

Time Studies as a Tool for (Computer Science) Education Research

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Abstract

Computer Science Education Research is often done in a very local setting and findings are difficult to transfer to other institutions. There are however several factors that speak in favor of expanding the research to an international scale, one is the wide spread of use of English and another is that the components taught are similar. Time is an important factor in studying how students learn and a suggestion is made on how to go forward to create a tool for performing time studies. Important issues concerning obtaining high quality data as well as some aspects of what it means to study are addressed.

1 Introduction

There are several factors that influence the effect of an education setting. Time is often a relevant aspect when studying the quality of the education. A coarse measurement of how much time the students spend on their studies can be a useful way to "take the temperature" of the education setting. What are the students spending time on? Maybe they have problems using the tools required for a course that add many hours to their time sheets. The problem to find a computer to work at is another example. A time study may be used to find these time consumers, and to help the students at the next instance of the course work more productively.

A more fine grain measurement related to lectures, books, web use, laboratory work, etc, can give much more interesting information. The crux is however to get accurate measurements, and also to define what studying really is. This is important in order to generate results that are of general interest.

It is important to identify what we want the students to spend time on, that is, to identify quality activities, in order to make a time study really useful. The measurement of time spent on quality activities, for example tasks that will help the student to learn the course objectives, and the corresponding learning outcome is highly interesting in education research.

A time study should thus be preceded by an analysis of the different aspects of the education setting and selection of the issues to study. A far from unimportant issue is *how* to perform the study, since it is important to get high quality data without impeding on the students study time and still get high quality data. A tool is thus highly desirable.

The remainder of the paper is structured as follow. Section 2 discuss some aspects of what studying, or learning, really is, which in section 3 is followed up with a general discussion of issues in time studies in order to obtain high quality data. A proposal for how to set up a time study and the results of a small pilot test are presented in section 4. Conclusions and a discussion of how to perform time studies at an international scale in order to perform Computer science education research are given in section 5.

2 What is Studying/Learning?

To perform a time study can be almost meaningless if it is done without a thorough investigation of what should be studied. Part of investigating is to define the meaning of studying, or rather how learning takes place. It is vital to know what the students are supposed to learn from a course, study program, lab assignment etc in order to design a time study. This process is close to the heart of (Computer Science) education research. There are several factors that are important in a study/learning situation; three that are subject to discussion and where a time study could be useful are mentioned here.

2.1 Group vs. Solo Study Time

Many Computer Science courses have group assignments; therefore it is interesting to discuss the somewhat fussy borderline between group study and solo study time. It is clear that, for example: when working on a program together (for example in front of a computer), or having a

meeting with the other group members, that this is certainly group study time. Some of the border activities could be if: e-mailing other group members, IRC/ICQ, or for example *working alone on a group project* are solo or group activities. A reason to study this division is the dispute about which form is suitable for learning.

2.2 Socializing

The students' socializing is closely related to the question "What is studying, and what is not". For example in a newly created project group for a course, getting to know each other is necessary for the students to be able to work well together later. How important is socializing for the communication flow in a group?

So, a question here is: Is Socializing non-productive time? It is possible to argue, e.g. socializing between lectures might be a good/efficient way to spend time and part of this time might actually be spent thinking of study related material. A question to try to answer is thus: How should socializing time be monitored in a time study.

2.3 Learning Takes Time?

Study situations might be radically different in how they allow time to pass as learning take place. It is often claimed that a certain time has to pass before a concept or skill has been acquired. Issues here are: Is learning depending on how much time is spent learning? How does the time spent correlate to the grade achieved? Is it always better to spend lots of time studying? Students who pass the exam might have started studying the night before, while others who don't pass the exam might have studied for weeks. These study patterns could be followed up with examining how much they remember in a year, or five, from now. Efficiency is always an issue, and one that could be studied by capturing how and when they spend time on their studies. This has to be done with care, for example: a student who spends a long time doing a lab might not be very well prepared. Maybe he/she didn't read the material or maybe he/she didn't attend the classes. Many students work at night, while they are really tired from a whole day of work and don't get much done since tiredness most likely results in ineffectiveness.

In the article by Carrington [1] he stress that there is little correlation between time spent and the grade given. Still it is useful as a measurement on quality, but it is more useful when combined with the grade. The "...using of quantitative indicators as a measurement of activities has also been criticized. The critics mean that one is risking to focus the attention on easily quantifiable factors..." [4], while the focus rather should be on *quality*, which cannot be measured in numbers. "The quantitative measurements are used in comparisons which will easily be misleading if not understood in the same context and if the originating cause is not analyzed" [4].

3 Issues in Time Studies

Taking consideration to different forms of studying is essential, but there are many other factors that contribute to the value of a time study. Perhaps the most important is to obtain high quality data from the students, a few issues in getting data of high quality is discussed. How to motivate the students to give accurate data is a central issue, others are what data to collect and how to do it.

When conducting a time study information flow is really important, that is the students need to be informed of what will be done with the numbers they hand in. If the students are to be anonymous, it will be important to stress that the connection with name/timesheet is done by other than the teacher, and perhaps how it is done, for example by code names. The fact that hours have no, or little, correlation with grade should also be presented, many hours not equal better grade or the opposite, so hours are not added or deducted. It must also be easy for the students to turn in the time records [1].

3.1 Motivation

The student motivation is highly correlated to the quality of the data. "Data gathering can be time consuming and tedious. To be consistently effective in gathering data, you must *be convinced of its value to you*. If you do not intend to use the data, the odds are you will either not gather them or the data you gather will be incomplete or inaccurate" [5].

Grade

Carrington [1] let the time reports be 5% of the grade. It is both good and bad: good in the way that more turn in them, but bad because they *have* to do it. There is a substantial danger in doing this, since it will lead to that more students will just scratch something down (estimation) just to hand something in.

Another way to use grade as a carrot is to simply include it into the course. If the time monitoring is part of the course curricula, then the students will have another understanding of the importance of the time study. The students who participate do it because they want, and hopefully they will find time monitoring to be useful for their own studies also in the future.

When teaching time studies, the students could be part of inventing their own way of doing a time study. This is close to what is suggested in the method ProMES [11]. As Pritchard says in the section on advantages with ProMES: acceptance: the organizational personnel must accept the system, that is; if the students are involved in the creation of the time log system, they will also accept it more easily.

One could also offer the students a program for self-helping as a part of the student counseling, by giving them information and means to do their own time study. This may be especially useful for the students who don't do so well. This may be combined with tips for studying more efficiently and maybe a discussion group with a supporting function.

Study Habits

To motivate the students, they should: "Remember that the point of gathering time data is to help yourself manage time. If the data you gather prove not to be useful, reconsider the way you gather data." [6]. For example: Are you really working the hours you claim be working? How about interruptions?

Students have some tendency to study for exams at the last minute. Some of this postponing behavior is due to that the students sometimes don't have any deadlines on a course until the exam. In [10] the students who state that they concentrated their study hours to the last third of the class, has significantly less total amount of study hours.

It would be interesting to study the "lasting effect" of the knowledge students who start studying on time compared to students who study at the last minute. Towe Wiiand, at Uppsala University, "has some data which illustrates some students tendency to 'save' their preparations for exams until just before the exam". It is not necessarily true that either group of students remembers more than the other.

To change the postponing behavior one can introduce small examinations every week in addition to the big exam in the end of the course. These small examinations should work as a stimulus to study more continually. However, it is important that the large exam in the end of the course isn't *replaced* by small exams during the semester. In the SOU 1992:1 report "Freedom, Responsibility, Competence - the Constraints for Undergraduate Studies" [4] they are strongly against the division of the courses into smaller subparts. The exams should be on larger concepts, and the exam should be covering 20-40 study credits. Small exams could be used together with larger exams, just as Curt Löfgren is suggesting, and it is not contradicting what is written in the SOU 1992:1.

"Time log data can also be used to understand how often your work is interrupted. Interruptions not only waste time, but they break your train of thought, leading to inefficiency and error." [6].

One cannot work hard for too long without interruptions. But it is important to be able to choose when. The ultimate situation is to be able to work intensively once you have started, and take a break when tired, and then answer e-mails, take some phone calls, talk with fellow-workers, or to have a coffee break.

Time studies may be used to understand how interruptions disturb our workflow. "Some engineers have told me that learning to control the number and duration of interruptions was one of the most important benefits of tracking their time." [6].

To motivate the students, it is important to consider what they get out of such a study. If the data has no value to you there is a great chance that you won't gather the data. Some kind of feedback could be part of what is needed to make the students get involved. A student in the Uppsala 98-study comment on the time study: "one got control over

how much one was studying and one could plan the time much better. For example: this week I have studied 40 hours, therefore I need to study 10 hours more during the weekend to reach 50 hours."

Feedback

Both data quality and student motivation leads forward to the very interesting issue: feedback. Is it possible to motivate the students go give reliable data by giving them adequate feedback?

There are different ways of giving, processing, and responding (and of course receiving - which may be the hardest part...) feedback. A short questionnaire, maybe just one or two questions could give lots of information, which can be used in different ways. It seems as if the longer the questionnaire - the longer and harder it is to give feedback on it.

It would be practical and time saving if the feedback could be automatic. If the students submit something via a program the only feedback of an e-mail saying "thanks for your participation..." would be enough, but more personal feedback may be more inspiring to the students.

In the study at Uppsala University in year 2000 [12] automatic feedback was used. This has also been done at Grand Valley State University. For example progress is shown in bars of time. The students may be instructed to reflect over their own progress compared to the time used.

"Once the data are gathered and are in a database, many automatic analysis tools could assist in estimating, planning, and progress reporting." [5]. There may also be such as a "...process instrument panel that would display your status and progress on this project compared to your plans and prior history on defects, development schedules, and productivity." [5].

3.2 How to collect

Anonymity

One student in Kallin's article express: "Often it is considered bad to be studying. You should have congenital talents and succeed as good as possible with as little effort as possible. Wish it was considered more OK to really study" [8]. If it is considered "bad" to study then there is a risk that the students will tell that they are studying less hours than they really do.

This is alarming when one is trying to do time studies. How will we be able to get reliable results if there is a built-in unwillingness to admit how much one is studying? Does it help with complete anonymity?

It could be a good idea to be able to know who has turned in what data -- to see if there is any correlation between time spent and the grade given, and even more interesting to know on *what* they spend time on.

When the students in the Uppsala 98-study were asked: "How important is it to be anonymous?" Some students

answered that they didn't mind but that others probably did. Many students feel uncomfortable with knowing that somebody would know how much time they use studying. This may be because they think that the number of study hours would indicate how intelligent they are.

"We are embarrassed about our errors and are anxious to improve", "The principal issue is whether the data you gather are for your personal use or for someone else's. If you are gathering data for someone who pay or evaluates your work, you will likely be careful to show good results. If it is for your personal use, however, you can be more objective." [5]. Is it possible to get usable data from students? If anonymity is used there is no chance of individual feedback, knowing who has registered data, who has not, or to be able to send reminders. Will it pay back to have total anonymity, in case of better data?

Time Estimation

Some time studies, e.g. Kallins study at Umeå University [8], Sweden, they ask the students to estimate the time they use for studying. This method is very imprecise, either the students may underestimate the time they spend studying, or they overestimate. It is impossible as an investigator to know which.

Overestimation: if the students are asked afterwards how much they have studied, they tend to overestimate, for example when using diaries, or journals for time estimation. Underestimation: the students brag about their study time; say that they study less than they really do to appear smarter [10]. Why is it this way?

To avoid estimations the students should write down their hours as soon as possible after studying, preferably simultaneously. This can be done by the help of e.g. a Palm Pilot, or a web page [12].

How to Track Time

To avoid estimation of time it is important that it is easy to record the hours for the students in a time study, otherwise it is unlikely that they will record their time at all. "Keep the time data in a convenient place." [6]. It should be possible to record time anytime when studying, for example at the computer, at home, and at the library. This means the time log data should be where? The easier it is to record the time data, the better. The time logs could be done on paper, palm pilot, portable laptop, or a recorded media (for example a recorded interview). There are different advantages and drawbacks with each of these, see [12].

Humphrey says on using a computer for collection of the time log data: "[one] approach is to record the time data on a computer. I have tried this and found that it took more time and was less convenient than making notes on paper. Computing systems should be ideal for this purpose, but suitable application support would be needed." [6].

3.3 What to collect

Time Slots

"When people talk generally about what they do, they often use hours as the measure. This, it turns out, is not very useful. The reason is that you will rarely do anything for a full hour." [6] Instead, Humphrey argues, one should measure every minute studied time. This approach might be overkill. We can agree in that hours are too large time slots, but maybe one could do a rough estimate into half-hours, or 15 minutes slots? In the Uppsala study in 1998, one-hour time slots were used. The students were asked to keep track of the hours in a responsible way: they could round off as they thought was most close to the reality.

Definitions

When doing a time study on students the investigators and the students must have the same view of what should be counted as studying. The students may be encouraged to make this decision themselves, e.g. if they interpret that the coffee break contain "enough" talk about study-related material, they should write it in the time log as study time.

What is study time? What about the time while sitting on the bus home? Thinking of a computer program or math problems? What about all other times when socializing and doing schoolwork is mixed together? What about lunch breaks that are filled with study related discussions? In the book "Ten Thoughts About Time [...]" [7] the 'thinking about it'-time is referred to as "preparatory time", as for example the time when you try to find a computer to work at, a place to sit and read or discuss. These are study time as much as the time for getting a printout for a program or waiting for a program to compile or run. As much as the time waiting in line outside the teacher's office to get help with a problem. All these are forms of studying.

What is the best way of categorizing time? Examples of some categories could be: class-time, lab-time, and reading-time. In the Uppsala 98-study [12] eight different categories were used, but how can we now what is the optimum? Humphrey says that: "Three to five categories should be enough for tracking time for one course" [6]. There is not one answer to how many categories is the optimum. The categories must be reasonable, and interesting. The categories may vary depending on the purpose of the study.

When using categories in a time study the students should be instructed how to use the outcome of their individual data for getting insight into how much time they spend on different things. The insight concept is also by Disney and Johnson [3] in relation to the Personal Software Process (PSP).

4 A Proposed Model for Time Studies

There are several things that may be worth to consider before doing a time study. In this section, a model for how to perform a time study is presented on the basis of the

findings from the M.Sc. thesis “Time Monitoring on Computer Science Students” [12].

A small pilot version of this model for time studies was run during two weeks towards the end of an Advanced Networks course at Uppsala University. The result of this study is discussed in “A First Attempt”, below.

4.1 The Different Steps in a Time Study

The information about the time study should be presented to the students more than once, for example both in a lecture and on paper. Everything they need should be written on the papers handed out to them. It should be clear where to send e-mail or who to ask if they have questions.

There should be clear information about the study, for example how their anonymity is kept, who is going to see what of their answers, the goal of the study, how they should record their time, and how to turn it in, and what is defined as studying in the study, etc.

One should especially stress that many hours is not the same as a good grade, or that fewer hours would give a better, or similar, grade. Emphasize that the study has no real interest in a single student's study effort, but rather how it looks in average. This doesn't mean that the individual student's data doesn't matter, it is of great value both to the investigation and hopefully to themselves, see more under Feedback, below.

The most important out of all of these things are how the information on how the Goal and Feedback are presented. These are very much connected, i.e. if the goal is fussy, there is no way of motivating the students to do the study, and it doesn't really matter how good the feedback is.

Choice of Investigator/Informant. The person presenting the information should be someone who as many of the students as possible have trust in. This person should *not* be a teacher on any of their current courses, or a student counselor who might be associated with study efforts or grades. It is also important for this person to be charismatic and easy to listen to.

It is also vital that this person has an understanding of the subject to be investigated. The investigator should collaborate with the course lecturer so that the time monitoring can reflect the current course instance.

A Clear Goal. The goal is always important when something is to be done. If the goal with the study is to find out if the students are studying too much, or too little, this should be revealed to the students. If the goal is that the students should learn to study more effectively the students must, of course, also be informed of this.

Change of Study Habits. May always be a goal for a time study. The students should be informed how they may use the time study for improving planning and effectiveness in studying.

Voluntary. A time study should always, when possible, be voluntary. The students should know this, and be

encouraged to participate for their own sake, i.e. to stress the use for insight into the studies. If the students may choose to participate or not there is less risk for faked data.

Anonymity. The students should always have the possibility to be anonymous. There is a great risk for faked data and/or loss of participating students if not.

Accessibility. It should be easy to turn in the data. This could be done for example via the Internet. Then it is possible to let them be anonymous by using for example code names. The students should also get paper log prepared in such a way that it is easy to fill in and use whenever wanted. This may be used in combination with the Online-form. They should be encouraged to use this continually to write down what they do.

Feedback. Feedback is primarily meant for motivating the students. If just using paper log, the students can look at these to get a good overview on how much they have studied during a week. If the students fill out a form via the web, it is easy to calculate data from the data entered, and to combine these with earlier data entered by the student or by the other students in the class. Information on how much the student has worked this day compared to other days/another week could be presented.

The teacher could also present numbers in class a couple of times during a course, for example after a deadline. The students could then be encouraged to start to study earlier on an assignment, or get a pat on the back for doing such a good job, and the average numbers for the class may emphasize these arguments.

Other Incitements. There should be another incitement than just the feedback to the students. This could be, for example, a cinema ticket for every five-week period completed.

How to Avoid Estimation of Time. The data should be written down as soon as possible after the student has studied. This should be done to avoid that the student estimate how much he/she has been studying. This will make the data more reliable. This is another reason for why the students should also have a paper log for their hours.

Definition of Study. What studying is should be defined clearly to the students. If the definition is up to the students, they should be informed of this.

4.2 Analysis of the Quality of the Data

When looking at the plain hours in a time study this will not give as much if not combined with interviews with the students. These interviews may reveal *what* the cause for increased/decreased working hours at an instance, and point out problems that may be changed at the next course instance. These interviews may in combination with the time study, and for example a short questionnaire be used as triangulation to see how reliable the data is.

Triangulation

A question that is hard to answer is: How do we know the quality of the data? The methods and instrument for measuring quality are incomplete. One can always criticize the quality entities measured and the results drawn from quality measurements [9]. In time studies the engagement of the students is very important, if the students are unwilling to answer, this will influence the quality of the data.

A time study should be combined with some other measuring instrument to get more reliable results. This is also a way of finding out how good the data is. If all three or, of course more, methods are indicating the same, the more reliable result. "Combining methods allows a sort of 'triangulation' among multiple perspectives, which can achieve a more complete account." [2].

4.3 A First Attempt of the Model

This is an attempt to do a time study by using submission via the web, and giving instantaneous feedback in diagrams. The goal for this study was to see if submitting via the web is a good way of doing time studies, and if it does help the student motivation to see diagrams over their study time. A second goal was to find out more on which parts of the course content the students spent their time and how much overhead the use of new technology introduced. The goal of helping the students to change study habits was not mentioned at all. These students were studying their third year at the university and the chance of motivating them to do the time study to get better study habits was not so great.

To be part of the time study was voluntary. The students had no chance of being anonymous, which most certainly did influence the answer rate. The students were asked to keep their data on paper logs to remember what they had been doing too avoid *estimation* of time. When they submitted the data they got a diagram over their hours, and the class average for that day. All the previous days with the student hours and the class average hours were also listed. The students got nothing else than this feedback for doing the study.

Feedback: The feedback is presented in the form of bars showing how many hours and minutes the student have studied for each day the study has been going on. Beside these bars, there are bars showing the average hours for the class.

The idea with the bars for hours on the home page comes from (Kutsal Berberoglu and Roger Ferguson at Grand Valley State University: their project is using PSP as a model for "instantaneous feedback" to the students). See <http://ferguson.csis.gvsu.edu/PSP/psplogin.asp>

Results: The quality of the data that were entered the students themselves reckon are good, but the answer rate is very low. The students did not see any benefits from participating. These students had also been part of an

extensive study earlier in the period, which might have lowered their motivation.

These comments were submitted on what they thought of submitting via the web compared to paper questionnaire: "Simple", "It's easier this way", "Everything done at one time (I do not have to remember to pick paper up, fill it in, hand it in, which gives me three things to remember instead of one as now).", "You forced me to", and "It's easier for you and for me it doesn't matter".

Improvements: Here are some suggestions on what could be better done in another study: The goal with the study should be clear to the students. All students must know that it is voluntary to participate. The students should have the possibility to be anonymous. The feedback needs to be better. Some kind of incitement is needed to motivate the students. The information to the students about the study need to be better, e.g. the students should be informed that the time should not be estimated, and how to log the hours most conveniently.

If the students are not anonymous, it is more convenient to use e-mail for registering the studied hours than using a home page. If still using a home page one should use fewer and smaller pages, these just take time to load.

5 Conclusions

Time is important in many ways and obtaining information on how students, and teachers, spend their time is a key issue in education research. A general survey over issues in relation to performing time studies has been presented. Positive side effects like helping students better plan their studies have been noted. A model for setting up a time study is proposed and the results of a small pilot run are given. The aim for a tool to do time studies includes preserving anonymity, as well as integrity, and being able to automatically generate feedback directly to the students. A somewhat conflicting aim is to be able to, correlate results with time spent in different activities.

There are many problems that may arise when doing time studies. It is important to consider these problems *before* a time study take place, otherwise the data collected may be useless. The answer rate may be high, and the data may still be of little value if the quality of the data is low. This may be the case when the students get an academic reward for handing in the data, for example bonus points for the exam, or a better grade.

Further development of the model, and especially the tool, in conjunction with a structured discussion of which educational issues to study at an international level would be of high value for the educational research community. In the Computer Science area this is especially true due to factors like the similarities in goal and extensive use of English literature. An easy to use tool together with a scheme to define the meaning of things to measure is vital in such an endeavor. Further development of the prototype tool used in the pilot study should be conducted followed

by studies of different aspects of Computer Science education.

References

- [1] Carrington, D., Time Monitoring for Students. In 1998 Frontiers in Education Conference, IEEE, 1998.
- [2] Daniels, M., Petre, M., & Berglund, A., Building a Rigorous Research Agenda into Changes to Teaching, Proceedings of the 3rd ACM Australasian Computer Science Education Conference, 1998.
- [3] Disney, A., & Johnson, P., Investigating Data Quality Problems in the PSP, Proceedings of the ACM SIGSOFT sixth international symposium on Foundations of software engineering, 1998.
- [4] Government report SOU 1992:1, Frihet, Ansvar, Kompetens - Grundutbildningens villkor i högskolan (Freedom, Responsibility, Competence - the Constraints for Undergraduate Studies), 1992, SOU 1992:1, Betänkande av högskoleutredningen (The Official Committee Report of the Commission of Higher Education), Stockholm, 1992.
- [5] Humphrey, W., Introduction to the Personal Software Process, 1997.
- [6] Humphrey, W. & James W. Over, J., The Personal Software Process (PSP): a Full-Day Tutorial, Proceedings of the 1997 international conference on Software engineering, 1997.
- [7] Jönsson, B., Tio Tankar Om Tid: Ostyckad & Styckad Tid, Ställtid, Tid – Det Enda Du Ha (Ten Thoughts About Time: Undivided & Divided Time, Preparatory Time), Brombergs Förlag, 2000.
- [8] Kallin, L., Studenters åsikter om studiemiljön vid institutionen för datavetenskap (Students opinions on the study environment at the department for Computer Science [at Umeå University]), 1999.
- [9] Löfgren, C. & K-G. Löfgren, K-G, Två uppsatser om kvalitet i den högre utbildningen (Two Essays on Quality in the Higher Education): 'Kvalitetssäkring av forskar- och grundutbildning' and 'Tid att studera kvalitet.', Grundserien i nationalekonomi, 1995.
- [10] Löfgren, C. & Nilsson, P., Frågor om hur studierna bedrivs, Kvalitéer i studier och utbildning, Univ. pedagogiska konferens i Umeå, 1995.
- [11] Pritchard, R., Description of ProMES, MEASURING AND IMPROVING ORGANIZATIONAL PRODUCTIVITY, Department of Psychology, Texas University, 1998.
- [12] Sandström, A., Time Monitoring of Computer Science Students, M.Sc. Thesis, Department of Information Technology, Uppsala University, Uppsala, Sweden, 2000.