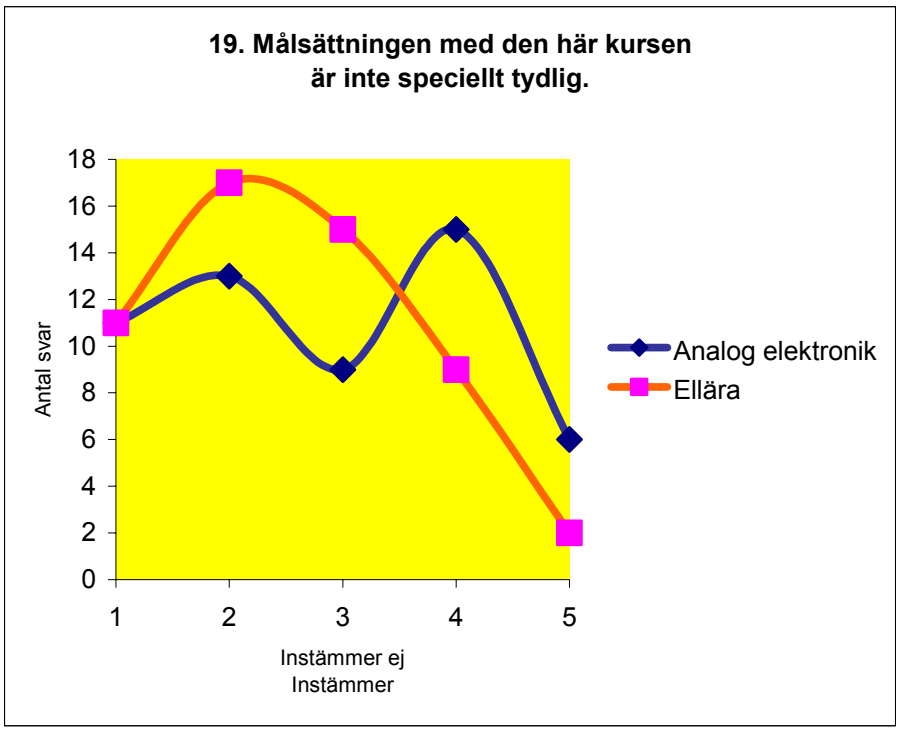
Medelvärde för Analog elektronik:	2, 82
Medelvärde för Ellära:	3, 22
Differens i medelvärde (A.e. – E.)	0, 40

Intervjusvar:

- Helt och hållet individuellt.
- Beror bara på läraren.
- Hänger inte samman med kursens upplägg, lärarberoende.

Kommentar från undersökningsledaren:

- Här ansåg de flesta att detta var lärarberoende och inte hade med kursens upplägg att göra. Däremot finns det en förhöjning av missnöje i Analog Elektronik. Den kritiska gruppen som helst vill att allt skall vara som vanligt.



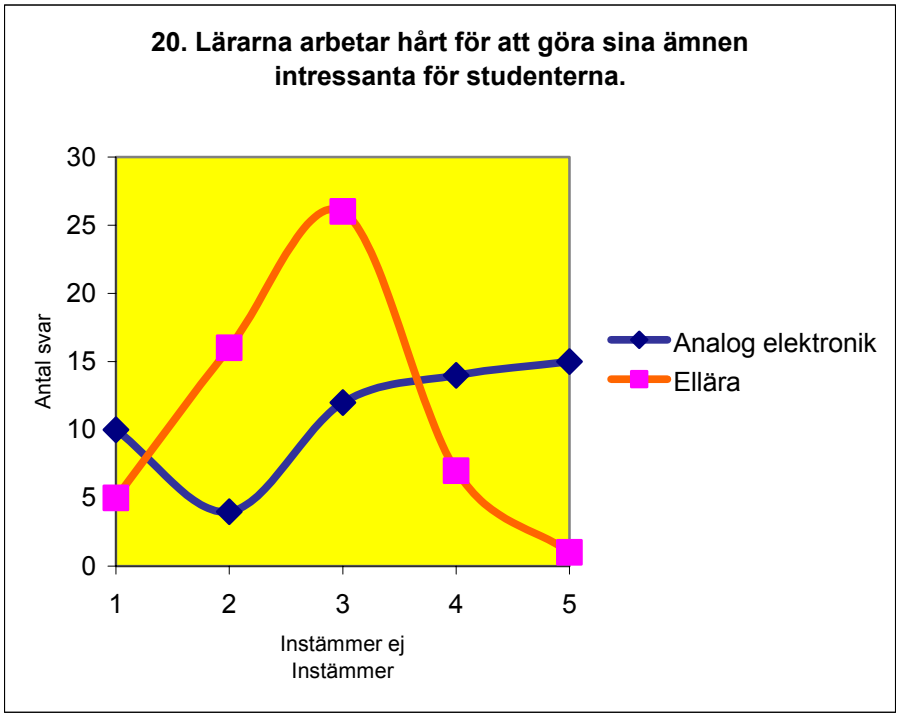
Medelvärde för Analog elektronik:	2, 85
Medelvärde för Ellära:	2, 52
Differens i medelvärde (A.e. – E.)	0, 33

Intervjusvar:

- (Se fråga 1.)

Kommentar från undersökningsledaren:

- Dubbelpuckel för Analog elektronik avslöjar att metodiken är tydlig och passar utmärkt bra för vissa studenter och är utomordentligt otydlig och svårgripbar för vissa andra.
- Elläran är lättare att förstå för de flesta.



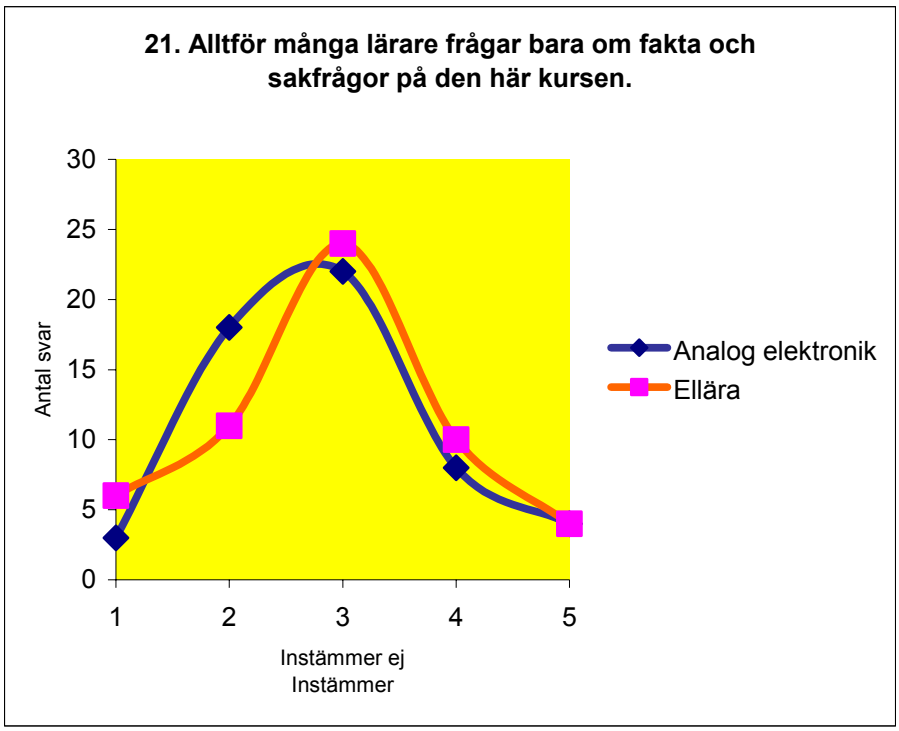
Medelvärde för Analog elektronik:	3, 36
Medelvärde för Ellära:	2, 69
Differens i medelvärde (A.e. – E.)	0, 67

Intervjusvar:

- Det handlar om läraren, inte om pedagogiken (de flesta överens).
- Ae: Det praktiska ökar intresset.
- Ae: Bra med verklighetstrogna kurser.

Kommentar från undersökningsledaren:

- Här ser vi en tydlig skillnad där lärarnas ansträngningar att motivera sina studenter är starkare under Analog elektronik. Intressant är dock den lilla gruppen som ”som vanligt” går mot strömmen och inte instämmer. Jfr. även fråga 6, 9 16, 18 och 25. De kan vara en och samma grupp studenter som förmodligen haft svårt att ta till sig metodiken under kursen i Analog elektronik.



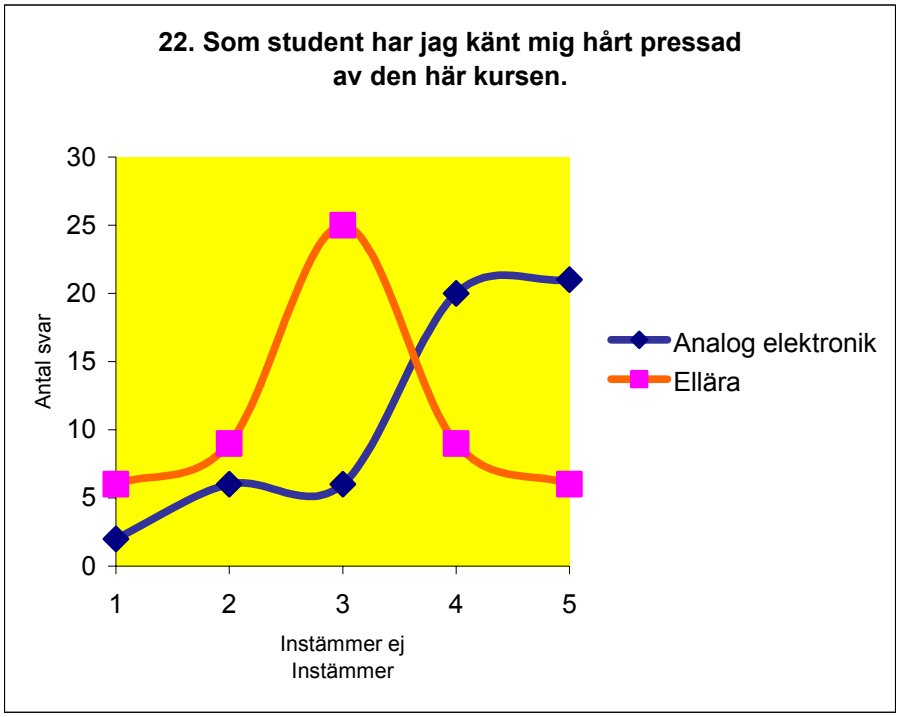
Medelvärde för Analog elektronik:	2, 85
Medelvärde för Ellära:	2, 91
Differens i medelvärde (A.e. – E.)	- 0,06

Intervjusvar:

- Oklar fråga.
- Diffus fråga, vad menas?
- Ae: Vi tvingas lösa problem utan hjälp.
- Ae: Lärare ofta frånvarande.
- Ae: För dålig koppling mellan bok och problem.
- Ae: Dåliga förklaringar, visa mer med exempel.
- Ae: Inga fakta, bara konstruktion.
- E: Bara fakta.

Kommentar från undersökningsledaren:

- Förvånansvärt symmetriska svar, både vad gäller medelvärde och kurvornas form. Detta antyder att vardagen i ”klassrummet” tillsammans med läraren har förändrats mindre än den grundläggande pedagogiken. Kan även antyda att frågan varit svår att förstå.



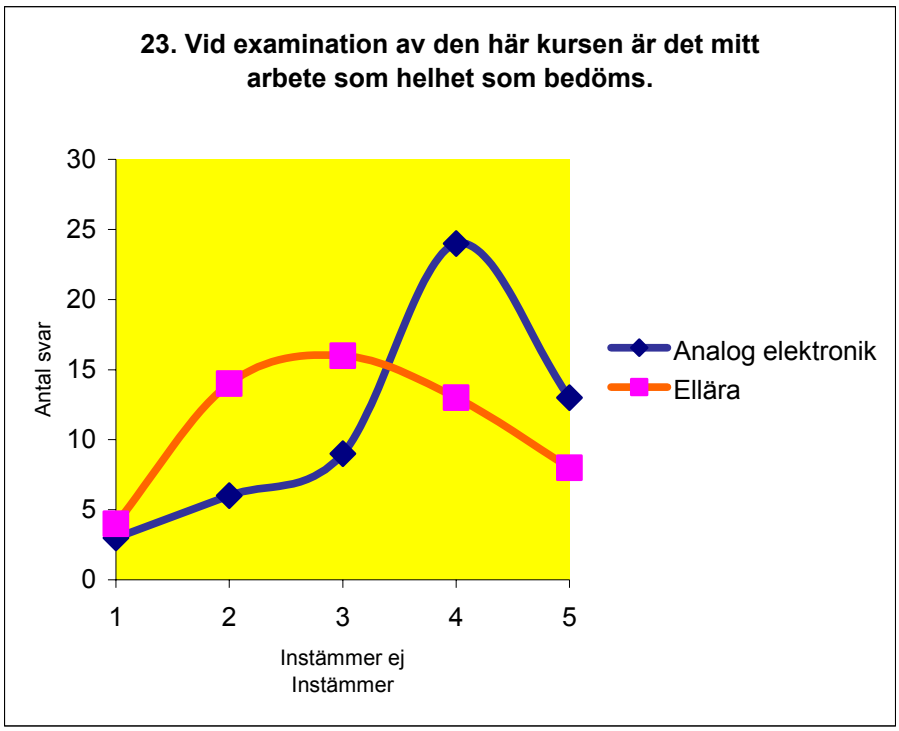
Medelvärde för Analog elektronik:	3, 95
Medelvärde för Ellära:	3, 00
Differens i medelvärde (A.e. – E.)	0, 95

Intervjusvar:

- Ae: Ja, mycket. (alla överens)
- Ae: Brist på tid. (alla överens)
- Ae: För mycket krav på hantverk, för lite kunskapsbyggande.
- E: Inte speciellt (många svar)
- E: Lugnt och skönt jämfört med Ae.

Kommentar från undersökningsledaren:

- Entydigt svar. De flesta anser att Analog Elektronik är mest betungande. Det finns dock en liten grupp som tycker motsatsen, att metodiken istället underlättar arbetet. Ännu en normalfördelningskurva som ställs mot en dubbelpuckel.



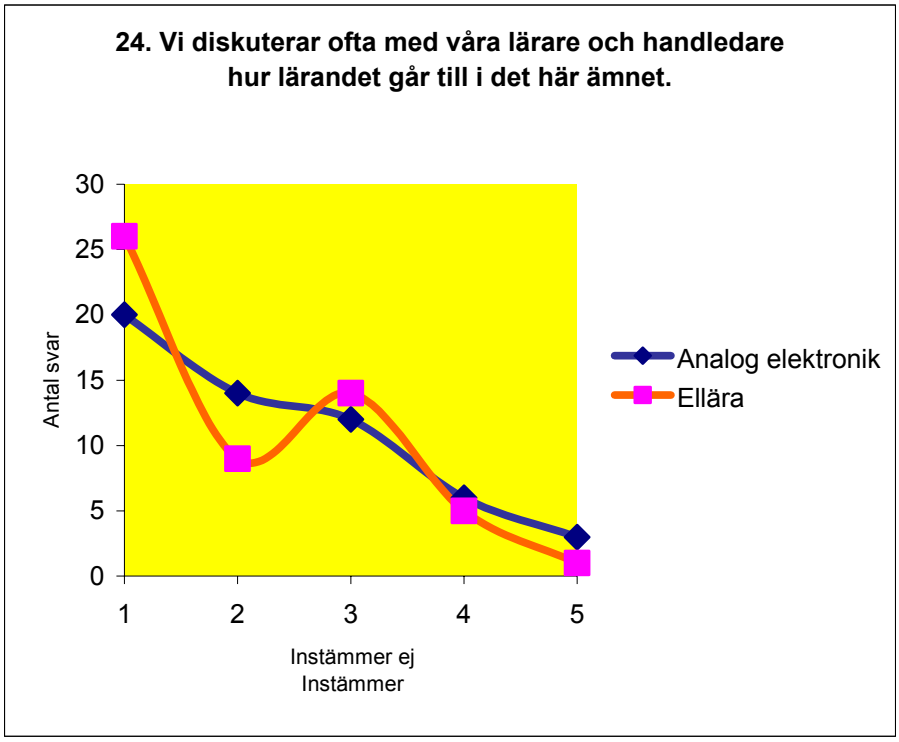
Medelvärde för Analog elektronik:	3, 69
Medelvärde för Ellära:	3, 13
Differens i medelvärde (A.e. – E.)	0, 56

Intervjusvar:

- E: Vi har inga tillfällen att visa vad vi kan göra, bara vad vi lärt oss.
- E: Bara tentan.
- E: Det är ju bara tentan som avgör.
- Ae. Här känns det som om allt arbete räknas.
- Ae: Jag har tappat motivationen att jobba extra.
- Ae: Jag blev av med lusten. För mycket att göra. Svårt att förstå.
- Ae: Dålig framförhållning ger tidsbrist.
- Ae: Kursen känns virrig. Lite som ett hopplock.
- Ae: Känns som man jobbar Ad hoc, undervisningen skapas i stundens ingivelse.

Kommentar från undersökningsledaren:

- En klar tendens som visar att många studenter har förstått syftet med Analog Elektronik och att man även uppfattat de annorlunda spelreglerna för Ellära korrekt.



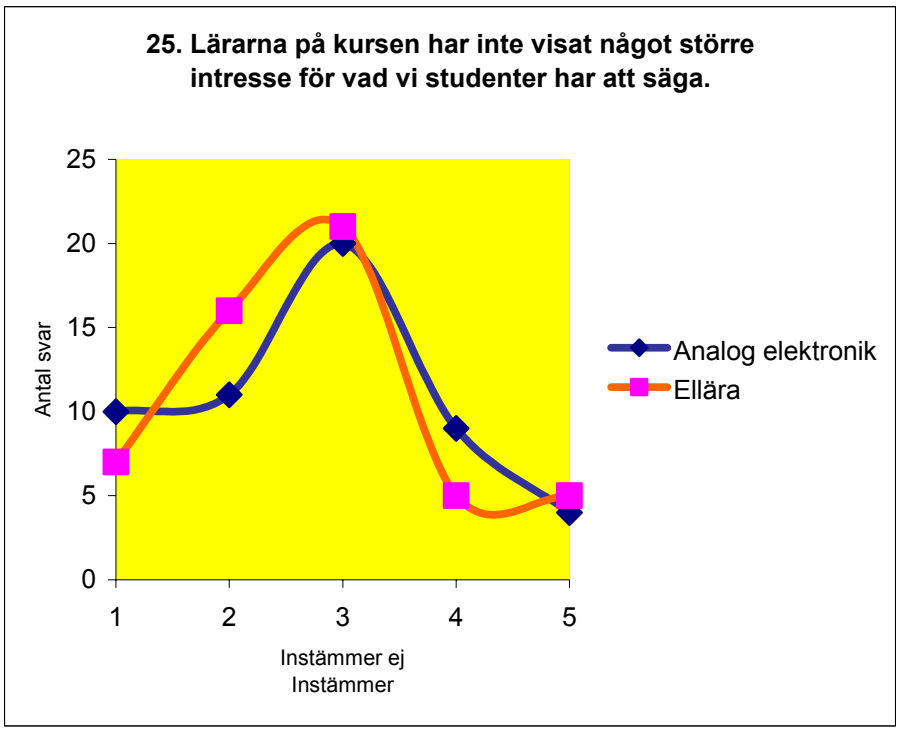
Medelvärde för Analog elektronik:	3, 24
Medelvärde för Ellära:	3, 20
Differens i medelvärde (A.e. – E.)	0, 04

Intervjusvar:

- Det här beror bara på läraren, inte på upplägget.
- Finns inte tid.
- Det har ingen visat intresse för.
- Jag förstår inte frågan.
- Diskussion i ämnet förekommer ibland. Aldrig om hur lärandet går till.
- För lite övningstimmar. Där kan man föra såna diskussioner.

Kommentar från undersökningsledaren:

- Här stämmer de två kurserna väl överens med varandra. Denna typ av diskussioner är tydligen ovanlig.



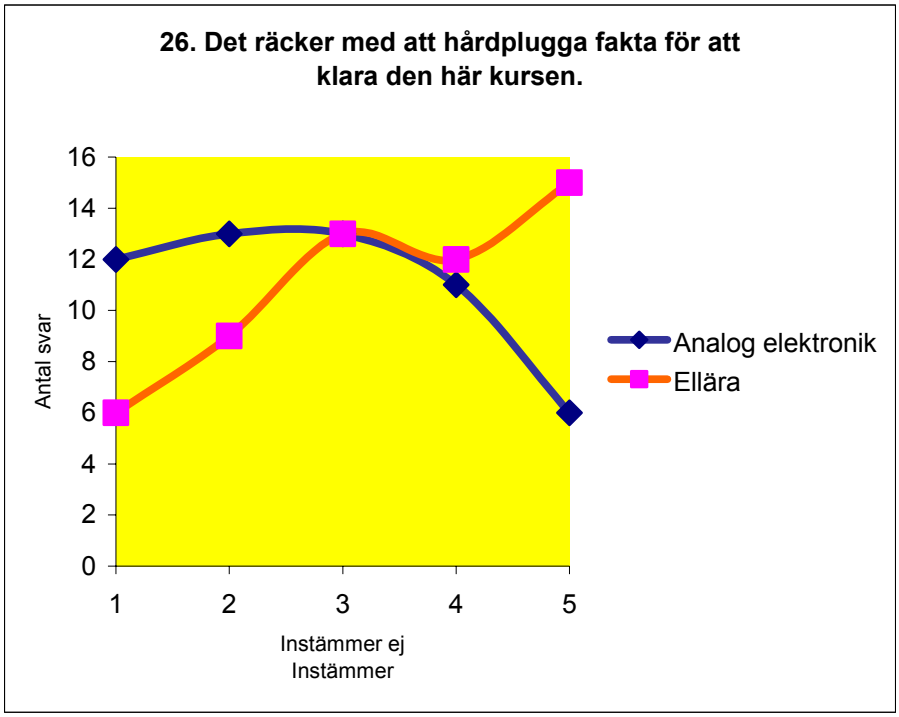
Medelvärde för Analog elektronik:	2, 74
Medelvärde för Ellära:	2, 72
Differens i medelvärde (A.e. – E.)	0, 02

Intervjusvar:

- Detta är individuellt för varje lärare, inte kopplat till kursens upplägg.
- Jag kan inte minnas någon lärare som varit intresserad av våra synpunkter.
- Har man synpunkter så håller man inne med dem för att inte uppfattas som kritisk.
- Lärarna är olika, en del inbjuder till diskussion andra inte alls.
- Diskussion förekommer bara på Analog elektronik, aldrig under Ellära.

Kommentar från undersökningsledaren:

- Här är man överens. Både när det gäller medeltal, spridning och kurvornas form. Kan tolkas som att man svarat på vad man tycker om lärarnas personliga insatser, snarare än på vad man tycker om kursernas olika upplägg.



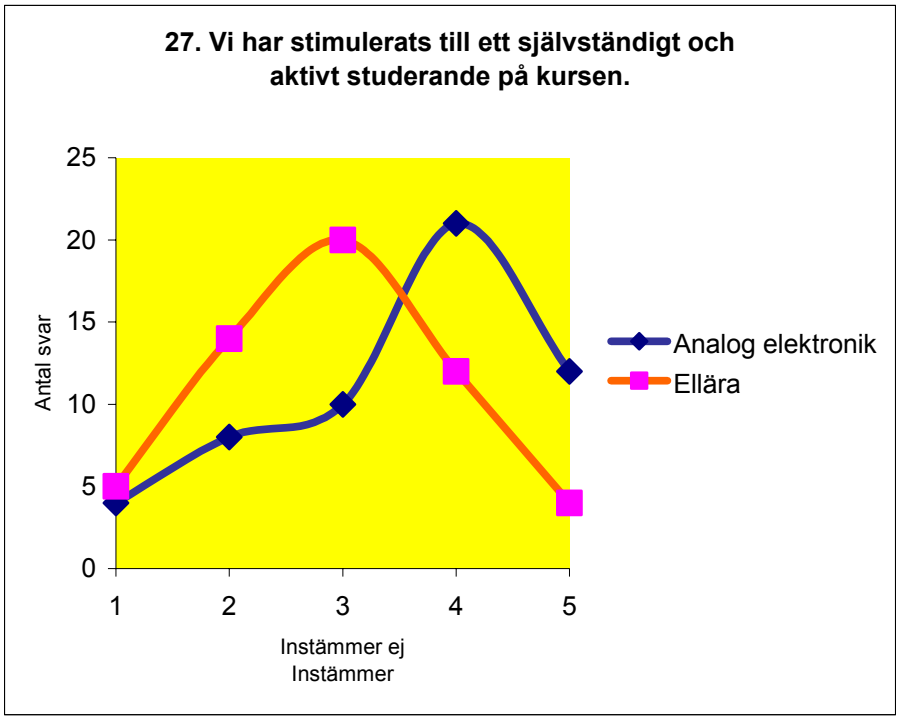
Medelvärde för Analog elektronik:	2, 75
Medelvärde för Ellära:	3, 38
Differens i medelvärde (A.e. – E.)	0, 63

Intervjusvar:

- Hårdplugg gäller på Elläran, på Analog elektronik räcker det inte.
- På elläran kan man spurta inför tentan. Det lönar sig inte att försöka öka på Analog.
- Ae: Det blir som man bestämt från början. Lönar sig inte att öka tempot efter hand.
- Ae: Det är första tentan som bestämmer ambitionsnivån.

Kommentar från undersökningsledaren:

- Det visar sig tydligt att det lönar sig bättre att hårdplugga fakta under Elläran, jämfört med Analog elektronik.



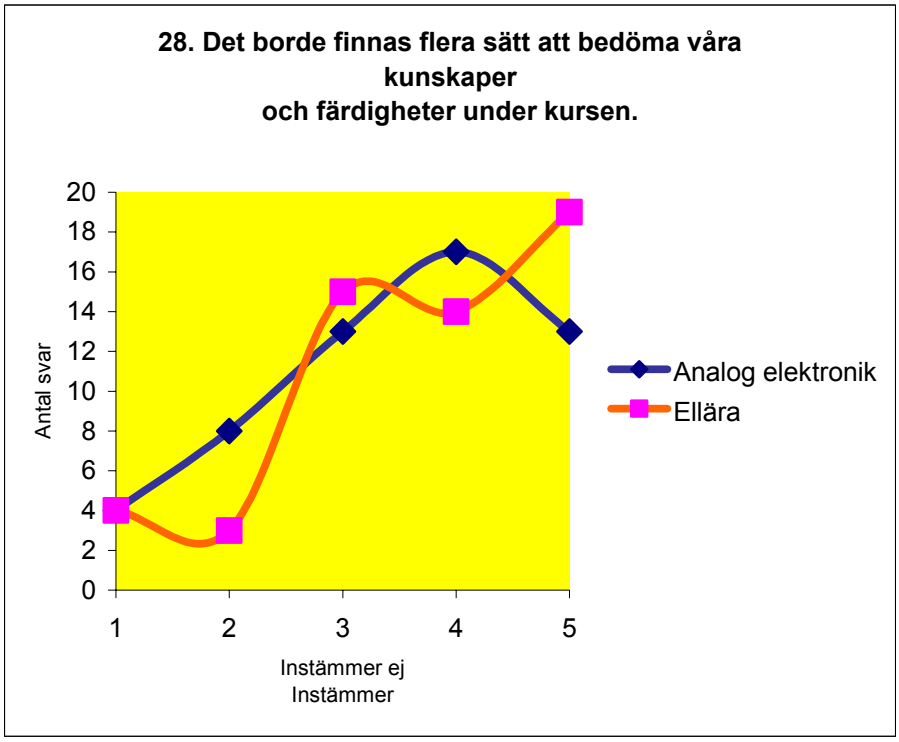
Medelvärde för Analog elektronik:	3, 53
Medelvärde för Ellära:	2, 93
Differens i medelvärde (A.e. – E.)	0, 60

Intervjusvar:

- Det finns inte tid över för att gå djupare in i ämnet.
- Ae: Det är ingen 4-poängskurs, det är en 8:a eller möjligen 6:a.
- Ae: Det finns ingen tid över för att planera egna initiativ.
- Ae: Tidsbristen gör att vi måste samarbeta för att hinna med.
- Ae: Vi löser många uppgifter tillsammans.
- E: Vi pluggar i grupp och samarbetar för att spara tid.
- Det finns alltid en viss ”fuskrisk” genom att kopiera de ”bästas” lösningar.
- Man lär sig ju av hur andra jobbar.

Kommentar från undersökningsledaren:

- En tydlig ”seger” för Analog elektronik dock med antydning till ”negativ” svans.



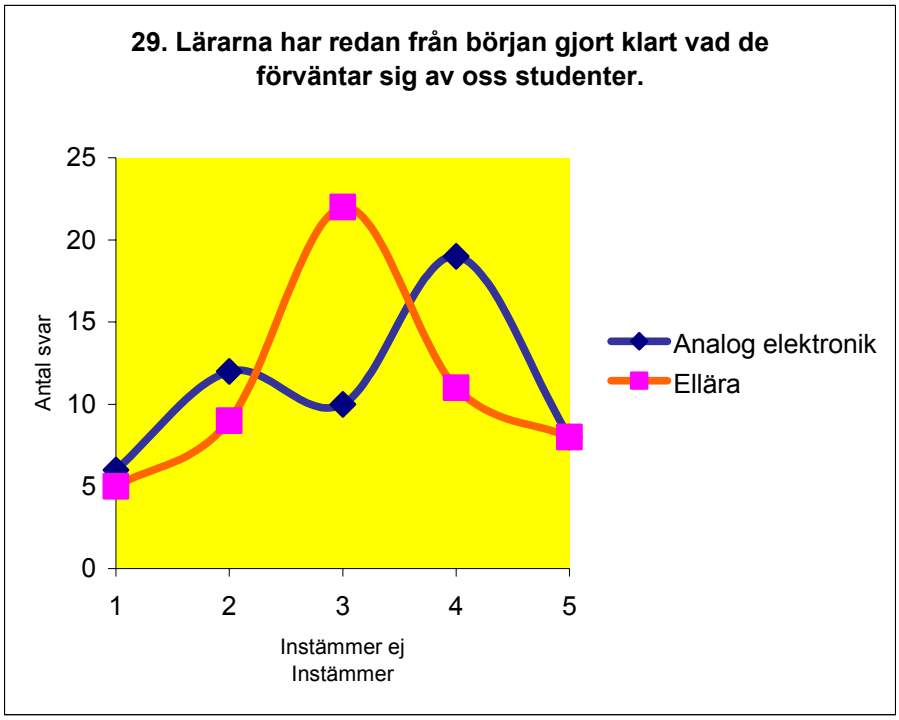
Medelvärde för Analog elektronik:	3, 49
Medelvärde för Ellära:	3, 75
Differens i medelvärde (A.e. – E.)	- 0, 26

Intervjusvar:

- Otydlig fråga, vad menas?
- Håller med.
- Lägg till mer laborationer och grupparbeten.
- Ja, det vore bra.
- Ae: Bra blandning.
- E: Blanda mycket mer.
- E: Lite tunt.
- E: Mer praktiskt arbete.
- E. Jag skulle vilja ha mer mätteknik och simulering.
- E: Lite tunt.
- Ae: Ping-pong var jättebra, varför slutade ni?
- Ae: Jag har aldrig ens loggat in på Ping-pong.
- Ae: Bra med tre olika sorters examinationer.

Kommentar från undersökningsledaren:

- En oklart formulerad fråga som spred viss förvirring. Resultatet antyder dock att man önskar mer mixade utvärderingsmetoder under båda kurserna. Inte antingen eller utan både och.



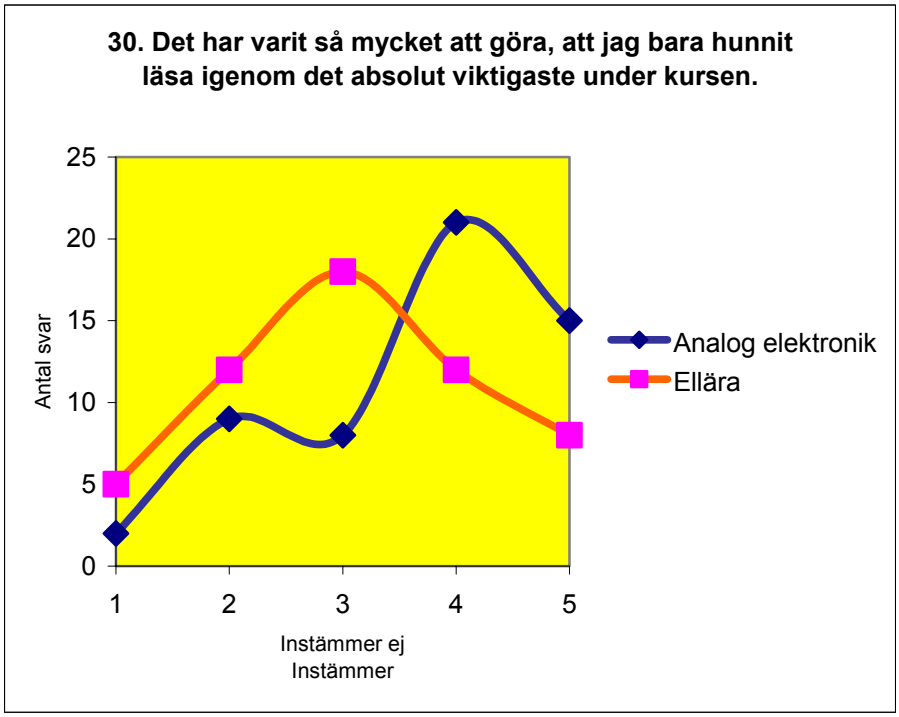
Medelvärde för Analog elektronik:	3, 20
Medelvärde för Ellära:	3, 15
Differens i medelvärde (A.e. – E.)	0, 05

Intervjusvar:

- Olika lärare kräver olika mycket.
- Det är inte relaterat till kursen, det är relaterat till lärarna.

Kommentar från undersökningsledaren:

- Elläras normalfördelningskurva kontrasterar mot Analog elektroniks dubbelpuckel som polariserar elevgruppen. Vissa förstår förväntningarna bättre med den ”nya” pedagogiken. Andra förstår förväntningarna sämre.
- Något som märktes under intervjuerna var att de mer utåtriktade, filosofiska och verbala studenterna hade lättare att ta till sig modellen med problemlösningspedagogiken under Analog elektronik. De mer tillbakadragna och resultatinriktade föredrog den traditionella.
- Alla var överens om att det ideala var en blandning.



Medelvärde för Analog elektronik:	3, 69
Medelvärde för Ellära:	3, 11
Differens i medelvärde (A.e. – E.)	0, 58

Intervjusvar:

- Ae: Vi är tvingade att läsa allt, man vet inte vad som är viktigt.
- E: Det räcker med att skumma igenom böckerna.
- Ae: Det är ett för stort språng mellan den odramatiska tentan i början och kraven i det tunga konstruktionsjobbet efteråt.
- Ae: Vi får för lite grundkunskaper innan det förväntas att vi ska sätta igång med ”fritt” arbete.
- Ae: Vi har inte fått tid över för att plugga.

Kommentar från undersökningsledaren:

- En klassisk normalfördelningskurva ställd mot en dubbelpuckel. Tydligt är ändå att de flesta anser att Analog elektronik är betydligt mer krävande än Elläran.