CHALMERS

Computer education in a developing country

A study of the educational effects of supplying rural schools in South Africa with computers

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Acknowledgements

Abstract

Since 2008 students at Chalmers University of Technology have been running a project which supplies rural school in southern Africa with computers to make technology available for the learners (pupils) at these schools. However, most research regarding the use of information and communication technology (ICT) in education is performed in Western countries where almost everyone has access to technology and computers almost everywhere. The situation in developing countries is very different and therefore the research regarding the use of ICT in education can not be directly transformed to the schools in these countries. The purpose of this study was to fill a part of that gap in the ICT research, which hopefully can be valuable for both the organisations that supply schools in these countries with computers and for the schools that receive computers.

The aim of this research project was to study how the inclusion of computers in the education affect both the learners and the personnel at the schools, and more specifically how it affects the science studies at the schools. Therefore these two main questions were studied:

- How has the inclusion of computers in the education affected the learners?

- Has the education in general and in chemistry studies in particular changed since the schools received computers?

To be able to answer these questions data were collected through a field study in South Africa during which observations, questionnaires and interviews were conducted. At the schools participating in this study computers were almost exclusively used in the subject Computer Application Technology (CAT), so the teaching of the other subjects had not changed that much since the schools received computers. By the results from this study no clear conclusion could be drawn regarding how the inclusion of computers in the education affected learners' motivation for their studies. However, both learners and personnel expressed that the inclusion of computers in the education were mostly positive and that it was important for the learners' future.

Glossary

Learner   The general term used for the pupils at the schools.

ICT   Abbreviation for information and communication technology, which is an extended term for information technology that also includes communication technologies.

Star for Life   An organisation operating in southern Africa which works with disadvantaged schools in order to inform the learners about how to protect oneself from the spreading of HIV and inspire them to be the masters of their own future.

CESA   Abbreviation for Computer Education in Southern Africa. A project run by students at Chalmers University of Technology, which supplies rural schools in southern Africa with computers.

OLPC   Abbreviation for One Laptop per Child. A similar organisation as CESA, which supplies school children around the world with laptops.

KwaZulu-Natal The area in South Africa were the schools, visited during the field study of this research project, were situated.

isiZulu   The native language in KwaZulu-Natal.

CAT   Abbreviation of Computer Application Technology, a subject where the aim is to give the learners knowledge about basic operation of a computer, such as managing files and folders at the computer, write documents and using spreadsheets, as well as some basic web programming.

GeoGebra   A mathematical software often used for educational purposes.

PhET   An educational software for the subjects of mathematics and sciences. Among other things, the software includes a graphic tool and simulations for science experiments.

Contents

1   Introduction

In the following sections this project, *Computer education in a developing country - A study of the educational effects of supplying rural schools in South Africa with computers*, will be introduced by first describing its context and background, followed by its purpose. Finally what is to be delivered as well as limitations will be described.

1.1   Background

According to UNESCO one of the fundamental human rights is the right to education (1). In Sweden we take that for granted, but it is not like that everywhere in the world. Many organisations are supporting this right in different ways, like building schools, making education more available for girls and supplying schools in rural areas with educational materials (1).

One of these organisations is Star for Life, which is seated in South Africa and is aiming for prevention of spreading HIV. Star for Life takes on disadvantaged schools in the country side to inform the learners (pupils) about the disease and how to protect oneself from infection. The purpose is to give the learners faith in the future and to show them that they can be the masters of their own destiny (2). Some of the schools that Star for Life is cooperating with is also connected to the project Computer Education in Southern Africa, abbreviated CESA. The aim of the CESA-project is to provide rural schools with computers, in order to give the schools the opportunity to involve computers in the education and make technology available for the learners (3).

Having computers available at schools makes it possible to use information and communication technology (ICT) in the education, which is expected to overall improve the outcome of the education (4). The use of ICT in education is also proven to improve learners' cognitive abilities, such as problem solving and creative thinking (4). By letting the learners use ICT in the education they gain a wider knowledge on how they could use that competence in their daily life and the including of computers will also allow the teachers to work more varied, which will benefit the learners' education in general (5). However, an extensive problem with the research regarding the use of ICT in schools is that most of it is based on studies in developed countries, where almost everyone has access to computers and other technology both in schools and at home (6; 7). The situation in South Africa, as well as in many other developing countries, is very different. South Africa is an economically segregated country, where the top decile of the population live on almost 60% of the national income while the bottom half live on less than 8% (8), and there is a huge difference in the availability of necessary resources in different areas (9). In South African country side, lack of computers is one of the most prominent obstacles in providing learners with ICT knowledge (7). Even in the schools with computers available, a multitude of other obstacles are pressing, such as deficiency in power supply (4) and that the computers attract thefts (6).

A countermeasure against the problem with lack of computers could be to supply the rural schools with such equipment, as CESA and other similar organisations do, which would also be positive since learners at some of these schools have expressed a wish for increased access to computers (10). A problem though, that arises when rural schools in

South Africa receive computers is that the teachers lack knowledge regarding how to use them in the education (4; 7). The computers often include good software for educational purposes, but many teachers are unaccustomed with the use of computers and thereby feel insecure when it comes to using them in their teaching (7). In many cases, they also have different opinions between themselves on how they want the computers to be used in the education. Should they use them as a tool to teach their usual curricula or should they use them to teach in a different way or new things (7)? A way to remedy this problem could be to provide the teachers themselves with education regarding alternative ways of how they could make use of the computers, however it is a slow process (7). In the beginning of the education process the teachers would feel that their knowledge about and confidence in teaching will drop, before they have acquired new knowledge. This may lead to a resistance against participating in such education and including computers in their teaching (7).

A study by Hartley & Treagust (10) has shown that having computers available in the education raises the learners engagement in their studies, and that learners would like to have increased access to computers, which can be seen as an argument for supplying schools with computers. On the other hand, Gutschmidt (6) could not demonstrate any positive effects regarding the learners' motivation and engagement in school work, as shown in her study linked to the organisation One Laptop per Child's (OLPC) work in a village in Kenya. Gutschmisdt (6) is also questioning whether supplying the schools with computers should be the main focus. She pinpoints that one of the main reasons why Kenyan school children are not engaged in or do not attend school is related to food security issues, such as paying the fee for the school meals, that the children have to help their families with the household's food supply or that they are hungry and therefore not able to focus in school (6). Furthermore, many Kenyan schools have lack of school books and/or classrooms big enough for all learners (6). Thus, a valid question is if not other resource allocations has higher priority than supplying the schools with computers. At the same time, the use of computers is constantly increasing in Kenya, even in rural areas (6), and thereby it is legitimated that the learners get to use computers in their education.

There are differences between the work of OLPC, which Gutschmidt studied, and CESA, whose work is going to be studied in this project. OLPC, as the name implies, supplies each learner with a laptop while CESA is giving a lesser number of computers to the entire schools, for learners to share. Nevertheless, as Gutschmidt (6) is pointing out, a problem with these kinds of projects may be that they are applying a Western mindset of how education can be developed without taking into account the circumstances of the current school situation. As mentioned above, this is a problem with the whole research area regarding the use of ICT in education, and a significant gap in our understanding is that there are few studies that examine the impact of ICT on education in South Africa (7). That is why this study is relevant.

1.2 Aim of project

The purpose of this study is to examine the educational effects of supplying rural schools in South Africa with computers. To reach this purpose there are two focus areas, the experience of including computers in the education from the learners' perspective on one

hand, and that of the teachers' and school leaders' on the other.

At the learner side, this project aims to study if the access to computers befriends the learners' education. The purpose is to determine whether the inclusion of computers have affected the learners' motivation for both their present and further studies, since previous research projects have provided ambiguous answers regarding that issue. At the personnel side of our study, the aim is to determine if the teachers find the computers to be an asset in their teaching. A common purpose for both focus areas is also to determine what computers are used for and to what extent they are used. Another aim is to produce some guidelines on how the use of computers in the education, and especially in the chemistry education, could be developed.

1.3 Research questions

To reach the aim of the project the following research questions are going to be studied. The questions are of two types, linked to each of the focus areas. The first type of question addresses the learners' perception of the use of computers for educational purposes and the second type addresses the teachers' experience of the inclusion of computers.

1. How has the inclusion of computers in the education affected the learners?

   1.1. Has it affected their motivation for their present studies and/or to continue to further studies?

   1.2. What pros and cons do they see with the computers?

2. Has the education in general and in chemistry studies in particular changed since the schools received computers?

   2.1. How do they use the computers at the schools?

   2.2. Have the teachers experienced the computers as an asset in their teaching? Do they find them useful?

   2.3. Could they use the computers more effectively?

1.4 Delimitations

The amount of time given to this project is 20 full-time weeks. The number of schools participating in this study will thereby be limited. The study will also be limited to just include secondary schools, which means from grade eight to grade twelve.

Before CESA started giving computers to the schools cooperating with Star for Life, no investigation regarding the learners' motivation for their present or future studies was performed, and no documentation about how the teaching was carried out either. Thus, there is no previous material to compare with, which may limit the conclusions that can be drawn from this study. The way this study is performed has to be adapted according to this.

Furthermore, this study may be limited by language difficulties. The researchers conducting this study have Swedish as their native language, but speak and understand English

fluently. On the other hand, the research objects reside in northeastern South Africa, where isiZulu is the native language. English is, however, one of the official languages of South Africa and the learners are studying English in both primary and secondary school, but there is still a risk for linguistic misunderstandings.

2 Literature review

This literature review will cover different research methods that are typically used in the area of social sciences. Both some methods that could be useful in the data collection phase of the project, as well as some methods that could be used to analyse the collected data will be covered.

2.1 Data collection

In this section different data collection methods that could be used in projects of the present type will be described, along with their advantages and disadvantages. The methods that will be covered are interviews, questionnaires respective observations. Commonly for all those methods are the importance of introducing the research project to the research subject(s), including its background and purpose, the researcher(s) who is (are) performing the investigation, what the results are going to be used for and what is to be expected of the research subject (11). The way to accomplish this may differ between the different data collection methods, however it always is equally important.

2.1.1 Interviews

Interviews are a qualitative research method where the researcher obtains a thorough insight into a situation since the interviewee can share his/her experiences and impressions with the researcher. To get insight regarding a person's view of his/her world is a major goal for the qualitative research method (11). An interview can differ in form, depending on how open or closed the questions of the interview are (12; 11). Closed questions mean that they can only be answered with yes or no (12). With open questions, on the other hand, the interviewee needs to speak more extensively to answer the questions. It is than natural that the more closed questions the interviewer asks the less the interviewee tells him/her (12). Häger (12) suggests that an interview should consist of open questions, since it otherwise tends to become more of an interrogation than an interview.

An interview can also differ depending on the number of interviewees participating at a time. To use more than one interviewee during the same interview is called using a focus group. Focus groups usually consist of four to twelve persons (13). During a focus group interview the interviewees explore and reflect on the questions together (13), and the purpose is to create a natural conversation between the interviewees rather than just a question and answer format between the interviewer and interviewee, as in a standard interview (14). The purpose with using focus groups is to hear different opinions and experiences of the question at hand (15). The interviewer's role is to listen to what the interviewees have to say and moderate the conversation, rather than ask questions (15). The advantage of this format is that the discussions becomes more open but at

the same time it can also make it difficult for the interviewer to control the course of the conversation (15). If a large group is interviewed there preferably could be several interviewers present, to get a more nuanced picture from the interview. (11; 14).

One thing to remember when conducting focus group interviews is that the openness of the discussion and which answers the researcher gets depends on the composition of the group and how comfortable the interviewees are with each other (13). Do they feel that they can open up to each other and express different opinions? It is important that the interviewer tries to create an open environment where different views are allowed to be expressed (15). The use of focus group interviews have been increasing in the last couple of decades, especially within social sciences (15; 13). The lively interaction that is common during focus group interviews may bring forth spontaneous, expressive and emotional views, and thereby this method can be useful within exploratory research in a new field (15).

During a standard interview it is the responsibility of the interviewer to lead the conversation and ask questions, but at the same time it is important that he/she do not take over the dialog. The interviewer's most important task during an interview is to listen actively to what the interviewee says, which is done by maintaining eye contact with the interviewee, nod, ask follow up questions and ask for clarifications when needed (14; 11). This makes the interviewee feel heard and that what he/she says is interesting, which makes him/her feel safe and comfortable to open up (11). This in turn is important so that the interviewer gets the answers needed to make a scientific research (14; 11).

One advantage with conducting interviews is that much information become visible and that impressions do not get lost in the process. Furthermore, the risk of being too formal when conducting an interview is low since the discourse is relatively colloquial. (14)

On the other side, a disadvantage with conducting interviews could be that the answer the interviewer gets depends on who he/she is and the relationship between him/her and the interviewee. For example age, sex and level of education for both the interviewer and the interviewee could affect the result (14). This means that depending on the level of trust the interviewee has for the interviewer and what effect he/she believes his/her answers will have, the interviewee's answer will differ and possibly depend on what he/she thinks that the interviewer wants to hear or what will give the best outcome for him/her.

2.1.2 Questionnaires

Floyd & Fowler (16) states that "Any time a sample is drawn from a larger population, by chance alone the sample may differ from the total population from which it was drawn". Questionnaires can be given to a large sample, so it is a quantitative data collection method, and thereby a conclusion valid for the whole population can be more easily drawn. To be able to minimise the random differences between the sample and the population is in fact one of the goals of using questionnaires as data collection method. However, it is important to keep in mind that how well the results of the sample corresponds to the entire population, depends on how well the sample is selected. (16)

A questionnaire can be conducted either on a paper or via an online server (16). The questions asked in the questionnaire can, as well as in an interview, be either open or closed (14). With closed questions, the respondents either select among various alternatives or

on a scale, while he/she answer with a short or longer running text at the open questions. If a graded scale is used, it is important to consider the different alternatives at the scale. If there are many options at the scale, it may be hard for the respondent to decide which he/she should choose and at the same time it is common that the researcher groups the answers while analysing the data (14). Kylén (14) brings up the example of a seven-point scale, where it is common that the researcher interprets 1-2 as bad, 3-5 as average and 6-7 as good, and that it is well worth to think about why a seven-pointed scale is used in that case. Furthermore, it is also important to think about whether it should be an even or odd number of steps on the scale (14; 16). When an odd number of options is used a mid-answer becomes available, which may be hard for the researcher interpret. It will be unclear whether the middle-answer really mean that the respondent think that the middle-answer is right, or if he/she do not know or do not want to take a stand (14)? For this reason, Floyd and Fowler (16) think that an even number of options should be chosen. Then the respondent is "forced" to take a stand (14).

One risk when using open questions is that the answers are unreadable due to poor handwriting (6). Furthermore, irrespective of the questions asked are closed or open, it is important to minimise the risk for misunderstandings when designing the questionnaires, which is done by not complicate the questions or ask several questions in one (14; 16). It is also an advantage to keep the questionnaire short so the respondent cope with answering all the questions and avoid that he/she loses interest halfway through (14).

An advantage with using questionnaires is that they enable an easy way to get an overall opinion in a matter. Furthermore, no face by face contact with the respondents is necessary, and it is also possible for the respondents to be completely anonymous. A negative side with questionnaires is that there is a risk of respondents misunderstanding questions and consequently answer them wrong, which can lead to invalid results. There is also a risk to get unreliable answers due to respondents lack of interest in the study or awareness of the importance of it. As with interviews, the respondents may also answer the questions the way they think is most beneficial for themselves. Finally, the conclusions drawn from a questionnaire survey may also be misleading if there is a large drop-out from the sample group. (14)

2.1.3 Observations

Through observations the researcher is able to study how people act in a certain situation without interfering, and it is thereby a useful data collection method when the work within an organisation is to be studied (17). In contrast to interviews and questionnaires, where the researcher get to know what people say that they are doing or their interpretation of their world, observations gives the researcher a direct picture of the situation. However, through the interpretations by the observer the protocol describing the situation could consist of a subjective picture of what really happened (14). However, having multiple observers or filming the situation, and thereby giving multiple researchers the possibility to interpret the situation, the problem with subjective observations can be diminished (17).

Kylén (14) argues that because it is unnatural to have an observing researcher present the subject of observation will be affected by that and the observed situation therefore will be affected by the observer. Tjora (17) on the other hand, deems that this only is

correct in the beginning of an observing period, then the observed persons will get used to the observer and after that act as they usually do. For this reason an observation can benefit from going on for a longer time so that the persons being observed get used to having the observer present.

An observation study can be conducted in different ways. The observer can choose to hide his/her observation by either fully being part of the observed situation as any other person involved, or by not being part of the situation at all and instead observe from a distance or with a hidden camera. Another observation method is that the people participating in the observed situation know that they will be observed. In that case the observer can either adopt a role as an observing participant, and thereby participate in the situation as anyone else but at the same time observe, or as a participating observer, where he/she mainly observe but partially participate as well. As mentioned, in the case where the observer is known, it is important that the people being observed get to know the aim of the study, the expectation of them and how they can follow up the study result. With a hidden observation, on the other side, this is not possible since doing that would reveal the observation. (17)

An observation can also differ in how structured it is. A fully structured observation means for example that the observer conducts a frequency calculation, while an fully unstructured observation means that the observer notes his/her perceptions and reflections, like diary writing (14). The latter form of observation is the most common one, and in that case the observer gets the observation data in form of a field diary (17). To get a useful outcome from that latter form of observation it is important that the observer really consider what it is that he/she is interested in studying before he/she starts the observation (17). Another thing that the observer should have in mind is that people being observed can be reminded of the observation through the observer's note taking and thereby they do not "forget" that they are being observed as easily (17).

2.2 Data analysis

Equally important as it is to collect data in a correct and scientific way is to use an appropriate data analysis method. In this section two methods will be presented. Affinity diagram is a suitable method to analyse data collected through interviews, questionnaires and observations. Wilcoxon rank-sum test is a statistical analysis method which can be used to analyse data that can be quantified, as for example scale answers from questionnaires.

2.2.1 Affinity diagram

The analysis method affinity diagram is a useful method when analysing qualitative data. This analysis method is carried out by going through all the collected data and note key points. Once that is done, the next step is to categorise all the notes so the ones concerning the same subject end up together, and then label each group of notes. The categorisation is performed by going through all the notes several times to ensure that all the pieces fall into the right category and that large groups are divided into subgroups. The final step of this analysis method is to go through all the categories and summarise the results from each of them. In this way the researcher gets an overall picture of the results from

the collected data, and can both identify areas where the information is insufficient and trends within the data. (18)

To get useful results from this data analysis method, creativity and an open mind is required when sorting the notes. It is important not to jump ahead and start sorting the notes from the beginning, since it in that case easily happens that the categorisation get based on the questions that were asked in the questionnaire or the interview and not what the answers actually say. (18)

Affinity diagram is a useful method when a group of researchers are working together to analyse a set of data, since it is based on finding correlations within the data and a group of people allows for more ways of thinking and thereby a richer analysis. For this reason it may be a less useful analysis method for a single researcher. (18)

2.2.2 Wilcoxon rank-sum test

The Wilcoxon rank-sum test is a nonparametric statistical analysis method. Many statistical tests need the tested data to have a certain characterisation, like for example normal distributed. A nonparametric test, however, is a hypothesis test that does not require any characterisation of the parameters (19). The Wilcoxon rank-sum test is used to compare two related sets of data.

When performing a Wilcoxon rank-sum test the values of two data sets are compared, to see if there is a difference regarding how big the values in respective data set are. The null hypothesis, usually denoted H_0, that is tested is that the two data sets are equal. There are three different kinds of the Wilcoxon rank-sum test, depending on the different hypotheses, denoted H_1, for when the null hypothesis gets rejected. These three cases are the right-tailed test and the left-tailed test for when H_1 is that the data set consisting of the smallest number of observations, consists of either lower or higher values than the other, and the two-tailed test for when there is no reason to suspect a certain shift in the size of values. This is usually expressed by looking at the two population medians, illustrated in table 1. (19)

Right-tailed test	Left-tailed test	Two-tailed test
$H_0 : M_X = M_Y$	$H_0 : M_X = M_Y$	$H_0 : M_X = M_Y$
$H_1 : M_X > M_Y$	$H_1 : M_X < M_Y$	$H_1 : M_X \neq M_Y$

Table 1: This table shows the three different test cases for the Wilcoxon rank-sum test. M_X and M_Y denote the medians for the two compared data sets X and Y.

Let X and Y, consisting of n_X and n_Y observations respectively, denote the two sets of data to be compared with the Wilcoxon rank-sum test. The test is based on a ranking of the combined data set, X + Y, consisting of $n_X + n_Y$ observations. The combined data set is ordered from smallest to largest, and thus, each observation gets a rank (20). The smallest observed value gets 1, the next 2 and so on, up to the largest observed value which gets ranking $n_X + n_Y$. The test statistic for the Wilcoxon rank-sum test is the sum of ranks of the smallest of the two compared data sets (19; 20). Depending on which type of Wilcoxon rank-rum test that is performed - the left-tailed, the right tailed or the two-tailed - the probability that the given rank sum is lower, higher or either lower or higher than certain values is calculated. These values, that the rank sum is compared

to, are precomputed and can be found in a Wilcoxon rank-sum test table. If the sizes of the two compared data sets, X and Y, are to large for the table to cover them a normal approximation can be used instead (19).

Since the result of the Wilcoxon rank-sum test, usually denoted P, is a probability, it has a value between 0 and 1. The P-value demonstrate the probability to reject the null hypothesis. In order to reject the null hypothesis it is common to set a 95 % confidence level, which means that the null hypothesis gets rejected if the P-value is lower or equal to 0.05.

3 Method

The project was divided into three phases; literature review, data collection and data analysis. The purpose of the literature review was to gain necessary information to be able to perform this research project in a scientific way. The data collection phase consisted of two parts, a field study in South Africa as well as preparation for the field study. In the last phase the collected data were analysed and results were formulated. The following sections will describe the course of action during each of these three phases.

3.1 Literature review

This research project aims to investigate the educational effects of supplying rural schools in South Africa with computers. To be able to carry out this project the first step was do a literature review which consisted of two parts.

The first part was to read about previous research in the field, which included reports regarding the inclusion of ICT in education in South African schools as well as the effects of supplying rural schools in other developing counties with computers. From this reading, information about what advantages and challenges previous researchers' typically had found with including ICT in the education was gained. It also gave an insight regarding what aspects this research project should focus on. A problem during this part of the literature review was to find relevant previous studies. As mentioned in section 1.1, most research regarding the use of ICT in education is done in Western countries where technology is a natural part of everyday life. Since the conditions in South Africa are very different, the findings from those studies are not directly applicable in the South African environment.

The second part of the literature review was connected to the research itself and covered different research methods that could be used during both the data collection phase and the analysis phase of this project. During the field study the use of computers in the education would be examined as well as the principals', teachers' and learners' opinions and experiences regarding the inclusion of ICT in the education. Possible ways to do this is by conducting observations, interviews and questionnaires and therefore these three data collection methods were covered in the literature review, to get to know the advantages and disadvantages of these methods, and to be able to decide which of the methods that should be used in the data collection phase. As mentioned in section 2.1.3, it may take some time for people to get used to having a researcher observing them and in the

beginning of an observation period they therefore do not act as they usually do. Since each school participating in this research project only will be to visited for one day the decision therefore fell on mostly using interviews and questionnaires.

First it was decided not to use observations at all but later that decision was changed to that observations were to be used, but only to get an overall picture of each specific school and to get some basic information about them. Interviews give the researcher qualitative data while questionnaires can be used to get quantitative data, see section 2.1.1 and 2.1.2 respectively, and the two data collection methods can therefore be considered as complementary to each other. Thus, it was decided that both of the methods were to be used, interviews to get qualitative data from principals and teachers, and questionnaires to get quantitative data from learners and some teachers who were not being interviewed. The reason why it was decided to both interview and hand out questionnaires to teachers was the limited amount of time for this project and the field study. Conducting an interview takes a lot of time and the number of interviews that could be conducted were thereby limited. Therefore the decision was made that the interviews with teachers and principals should be complemented with questionnaires given to teachers not being interviewed. In this way both qualitative and quantitative data from the personnel were collected. It was decided not to conduct any interviews with the learners due to a greater risk of linguistic misunderstandings and because of the time-limit. The reading about the data collection methods also made it possible to make well planned decisions when designing the interview guide and questionnaires.

Besides reading about data collection methods (to be able to carry out the data collection phase in a good way) it was considered equally important to read about data analysis methods, to be able to analyse the collected data properly. It was decided to read about affinity diagrams since we in the research group have some previous experience working with this method and since it is a suitable method to use when different people are to work together to analyse the data. An advantage with affinity diagrams is that it makes it easy for the whole research group to work together with the analysis, since it gives everyone a clear view of the collected data which facilitates an open discussion. This part of the literature review also included reading about the statistical method Wilcoxon rank-sum test to be able to compare data collected from different groups with each other. Since the collected numeric data were generated from a scale from 1 to 4 an appropriate way to compare data from different groups is through the Wilcoxon test and therefore it was decided that this statistical method was to be used.

3.2 Data collection

In this section the data collection phase will be presented. The first subsection includes a description of the course of action when designing the interview guide and the questionnaires while the second subsection describes how the field study was carried out.

3.2.1 Preparation

The first step in the data collection phase was to design the interview guide and the questionnaires. The content in those were discussed and formulated in mind maps to make sure all the research questions would be covered. When designing the interview

guide it was decided to mostly use open questions to let the interviewee speak freely as much as possible. The questionnaires were designed with both open and closed questions to fit the information that wanted to be gained. Open questions were used to get more detailed answers and to let the respondents really express their opinions. Closed questions were constructed in the form of scales and multiple choices. The questions with a scale response were designed so that the respondent would express to what extent he/she agrees with a statement. It was decided to keep the scale rather compact to simplify the analysis of the results. Furthermore, it was decided that the scale should have an even number of alternatives to make the respondents take a stand. In that way a middle alternative, which can be harder to interpret, was avoided. From these criteria a four level scale was formed. When designing the questionnaire for the teachers the questions in the interview guide were taken and adapted to a questionnaire format.

Since no previous investigation regarding the learners' motivation had been made at the schools participating in this study it was decided to create two different questionnaires for the learners. One for the learners who used computers in their daily education, referred to as the study group. The other questionnaire were made for a control group consisting of learners who did not use computers in their daily education. This was done to be able to compare the results from the different groups with each other and thereby get a notion of how the inclusion of computers in the education affected the learners' motivation to both their present and future studies.

Another important aspect when designing the questionnaires was to keep them rather short to maximise the likelihood for respondents to put an effort into every answer, as Kylén (14) states. This was considered especially important for the questionnaires that should be given to learners and therefore it was decided to not make them longer than they were held on the front and back of a sheet of A4 paper. The questionnaires and interview guide can be found in Appendix I, II, III and IV.

As mentioned, the questions were designed by making sure that they covered all the research questions for this project. For some research questions it came pretty natural how the information should be found out and what questions to ask, like "What pros and cons do they [the learners] see with the computers?". To gain information regarding that question straight questions about what pros respective cons they see with the use of computers in the education were asked to the learners.

Some difficulties arose when formulating questions that could give an answer to the research question "Has it [the inclusion of computers in the education] affected their [the learners'] motivation for their present studies and/or to continuing to further studies?". To answer this question how to measure motivation had to be considered, which was not an easy task since it is hard to measure a feeling (25). After discussing how to answer this two-sided question it was decided to direct questions to both teachers and learners to try to find an answer. To the teachers, questions about how they define a motivated learner, how many motivates learners they have at the school and if they could see any trend regarding the number of motivated learners were formulated to answer the first part of the question. To answer the second part the teachers got questions about if they could estimate how many learners that are continuing to further studies and if they saw any trend regarding that figure.

One way to get an answer from the learners regarding their motivation could be to plainly ask them, but that would have been a rather leading question. So instead of just asking

that, other ways to find out about the learners' motivation and different ways to measure motivation were considered. Studies have shown that motivation is usually connected with positive emotions and to have a positive attitude to learning have been shown to increase the motivation level of learners (24). In a school environment that could be connected to having a positive attitude to school in general. With background in this, it was decided to study how joyful the learners experience their studies and how comfortable they feel in school, since we felt that those two emotions could indicate that a learner had a positive attitude to school. We wanted to study both the level of motivation in general and in addition if it had any connection to the computer usage, and therefore the statements "I feel comfortable in school", "I think my studies are joyful", "I feel comfortable using the computers" and "I think it is joyful to use the computers" were included in the questionnaires. Even though it could be a little weak to just use these two criteria, comfortable and joyful, to measure the level of motivation among the learners, we decided to do it because we, as mentioned, wanted to keep the questionnaire rather short so that that the learners really answers all questions.

To ask questions that should answer the research question "How do they use the computers at the school?" was also rather straight forward. Questions about what they did at a typical lesson where they used computers were asked to both teachers and learners and in addition teachers also got a question about how they usually used computers in their teaching. The latter question were also supposed to partly give answers to the research questions "Has the teacher experienced the computers as an asset in their teaching? Do they find them useful?" and "Could they use the computers more effectively?". The teachers also got questions about how experienced they were with using computers, what computer education they personally had and how often they used computers in their teaching. Along with questions about what pros and cons the teachers saw with the use of computers and if they had and ideas about how the school, as well as themselves in their teaching, could use the computers more often, answers to these last three research questions were hoped to be found. Since the research also has a focus on the use of computers within the chemistry studies, specific questions about how the computers were used in that subject were asked to chemistry teachers as well.

Finally an information box were added on the questionnaires to inform both learners and teachers about the purpose of this study and pinpoint that their answers would not affect whether they get more computers. The latter was done to minimise the risk of learners and teachers answering in a way they thought would enhance their chances to get more computers and also maximise the chance that they respond truthfully. During the interviews this information were giving orally in the beginning of the interview.

3.2.2 Field study

When the interview guide and the questionnaires were designed the next step of the data collection phase took place, which consisted of a field study in South Africa. During this field study eight of the schools that Star for Life is cooperating with were visited, and a total of ten interviews with teachers respective principals were conducted, 20 questionnaires were given to teachers and 118 study group questionnaires respective 70 control group questionnaires were handed out to learners. Table 2 shows the number of interviews and questionnaires at respective school. Before any interviews were conducted or questionnaires were handed out, we researchers introduced ourselves and the project along

with its aims and how the respondents participation helped us.

School	Interviews	Questionnaires		
		Teachers	Study group	Control Group
1	1 T & 1 P	1	9	-
2	1 T	-	17	23
3	2 T	5	-	12
4	2 T	-	5	-
5	1 T	-	8	-
6	1 T	6	48	-
7	-	7	24	35
8	1 T	1	7	-
Total	10	20	118	70

Table 2: The table shows the number of interviews with teachers (T) and principals (P) that were conducted and how many questionnaires of the different forms that were handed out during the field study.

In addition to conducting interviews and handing out questionnaires, observations were performed at the schools as well. From the beginning this was not planned but it was done to get an overall impression of each school and their environment, surroundings and resources. The observations were carried out by taking a tour of the school and talking to personnel, learners or Star for Life coaches about the learners' everyday lives and the conditions of the school. By doing this, useful background information about the schools and the life in the areas where the schools were situated were gained.

At school number 1 three persons from the personnel participated in this study. The principal and the Computer Application Technology (henceforth abbreviated CAT) teacher were interviewed and a technology teacher filled in a questionnaire. The teachers were chosen since they were the two teachers at the school who had computer experience. Ten learners filled in the study group questionnaires as well, and they were picked out by the CAT teacher. The learners all studied CAT. The observation at this school were done by a tour of the school by the Star for Life coach who were working there.

At school number 2 two learners from grade 12, the Head Girl and Good Man of the school, were guides on the tour of the school. During the tour many of the classes got an introduction of us researchers and our project along with information about that they could participate in the study in a specific classroom later in the day. The learners got to chose if they wanted to participate by themselves. At this school 17 study group questionnaires and 23 control group questionnaires were filled out by the learners. In addition an interview with a mathematics teacher who had computer knowledge were performed.

Two interviews and five questionnaires with teachers were conducted at school number 3, so much information regarding the teachers' view on the inclusion of computers were gained at that school. Since the school did not use computers in the education 12 control group questionnaires were handed to learners at the school. All these learners were from one and the same class. The observation at this school was done by informal conversations with the principal of the school and the school's Star for Life coach, and a tour.

At school number 4 they did not use computers in the education either so only control

group questionnaires were handed to the learners at that school. Five questionnaires were given to learners in total and the learners were chosen by the Star for Life coach at the school. In addition two interviews were conducted with teachers at the school. To gain the information about in which context this school were situated it was observed by a tour lead by the Star for Life coach at the school.

School number 5 was observed by a tour of the school guided by a teacher, during which the computer lab was visited and a general overview of the school situation was gained. An interview were conducted with that teacher as well. Eight study group questionnaires were given to learners at this school. The learners consisted of some who were picked out by the Star for Life coach at the school and in addition they brought their friends along.

A introduction to school number 6 was given by the principal of the school along with a Star for Life employee who previously had worked as a coach at that school. In addition there was a tour of the school where some classrooms, the computer lab and the schoolyard were observed. The study group questionnaires were given to all the learners at the school who studied CAT, total 48, and an interview were conducted with the CAT teacher. In addition six questionnaires were handed to teachers at the school.

At school number 7 some language barriers were experienced, and for that reason no interviews were conducted. Seven questionnaires were handed to the teachers and 24 study group questionnaires respective 35 control group questionnaires were handed to learners at the school. The observation at this school were performed by a short conversation with the principal and a short tour without any guide.

One interview and one questionnaire were conducted with teachers at school number 8. In addition seven questionnaires were also handed to learners. The learners were picked out by the CAT teacher by taking the first learners he could find. The observation of the school consisted of a short tour of the school with the Star for Life coach as a guide, observing and talking to two learners who had borrowed a laptop and used it for a history paper and a demonstration of a machine called I-box who the mathematics and science teachers used in their teaching.

3.3 Data analysis

The data analysis phase of this project was initiated by using the affinity diagram method to analyse the data collected during the field study. This method was performed by reviewing the questionnaires and the transcriptions of all interviews and put all relevant information down on post-it notes. When this was done the notes were sorted based on the information they contained. After the first sorting all the notes were reviewed again to make sure that they were placed in the right category and some categories were divided into subcategories. When all the notes were in the right place the information was summarised in a verbal dialogue between the researchers and a majority of the results of the study could be formulated.

In order to properly analyse the numeric data and compare the results from the study group and the control group the analysis were complemented with the non-parametric statistical method Wilcoxon rank-sum test. When performing the test the null hypothesis was that there is no difference between the two groups and the alternative hypothesis

is that there in fact is a difference between the two groups. To perform the test the mathematical software MATLAB was used. The result of the Wilcoxon test, the P-value, indicates if the null hypothesis can be rejected or not, and thus conclusions about whether there was a difference between the study respective the control group could be drawn. Along with the affinity diagram the Wilcoxon test gave an overview of all the results from the field study.

4 Result

In the following sections the result of this study will be presented. The first section contains basic information on all the schools participating in this study as well as a report on which computer assets each school had and how they were used. The second section presents the result regarding how the including of computers has affected the learners' motivation to both their present and their further studies. Following that, the last section includes a more detailed description on how different schools are using computers in the education along with the challenges and opportunities that comes with that use. It also includes both learners' and teachers' experience of using computers in the education as well as a report of what the schools need to use computers more effectively.

4.1 The investigated schools and their computer resources

Eight schools participated in this study in total. Among these the access to computers differed much, from just a handful computers, which were only used for administrative tasks, to 36 desktops, 25 laptops and 26 tablets at one school. Table 3 shows basic information about each school, including the number of learners and computers and if they had any other special resources. Figure 4.1 shows a map of South Africa with KwaZulu-Natal, the area which the schools participating in this study are situated, marked in red colour.

> 'Remember the demographics for this area says we are rural. Predominantly this is a farm area. Predominantly people here are broke. Predominantly this area only stay and those things that we need to survive. [...] Some of them doesn't have electricity. [...] That is why the government has introduced, introduced what is called a nutrition program. That kids only get to have one good meal from school, at school only. Per day. They only eat here. Nowhere else. They will eat tomorrow again. Saturday, Sunday there are nothing to eat. They have to feed for themselves. It's life. It's tough. You can imagine. Very, very tough.'

Quote 1: Interview answer from the principal at school number 1.

As the principal expresses in quote 1, in this area there are few industries or large companies, some people don't have electricity at home and some people have problems with
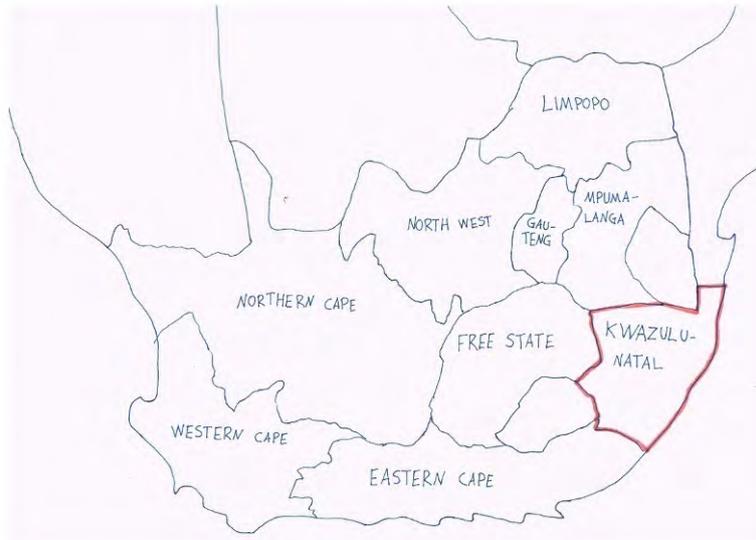
Figure 4.1: Map over South Africa, where the area of the field study, KwaZulu-Natal, is marked in red.

food security. The government is running a nutrition program that gives each learner a proper meal daily at school, but for some learners this is all they eat in a week. They are not eating any meals at home, not even on weekends. The schools participating in this study were situated in that rough reality.

At school number 1, 6 and 7 they are using computers in the education in a similar way. Each school had about 25 computers for use in teaching of the subject CAT. Unfortunately all the computers at the schools did not work, but the school with the least number of working computers had 12 pieces. Each school had one teacher teaching CAT and the subject were scheduled daily. None of the schools had internet when we were visiting. However, school number 6 would get internet within a couple of days along with 26 tablets. They planned to use the tablets in the teaching of other subjects than CAT. The teachers at these three schools expressed that, for them to be able to use computers in the education more frequently, internet is required. The learners should be able to search for information needed for different school assignments. The principal at school number 6 had high hopes that the tablets and the internet access that they were getting would be useful for that purpose. The teachers at school number 1 also expressed that they would have used the computers more if they had some more educational software, such as software for Computer Applied Drawings, CAD.

At school number 3 they had approximately the same number of computers as school number 1, 6 and 7. However, they did not use the computers at all. The principal at this school explained that the school, some years ago, had very good results; the learners had good grades and school environment was pleasant. However, the at that time incumbent principal had quited abruptly and the school did not had any real management until the present principal had taken over a few months before this research took place. This had led to dropped grades for the learners and they were now not so good and the school environment was nowadays a bit messy. This was the reason that the computers that this school had received a couple of years ago never had come into use, and instead of being used just stood along a wall in a staff room, all dusty and not connected. Nevertheless, the school had had CAT education previously, but at that point they only had ten computers

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School	Number of learners	Number of computers	Internet connection	Commentary
1	1197	28	No	
2	Around 1000	Around 8	No	The computers were only used for administrative tasks. One teacher used his personal computer and the software GeoGebra in his mathematics teahing.
3	1167	24	No	
4	Around 600	6	No	The computers were only used for administrative tasks.
5	390	10	Yes	
6	500-600	Around 20 desktops and were just about to receive 26 tablets	No	They were just about to receive wireless WiFi
7	778	Around 25, but just 12 working	No	
8	Around 1200	36 desktops, 25 laptops and 26 tablets	Yes	The school had wired internet connection but were just about to receive wireless WiFI as well. The school had an I-box (see text).

Table 3: The table shows some basic information regarding the schools that were participating in this study, like number of learners and computers, if they had internet connection and some other important commentaries.

which had been too few to have a real functional education, and the subject had therefore been removed from the schedule. The three teachers who had taught CAT were still working at the school and they all had studied some kind of computer or IT education at university level. This shows it was not lack of expertise concerning the use of computers that had prevented the school from starting to use computers. The teachers expressed that they needed the approval from the principal and the school management team in the municipality to be able to start using the computers in the education. The teachers at this school who participated in this study had together several ideas on how they could use the computers in the education, including reintroducing CAT on the schedule. They also emphasized that it would have been good if they could use the computers in other subjects as well and let the learners use them to search for information, write their papers and watch videos linked to the education. They all thought it would had been an advantage if they had had internet at the school. The teachers at school number 3 also felt that it would be good if as many learners as possible, most preferably all of them, could have access to computers in their education, as quote 2 exemplifies.

> 'I think all of the subjects, yes you can. Or maybe if it's not like
> that, then maybe there should be a computer teacher. So
> everyone should come, yes every class should come. Maybe
> there must be two or three teachers for computers. And then
> the class will come, and he or she will conduct all the classes
> for the computers for the whole school. Every day. Maybe
> monday it's grade 8 and on the following day grade 9 up until
> grade 12. Because I don't think it would be possible for all
> the teachers to conduct the computer classes.'

Quote 2: Interview answer from teacher number 1 at school number 3
on question about in which subjects the computers could be used.

School number 5 had a bit fewer computers than the previously mentioned schools, and they used the computers in a different way as well. Since they lacked any teacher who could teach CAT, they did not have that subject on the schedule. Instead they used the computers in the education in other subjects, by the teachers bringing their classes to the computer lab to let them use the computers during the lessons. The learners could also ask for permission to use the computers outside the daily schedule as well, and if there were any teacher available he/she could bring the learners to the computer lab and let them use the computers. The school had a modem so that they could connect to internet and the learners thus had the opportunity to use the computers for research. To be able to use the computers more frequently the teachers at school number 5 would have needed more computer knowledge and preferably a specific computer teacher who could teach CAT.

At school number 2 and 4 they had very few computers, and the ones they had were used only for administrative tasks by the personnel. Some teachers at these schools used their private computers in their teaching, for example to be able to show graphs in mathematics or business studies or maps in geography. Both schools had computer experienced teachers who expressed that it would have been helpful if they could use educational software in their teaching. Mutual for the both schools were also a shortage of space and there were no classroom that would have been natural to turn into a computer lab, if they had received computers.

At the last school that were visited during the field study, number 8, the conditions to use computers in the education were totally different from the previously mentioned schools. The school had 36 desktops, 25 laptops and in addition they had recently received 26 tablets. In the computer lab, where the desktops were located, they had wired internet connection but along with the tablets they were now also about to receive wireless WiFi. The computer lab was used for the education of CAT, while the learners got to use the laptops in their other subjects, for example if they had a paper to write or if they needed the internet for searching information. The learners needed to ask for permission to use the computers and they were only allowed to do so with a teacher present. Many of the teachers at the school used computers in their teaching, for example to be able to show a PowerPoint presentation.

In addition to the computers and tablets mentioned above, school number 8 also had a machine that they called information box, abbreviated I-box, which were used by the

science and mathematics teachers. The I-box was a kind of computer connected directly to a projector, so that the things that would normally be shown on the screen instead were projected. To be able to control the I-box there were a keyboard, a mouse and a drawing tablet. The drawing tablet could be controlled by using either your hands or a dedicated pen, and it could be used to draw or highlight in a PDF, PowerPoint presentation or really anywhere in the picture that was currently projected. If the marking was done in a PDF or a PowerPoint presentation, you could chose to save the version with the markings when the program was closed down. The reason why this tool was used by science and mathematics teachers exclusively was that the I-box was equipped with specific files and software for the education in those subjects. These files and software included PowerPoint presentations for almost all sections in the mathematics and science education, as well as a software called PhET with which graphs could be drawn or science experiments could be simulated. The science and mathematics teachers thought the I-box was an excellent tool and they used it frequently.

To almost exclusively see advantages with the use of computers in the education and the idea that all learners should learn how to use a computer in secondary school were common for both the personnel and the learners at all the participating schools. Quote 2 is an answer on the question "What pros do you see with using computers in the education?" from a teacher at school number 3, which concludes why they thought that use of computers should be a natural part of education of all learners.

> '- Makes learning interesting.
> - Makes learners future orientated.
> - Prepares learners for university.'

Quote 3: Questionnaire answer from teacher number 7 at school number 3 answering the question "What pros do you see with using computers in the education?".

4.2   General motivation among learners

The level of motivation among the learners was measured by directing questions to both learners and personnel, see section 3.2.1. Both the learners' motivation for their present studies as well as their willingness to continue to further studies after secondary school were investigated in this way.

4.2.1   The learners' motivation for their present studies

The learners were asked to state to what extent they agreed to the statements "I think my studies are joyful" and "I feel comfortable in school". Most of the learners, in both study and control group, agreed to both these statements, which are illustrated in figure 4.2 and 4.3. The Wilcoxon rank-sum test were used to compare the answers from the different groups. Several tests were performed, both comparisons between the whole study respective control group, but also comparisons between the study and control groups at those schools where data were gathered from both groups.
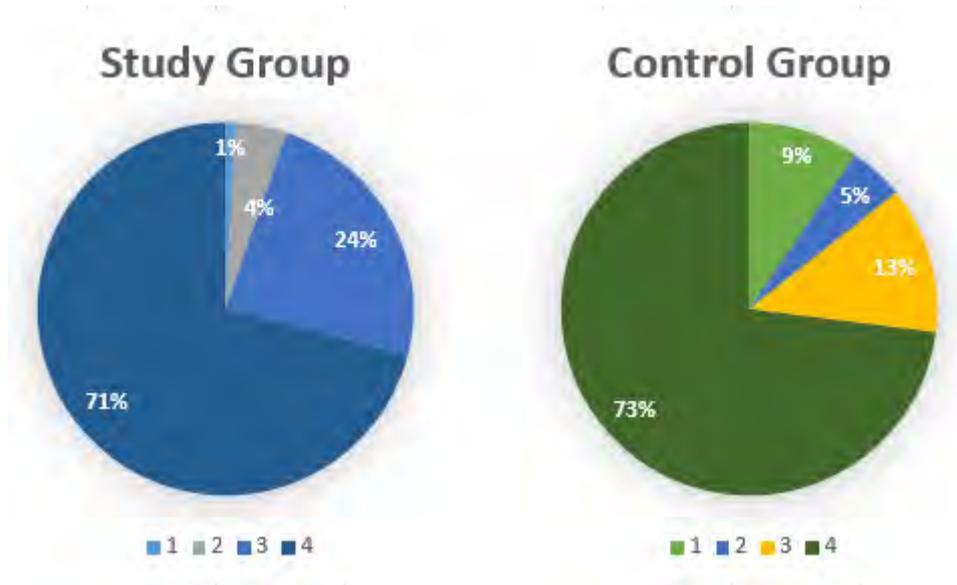
Figure 4.2: The learners' answer to the statement "I think my studies are joyful", where 1 symbolises total disagreement and 4 is total agreement.
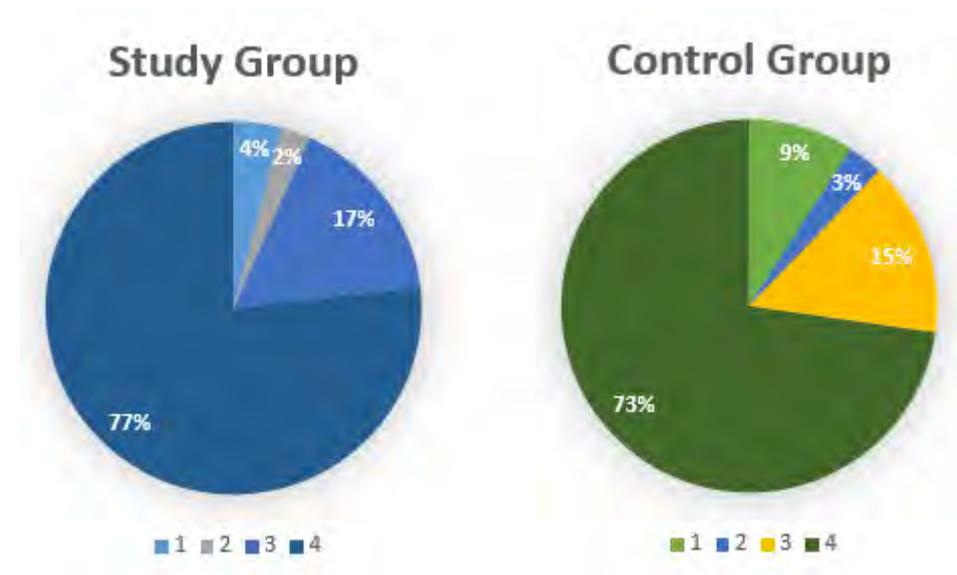

Figure 4.3: The learners' answer to the statement "I feel comfortable in school", where 1 symbolises total disagreement and 4 is total agreement.

The P-value for the comparisons between the whole groups were 0.92 regarding how joyful the learners found their studies and 0.49 regarding how comfortable the learners were at school. At the schools where data from study and control group were gathered, school number 2 and 7, the P-value regarding how joyful the learners found their studies were 0.91 respective 0.59 and the P-value regarding how comfortable the learners were at school were 0.88 and 0.16 respectively. A compilation of these results can be seen in table 4. Figure 4.4-4.7 show how the learners at school number 2 and 7 answered the two questions. Since all the P-values from the tests are higher than 0.05 no distinctive difference can be seen between the compared groups. Thereby, according to the answers to the questions

directed to learners, most of them, in both study and control group, were motivated for their studies.

Group	Statement	P-value
All learners	I think my studies are joyful	0.92
	I feel comfortable in school	0.49
The learners at school number 2	I think my studies are joyful	0.91
	I feel comfortable in school	0.88
The learners at school number 7	I think my studies are joyful	0.59
	I feel comfortable in school	0.16

Table 4: The table shows the result from the Wilcoxon rank-sum tests performed on the different data sets. The P-value states if the there is a distinguishable difference between the two compared data sets. To be able to say that there is a difference between the data sets the P-value should be lower or equal to 0.05.
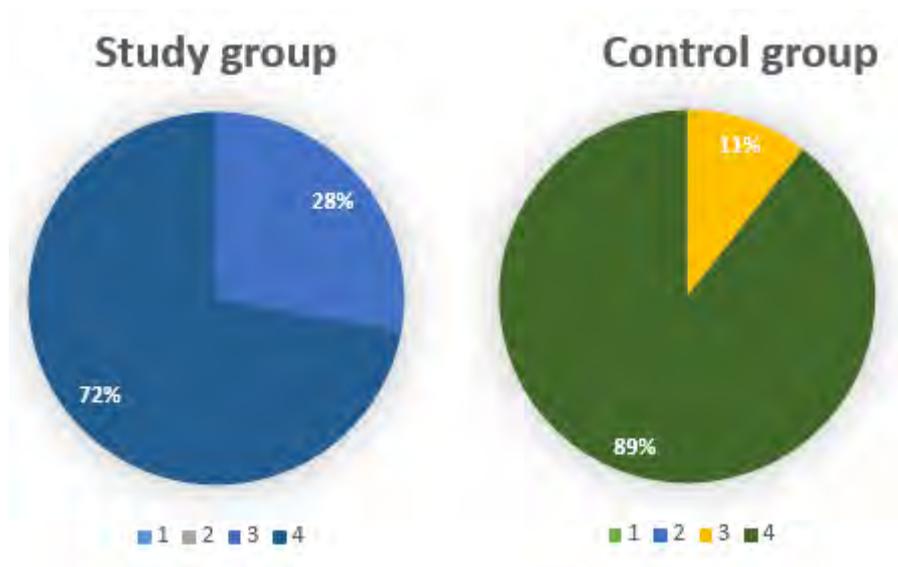

Figure 4.4: Answers from the learners at school number 2 to the statement "I think my studies are joyful", where 1 symbolises total disagreement and 4 is total agreement.
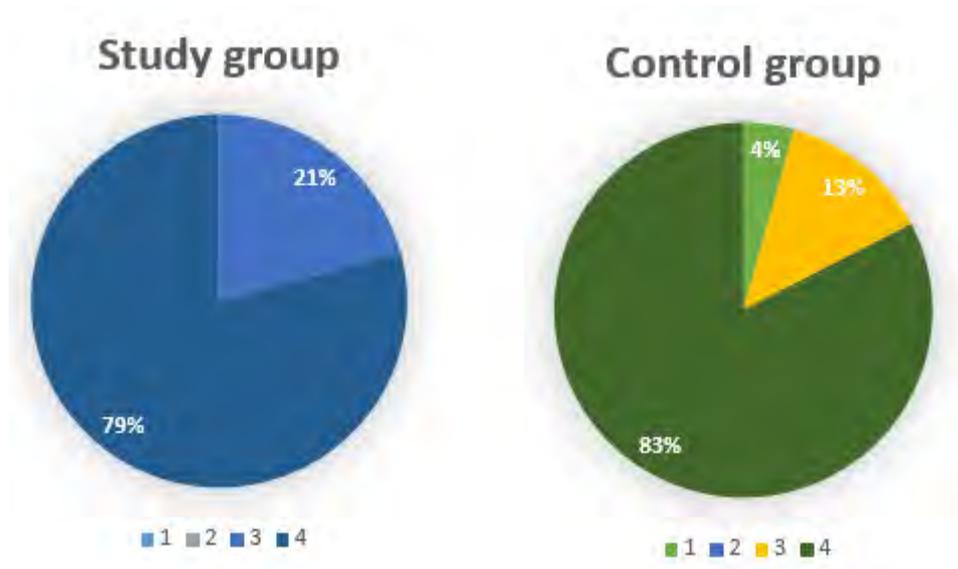
Figure 4.5: Answers from the learners at school number 7 to the statement "I think my studies are joyful", where 1 symbolises total disagreement and 4 is total agreement.
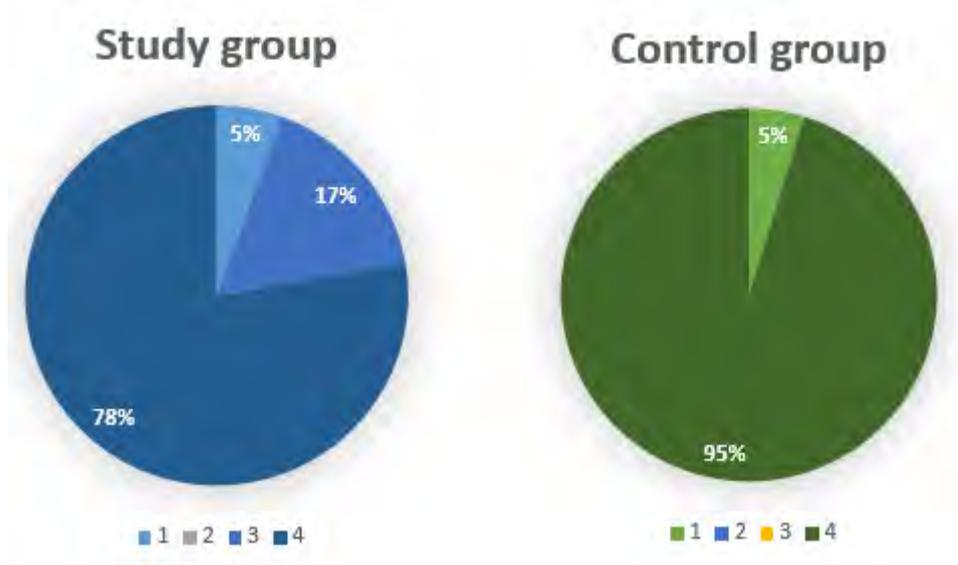

Figure 4.6: Answers from the learners at school number 2 to the statement "I feel comfortable in school", where 1 symbolises total disagreement and 4 is total agreement.
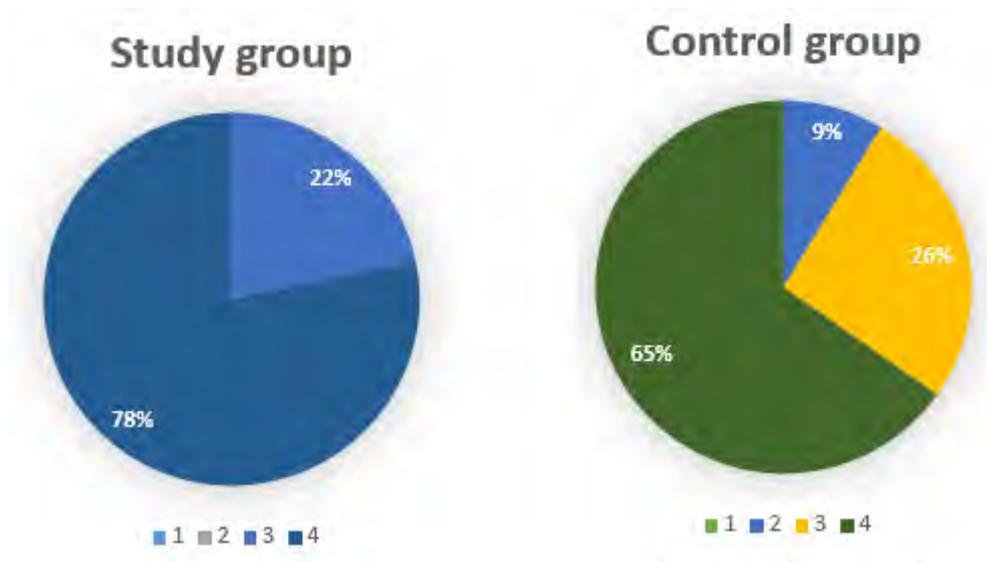
Figure 4.7: Answers from the learners at school number 7 to the statement "I feel comfortable in school", where 1 symbolises total disagreement and 4 is total agreement.

However, almost all interviewees (personnel) expressed that there are not that many motivated learners at the schools. They said that a major reason for that was the everyday life situation for the learners. The area were these schools were situated and where the learners lived was very rural and poor. According to the personnel, this for the learners led to more essential things to focus on than school. Some of the learners had to help provide for their families. Other families had, as mentioned in section 4.1, food supplying issues which led to learners having difficulties to focus in school due to hunger. Some learners did not have much faith in the future and thereby were not motivated for their studies.

On the other hand, the personnel had high standards regarding what characterised a motivated learner. A motivated learner had to have almost perfect attendance, he/she should actively participate in all activities and school work, think about how he/she presented himself/herself in class, talk to the teachers, ask a lot of questions, always show interest for his/her studies and really take an active part in his/her learning. A motivated learner should also dress properly and always come to school with a clean uniform as well. Last but not least most of the personnel also expressed that a motivated learner should have good results in his/her school work and get high grades, as exemplified by quote 4. As mentioned, not many of the learners qualified as motivated according to the personnel.

> 'Motivation is measured in performance and performance can only be understood in terms of results'

Quote 4: Interview answer from the principal at school number 1

To be able to say if the the including of computers had an impact on learners' motivation for their studies, the personnel were also asked if they had seen any trend regarding the number of motivated learners at the schools. A few persons in the personnel answered that the number of motivated learners had increased over the recent years. However, most

of the personnel stated that the number of motivated learners went up and down from year to year, but that no clear trend could be discerned.

4.2.2 The learners' motivation to continue to further studies

Almost all of the interviewed personnel expressed that there were few learners who continued to further studies after secondary school, see table 5. The reason for that were, just as mentioned earlier, that the schools were situated in a rural area, as expressed in quote 5. To study at the university in South Africa you have to pay a registration fee, which is impossible for many of the learners from this area. Some of the learners had the fortune to get a scholarship to be able to pay for the registration fee, see quote 6, which made it possible for them to continue their studies, but since the universities have semester fees as well, some of the students can not continue their higher education after the first semester. So the personnel expressed that few of the learners continued their studies after graduating from the schools visited during this study. However, when they were asked to estimate how many in percentages, many of the personnel said quite a large number. In the questionnaire the personnel were asked to estimate how many of the learners that were continuing to further studies on a scale from 1 to 4, where 1 symbolised almost none and 4 symbolised almost everyone. According to the answers on that question, which can be seen in figure 4.8, most of the personnel who were handed questionnaires expressed that many of the learners continued to further studies. So the answers regarding how many of the learners that were continuing to further studies were ambiguous.

| School | Interviewee | Interviewee's estimation | |
		expressed in words	expressed in percentages
1	Teacher 1	Few of them	About 50 percent
	Principal	Less than 20 percent	
2	Teacher	Very few	Maybe 20 percent
3	Teacher 1	Not many of them	30 of 173
	Teacher 2	Not that many	About 50 percent
4	Teacher 1	There are many	About 50 percent
	Teacher 2	There are many	About 70 percent
5	Teacher	The number is very low	7 percent
7	Teacher	Few, very few	About 40 percent.
8	Teacher	Not many	20-30 percent

Table 5: The personnel's estimation of how many learners that continue to further studies after secondary school expressed both in words and percentages.

> 'That is a bit of a challenge because the community around here are predominant rural, poor, unemployed. Of the 80 percent, of the 85 percent that passed last year about 20 percent, less than 20 percent actually are at university, university of technology and other. Planning it, higher further institutions. Because like you must have seen no futures, no industries. They go to the work on the field on, on, on the

plantation. Planting, which they do for their own personal consumption...'

Quote 5: Interview answer from the principal at school number 1, talking about how many learners that are continuing to further studies after graduating from that secondary school.

'... this year we had many of them go to university studies. Star for life was paying for the registration. [...] [Interviewer: How large is the registration fee?] Mm, Star for life's paying 5000 rand.'

Quote 6: Interview answer from a teacher at school number 5, talking about how many learners that are continuing to further studies after graduating from that secondary school.
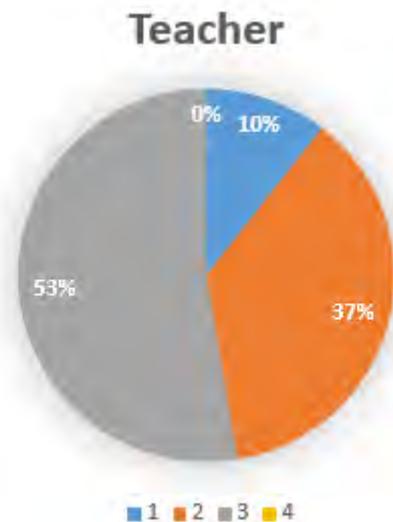

Figure 4.8: Questionnaire answer from teachers asked to estimate how many learners that continue to further studies after graduating from secondary school. 1 stands for almost none of the learners, and 4 stands for almost all of the learners.

Just as the personnel were asked to state if they had seen any trend regarding the learners' motivation for their studies, they were also asked to state if they had seen any trend regarding the number of learners that continued to further studies. The answers on this question also were ambiguous; most of the personnel expressed either that no trend could be seen or that the number of learners that continued to further studies had increased the recent years. At the same time though, some persons from the personnel expressed that the number were decreasing over the recent years.

According to the results of the questionnaires handed to learners most of them, in both study and control group, were willing to continue to further studies. The Star for life crew pointed out that a major part of their work was to inspire the learners to have a goal with their life, to be willing to believe in their dreams and work to achieve them, which they felt increased the learners' motivation to continue their studies after secondary school.

Figure 4.9 demonstrates the learners' answers to the question about if they wanted to continue their studies.
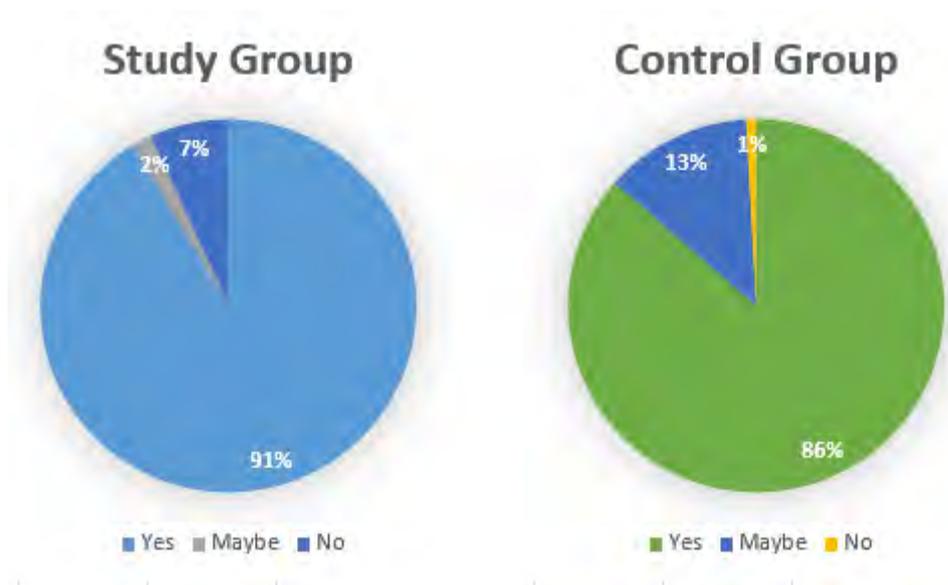
Figure 4.9: This figure shows the learners' answers to the question "Do you wish to continue to further studies after high school?".

4.3 Intended and observed effects of using computers

In this section, how the inclusion of computers effected the education in general and in chemistry studies in particular, is going to be presented. What advantages and disadvantages the learners and the personnel saw with the use of computers also will be presented, as well as what is missing in order for the schools to enhance their use of computers.

4.3.1 Usage of computers in the education

To gain knowledge about how the computers were used in the education, questions about this were asked to both learners and personnel. Both questions about how they used computers in the education in general and specific questions about how they used computers in science and chemistry studies in particular were asked.

As presented in section 4.1, the computers were mostly used in CAT and rarely in any other subject. The subject CAT was divided into two parts, a theoretical one and a practical one, and the computers were used in both these part, see quote 7. During the theoretical part the teacher either used the computer to show a PowerPoint presentation while lecturing or he/she projected his/her own screen and showed the learners how to do different things on the computer. At these sessions, the learners usually repeated what the teacher were doing by themselves, in other words, it was like a "following the leader" exercise. During the practical part of the CAT-course the learners were given tasks to perform on the computers and the teacher instructed them when they ran into problems.

'A typical lesson. Practical or theoretical? [Interviewer: Both. What are you doing when you are having practical?] It depends. Okay, it depends on the, on the, which schedule. So it's the only document that guides us what to do. But most of the time whenever we are doing practicals they are working with the application programs like word processing, Microsoft Excel, data bases, as well as HTML where they design basics websites. [...] [Interviewer: And the theoretical part, what are you doing?] I am using slides. Our books comes with slides, each thing got its slides. Still we are using a projector as well as the book. Because some of the things we teach we are still, or some of the things here in the, in the work schedule appear in the slides, but you have to add the information from the book.'

Quote 7: Answer on the question "Can you describe a typical lesson where you use the computers?", given by a teacher at school number 6 during an interview.

At most schools the teachers only occasionally used computers in the teaching of other subjects than CAT. Most commonly they used them to show PowerPoint presentations, but some teachers also used educational software, for example to show graphs, or showed educational videos. For these purposes the teachers usually used their personal computers and sometimes also personal projectors when the school did not have that equipment, as expressed in quote 8. This means that the computers were rarely used in the education of chemistry, with only one exception – school number 8.

'I use my personal computer as well as a projector. [interviewer: A projector? Your personal projector?] Yes it is my personal. Then I used to use it when I am teaching. [Interviewer: How are you using them?] I just, if I am just, if I want to show something like notes I can when I just take notes and then just write them on the, on the PowerPoint, and show it for the learner, and project it.'

Quote 8: Interview answer from teacher 2 at school number 4 on the question "Do you use computers inyour teaching?".

As mentioned in section 4.1, school number 8 had the I-box which they frequently used in the teaching of science and mathematics. Partly, the mathematics and science teachers at school number 8 used the PowerPoint presentations at the I-box, just like other teachers at the visited school used PowerPoints in their teaching, but they also frequently used the educational software that the I-box included. Mainly they used PhET, a software which could be used to show graphs, calculations and simulations of science experiments. A multitude of different science experiments could be simulated, some examples are shown in figure 4.10. In chemistry, you could, for example, use the software to simulate what

happens if you pour sodium in water, as seen in figure 4.10b. This software made it possible for the teachers at the school to show a wider range of experiments than they could have done otherwise, since it made it possible for them to simulate experiments that they did not have resources to perform in the classroom.

> 'I can use them when I want to see how is the experiment is done.'

Quote 9: Questionnaire answer from learner 116 at school number 8.


(a)   (b)
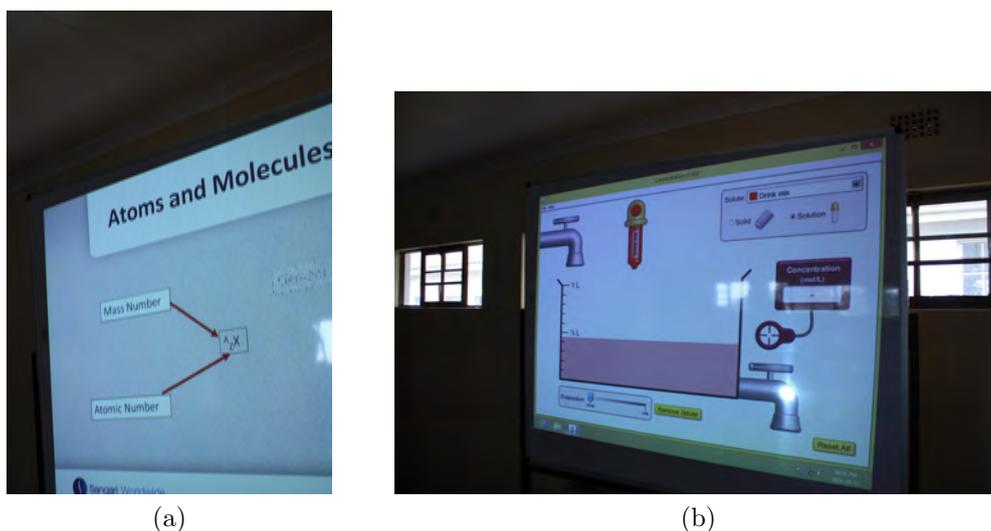
Figure 4.10: The figures show screen shots from the demonstration of the I-box and the software PhET.

The frequent use of computers in chemistry studies at school number 8 were not exclusively supported by interviews with personnel and demonstrations of the I-box, it could also be seen in the learners' questionnaire answers. The learners at school number 8 had more examples of how computers could be used in the chemistry education than the learners at the other schools visited during this study. Among other things they said that they could use the computers to write laboratory reports, watch experiments, research and find information about things they felt unsure about, writing notes and getting notes emailed from the teacher, as partly can be seen in quote 9-11.

> ''No, I think we can use them in a way of writing notes or the teacher could just email us the notes [. . .].'

Quote 10: Questionnaire answer from learner 77 at school number 6.

> 'Yes. If there is something don't understand, you may go to using a computer for make research or information about your chemistry studies.'

Quote 11: Questionnaire answer from learner 69 at school number 6.

Some learners at the other schools also suggested that the computers could be used to search for information and write laboratory reports, but many also expressed that they

had no idea about how to use computers in their chemistry studies, like in quote 12. This could be seen in both study and control group, however it was most common within the control group to not have any ideas about how computers could be used in the education outside of CAT studies.

> 'I don't know how to use a computer for chemistry studies.'

Quote 12: Questionnaire answer from learner 114 at school number 7.

4.3.2 Advantages and disadvantages seen with the use of computers

The respondents of this study predominantly saw advantages with using computers in the education, and many of them even said that there are no disadvantages. The teachers who used computers in their teaching pointed out one reason for that: it makes the learners more motivated and engaged during the lessons. The learners also showed a positive attitude to using computers in the education and thought it is joyful, as seen in figure 4.11. Most learners, in both study and control group[1], also expressed that they felt comfortable with using computers, see figure 4.12. The learners also said that using computers made the lessons more interesting, and some expressed that it make them think in new ways, as learner 84, school 6, express in quote 13 as an answer to the question "What pros do you see with using computers in the education?".

> '- It make my mind free, no stress. - It also make me think out of the box. - It feels more great in terms of privacy. - It just feels super great.'

Quote 13: Questionnaire answer from learner 84 at school number 6.
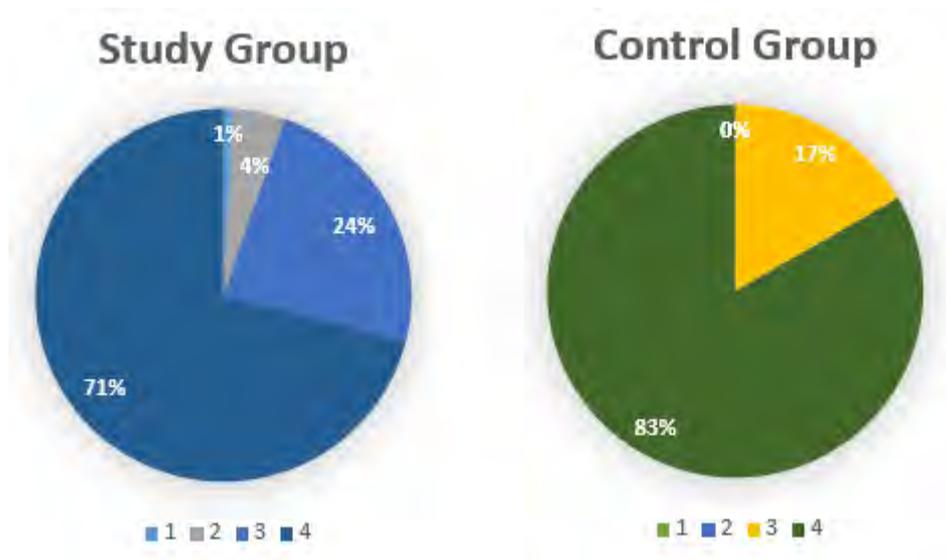
Figure 4.11: The figure illustrates the learners' answers to the question "How joyful do you think it is to use a computer?".

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[1]The control group results are based on answers from those learners who had used computers in their every day life.
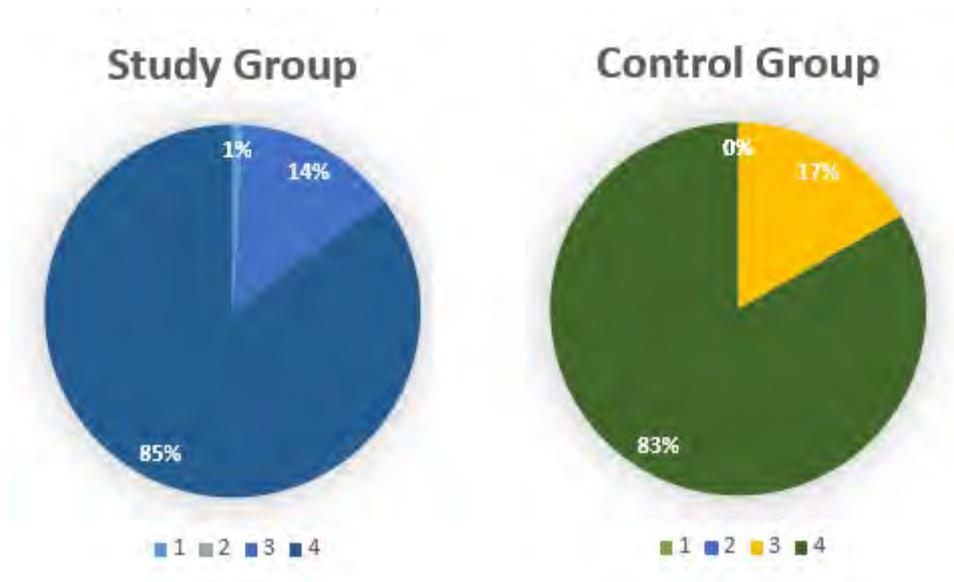
Figure 4.12: The figure illustrates the learners' answers to the question "How comfortable du you feel with using computers?".

On the other hand, some respondents said that there was a risk that the learners became unfocused when the teacher showed a PowerPoint presentation since it made the learners passive.

Some learners expressed that one advantage with learning how to use a computer was that they then also could use it for fun, like for playing games, watching movies and so on. On the contrary, other learners expressed these amusements as a risk with using computers since it could distract them from the school work and make them lazy.

Many learners expressed that computer usage may have a negative impact on their health, such as problems with the eyes and sore neck and back, which quote 14 is an example of.

> 'The can be dangerous to health and if you sit long you will have
> eye problem and headache and backache.'

Quote 14: Questionnaire answer from learner 88 at school number 6.

The reason why many of the respondents said that using computers in the education exclusively was positive was that they saw a specific and very strong advantage with using computers, namely that the learners get to learn how to use a computer. Almost all the respondents pinpointed that this was an advantage with having computers at the schools. The reason for this is, as they expressed and exemplified in quote 15, that we live in the world of technology, and knowing how to use a computer becomes more and more important. Many of the personnel also expressed that there is a great risk of being left out if you do not know how to use a computer.

> 'Positive things that I can see with using computers. Number 1,
> we are living in the world of technology, so using computers
> would be familiar with anything out there. Everything is

technological so if you don't know anything about technology
you'll be left out. So it would be like you don't belong. And
another thing, if you don't use or study anything technology
it's uhm.. I mean life would be difficult for you, life wouldn't
be easy for you.'

Quote 15: Interview answer from teacher 2 at school number 3.

Many teachers also expressed that it is crucial for the learners to know how to use a
computer for them to be able to continue their studies at university, see quote 16. As
illustrated in figure 4.13, the learners also believed that the use of computers in secondary
school were beneficial if they wanted to continue their studies.

'Once you are at university level everyone there should know
how to use computers...They don't teach you how to do,
they just tell you that "You must do that and it must be
typed and you should do it on a computer". So if you haven't
done computer back at your secondary school level you find
difficulties. Then you won't be able to do it, so that's why
you start feeling like you're left out, you don't belong to that
world. And you lose confident, you be like "Ah, I don't know
computer'

Quote 16: Interview answer from teacher 2 at school number 3.
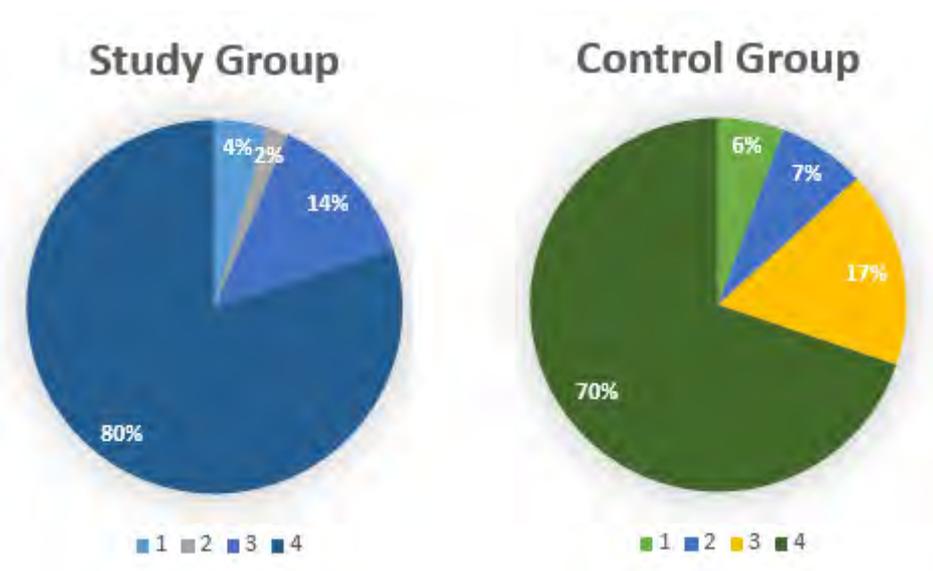
Figure 4.13: The figure illustrates the learners answers regarding if they thought it
would be beneficial for them to know how to use a computer if they continued their
studies after secondary school. The answers were given on a scale from 1 to 4, where
1 symbolised "Not likely" while 4 symbolised "Most likely".

Almost every respondent, both learners and personnel, pointed out that technology and
computers take a continuously greater role in the society of today, and thereby it is a

huge advantage for the learners to get to use computers in secondary school, whether they continue their studies or start working after their graduation.

4.3.3 What is missing to facilitate a greater use of computers in the education

As mentioned in the previous section (section 4.3.2) the respondents of this study mostly saw advantages with using computers in the education, and they wished to do it more frequently and have more access to computers. However, there were several reasons to why computers were not utilised more often. Most of them connected to lack of resources.

Many of the teachers expressed that they needed to get more computers to the schools in order to give more learners access to computers. However, as previously described, the computers mostly were used in CAT, and thereby not used all day long. So at most schools there were room in the schedule to increase the use of computers. Some of the schools offered the learners access to computers beside the regular class schedules, but only with a teacher present. The reason for this was to prevent theft and sabotage.

Even though personnel on many of the schools expressed that they needed more computers, few of the schools had any real plan regarding how to facilitate a greater use of computers in the education. Some teachers at school number 3, where the computers were not used at all, expressed a need to sit down together and make up a plan for the computer usage, as exemplified in quote 17. As seen, they expressed a need to have a common view on how to use computers in the education in the best way, something that teachers at some of the other schools pinpointed as well.

> 'Yes, maybe as a team we could sit down and figure out how we are going to use them as a whole school. Because for me, only I cannot. We can sit down as a team and think and see and draw a plan how to. Because the whole school need to.'

Quote 17: Interview answer from teacher 1 at school number 3 on a question about if she had any idea about how she could use computers in her teaching.

Most learners did not have access to computers in their home environment or outside of school since they could not afford to buy one. As a cause, the learners had limited understanding of computers and how they can be used, according to them. Another consequence was that the time the learners spent by a computer varied a lot, many of them spent barely any time at all by a computer while the learners that attended CAT used a computer one time per day in general. Despite the learners' limited access to computers most of them felt comfortable using computers and thought it was joyful, as illustrated in figure 4.11 and 4.12 in section 4.3.2. However, some of the learners expressed that they needed more time by a computer to get a great knowledge.

Beside the limited amount of computers at the schools, there were also a lack of other resources that prevented a greater use of computers in the education. Sometimes one of those were access to electricity. In South Africa, the power distribution grid is sometimes switched off in different part of the country, in order to save power, so called load shedding. This is especially common in rural areas, like where the schools participating in this study

are situated.

Some teachers also expressed problems connected to showing PowerPoints in their teaching. Besides some schools not having any projector, as mentioned in section 4.3.1, some teachers also expressed that they missed a board to project on as well as curtains to obscure the sunlight that shone through the windows, see quote 18.

> 'Sometimes I use it. Because we, we do have projector. It is just that we do not have a board to reflect to. So, I just place it on the wall. Sometimes it is not clear. Like last year I used it in class grade 12 science. It was used to project on this color of the wall [points on a wall white light orange color] Yeah. Yeah, so that is the reason why I wish to use it daily, but it depends on the light during that day.'

Quote 18: Interview answer from teacher at school number 2.

There were also lack of resources connected to the main reason to why the respondents wanted to use computers in the education - to be able to search for information. To do this, either internet connection or some kind of offline encyclopedia is required. When this study were performed most of the schools lacked internet access, only two out of eight visited schools had internet, and one more were about to receive it the following week. In addition, none of the personnel expressed that the school computers had any kind of offline encyclopedia either. However, not all seemed to have the understanding about these requirements, since many of the respondents expressed that they only needed more computers.

In summary, there were many things missing at the schools to facilitate an extended use of computers in the education. On one hand, there were lack of resources, such as computers, power supply, projectors, curtains, boards or good walls to project on, internet access and last but not least educational software. On the other hand there were some lack of knowledge about the many different ways to use computers in the education. Many teachers had good computer knowledge but most schools lacked a common plan for how to include computers in the education, especially in other subjects than CAT.

5 Discussion

This section will begin with a discussion of the results from this study and its reliability, followed by a discussion of the chosen method.

5.1 The usage of computers at the schools

As previously mentioned the usage of computers in the education varied a lot between the eight different schools which were participating in this study. Some schools used computers in the education several times a day while others barely used computers at all. Of course this was partly related to the number of computers respective school had access

to, and as Naicker (7) states lack of computers are a significant factor when it comes to using computers in South African schools. However, this did not entirely explain the differences in the use of computers at the schools participating in this study. For example school number 4 did not have as many computers as many of the other schools but still they used them a lot, while school number 3, which were one of the schools that had most computers, did not use them at all. In school number 4 the learners used the computers in any subject when they were in need for it, they just needed to ask for permission. School number 8 used the same system as school number 4 and school number 6 also was about to introduce it now when they received tablets.

We feel that the other schools could have benefited by taking inspiration from the use of computers of those three schools, since a good general access to computers helps the learners in the future, both with their studies and work (5). For this reason, if there is any time when the computers are not used for a specific subject or lesson it would have been good for the learners to have access to the computer lab and use them. By doing that the schools could have used their computers more frequently and more learners could have learned how to use a computer during their secondary school studies. A reason why this was not done was, according to teachers, was due to the risk that the learners would sabotage the computers if they were alone in the computer lab. However, a way to avoid that could have been if teachers took turns to supervise the computer lab so that it would always be under observation.

Mutual for school number 4 and 8, which let the learners use computers in many subjects, were also that they had internet connection, and school 6 was about to receive it along with the tablets. Of course this made it more easy for the schools to use the computers in different subjects since the learners could use them to search for information for a paper in any subject. At the same time, a way to circumvent this problem could be to use an offline encyclopedia so that the learners could search for information even without internet connection. That would facilitate greater use of the computers. However, it is not as simple as just providing the schools with computers that includes an offline encyclopedia and other educational software. Just as Naicker (7) states, we found that most teachers have lack of knowledge about educational software and how to use them in their teaching. Almost all teachers expressed that they were experienced with the use of computers, and all of the CAT teachers had some kind of university education in the field of computer science or information technology. Still they mostly used just the Microsoft Office package in the education. Some teachers knew about some educational software they could use in their subject but just a few of them really used them. As our result shows the computers were mostly used in CAT and, just as Assan & Thomas and Naicker(4; 7) say, we think one of the main reasons for this is the teachers lack of knowledge and ideas regarding how to use the computers in their teaching.

Another thing that became clear during the field study in South Africa was that the school management team had a significant impact on the school activities, and thereby if and how the school used computers in the education. For example, school number 3, where the received computers had not come to use at all, had had real problems with a lack of school management for a couple of years, while school number 6, which were just about to receive both tablets and wireless WiFi, had a very enthusiastic principal who seemed to really engage in the school and her work. This is also strengthened by the Department of Education in South Africa. In the text *Understand School leadership and governance in the South African context*, they state that good school leaders are characterised by

passion, namely passion for

- achievement - they believe in all the children and their potential,

- caring - they really care for their learners at do that little extrafor them,

- collaboration - they encourage collaboration both within the school and its personnel and learners, as well as with other schools,

- commitment - they are committed to their schools both at good days and the bad ones,

- trust - they create an environment where the teachers feel that they are trusted to take their own decisions, and where they thereby take their own responsibility, and

- inclusivity - they include parents, guardians and other stakeholders in the school's work and make the school a real part of the community (21).

As of this we feel that it is equally important with the principal's knowledge about how the computers could be used in the education as the teachers.

5.2 General motivation among learners

According to the results of this study, it could not be established that the inclusion of computers affected the learners' motivation to either their present or further studies, which corresponds to the result from Gutschmidt's (6) research on the work of OLPC in Kenya. However, as mentioned in section 3.2.1, two difficulties were considered when it came to trying to find out if the inclusion of computers in the education had affected the learners' motivation for their studies.

Firstly there had been no previous research regarding the level of motivation among the learners before they had received computers and therefore there were no previous data to compare with. This difficulty was circumvented by using both a study group, which consisted of learners who were using computers in their education, and a control group, consisting of learners who did not. In addition the personnel who participated in this research were asked if they had seen any changes regarding the level of motivation among the learners over the past years.

The other difficulty was regarding how to measure the level of motivation. Just like Gutschmidt (6) pinpoints, measuring motivation is not an easy task. We reasoned that a learner who feel comfortable in school and who think that his/her studies are joyful probably is motivated for his/her studies, and therefore we checked to what extent the learners agreed to those two parameters. Studies has shown that motivation is usually connected with positive feelings regarding a subject (24). How comfortable the learners are in school and how joyful they find their studies is connected to positive emotions and that is the main reason to why those two parameters where chosen. This method was not optimal, among other things, it was a little sparse to only check those two statements, and it might have given a better understanding about the learners' motivation to ask some more questions connected to the learners' engagement to their studies, as Gutschmidt (6) did. Another option that was discussed during the design of the interviews were to ask the learners directly if they were motivated with their studies. The reason this was not done, was partly due to that we felt it would be a rather leading question, which can affect the

respondent's answer (14). Furthermore, the feeling of being motivated and the perception of what motivation is are subjective. For that reason it might have been hard to draw any conclusion about the level of motivation among the learners from a direct question, which were the reason why Gutschmidt (6) did not ask that question either.

That the perception of motivation is subjective is also reflected in the comparison of the answers from the learners and the personnel. As mentioned, by our interpretation of the learners' answers, they were motivated both to their present and further studies. The teachers, on the other hand, had very diverse answers on how many learners that were motivated and how the number of motivated learners varied over the years. However, most teacher had high standards for how a motivated learner should behave, which probably had an impact on how many learners they defined as motivated. Among other things, the personnel said that a motivated learner always were engaged in their studies and asked questions, helped their friends, got great grades in all subjects and dressed properly. A reason that some teachers thought there were rather few learners who fulfilled these criteria could be the fact that the learners lived in a rather tough environment, just as the principal at school number 1 expressed, see quote 1 in section 4.1. Some learners did not get any food except school meals and they were probably rather hungry which of course might have affected their engagement in their studies and school performance. This fact was something that was also noted during OLPC's work in Kenya (6).

In accordance to the above reasoning, the level of motivation the learners have for their studies is not clear, since the answers from the learners and the personnel differ regarding this question. In addition, it can not be stated that the inclusion of computers in the education affected the learners' motivation for their studies according to the above data, since there were no difference in the answers from the control and study groups regarding their motivation and no unambiguous answer from the personnel regarding how the level of motivation has changed over time. On the other hand, Hartley & Treagust (10) state that the learners become more engaged with their studies when using computers in the education, and some signs of that were actually found during this research as well. Several teachers mentioned that an advantage of using computers in the education was precisely that it made the learners more engaged and interested in the lessons since computers are new and exciting for them. This could be seen as an argument for that inclusion of computers in education do in fact increase learners' motivation to their present studies.

The research data regarding the number of learners who continue on to further studies after graduating from secondary schools were hard to interpret. The questionnaire answer varied very much. During the interviews, all respondents said that there were few learners who were continuing to further studies, but on the follow-up question about whether they could estimate how many learners that really were continuing on in percentages many of them mentioned numbers around 50%. As many as 50% of the learners continuing with university studies seems unlikely, since other sources show a different picture. CIA (22) states that over 50% of the young South African population, age 15-24, is unemployed. In addition the Statistics South Africa, which is the governmental cooperate for delivering statistics, reports that within the Black African population only around 25% graduates from secondary school and under 2% get a bachelor degree and among the population living in farm areas only about 20% graduates from secondary school and 2% get a bachelor degree (23). The schools participating in this research were situated in a farm area were the absolute majority of the people were Black African. For this reason we chose to overlook the personnels' estimations regarding the number of learners who are

continuing on to further studies after graduating from secondary school and just listen to the words that there is very few who do so.

5.3 Choice of method

From the beginning we were not planning to conduct any observations during the field study, because of a risk that people being observed do not act as they normally do since they are not accustomed with the observer (17). However, on site in South Africa we received much information about the school environment and the learners' everyday life by informal conversations with principals and Star for Life coaches as well as tours of the schools. We classified this collection of information as observations. We drew a lot of attention to us at the schools so, just as the risk Kylén (14) mentions, and we felt that the people at the schools often acted a bit unnatural with us being around. Therefore we feel that it was a good decision not to use observations in a further extent. On the other hand, we feel that our observations did contribute to a deeper understanding of advantages and challenges associated with the use of computers in the education in the schools visited during this study. Therefore they added value to our research.

The conditions during the interviews varied widely, and thus did the quality of them. Most interviews were conducted sitting by a table in either a personnel area or an empty classroom, without any time limit. In other words, they were conducted under good conditions. During some interviews on the other hand, different obstacles occurred. A couple of interviews were conducted standing in a small, very warm room surrounded by background noise from the school yard. Others were conducted under a strict time limit or interrupted multiple times by people not participating in the interview. These things affected the interviews negatively as the interviews did not run as smoothly as the ones conducted under good conditions. It also decreased the possibility to ask follow up questions. Despite this, the overall quality of the interviews was good, and we feel that we gained valuable data from them.

The quality of the results from the questionnaires varied more than the quality of the interview results. Most responses from the teacher questionnaire were clear and the data that we gained were rewarding for our research. The data from the teacher questionnaire responses completed the data from the interviews in a good way since it contributed to quantity in our set of data beside the quality from the interviews. The responses from the two different learner questionnaires were also largely good and we felt that it was good to gain a large set of data from the learners. However, the two learner questionnaires also generated a couple of problems.

Many of the learners were unaccustomed with filling out questionnaires, and those learners had a hard time knowing how to answer some of the questions. It was mainly the closed questions that generated this problem. The learners did not really understand how to answers the questions when the answer should be marked among different alternatives or on a scale. We explained how to answer these questions, but we do not think the learners always grasped the information. From the questions where the answer should be marked on a scale we got very uniform responses, almost all learners answered with a "4" (the maximum answer). There is an uncertainty regarding the accuracy in these responses. Did all of them really thought "4" was the best response or had they just not really grasped the differences between the different alternatives on the scale?

We also encountered some linguistic problems regarding the questionnaires given to the learners. We used the words "pros" and "cons" in two of the questions and the learners had problems understanding these words. The reason for this was mainly that there are no corresponding words in isiZulu. To overcome this problem, we explained what these two words meant when we introduced ourselves, our research and the questionnaire, which led to that the learners mostly managed to answer these questions. Due to the linguistic problems, in combination with some poor handwriting, there were also some answers we were not able to read or understand, and which therefore have been disregarded. Some other answers have been disregarded because they have been contradictory. We asked the learners in the control group if they had ever used a computer, and if so there were some follow up questions about how often and in which context they had used a computer, how comfortable they felt with the use of computers and how joyful they thought it was. Several of the learners in the control group answered that they had never used a computer but then also answered the follow up questions about the use of computers, which have led to contradictory answers. The reason for this may have been that the learners did not understand the questions correctly, and it that case it was a linguistic problem. However, no matter the reason, we had to disregard these answers since we could not tell if the learners never had used a computer and just answered the rest of the questions anyway or if they had used a computer and the answers at the follow up questions were correct.

We informed both teachers and learners that we only were there to do a scientific study regarding how the inclusion of computers had affected the education. We also expressed that we are not involved in the precess of supplying the schools with computers, and that we could not affect which school that gets computers and how many. The reason for this was that we wanted to maximise the probability that the respondents answered truthfully and not in a way that they thought would benefit themselves the most, or that would give them more computers. At most schools this message seemed to come through. However, at one school there were some misunderstandings regarding our visit. The personnel and school management thought we were coming to supply them with school materials, so the focus in both interviews and observations fell on explaining for us what they were missing rather than explain how they used the computers that the school had received.

In face of the discussed problems the data collection went rather well in general. Overall the observations, interviews and questionnaires generated both qualitative and quantitative data that were useful for us to answer the research questions of this project. Of course the questions in the questionnaires and the interviews were not perfect but we did not have to make any changes or additions to either of them, even though we had to explain some of the questions in the questionnaires for the learners. The problems with the questions could possibly have been avoided by doing a pilot study and test the questions in the questionnaires and the interviews, but due to difficulties regarding the conversation between Sweden and South Africa and the time constraints this was not done. We discussed to perform a pilot study at Swedish schools but decided not to do so since the everyday life in general and more specific the availability of technology is very different in Sweden compared to the South African country side and also because the linguistic difficulties would probably not have been detected in a pilot study in Sweden either. However, during the design of the interview guide and the questionnaires a Swedish teacher had a look at them and gave us valuable feedback regarding what type of information she thought would be gained from the questions and thereby we were able to improve the interview guide and the questionnaires.

We chose to use the analysis methods affinity diagram and Wilcoxon rank-sum test. The reason why we chose affinity diagram was mainly that it is a suitable analysis method to use when a group of researchers will work together with the analysis since it gives all of the researchers a good overview of the analysis. Thanks to the good overview we got through this analysis method it was easy to discuss and summarise the results of our study. The Wilcoxon method was used to analyse the numeric data we gained through the learners' questionnaires and compare the study and the control group. Just by looking at the results from the study and the control group respectively we suspected that there was no difference in the results from the two different groups but we felt that it was good to confirm this theory but using a statistical analysis method. However, as previously discussed, the reliability of the results from some of the questions from the learners' questionnaires may be a bit uncertain, and of course that affects the conclusions that can be drawn from the tests of these data.

Overall we feel that our analysis methods worked good for the collected data. Unfortunately, the time for the field study was postponed from the original time plan which led to less time for the analysis than originally planned from the beginning. This may have affected the quality of the analysis since it was performed rather quickly and the analysis therefore was not as thorough as it could have been.

5.4   Further research

During this research project some questions and ambiguities arose that would need to be investigated further. In this section these areas are addressed.

Most learners and personnel at the schools expressed that the learners would benefit later in life from having used a computer in secondary school, and especially if they continued their studies at university. More specific multiple teachers also expressed that not knowing how to use a computer would be a disadvantage for the learners who continued their studies, and a possible risk for drop off from the university. According to this it is easy to argue that it is a great advantage for the learners to learn how to use and to be accustomed with computers and that itself would be an argument for giving them that possibility. But to really be able to say that this is correct and draw these conclusion this area would need to be investigated further, for example by a study at university level to investigate the students' and personnel's views on how important it is to know how to use a computer when starting university studies.

Furthermore, this study indicated that there were deficiencies in the use of computers at the schools. The schools used the received computers in different ways and to a different extent. In the discussion part of this report some ways to expand the usage of the computers in the education are discussed, but this area may benefit from further studies. How the teachers would like to use the computers in their education and what they are missing to be able to do that are questions that could be investigated to increase the use of the computers.

Finally, this study did not succeed to answer the question about how the inclusion of computers in the education affected the learners' motivation to their studies in a reliable way, and therefore this questions could be investigated further. One of this study's deficiencies in this area is the way of measuring motivation. This was not of one of the main

focuses of this research project and more work could have been put into reading more about different ways to measure motivation. On the other hand, as mentioned in this report, with support from previous research, it is not an easy task to measure a feeling such as motivation and therefore more research may be useful in this field.

Another deficiency in the answer of the research question about learner's motivation is the unreliability of the learner's questionnaire answers. Many of the learners participating in this study had probably never answered a questionnaire before and therefore questionnaires may not have been the most optimal research method in this case. With this in mind it may be useful to do a new study regarding how including of computers in the education affect learners' motivation to their studies, but using another method.

6   Conclusion

Most of the schools participating in this study, and which had more than just a handful computers, used computers daily in the education. However, the most common use of computers were to use them only in CAT - a subject that was not on the schedule before the school received computers. Furthermore, CAT was only a part of some study packages, which means that only some learners were able to chose to read it, and learners who did not read it, had in general no access to the computers.

Most schools did not use the computers beside the regular CAT schedule, with exception for the two schools with internet access. Those two schools used computers in other subjects as well, mostly to let the learners seek information online. However, the teaching of other subjects than CAT had, in general, not changed since the schools received computers. In those cases when teachers did use computers in their teaching of other subjects than CAT, they mostly used their personal ones and not the school ones. And using personal computers in teaching was something that the teachers at the schools that did not have computers did as well. Generally this means that, for most learners the education have not changed since the schools received computers.

The personnel expressed several reasons to why the computers were not used more frequently, and that hampered the use of computers in education. Most of them were connected to lack of resources, such as having too few computers at the school, not having a projector or sufficient peripherals to project and missing internet connection. In addition, although a large part of the personnel had good computer knowledge in general, they lacked knowledge about how to include computers in their teaching besides just showing PowerPoint presentation or using Excel for counting. One school, however, frequently used the educational software PhET which really gave the chance to improve the science education. To supply schools with this and other educational software, for example GeoGebra for mathematics and Kiwix - an offline version of Wikipedia, together with education about how the software can be used, would enable for an enhanced use of computers in the education.

No clear evidence that the inclusion of computers in the education affected the learners' motivation for either their present or further studies could be found during this research project. However, learners expressed that the school work becomes more interesting and joyful when computers are used in the education. That was also strengthened by

the teachers expressing that the learners become more engaged when they were using computers in their teaching.

Almost all the respondents of this study expressed that it is important for the learners to learn to use a computer, since we live in the world of technology. Knowing how to use a computer is a great advantage for the adolescents, whether they are applying for a job or continuing to university after secondary school, and there is a big risk that they feel left out if they can not use a computer. For this reason it would be good if most learners, and preferably all of them, got to learn to use a computer during their mandatory school years. To make this possible, the school and the school personnel need both more resources and more knowledge about how to use computers in the education, as mentioned above. And giving them that will probably increase the opportunity for schools in rural parts of South Africa - and in other similar places - to use computers daily in a proper way.

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Appendices

Appendix I

Questionnaire given to study group learners.

Computer education in a developing country

The purpose of this study is to examine the educational effects of supplying rural schools in South Africa with computers. To do this we would appreciate if you could answer this questionnaire regarding your experience of the computers. We kindly ask you to answer the questions as honestly as possible.

All your answers will be handled anonymously. Your answers will not affect whether you get more computers or not, since we who perform this study don't have anything do to with the donation of computers. We are only looking to do a scientific research regarding the use of computers in the education.

School: ……………………………………………………..……………………………………………………….

Grade: ……………….

Age: …………………..

Gender:

☐ Male
☐ Female

---

1. I feel comfortable in school.

I disagree ☐ ☐ ☐ ☐ I agree
            1 2 3 4

2. I think my studies are joyful.

I disagree ☐ ☐ ☐ ☐ I agree
            1 2 3 4

3. Which of these subjects do you study?

☐ Mathematics   ☐ Chemistry
☐ Computer science ☐ Physics
☐ Biology   ☐ Language
☐ Civics   ☐ Religion
☐ Geography   ☐ History
☐ Other, please specify:

………………………………………….......

4. How often do you use the computers?

☐ Every day
☐ Several times a week
☐ Once or twice a week
☐ Once or twice a month
☐ Less often/never

5. In witch subjects do you use the computers?

☐ Mathematics   ☐ Chemistry
☐ Computer science ☐ Physics
☐ Biology   ☐ Language
☐ Civics   ☐ Religion
☐ Geography   ☐ History
☐ Other, please specify:

………………………………………….......

6. Mark which of the following software you have used.

☐ Open office / Libre office
☐ Dictionary
☐ Mathematical software, e.g. Octave, GeoGebra, Gapminder CAST and Thinkerplot
☐ Chrome
☐ Skype
☐ Kiwix – Wikipedia
☐ Programming software, e.g. Scratch and Python
☐ Other, please specify:

…………………………………………………….

Please turn!

i

7. Please describe a typical lesson where you used the computers. How did you use them?

…………………………………………………………………

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…………………………………………………………………

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…………………………………………………………………

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…………………………………………………………………

8. If you have used the computers within your chemistry studies, please describe how. If not, can you think of any way to use them?

…………………………………………………………………….

…………………………………………………………………

…………………………………………………………………

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…………………………………………………………………

9. I feel comfortable using the computers.

I disagree   ☐   ☐   ☐   ☐   I agree
            1   2   3   4

10. I think it is joyful to use the computers.

I disagree   ☐   ☐   ☐   ☐   I agree
            1   2   3   4

11. What pros do you see with the use of computers?

…………………………………………………………………

…………………………………………………………………

…………………………………………………………………

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12. What cons do you see with the use of computers?

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…………………………………………………………………

…………………………………………………………………

13. Do you wish to continue to further studies after high school?

☐   Yes
☐   No
☐   Maybe

14a. If no on question number 13:
Can you please explain why?

…………………………………………………………………

…………………………………………………………………

…………………………………………………………………

…………………………………………………………………

…………………………………………………………………

…………………………………………………………………

14b. If yes on question number 13:
Do you think that you will benefit from having used a computer in high school?

Not likely   ☐   ☐   ☐   ☐   Most likely
            1   2   3   4

Thank you for your cooperation!

Appendix II

Questionnaire given to control group learners.

Computer education in a developing country

The purpose of this study is to examine the educational effects of supplying rural schools in South Africa with computers. To do this we would appreciate if you could answer this questionnaire regarding your experience of your studies. We kindly ask you to answer the questions as honestly as possible. All your answers will be handled anonymously.

School: ……………………………………….……………………………………………………….

Grade: ………………

Age: …………………..

Gender:

☐ Male
☐ Female

---

1. I feel comfortable in school.

I disagree   ☐   ☐   ☐   ☐   I agree
         1   2   3   4

2. I think my studies are joyful.

I disagree   ☐   ☐   ☐   ☐   I agree
         1   2   3   4

3. Which of these subjects do you study?

☐ Mathematics   ☐ Chemistry
☐ Computer science ☐ Physics
☐ Biology   ☐ Language
☐ Civics   ☐ Religion
☐ Geography   ☐ History
☐ Other, please specify:

…………………………………………......

4. Please mark which of the following tools you have used within your education.

☐ Pen/pencil   ☐ Paper
☐ Protractor   ☐ Ruler
☐ Computer   ☐ Student
☐ Calculator   literature
☐ Other, please specify:

………………………………………….........

5. If you study chemistry, please describe a typical lesson. If not, describe a science or mathematics lesson.

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………………………………………………………………

………………………………………………………………

………………………………………………………………..

Please turn!

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6. Have you ever used a computer?

- ☐ No
- ☐ Yes

7. If no on question number 6, go to question number 11.
If yes on question number 6, in which context have you used a computer?

- ☐ At home
- ☐ In school
- ☐ Other, please specify:

    …………………………………………..

8. How frequently have you used a computer?

- ☐ Just occasionally
- ☐ Regularly:
    - ☐ Every day
    - ☐ Every week
    - ☐ Every month

9. I feel comfortable with using computers.

I disagree ☐ ☐ ☐ ☐ I agree
         1 2 3 4

10. I think it is joyful to use computers.

I disagree ☐ ☐ ☐ ☐ I agree
         1 2 3 4

11. Can you think of any way to use computers in your education? Please describe.

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……………………………………………………………
……………………………………………………………
……………………………………………………………

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……………………………………………………………..
……………………………………………………………
……………………………………………………………
……………………………………………………………
……………………………………………………………

12. Do you wish to continue to further studies after high school?

- ☐ Yes
- ☐ No
- ☐ Maybe

13a. If no on question number 12:
Can you please explain why?

…………………………………………………………………
…………………………………………………………………
…………………………………………………………………
…………………………………………………………………
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13b. If yes on question number 12:
Do you think that you would have benefited if you had used computers in your high school?

Not likely ☐ ☐ ☐ ☐ Most likely
         1 2 3 4

Thank you for your cooperation!

Appendix III

Questionnaire given to study teacherss.

Computer education in a developing country

The purpose of this study is to examine the educational effects of supplying rural schools in South Africa with computers. To do this we would appreciate if you could answer this questionnaire regarding your experience of the computers. We kindly ask you to answer the questions as honestly as possible.

All your answers will be handled anonymously. Your answers will not affect whether you get more computers or not, since we who perform this study don't have anything do to with the donation of computers. We are only looking to do a scientific research regarding the use of computers in the education.

School: …………………………………………………………………………………………………

Age: ………………

Gender:
- ☐ Male
- ☐ Female

---

1. What education do you have?

………………………………………………………………....

2. For how many years have you worked as a teacher?

…………………………………………………………….

3. Which grades do you teach?

……………………………………………………………....

4. Which of these subjects do you teach?

- ☐ Mathematics ☐ Chemistry
- ☐ Computer science ☐ Physics
- ☐ Biology ☐ Language
- ☐ Civics ☐ Religion
- ☐ Geography ☐ History
- ☐ Other, please specify:

  ……………………………………........

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5. How many students do you have at this school?

……………………………………………………………

6. Which of these subjects to the students study?

- ☐ Mathematics ☐ Chemistry
- ☐ Computer science ☐ Physics
- ☐ Biology ☐ Language
- ☐ Civics ☐ Religion
- ☐ Geography ☐ History
- ☐ Other, please specify:

  ……………………………………........

7. Please describe a motivated student.

……………………………………………………………………

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……………………………………………………………………

……………………………………………………………………

……………………………………………………………………

8. Do you have many motivated students at this school?

A minority ☐ ☐ ☐ ☐ A majority
          1   2   3   4

Please turn!

9. Please estimate how many student that are continuing to further studies after studying here?

A minority ☐ ☐ ☐ ☐ A majority
            1 2 3 4

10. Have you noticed any trend regarding how many students that are continuing to further studies?

- ☐ No, it goes up and down
- ☐ No, it is on an equal level from year to year
- ☐ Yes, it is increasing
- ☐ Yes, it is decreasing

11. How many computers do you have at this school?

……………………………………………………………………

12. When did you receive your first computers?

……………………………………………………………………

13. How many of them are working?

A minority ☐ ☐ ☐ ☐ A majority
            1 2 3 4

14. Do the students have access to the computers?

- ☐ Yes
- ☐ No

15. How often are the computers used for educational purposes?

- ☐ Several times a day
- ☐ Sometime every day
- ☐ Several times a week
- ☐ Once or twice a week
- ☐ Less often/never

16. Can you think of something that would get your school to use the computers more often?

……………………………………………………………………

……………………………………………………………………

17. How often do you use the computers in your teaching?

- ☐ Every day
- ☐ Several times a week
- ☐ Once or twice a week
- ☐ Once or twice a month
- ☐ Less often/never

18. Please describe a typical lesson where you use the computers?

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19. What pros do you see with the use of computers in the education?

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……………………………………………………………………

20. What cons do you see with the use of computers in the education?

……………………………………………………………………

……………………………………………………………………

……………………………………………………………………

……………………………………………………………………

……………………………………………………………………

21. How experienced are you with computers?

No experience   ☐   ☐   ☐   ☐   Great experience
                1   2   3   4

22. Which of the following software do you have installed at the computers? How experienced are you with them?

	Have got this software				**Have not got this software**	**I do not know if we have this software**
	No experience	Have seen it	Have worked with it	Great experience		
Open Office/Libre Office	☐	☐	☐	☐	☐	☐
Dictionary	☐	☐	☐	☐	☐	☐
Mathematical software, e.g. Octave, CAST, GeoGebra, Gapminder, Thinkerplot	☐	☐	☐	☐	☐	☐
Chrome	☐	☐	☐	☐	☐	☐
Skype	☐	☐	☐	☐	☐	☐
Kiwix – Wikipedia	☐	☐	☐	☐	☐	☐
Programming software, e.g. Scratch, Python	☐	☐	☐	☐	☐	☐
Other, please specify: …………………...................	☐	☐	☐	☐	☐	☐

Thank you for your cooperation!

Appendix IV

The interview guide used when interviewing personnel.

		ANSWER	
Personal questions	What is your name?		
	How old are you?		
	For how long time have you worked as a teacher?		
	What educatioon do you have?		
	Can you describe your computer education		
School questions	How many students do you have at this high school?		
	How old are them?		
	Which grades		
	Which subjects do the students study at this school?		
	How is the attendance of the students?		
	Can you describe a student that is motivated?		
	Do you have many motivated students at this school?		
		Is that on an equal level from year to year or have you seen any difference	

	Do you have any feeling for how many student that are continuing on to futher studies aer they finished high school here?		
		Is that on an equal level from year to year or have you seen any difference	
	How many computers do you have at this school?		
	When did the school first resive computers?		
Computer question	Are all of them working?		
	Do the students have access to the computers?		
	How often do you use the computers at this school in total?		
	How often do one class have access to the computers?		
	Can you think of anything that would make the school use the computers more often?		
	Do you use the computers in you teaching?		

	Can you describe how a typical lesson where you use them?		
		How often do you use them in your teching?	
		Is there anything that would make you use the computers more often?	
	Do you have any idea of how you could use them?		
		Would you like to get tips or advice of how you could use them?	
		What is the reason that you don't use them?	
	What pros do you see with using computers in the education?		
	What cons do you see with using computers in the education?		
	Do you know within which subjects, beside your own, the computers are used?		

	Do you know which softwares you have installed on the computers?	
	Which of them do you use?	

Appendix V

Affinity diagram of the study group data.
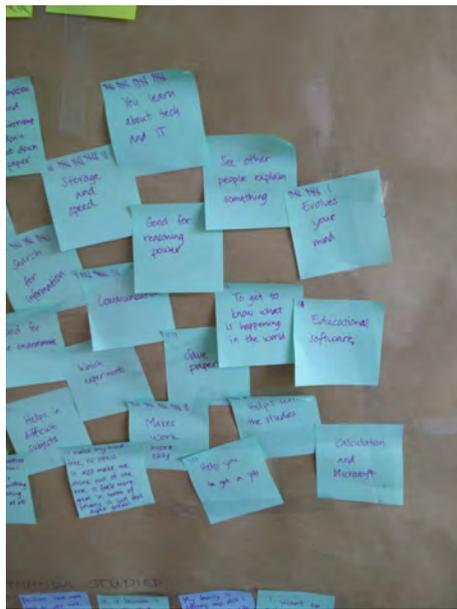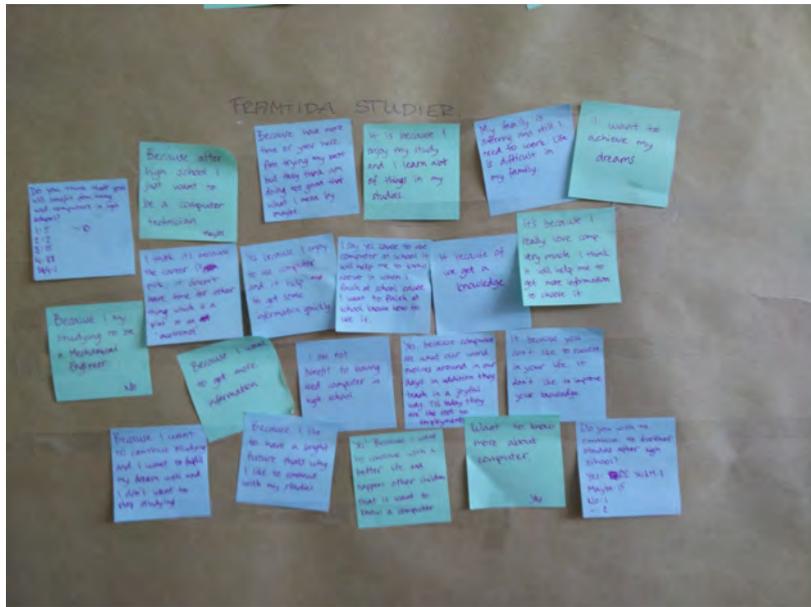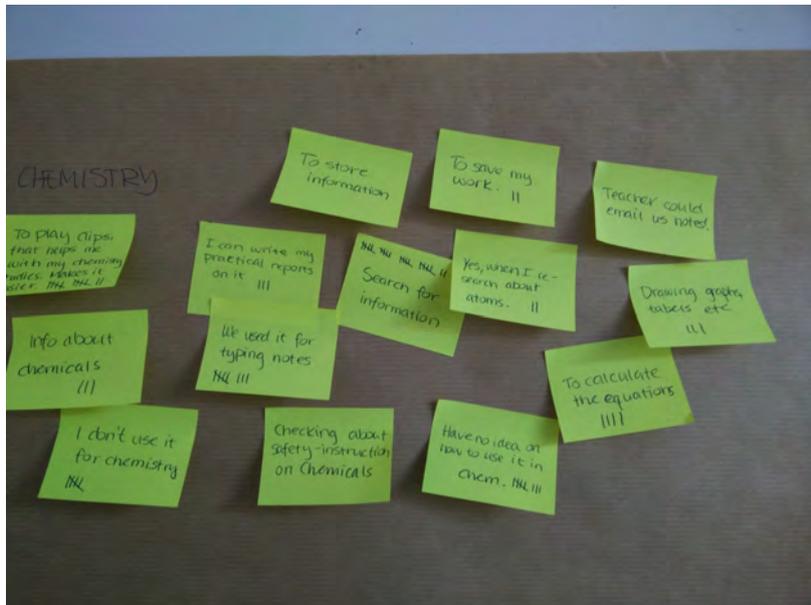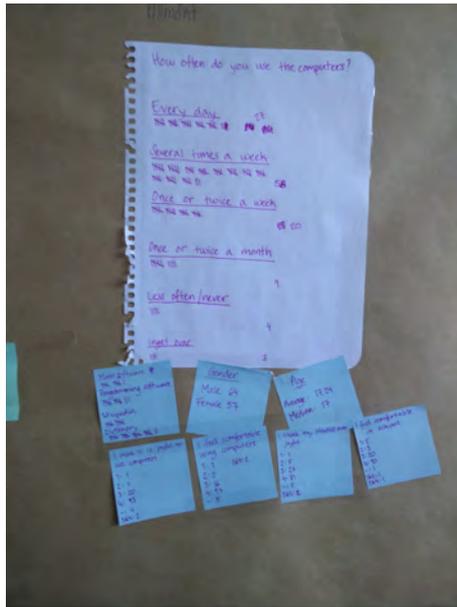
# Appendix VI

Affinity diagram of the control group data.
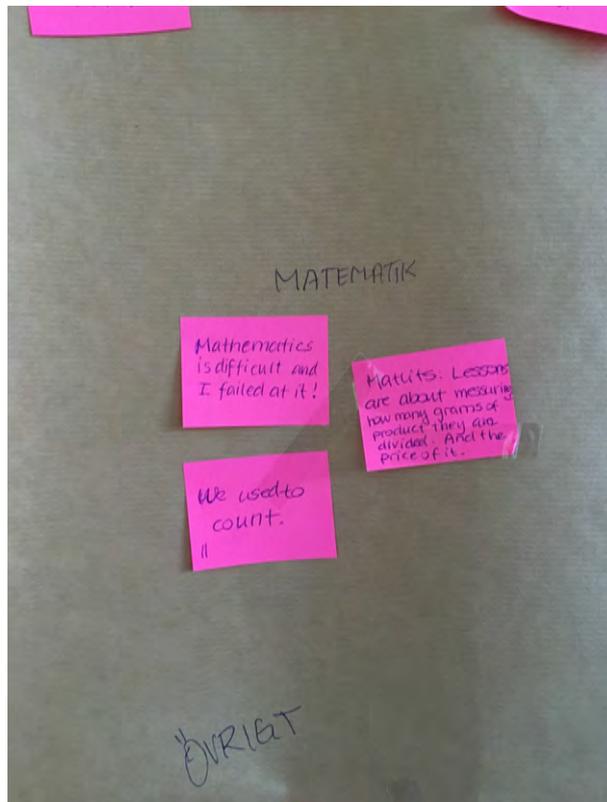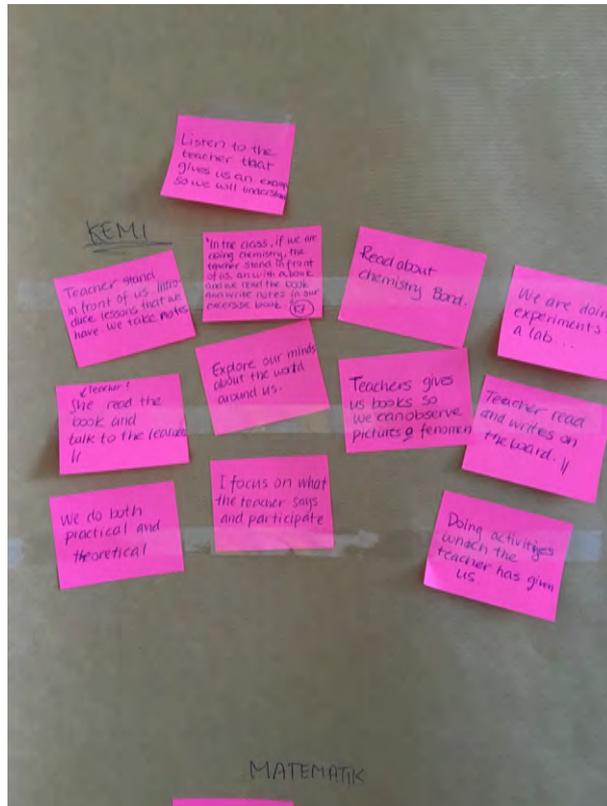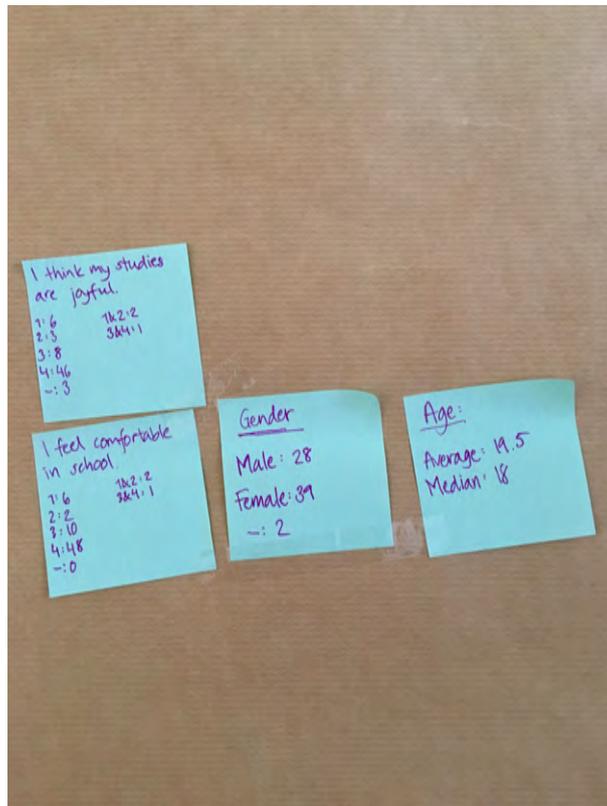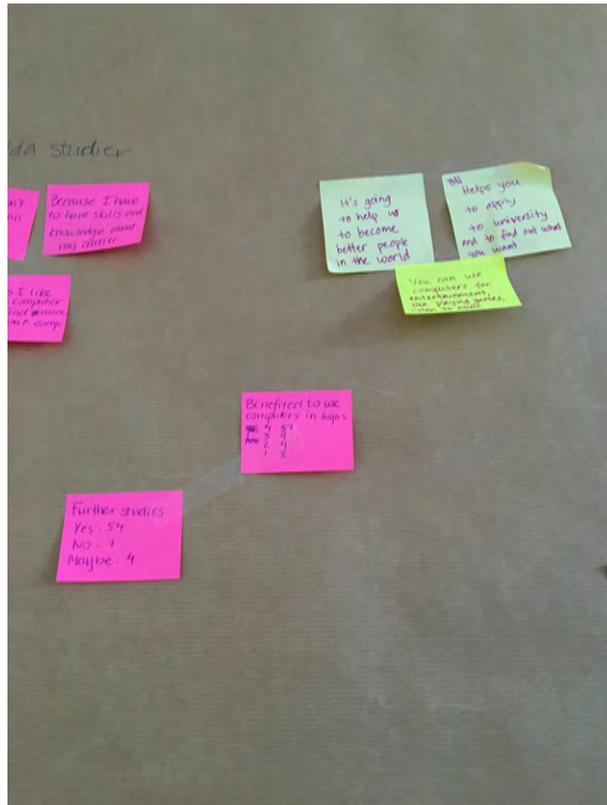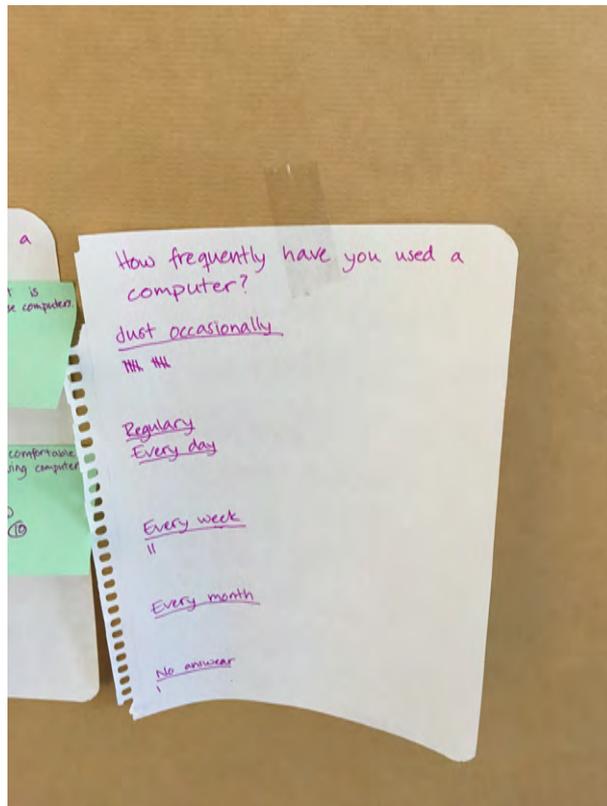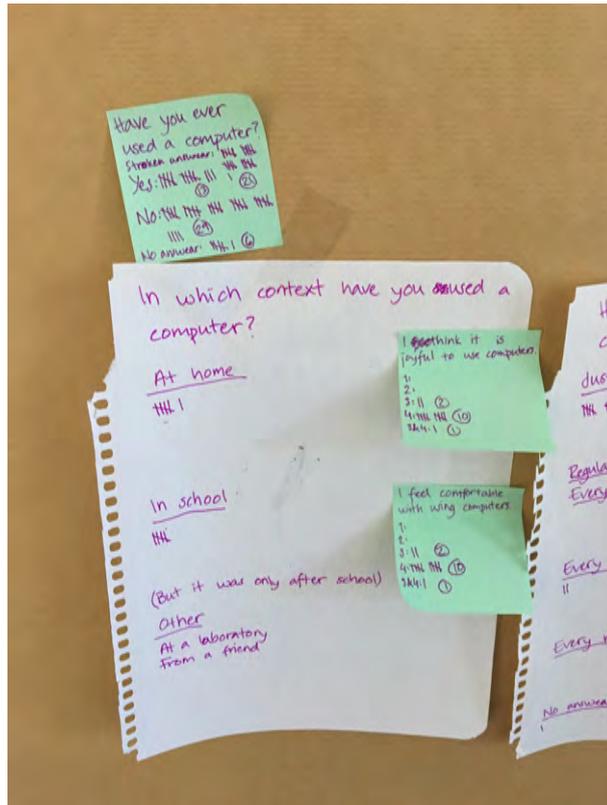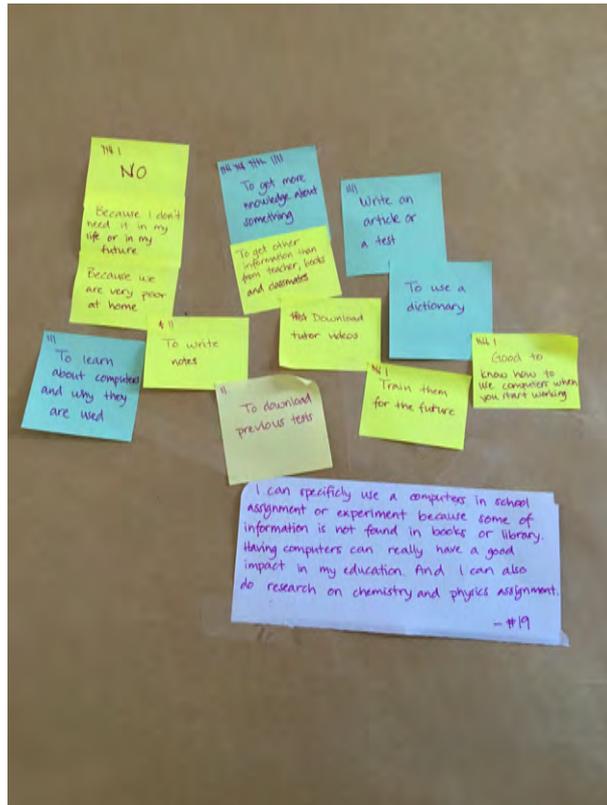
Appendix VII

Affinity diagram of the personnel responses from both questionnaire and interview.

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Fortsatta studier

Allmänt om livet!

Coming from poor homes.

Problems at University - if you lack experience.

University doesn't teach you. Expects you to know how. ⇒ lose confidence

XXX
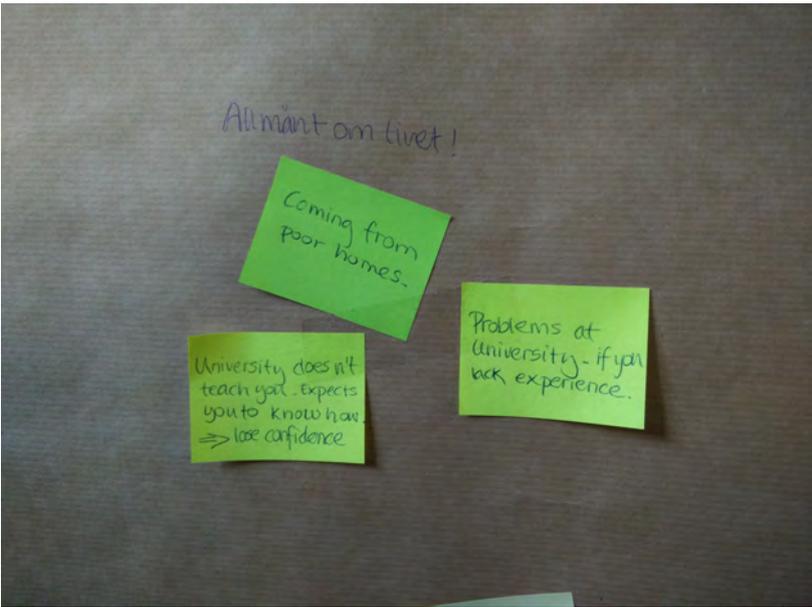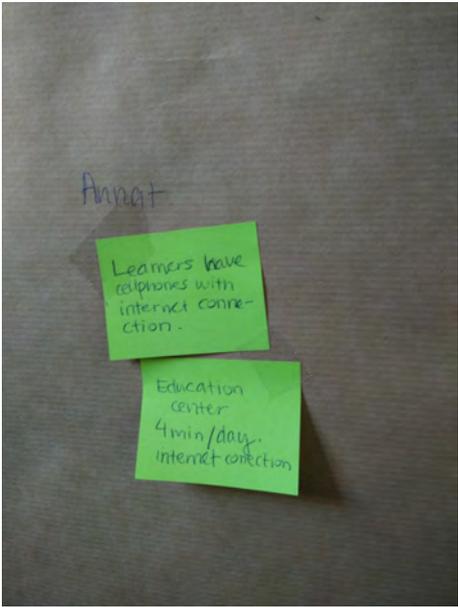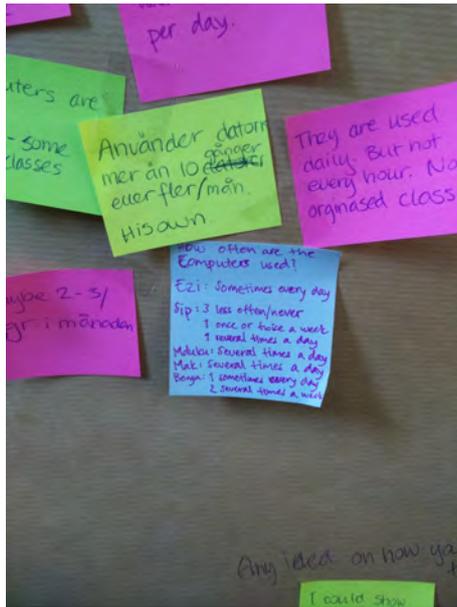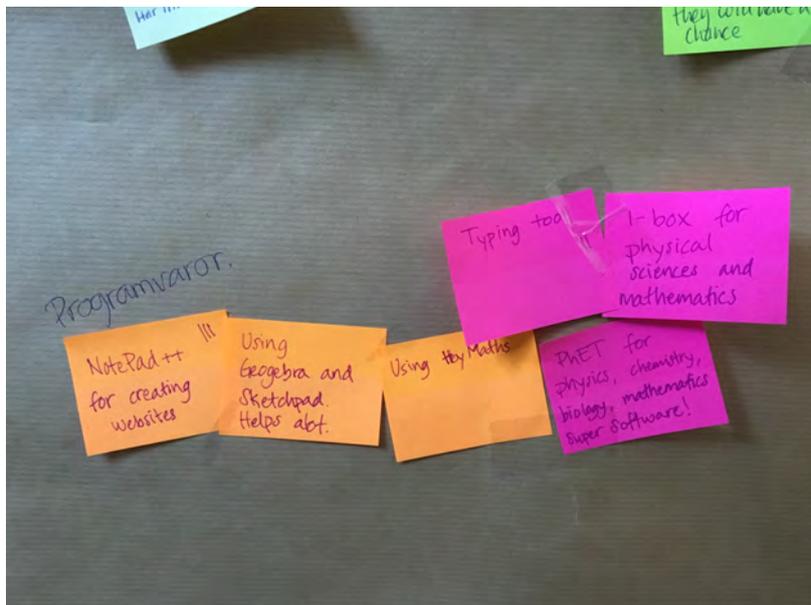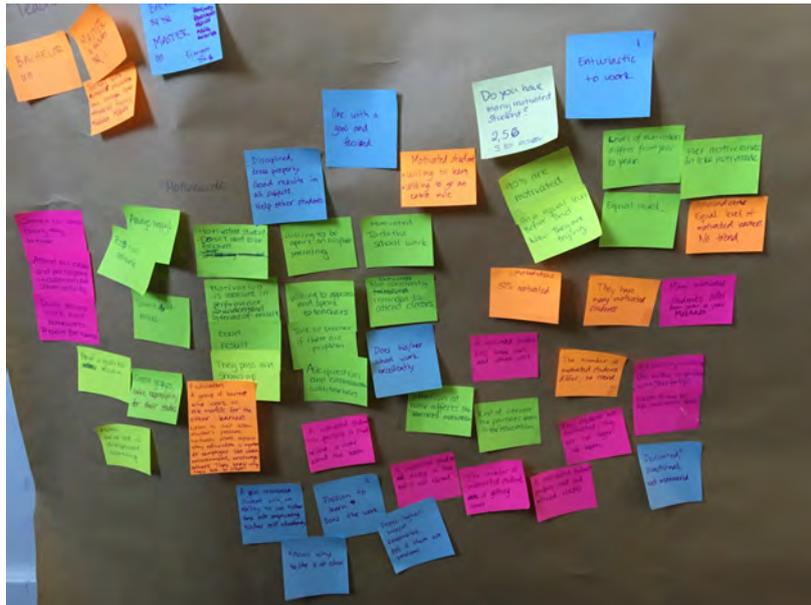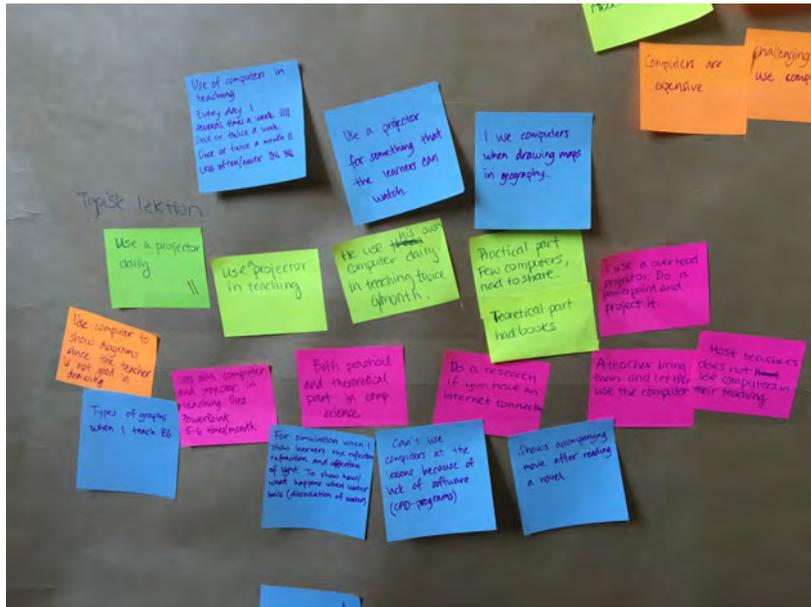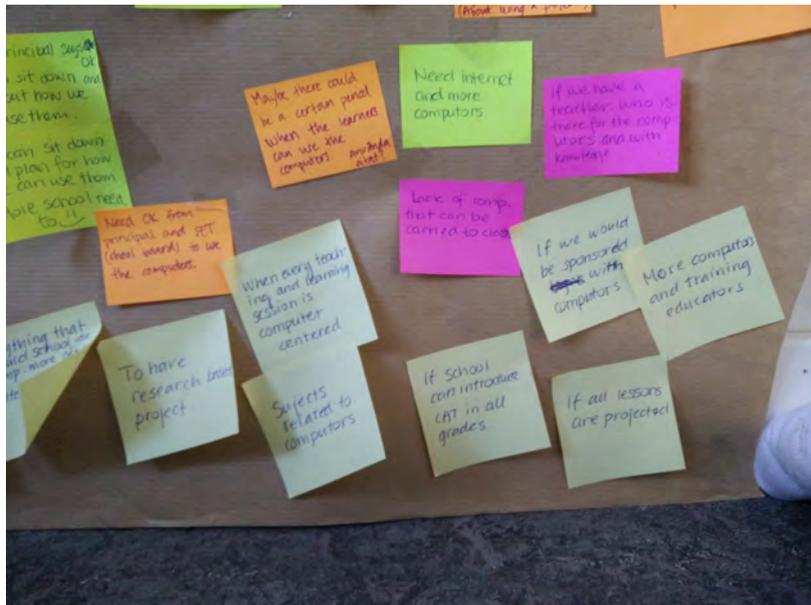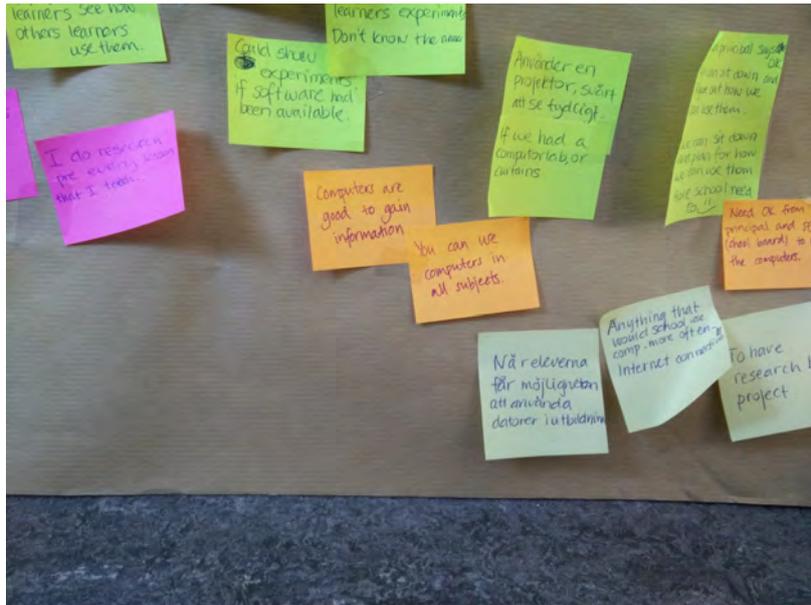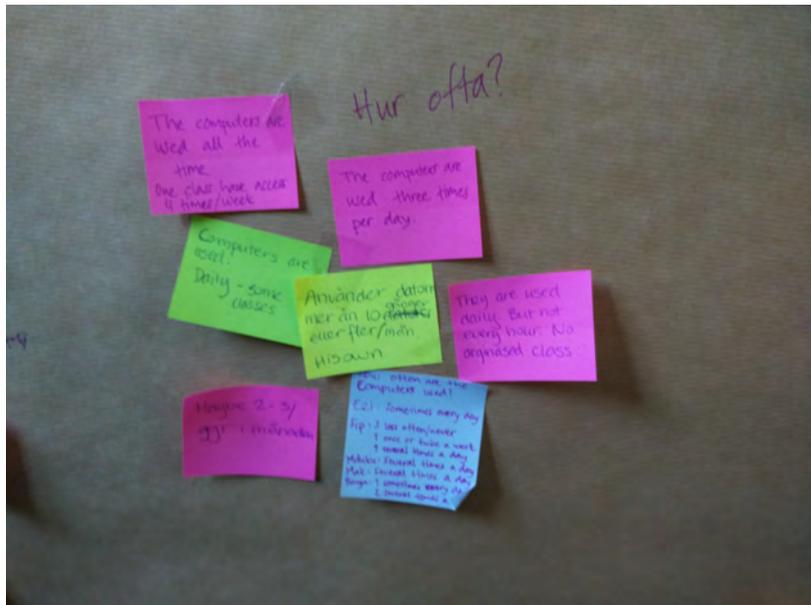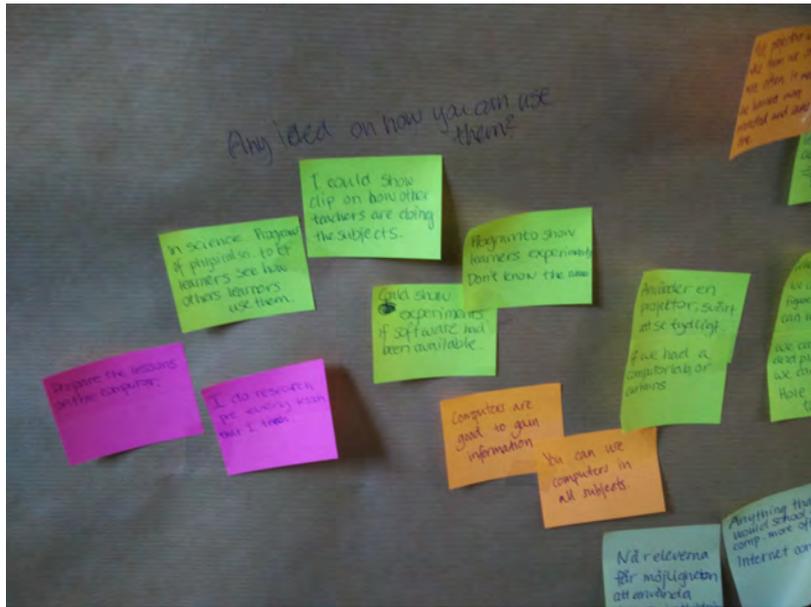
Appendix VIII

In the following section the MATLAB code for the Wilcoxon rank-sum test are presented.

Questions that have been studied:

- I feel comfortable in school
- I think my studies are joyful
- I feel comfortable with useing a computer
- I think it is joyful to use computers

The code used in MATLAB:

$[p, h, stats] = ranksum(x, y)$

where x is the set of answers from the study group and y is the set of answers from the control group.