UNIVERSITEIT TWENTE.

OPENBARE SCHOLENGEMEENSCHAP Piter Jelles®

THE EFFECT OF THE USE OF EXPECTED TIME-ON-TASK INDICATORS ON THE BEHAVIOUR OF HIGH SCHOOL PHYSICS STUDENTS WITH RESPECT TO HOMEWORK ASSIGNMENTS

Master thesis report

Enschede, September 2014

Harmen K.P. Mulder
s0088501
Master Science Education and Communication
University of Twente

Graduation committee:
Dr. J.T. van der Veen
Dr. Ir. H.J. Pol
Dr. F.G.M. Coenders

Abstract

A lot of students do not make their homework. The hypothesis is that this can be caused by the fact that students do not know how much time is required for making the homework assignments. To answer this hypothesis, the following question was addressed: what is the effect of the use of expected time-on-task indicators (ETI's) on the performance p and time-on-task t_t of students with respect to homework assignments in the context of high school physics classes? This study is meant as an investigation of how to set up a proper research that can answer the question above. For that reason, this report will not answer the question above, but can be seen as a basis for follow-up research, which should be performed on a larger number of students. First experiments were performed and analysed to test the working of the chosen method and materials. Furthermore, a student survey was taken and teachers were asked for their opinion to provide input and recommendations for follow-up research.

A qualitative analysis of the different measurements approaches based on several criteria showed that using computer exercises was the best measurement approach. Furthermore, analysis of different computer programs resulted in using the computer program ProProfs during this study. Two classes, one 4 havo (higher general secondary education) class and one 5 vwo (pre-university education) class, were given homework sessions with these computer program during a period of 8 weeks. Sometimes unrealistically high values of t_t were measured with ProProfs. This might be caused by the fact that students started a homework sessions and continued and finished it later on without closing the program in between. Therefore, the time perception was also measured. If the difference between time perception and t_t was too high, these measurement values could be excluded from the analysis.

The influence of ETI's on t_t an p were measured using two different methods. Because of the analysis time, Method 2, in which students were ascribed to two fixed groups (experimental and control group), was preferred above Method 1, in which the ascription of the students to one of the two groups was done randomly every week, resulting in different students in the two groups every week. However, from experiments with both Method 1 and 2 it was found that only a small amount of students made the homework via the computer. Therefore, it is important to let students also make homework without ETI for multiple times before the experiment, such that it can be used as a reliable reference for t_t. Moreover, the students have to see the homework as a habit and therefore make it. This is very important for follow-up research which should be performed to obtain a larger amount of data, because the data obtained in this research is not enough to draw any conclusions on the effect of ETI's on the p and t_t of students with respect to homework assignments in the context of high school physics classes.

The homework sessions that were made, were not always made very seriously by the students. Therefore, it is important that teachers check the student answers. Homework sessions that were made by for example only filling in question marks, should be excluded from analysis. To prevent that students will do this again, the teacher should talk to the student about this and possibly give the student an alternative and similar homework session.

Furthermore, the given ETI was not always corresponding to the t_t of the students, also because of the large spread in t_t of the students. This arises the question if it would not be good to use ETI's dependent per student. However, ETI's per student would in practice hardly feasible, unless smart software is used for it. On the other hand, the general ETI's can still be used by the student as an estimate, when students perceive that the ETI's of previous homework sessions are not realistic for them. To minimize the error, at least short homework sessions of maximum 30 minutes should be made with an ETI based on teacher experience.

From the student survey, it was concluded that providing the homework via the student email was not the best way, because students were hardly using it. Furthermore, 62% of the students did not notice the ETI in the homework. Therefore, the notification of the ETI should be improved, by for example providing the ETI in the message to the students and not in the homework itself. Consequently, the students can see the ETI before they decide to make the homework or not and therefore can result in bigger differences between the control and experimental group. Alternatively, an ETI in the form of a progress bar can be used to increase that change of students noticing the ETI. The most important result from the student survey was that 79% of the students indicate that having an ETI on their homework is pleasant. Additionally, 34% of the students indicate that they would make the homework sooner if it was provide with an ETI. Therefore, it would be worthwhile to further investigate the effect of the use of ETI's on the behaviour of students with respect to homework assignments in the context of high school physics classes.

Table of Contents

Chapter 1 Introduction

The amount of time spent on an assignment has a proven positive effect on the performance of a student [1]. However, many students do not spend enough time to make all the homework assignments. The hypothesis is that this could be caused by the fact that students do not know how much time is required for making the homework assignments. In other areas this effect has been extensively studied and it has been shown that the use of so-called expected time-on-task indicators (ETI's) can significantly influence people's behaviour in a positive way. One of these areas is for example traffic light control. The use of traffic lights that are equipped with time-to-green indicators show a reduction of the number of people crossing during red signs [2, 3]. A comparable effect is found in waiting cues for helpdesk call enters [4]. To investigate if similar strategies apply to education and student behaviour the following question will be addressed:

What is the effect of the use of expected time-on-task indicators (ETI's) on the performance and time-on-task of students with respect to homework assignments in the context of high school physics classes?

This study is meant as an investigation of how to set up a proper research that can answer the question above. For that reason, this report can be seen as a basis for follow-up research, which should be performed on a larger number of students. Therefore, this research does not directly give an answer on the question if ETI's have an effect on the behaviour of students with respect to homework assignments. First experiments were performed and analysed to test the working of the chosen method and materials. Furthermore, a survey was taken from the students and teachers were asked for their opinion to provide input and recommendations for follow-up research.
First, this report gives a scientific background in Chapter 2, followed by a hypothesis in Chapter 3. Next, Chapter 4 gives a design of this research and Chapter 5 describes how this research was implemented. Subsequently, the results are presented in Chapter 6 and a discussion of the results and a general discussion is given in Chapter 7. Finally, conclusions and recommendations for follow-up research are given in Chapter 8.

Chapter 2 Scientific background

In this chapter a scientific background is given that is relevant in this study. First, the effect of the time spent on a task (time-on-task) on the efficiency of learning is discussed. Second, the perception of time spent on a task is described and third continuing with an overview of research fields that have addressed the use of ETI's. Fourth, the use of ETI's in education is addressed and finally homework in general is discussed.

2.1 Time-on-task

There is a vast amount of literature describing the effect of time-on-task t_t on the efficiency of learning. The t_t is defined as the time that is spend on an exercise or an assignment. One has to distinguish between the t_t and the engaged time (that is the productive time). It was found that in a classroom environment the engaged time is only 50% of the total time [1]. This means that increasing the total time spent in class or on an assignment does not help if not at the same time the engaged time is increased [5]. Since the engaged time is hardly measurable, the t_t will be used as a measurement tool. A total number of 100 studies on the effect of t_t were analysed by Hattie [1]. This meta-analysis and other studies are summarized in an effect size d, which is defined as:

$$d = \frac{\mu_{treatment} - \mu_{control}}{\sigma}, \tag{1}$$

with $\mu_{treatment}$ and $\mu_{control}$ the mean of the effect (e.g. the result of a test) with the treatment and of the control respectively, and σ the pool sample standard deviation. This scale means that if d=0 there is no effect of the treatment on learning, if d<0 there is a negative effect and if d>0 there is a positive effect. The meta-analysis of Hattie, including 100 different studies, shows an effect size of d=0.38 with a standard error of 0.1 [1]. Although the absolute values of the effect size is rather difficult to interpret it can be concluded from these studies that an increased t_t has a positive effect on learning. Based on the study of Hattie, the observed effect size is about average and ranks 70th on a total number of 136 effects. In other fields than education similar results are observed. For example, the t_t is directly related to the performance in music [6].

2.2 Perception of time-on-task

Time perception is a widely studied topic in psychology. There exist basically two theories: the memory and the attention model. According to the memory model, an interval of time filled with mental work or events is judged to be longer than the ones with less work of the same duration [7]. This is why the drive to a new place seems to be longer than the way back. However, if more attention is allocated to processing the on-going task rather than to keep track of time, according to the attention model, the perceived duration shortens. This explains why "time flies when having fun" [8]. The perceived time can be measured from a prospective or a retrospective paradigm. In most studies the prospective paradigm is used, where the object of study is informed before the experiment that they will be asked to make a time estimate after the experiment.

In this study it is important if the perception of t_t can be influenced. A number of studies, especially in the marketing and consumer research, have investigated the influence of waiting time fillers on the perception of the waiting time. Waiting time fillers are frequently used in telephone commercial services. Antonides [4] distinguishes two psychological reactions to waiting: (i) perception of time and (ii) wait evaluation. The perception of waiting time is the time the object thinks he had to wait. This can be shorter, equal or longer then the real waiting time. Therefore waiting time fillers can have both a positive and a negative effect on the perceived waiting time. Wait evaluation describes how the object has experienced the waiting time. Research shows that providing information about the expected waiting time reduced the overall overestimation of perceived time [4]. As a long perceived waiting time has a strong negative effect on the wait evaluation, conversely the wait evaluation is more positive in case information about expected waiting times is provided. Also other fillers like queue information and music were studied. Both queue information and music also decreased the perceived waiting time although to a lesser extent than information about expected waiting times. Although students may

already use music during homework assignments to increase their “wait evaluation”, this aspect will not be addressed in this study.
In the field of traffic behaviour similar results are obtained with respect to pedestrian behaviour in relation to countdown timers for traffic lights. The perception of the waiting time decreased substantially when introducing countdown timers to provide the pedestrian information on the expected waiting time at traffic lights [3].

2.3 The use of expected time-on-task indicators

The use of ETI’s has been extensively studied in the context of modifying pedestrian behaviour at signalised pedestrian crossings. Illegal crossings during the red man sign result yearly in many casualties. The use of countdown timers to influence pedestrian behaviour has been shown to significantly decrease the number of illegal crossings [3]. In this case the countdown timer shows an indication of the time the pedestrian needs to wait before the green man appears. This study has led to an increasing number of installed countdown timers. In a more recent study similar behaviour was observed [2]. The use of ETI’s has also been studied with respect to telephone waiting times. Here studies are more focussed on the perception of the time and not on the behaviour of customers. One could envision that customers are more tended to wait for a helpdesk employee if ETI’s are applied compared to a control without the use of ETI’s. However, to the best of my knowledge this effect has not been studied.

2.4 Expected time-on-task indicators in the context of teaching

To the best of my knowledge the effect of ETI’s in an educational setting has not been studied.

2.5 Homework

In this research the effect of ETI’s on t_t was tested with respect to homework assignments in the context of high school physics classes. Hattie [1] also did a meta-analysis on the relation between homework and achievement. Based on data from Cooper [9-11], DeBaz [12] and Paschal [13], an average effect size of 0.29 with a standard error of 0.027 was found. Again, this absolute value of the effect size is rather difficult to interpret, but it can be concluded that also homework has a positive effect on the achievement of students. This observed effect ranks 88th on a total number of 136 effects. Recently, Kohn [14] doubts if homework had a positive effect on achievement or performance of students. Kohn also states that research on homework report conflicting results and that most homework studies show only an association and not a causal relationship. Regarding Jongsma [15] “there is no good evidence that homework produces better academic achievement”. This means that still a debate is on-going on the effect of homework on achievement of students. However, the goal of this research is not to determine the effect of homework on achievement. Therefore, this will not be discussed in detail, but the focus will be on the question if there is an effect of the use of expected time-on-task indicators (ETI’s) on the performance and time-on-task of students. This will be tested on homework assignments in the context of high school physics classes, which means that homework in this case is a means to an end. In this research the homework can be seen as a task on which students can spend time.

Chapter 3 Hypothesis

Before designing the research plan, first the anticipated effect the ETI's will have on the behaviour of the student is hypothesized. To illustrate the different effects that ETI's can have on students, four different type of students (category I-IV) are considered. These students are classified in terms of concentration, performance and motivation as is shown in Table 3.1. Only four types are chosen, because they already cover a broad range on t_t and p as shown in figure 3.1 and illustrate the different effects ETI's can have on students.

Table 3.1: *Overview of a number of different type of students*

Type	Concentration	Performance	Motivation
I	+	+	+
II	-	+	+
III	-	-	+/-
IV	-	-	-

I. Students that need little time to make the assignments correct and have a large motivation.

II. Students that have a normal motivation but need more time to make the assignments because they are easily distracted. (they are not efficient)

III. Students that have a reasonable motivation but are easily distracted and have difficulties to answer the questions.

IV. Students that have a low intrinsic motivation to make the assignments. They will spent none to almost no time and score bad on the number of correctly made assignments.

With respect to these four types of students different responses on the use of ETI's are expected. Here, the effects of ETI's on the t_t (measured as the difference between the time the assignment is finished and the time the assignment is started) and the performance p (how well the assignment or the final test was made) are considered. The parameter t_t can be measured easily. However, it should be noted here that it is assumed that the students will use all of the measured time on making the assignment, since it is hardly measurable if students are working on the homework assignment or not. If it is assumed that a change in the t_t is related to a change in p (if a student spends more time on his or her homework he or she will get better scores) a performance measurement can be used to address the effect of ETI's on t_t. Figure 3.1 visualizes a possible effect of ETI's differentiated to the four types of students as defined in Table 3.1. Considering the t_t, it is noticed that both an increase (for students that are not highly motivated to make the assignment) and a decrease (for students that are easily distracted) may be expected. Although, it is expected that the overall score on the assignments and final test scores will show a positive effect, the size of the effect can strongly depend on the type of student. It is essential to not only consider the t_t as a measurement, but in addition take the result of the assignment into account. In this way it can be seen if students make their homework seriously and therefore gain a better insight in the overall effect of the use of ETI's.

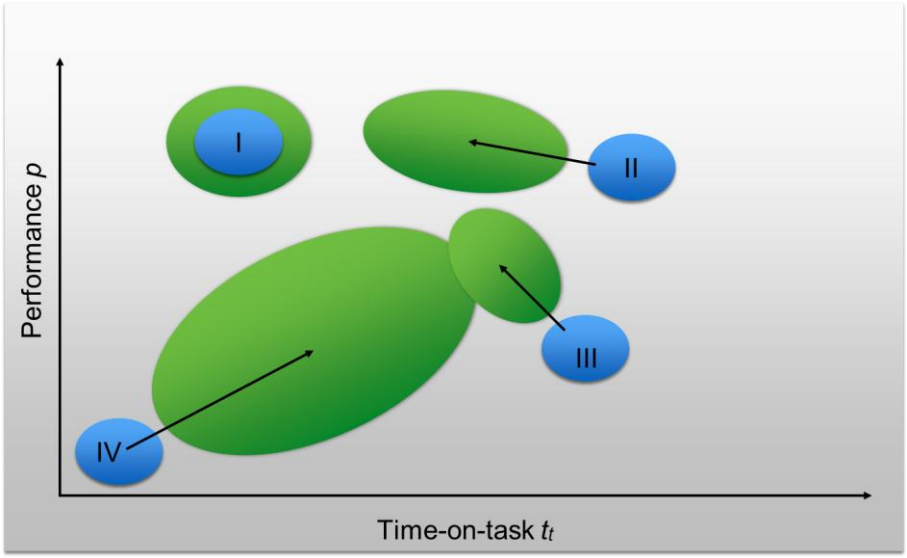

***Fig: 3.1**: Schematic representation of possible scenarios of the effect of applying expected time-on-task indicators on the performance p and time-on-task t_t of students (green) compared to a control (blue). Four categories of students are indicated, namely (I) bright students that need a limited amount of time to obtain high scores; (II) students that need more time but have good scores; (III) students who usually spent enough time, but have with a relatively low score; (IV) students that do not spent any time on the exercises.*

Next, the expectations on the perception of time with respect to the use of ETI's are considered. According to the attention model of time perception, time is experienced as short if one is so much occupied with a task that no attention is paid to time (there is no reference of time during the task). For example if a student is really enjoying his homework (s)he "forgets" time. In this case the use of ETI's may make him or her more aware of time and it can be expected that therefore his or her perception of time will increase, which in this case is a possibly unwanted effect. On the other hand, students that are easily distracted during assignments (they look at their watch, they play with their mobile phone etc.) are continuously aware of time and will have the perception that the assignment took a lot of time. The use of ETI's for these students will lower the reference to time and it can be expected that this has a positive effect on the perception of time.

Chapter 4 Design

In this research three parameters are interesting to measure, namely, t_t, p and the time perception. These parameters can be measured in different ways, for example by video analysis, observation by people, via the computer or by self-evaluation. A qualitative analysis is done to see which approach is the most suitable with respect to several criteria, for example if the experiment can be done at home or in the classroom and how accurate and reliable the results will be. Table 4.1 shows the result of this qualitative analysis. The different measurement approaches are evaluated on different criteria and are marked on a 5 point scale, going from '- -' (very bad) to '++' (very good). Based on this detailed analysis it was decided to use computer exercises, because they can provide very accurate and detailed data (t_t per exercise), which can be analysed relatively fast. Furthermore, the exercises can be done in the classroom and at home and it has a low influence on the experiment and impact on teaching. Additionally, measuring the p will be very reliable. The measured t_t on exercises made at home is less reliable (because it is possible that students log in for an exercise and then get distracted by other things and continue with the exercise and finish it on a later time point), indicating the importance of measuring also the p per exercise. The accuracy of determining the correctness of the exercises by the computer works well for multiple choice questions. When choosing for open answer questions it is important that the teacher determines if the questions is answered correctly or not. Alternatively, students can be given open questions with number-answers which can be evaluated with software, if needed with a certain bandwidth and parameter directed, where students get similar exercises with different numbers. Measuring the time perception is not included in Table 4.1, because self-evaluation is the only possible way to measure this. The time perception can be asked as an open question after the homework assignments with the computer.

Table 4.1: Qualitative analysis of different measurement approaches

	Measurement approaches	**Criteria**								
		in the classroom	***at home***	***accuracy***	***data analysis***		***influence on experiment***	***reliability***	***impact on teaching***	***Implemen-tation***
					amount of work	*amount of detail*				
Time-on-task	*Video*	+	-	- (only total time-on-task)	- -	+/-	+/-	+	-	+/-
	observation by (external) people	+	-	- - (only total time-on-task)	-	-	+	+/-	+/-	+/-
	computer exercises (logbook)	+	+	++	++	++	+	-	+/-	-
	self-evaluation	+	+	+/-	+/-	+	-	- -	+/-	+
	Lifescribe pen [16]	+	-	++	-	++	-	+	-	-
Completed exercises (total, correct and wrong)	*computer exercises (logbook)*	+	+	+/- (works only for multiple choice)	+/- (depends on type of question	+/-	+	+	+/-	-
	evaluation teacher (manual hand-in of homework)	+	+	++	+/-	++	+	+	+/-	+
	self-evaluation	+	+	+	+	+/-	+/-	+/-	+/-	+
	Lifescribe pen	+	-	++	-	++	-	+	-	-

When using computer exercises, it is a requirement to use an already available computer program, because writing a new computer program would be too time-consuming. Therefore, an analysis was done on the already available computer programs (quiz makers, student response systems) which can be used for this research. The computer programs should be accessible for teacher and students at school and at home and preferably web-based, such that students are able to log out before all the exercises are finished and log in on a later time point. Moreover, the program should provide the t_t (preferably per exercise) and the p (results of the exercises) of the students. Furthermore, it should be possible for the teacher to upload or create (different kind of) exercises in the program. Various computer programs were found and judged on these criteria. Results are shown in Table 4.2. It was decided to use the ProProfs computer program based on the fact that all requirements were met and the many options of this computer program.

Table 4.2: Qualitative analysis of different computer programs

Computer program	**Criteria**						
	accessible for teacher and student	*at home*	*school*	*provides the necessary data*	*possibility to log in/out during test*	*Options*	*costs*
Polleverywhere [17]						open ended, clickable image, multiple choice	€47,94 per month (250 responses per poll)
Socrative [18]				does not provide time-on-task		short answer, multiple choice	Free
SMART [19]				does not provide time-on-task		Design assessments using six question types – true or false, yes or no, multiple choice, multiple answer, numeric and text response, insert classroom, connection with SMART board, import from Word/Excel	€73.03 per year
ProProfs [20]						multiple choice, checkboxes, true-false, fill in the blanks, essay, matching, write text, video, upload document	€29.48 - €51.61 per month (=yearly =50% discount)

Chapter 5 Implementation

5.1 Realisation

The experiment was performed on two different classes, one 4 havo (higher general secondary education) class with 16 students and one 5 vwo (pre-university education) class of 18 students.
The 5 vwo class on which this research was performed was taught by Harmen Mulder (HM) under supervision of Dennis van der Woude (DW). HM also evaluated the homework assignments. Preceding to the homework assignments, the students were stated the importance of making the homework assignments because of the small amount of lessons during the period the students were taught. Stating the importance of making homework was repeated every week, but there were no consequences of not making the homework assignments.
The 4 havo class was taught by Cok van Zuilen (CZ) and by HM. HM also evaluated the homework assignments. Again, prior to the homework assignments, the students were stated the importance of making the homework assignments because of the small amount of lessons in the period the students were taught. In the beginning, the students were not obliged to make the homework assignments in such a way that there were no consequences of not making the homework assignments. After four weeks, when observing that students were not making homework and hoping it will change the behaviour of the students with respect to making homework, the whole 4 havo class was stated (by sending an email, see Appendix C) that the students that did not make the homework do have to stay behind the week after. Another four weeks later, when observing students were again not making a lot of their homework, all the students were told that they could gain bonus points for their end test. By making all the exercises (in a serious way) from the fifth week on, students could score a “pass” (1 bonus point). By making all the homework exercises from the beginning the students could score a “good”, resulting in two bonus points for the end test. For the measured p of the end test, the score without these bonus points was used.
The homework was send to the students by sending them a link via their school email (see Appendix D for an example). By clicking on the link the students were forwarded to a website with the homework assignments. Two versions of each homework session were made. One of the versions was provided without an ETI and one of the versions with an ETI in the opening screen where students should log in with their name and email address. An example of a version with ETI is presented in Appendix E.

5.2 Measuring time-on-task and performance

Using the computer program ProProfs, assignments were made which students had to make at home. For the first homework assignment in week 15, none of the students got an ETI, to get indication of level of the student and how much time students will take for their homework. From the second week on, students were given either homework with ETI or homework without ETI. The students were randomly ascribed to a group with ETI or to a group without ETI. The ascription was done using two different methods. In week 16-20 Method 1 was used, meaning that the ascription to one of the groups was done weekly, which resulted in different students in the two groups every week. In this period the students were given 6 homework sessions. The total time measured by the computer program ProProfs was used as a measure for t_t. The answers to the homework questions were used as a measure for p. In week 21-24 Method 2 was used, which means the students were ascribed to two fixed groups, an experimental group with ETI and a control group without ETI. To evaluate p with respect to t_t, a figure like proposed in the hypothesis will be presented. To assign the students to a student type, like presented in Table 3.1, t_t, was measured for one homework session without ETI and was used as an initial measure for t_t. Furthermore, the results of previous end tests of students were used as a initial measure for p. After receiving five different homework sessions, where half of the students (randomly chosen) received the homework with ETI’s and half of the students without ETI’s, the t_t and p were measured again to evaluate the influence of ETI’s in homework. The t_t was again measured as the total time measured the computer program ProProfs and the average t_t of the five homework sessions is used the measure for t_t. The results of the end test were used as a final measure for p.

5.3 Measuring the perception of time

In the last three weeks (5 homework sessions) perception of time of the students was measured by asking the students how long they thought that they were working on their homework. This was asked to the students after they finished their homework which means that the perceived time will be measured from a retrospective paradigm. Furthermore, students were asked by using a multiple choice question if the exercises where a) too long, b) reasonable or c) too short.

5.4 Indication of expected time-on-task

There are different ways to indicate the expected t_t, for example by indicating the expected t_t prior to the homework exercises. This is a precise way of letting the students know how much time they will need to make the assignments. Nevertheless, it is also susceptible to errors, because every student needs a different t_t on their exercises. To minimize this error relatively short homework exercises (on average approximately 30 min) are used. Using time indication it is important to consider if the time indication should be done realistic, too long or too short. This might give different results on the experiment. If the time indication is too short, the students will start the exercise more likely. However, if they see that they passed the indicated time, it is more likely that they stop their exercises before they are completely finished. Moreover, for the next assignment, the ETI might not be taken seriously by the students, losing the effect of using an ETI. On the other hand, when the time indication is too long, students may not even start with the exercises. For this research it was decided to not test these effects, but to use a realistic time indication. Exercises were made by HM and compared to exercises made by the students during the lessons to estimate a realistic ETI for the students. At the end of this research the ETI were compared with the real t_t and it was evaluated if the ETI was realistic.
Alternatively, also a progress bar can be used, which is less susceptible to errors. For the use of a progress bar, one can assume the t_t per exercise as a fraction of the total t_t of the exercises. For example, if the first exercise is 10% of the t_t, then with the start of the second exercise the progress bar is progressed 10%. However, a progress bar gives only an indication of time during and not prior to the homework exercises. Therefore this way of indicating time was not used.

5.5 Materials

For this research the computer program ProProfs is used. The program allows to upload files and to create exercises online. Two versions of tests (one with ETI and one without ETI) were made. ETI's were added prior to the exercise as an extra text line (see Appendix E). The program saves the results of the assignments, which can be used as p, as well as the total time, which can be used as a measure of t_t, assuming that students use all the measured time to work on homework assignments. One assignment is made on one page with made it possible to measure the t_t per exercise with this program as well. This also allows the students to log out after finishing one exercise and log in later on.

5.6 Evaluation of homework with computer and use of ETI's

First, to improve the homework and to find out why students made their homework or not, students were questioned by HM and via a survey. Students were asked if and why they made homework or not, what could be improved on the given homework, what kind of questions (open questions or multiple choice questions) they prefer and what they think is useful, if they find it useful if they are given ETI's for their homework and if they would make homework sooner when an ETI was provided with their homework. The student survey is presented in Appendix A. Results are presented in Chapter 6.7.
Second, the teachers and supervisors of HM were also asked on their opinions which are presented in this section. CZ and DW were asked to their opinion on this research, possible improvements and if they think that this research should be continued. The opinions are presented in Chapter 6.8.
Third, also own experiences of HM with ProProfs are written down. These experiences are also presented in Chapter 6.8.

Chapter 6 Results and analysis

6.1 Finished homework

As mentioned before, the measurements were performed in two classes, namely a 4 havo class and a 5 vwo class. An overview of the number of students that finished their homework sessions per week for the vwo 5 class and the havo 4 class is given in Fig. 6.1 and Fig. 6.2 respectively. Only when a homework session is finished, data is received by the computer program ProProfs and analysed.

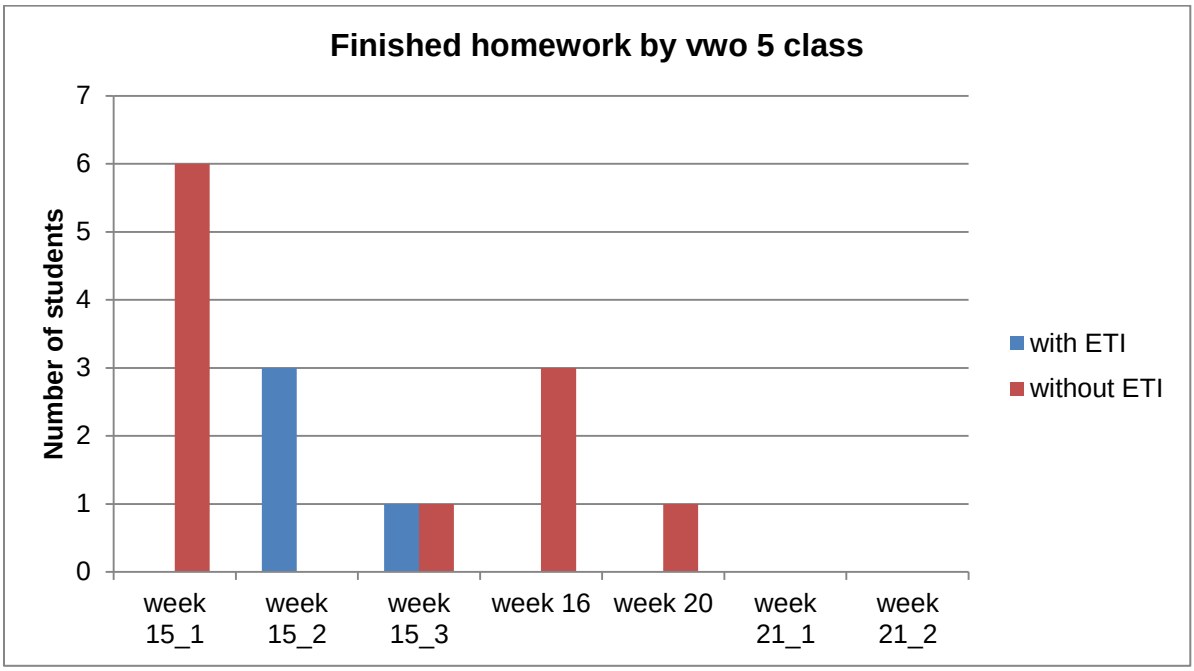

Fig. 6.1: The number of students of vwo 5 class per week that finished their homework for students who received homework with ETI (blue) and without ETI (red).

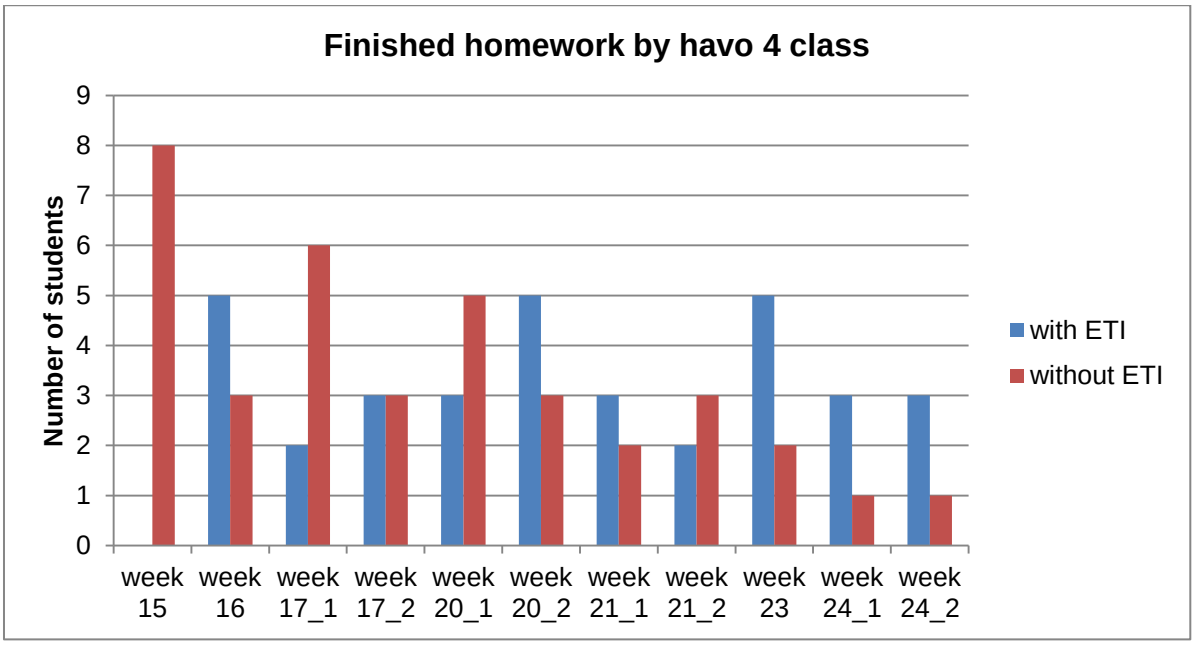

Fig. 6.2: The number of students of havo 4 class per week that finished their homework for students who received homework with ETI (blue) and without ETI (red).

From Fig. 6.1 it can be noticed that homework in the vwo class was hardly made. Therefore, it was decided to only analyse the results of the havo 4 class in detail. Some of the measured data, like the survey which was made to evaluate the used format with homework via the computer and the use of ETI's in homework, will be analysed for both classes.

6.2 Measuring time-on-task with ProProfs

With the computer program ProProfs the start time, end time and time per exercise were measured. From the analysis it was found that the average effective time (sum of the measured times per exercise) was not always equal to the average total time (end time minus start time) as shown in Fig. 6.3.

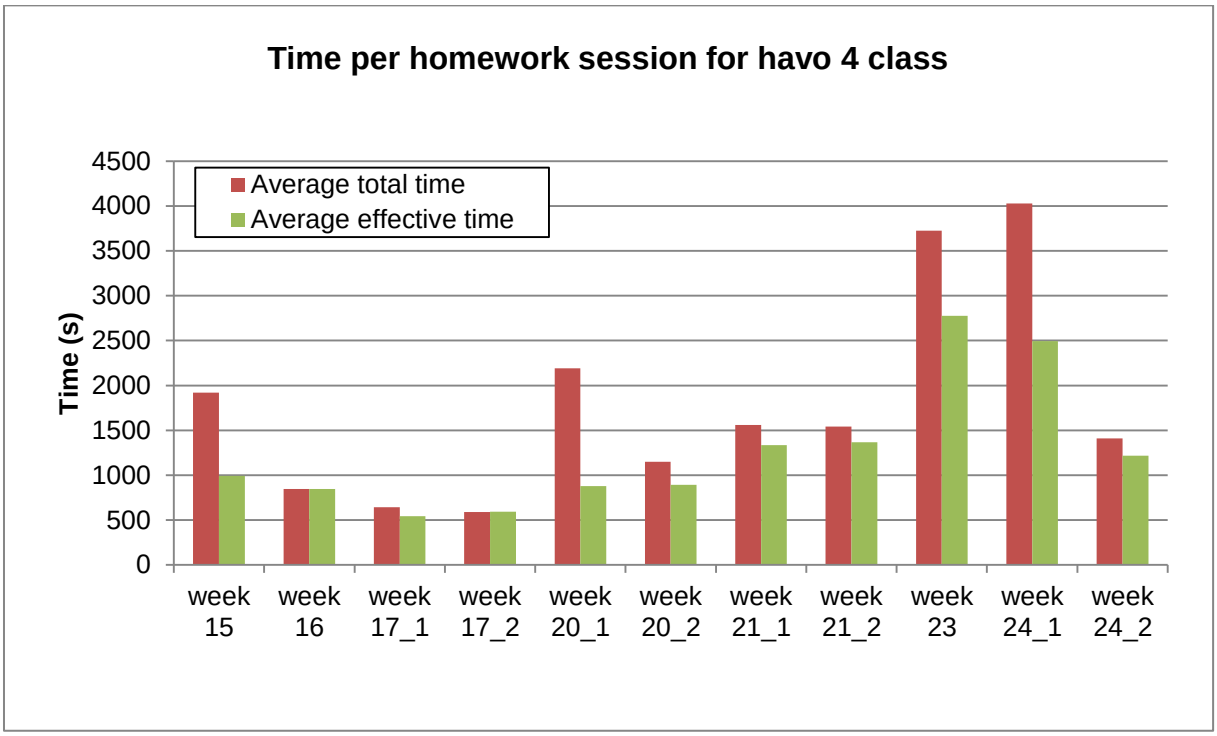

Fig. 6.3: The average taken time (end time minus start time) and average effective taken time (sum of the measured times per exercise) per homework session.

To find out what was causing this difference, a few homework sessions were made while measuring the time per exercise and total time of all exercises offline with a digital stopwatch. A few homework sessions were made with making use of the options of saving, stopping and resuming, and going back and forward between questions. Next to that, also a test was made without using any of the previously named options. Results are presented in Table 6.1. From the results it can be concluded when saving, stopping and resuming or switching between questions, the measured time per question by the program ProProfs is incorrect. So the effective time, which is the sum of the times per question, should not be used as a measure for the t_t. On the other hand, while still not completely correct, the total time measured by ProProfs, which is the end time minus the start time, is very close (< 15s) to the measured time with the offline digital stopwatch. Therefore, the total time measured by ProProfs was used as a measure for t_t.

Table 6.1: Verification of measured time with ProProfs

Test	Question	Action	Offline measured time (min:sec)	Measured time ProProfs (min:sec)
1	1	-	3:55	3:56
	2	before stopping	1:02	0:01
		resuming in same window	1:01	
	3	before stopping	1:02	0:47
		resuming after closing window	0:47	
	4	1st time on this question	1:09	0:01
		after going back to this question	0:40	
	5	before going back to previous question	0:57	0:41
		after going back to this question	0:37 + 0:54 (first no answer was filled in and program was still waiting for answer)	
	6	before stopping	0:42	0:00
		after resuming on different computer	1:02	
	total	-	13:48 (if including waiting time at question 5 to go to next question)	14:01
2	1	-	0:59	1:00
	2	before stopping	0:53	0:01
		resuming in same window	1:26 (1:05 after stopping)	
	3	before stopping	1:23	0:58
		resuming after closing window	1:00 (0:48 after stopping)	
	4	1st time on this question	1:11	0:01
		after going back to this question	0:57	
	5	before going back to previous question	0:39	0:56
		after going back to this question	1:36	
	6	before stopping	1:20	0:00
		after resuming on different computer	1:52 (2:15 after stopping)	
	total	-	13:16	13:25
3	1	-	1:12	1:13
	2	before stopping	0:40	0:45
		resuming after closing window	0:45 (2 ½ days after stopping)	
	3	-	1:00	1:00
	4	-	0:44	0:45
	5	-	0:29	0:29
	6	-	0:35	0:36
	total	-	5:25	5:31
4	1	-	0:57	0:55
	2	-	0:58	0:59
	3	-	1:34	1:35
	4	-	1:36	1:37
	5	-	1:43	1:43
	6	-	0:25	0:25
	total	-	7:16	7:15

6.3 Time perception in relation to time-on-task

Results of time perception versus real t_t are shown in Fig. 6.4. Each attempt in the graph is one homework session finished by one student. For the attempts 1-8, which are attempts without ETI, 63% of the students think they worked longer on their homework than they really did, 25% of the students thinks that he/she spend less time on homework than they really did and one student (13%) did not answer the question. From the students who received homework with ETI (attempt 9-27) 50% of the students thinks that he/she spend more time on homework than they really did, 39% of the students thinks that he/she spend less time on homework than they really did and two students (11%) did not answer the question. However, for the attempts with ETI, three measured values for the time taken are much higher than the time perception. This is possibly caused by the fact that the student stopped working on the homework and later continued working on it, without saving and quitting the program in between. Excluding these three attempts, 60% of the students thinks that he/she spend more time on homework than they really did, 27% of the students thinks that he/she spend less time on homework than they really did and two students (13%) did not answer the question. This illustrates that excluding

the three values, gives completely different percentages. From the measured data excluding the three unrealistically high measured values, on average the difference between time perception and time taken is 485 seconds for students who received homework with ETI and 374 seconds for students who received homework without ETI. However, the attempts presented in Fig. 6.4 are coming from two different students who received homework without ETI and five different students who received homework with ETI. Moreover, the standard deviations of the measured differences between time perception and time taken are 488 seconds and 367 seconds for students who received homework with and without ETI respectively. Consequently, the individual students and attempts are strongly influencing the data, which means that more data should be obtained to draw conclusions from this data.

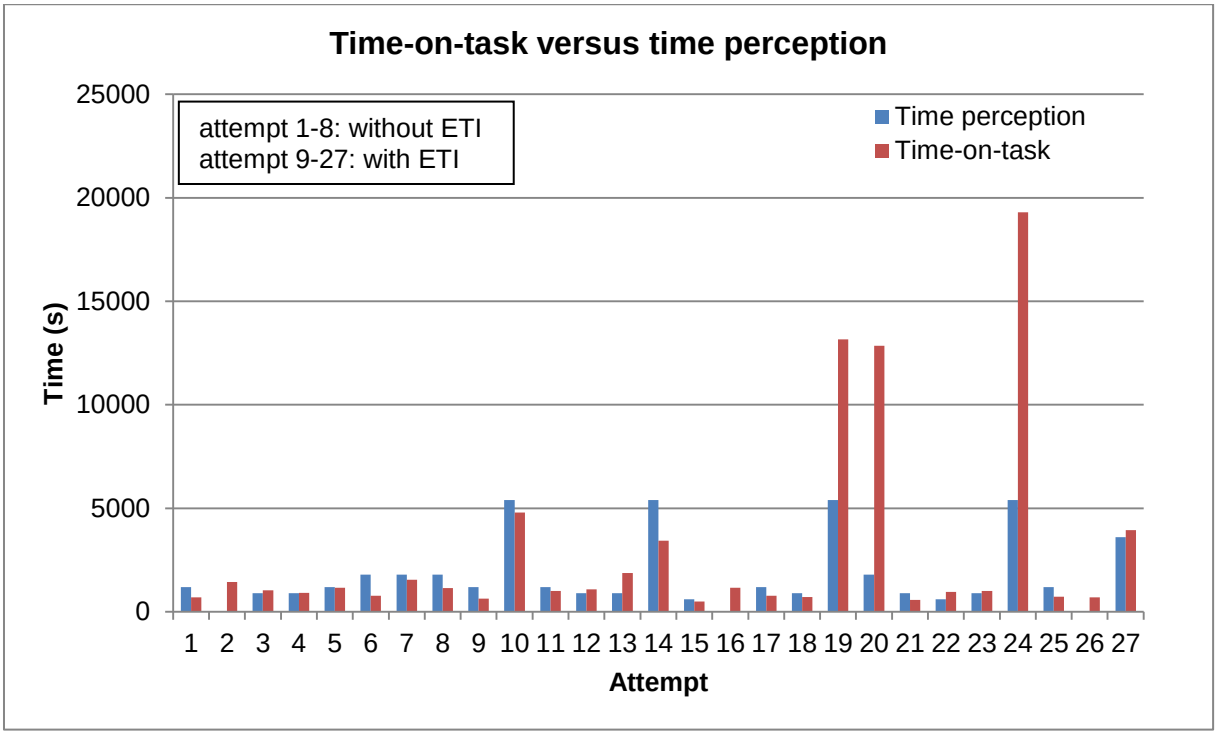

Fig. 6.4: Time-on-task (blue) and time perception (red) per attempt from different students without ETI (attempt 1-9) and with ETI (attempt 10-27).

To the multiple choice question what students found of the homework, 100% answered the question with reasonable and 0% with too long or too short. This means that if students make their homework, they found the length of the homework, which varied in ETI from 15 till 30 min, reasonable.

6.4 Homework with and without ETI: differences in time-on-task and percentage made

The percentage of students that make their homework was determined per week and is shown in Fig. 6.5 for both the students who received homework with and without ETI. From Fig. 6.5 it can be seen that per week the percentage of students that finished their homework varies from week to week. There is no indication that students make homework sooner with or without ETI. Fig. 6.6 shows the number of students that finished their homework. The measured total time with ProProfs is used as a measure for t_t and is plotted in Fig. 6.7 for the students who received homework with ETI and without ETI. The error bars are the sample standard deviations of the measured t_t. A couple of very high values for t_t were measured, causing the high values for the standard deviation.

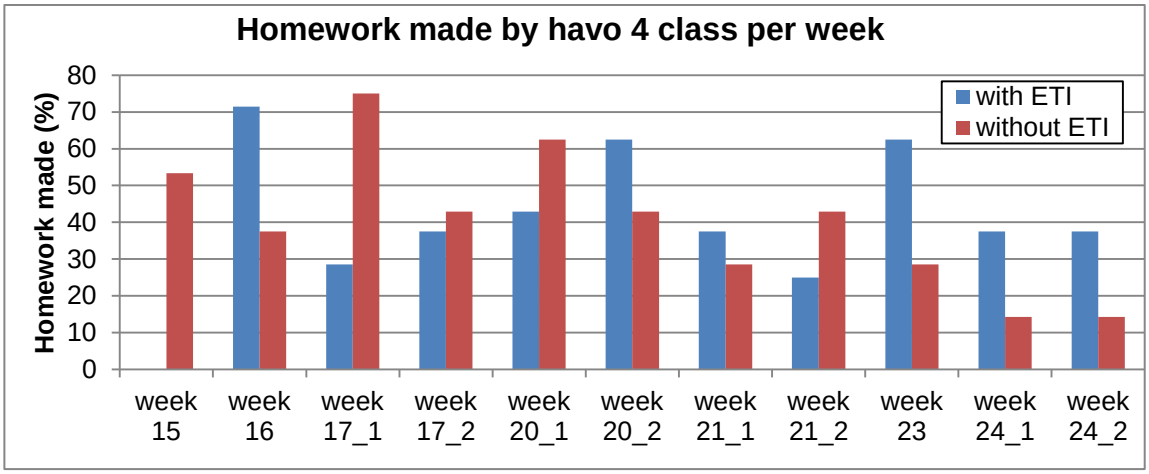

Fig. 6.5: Homework made by havo 4 class per week for students who received homework with ETI (blue) and students who received homework without ETI (red).

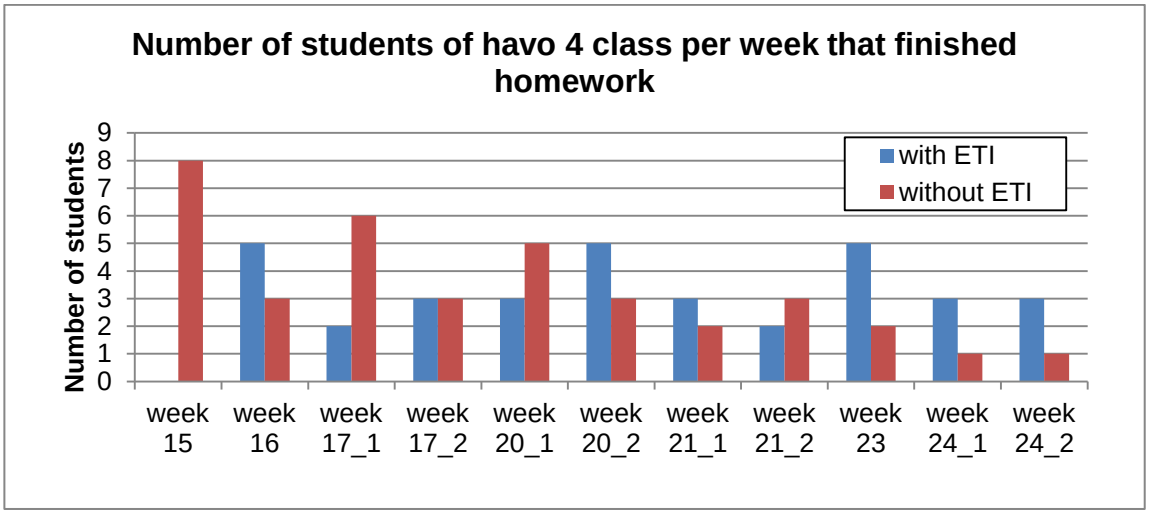

Fig. 6.6: Number of students of havo 4 class per week that finished their homework for the group of students that received homework with ETI (blue) and the group of students that received homework without ETI (red).

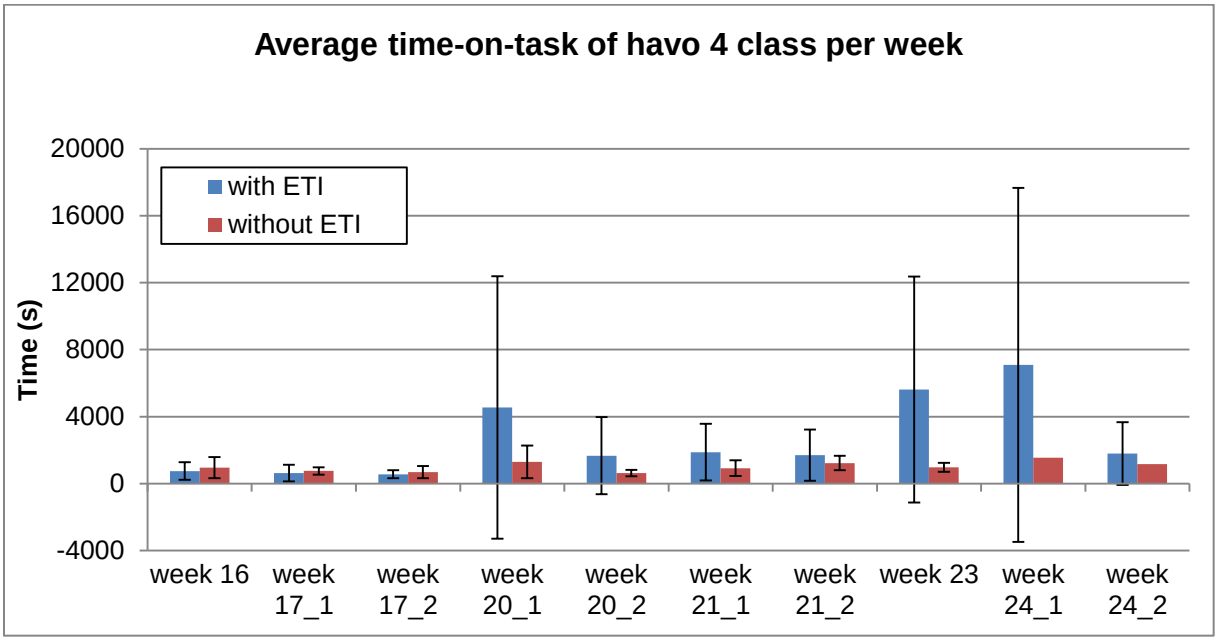

Fig. 6.7: Average time-on-task for havo 4 class per week for the group of students with ETI on their homework (blue) and the group of students without ETI on their homework (red).

6.5 Time-on-task in relation to performance

The time-on-task in relation to performance was measured using two different methods. The results of this analysis are presented separately under the headings Method 1 and Method 2.

Method 1

In the first four weeks the students were randomly appointed to either the group who got homework with ETI or the group who got homework without ETI. An overview of how many homework sessions the students received with and without ETI is given in Fig. 6.8, where the names listed on the x-axis are fictive names.

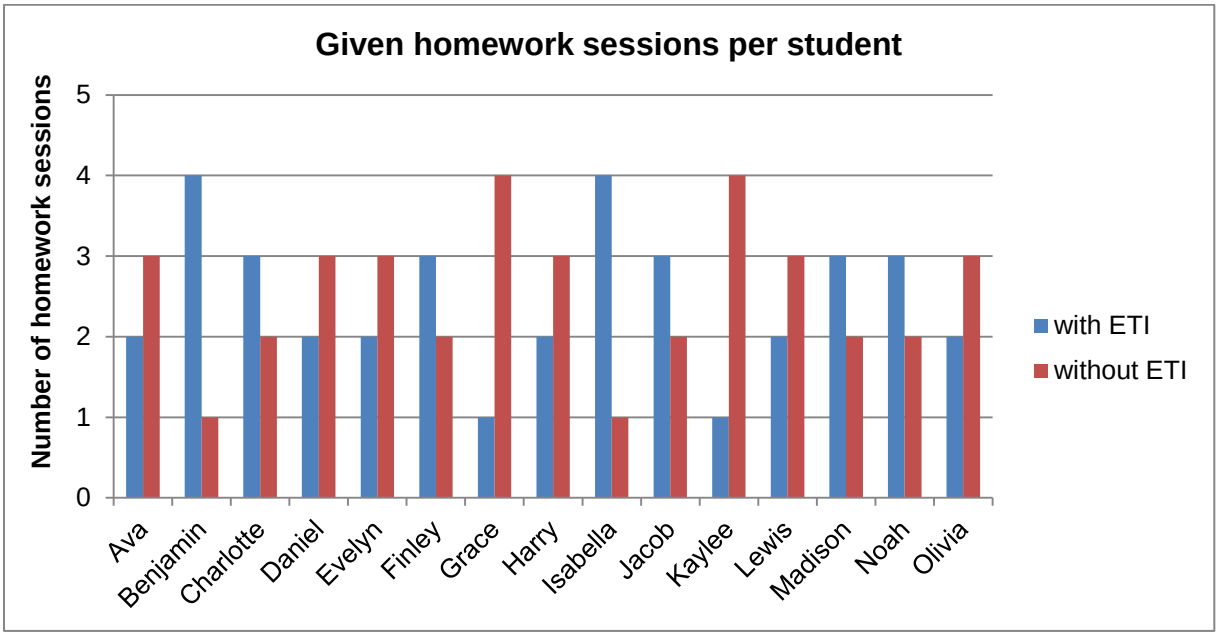

Fig. 6.8: The number of given homework sessions with ETI (blue) and without ETI (red) per student of the havo 4 class.

The homework that was made per student is shown in Fig. 6.9. From the results in can be seen that three students did not make homework at all. Furthermore, the percentage of the homework made is sometimes higher for students who received homework with ETI than for students who received homework without ETI, but sometimes it is also the other way around.
Besides, the average t_t of the finished homework sessions per student is shown in Fig. 6.10. The large peak on t_t for one of the students is again observed, but this might be due to the fact that the student was not making homework during the measured time, because the indicated time perception given by the student was much lower. Next to that, the students sometimes spend more time on homework with ETI and sometimes more time without ETI. The relatively high error bars, which represent the standard deviation of all the measured values of t_t of the finished homework sessions per student, indicate that the spread of t_t within the homework sessions with ETI and within the homework sessions without ETI is also relatively high. Some of the bars in graph 6.10 do not have an error bar, because these bars represent single values.

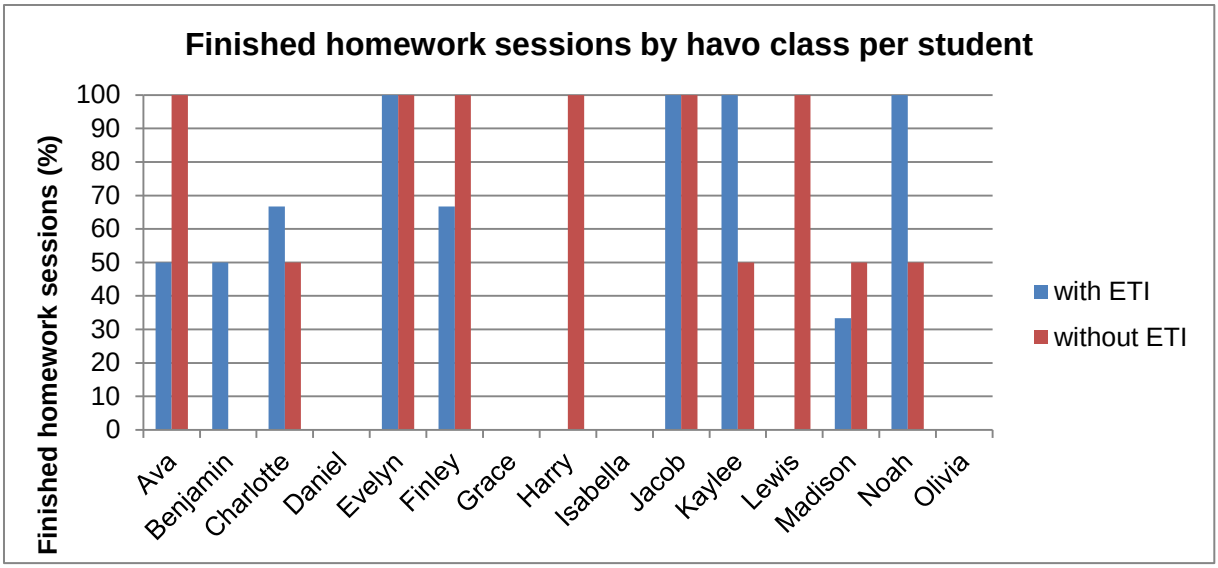

Fig. 6.9: The percentage of finished homework sessions with ETI (blue) and without ETI (red) per student of the havo 4 class.

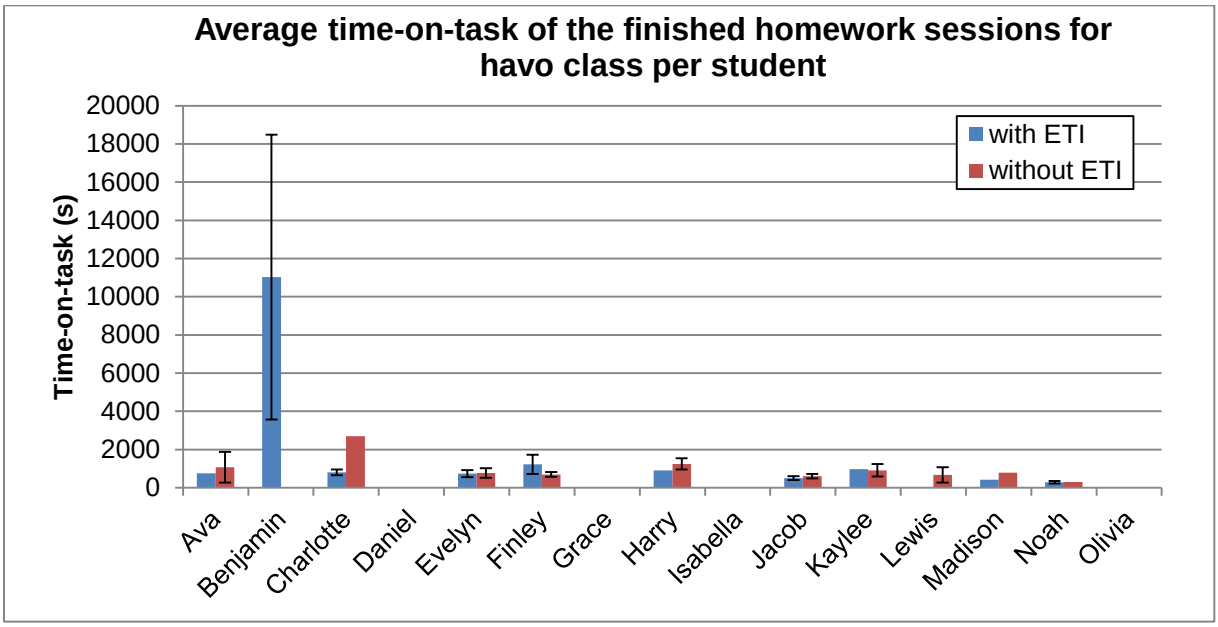

Fig. 6.10: The average t_t of the finished homework sessions with ETI (blue) and without ETI (red) per student of the havo 4 class.

Five homework sessions were finished by a number of students, resulting in total 54 finished homework sessions, consisting of each approximately 10 questions. To examine each individual question on *p* is too time-consuming. For that reason, it was decided to not do a very detailed analysis on the *p*, the results of the homework questions. However, when looking more globally at the homework of the students it can be seen that often students take no longer than 25 minutes and mostly in between 5 and 15 minutes per homework session, if they make the homework at all. Looking at the results of the homework, it was noticed that students don't spend a lot of time on the questions, by for example looking up the answer in the book. If they don't know the answer, the students just give often a wrong answer or fill in something like a question mark or a hyphen before they continue to the next question.

Method 2

Fig. 6.11a and Fig. 6.11b show the finished homework for students with ETI and without ETI respectively, using method 2 in which students were ascribed to two fixed groups (experimental group with ETI and control without ETI). From the group of students with ETI, 3 of the 8 students did not finish any homework at all, 3 of the 8 students finished all the homework sessions, 1 of the 8 students finished 40% and 1 of the 8 students finished 20% of the homework. The numbers are a bit higher compared to students who did not receive an ETI, where only 1 of the 7 students finished all the homework, 4 of the 7 students did not make homework at all, 1 of the 7 students finished 20% and 1 of the 7 students finished 60% of the homework.

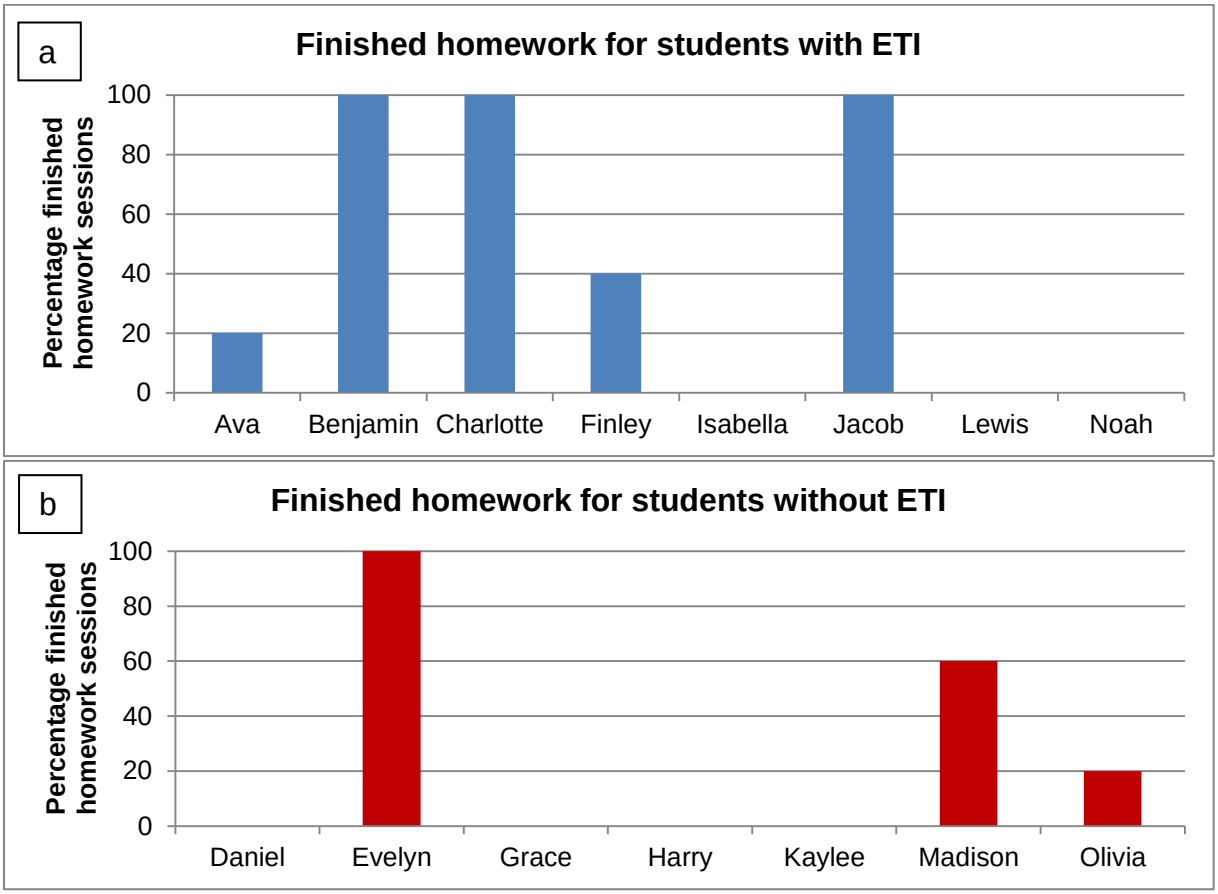

Fig. 6.11: Percentage of finished homework sessions for students **a)** with ETI and **b)** without ETI.

Also the t_t of the finished homework sessions, as presented in Fig. 6.12, shows a higher average t_t for homework with ETI compared to homework without ETI. However, as also was mentioned before, this is mainly caused by the fact that for two of the students unrealistically high t_t were measured, which is also illustrated by the high error bars representing the standard deviation.

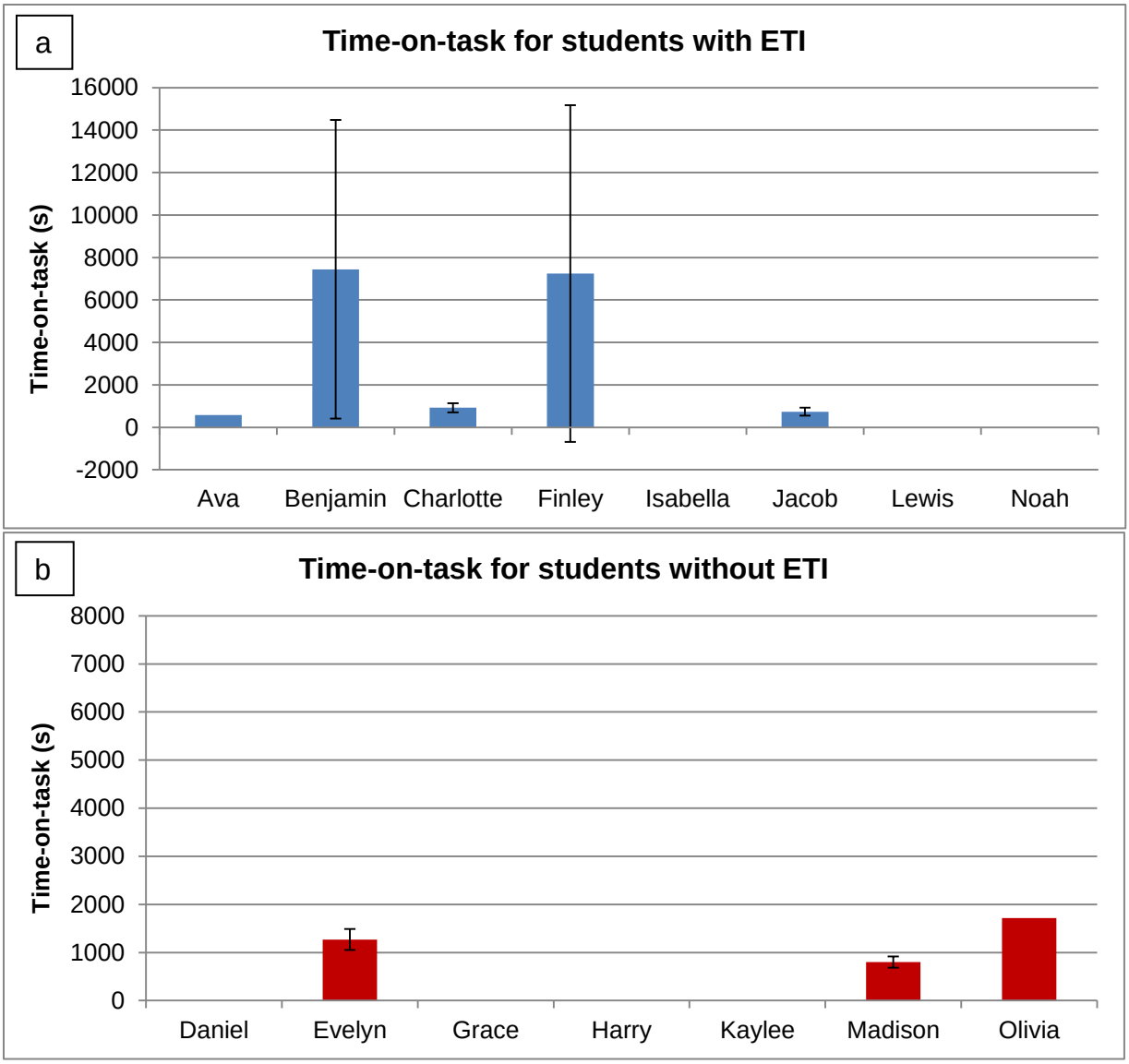

Fig. 6.12: Average time-on-task of the finished homework sessions for students **a)** with ETI and **b)** without ETI.

The measured t_t is also compared to the performance p as was proposed in the hypothesis. Fig. 6.13a shows the development of p and t_t for students who received homework with ETI and Fig. 6.13b shows the development of p and t_t for students who received homework without ETI. Each blue dot in the graph represents a student before he or she received homework. The red squares represent the students after they received homework. The green arrows shows which blue dot corresponds to which red square and illustrate the development in t_t and p. The vertical error bars represent the standard deviations in the results of the end tests. The horizontal error bars represent the standard deviations of the t_t of the five homework sessions which were given to the students.

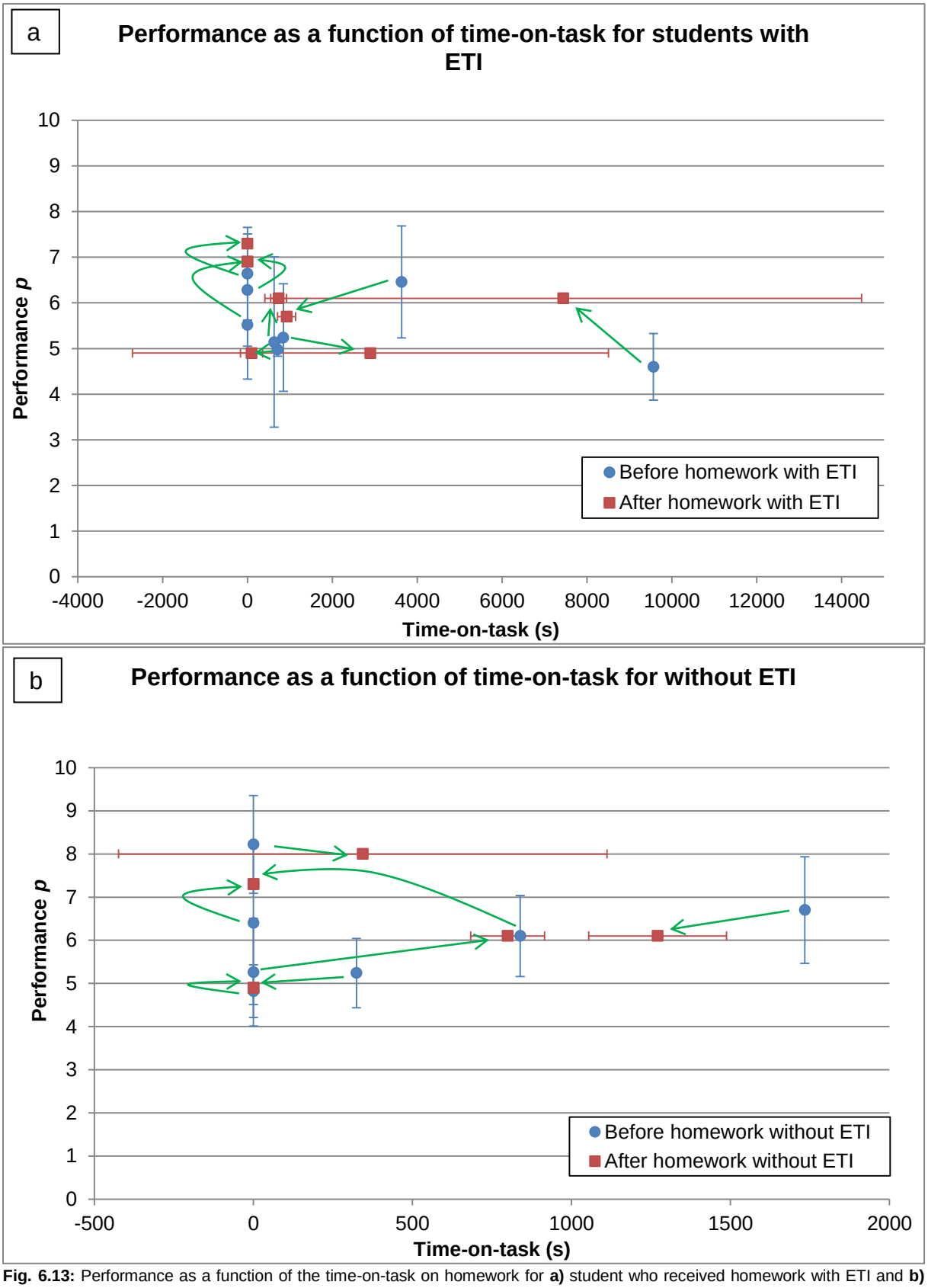

Fig. 6.13: Performance as a function of the time-on-task on homework for **a)** student who received homework with ETI and **b)** student who received homework without ETI. Every dot represents a student who received homework and the green arrows indicate which blue dots (before receiving homework) belong to which red squares (after receiving homework).

6.6 Measures taken during experiment

Two measures were taken during the experiment. Firstly, in week 20 students were sent an email of the measures of staying behind when not making homework (see Appendix C). Secondly, in week 23, the students were told they could earn bonus points by making their homework. These measures were taken to let students make their homework. Before taking the measures, hardly any homework was made by the students and hardly any data was obtained. Fig. 6.14 shows the number of finished homework sessions by havo 4 class per week, illustrating when the homework was made. From Fig. 6.14 it can be seen that the measures of staying behind when not making homework resulted in a peak of the number of finished homework sessions. Next to that, it is clearly visible that students finish more homework just before the end test, which might be related to the fact that students could earn bonus points for their end test when their homework was finished before end test.

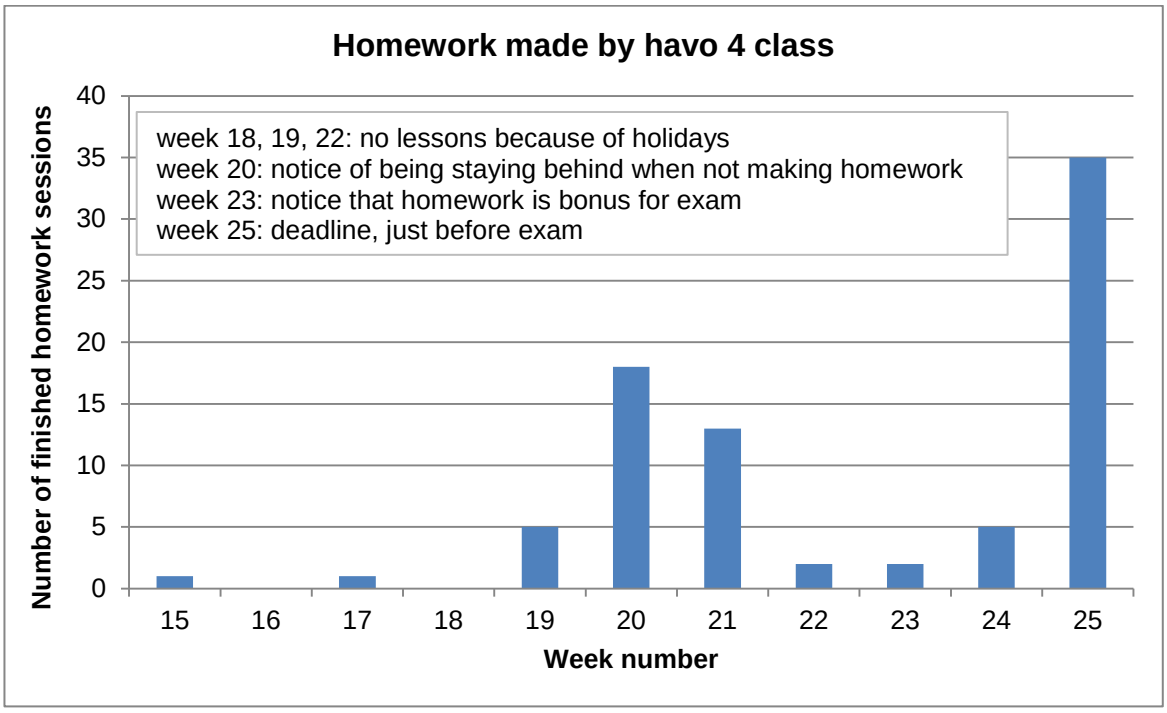

Fig. 6.14: Number of finished homework sessions by havo 4 class per week.

6.7 Results on student survey

The results of the student survey are given in this section. The survey was taken in the havo 4 class and the vwo 5 class. Results from both classes were analysed together, but also presented separately within the histograms in which the results are presented. In the first question of the survey students were asked if they noticed the ETI in the survey. Of the students that received an ETI, the majority (62%) did not notice the ETI, which is shown in Fig. 6.15.

On the question if students think an ETI on the homework will be pleasant, 79% of the students responded positively, which is shown in Fig. 6.16. Most of these students gave as a reason that they could make a better planning and a few students said that this would give an indication if they could finish the end test in time. Arguments against an ETI on homework were that time in which students make homework is different for everyone, the time indication is usually wrong and it will take more time, it is demotivating if it is too long (>15 min) and one student indicated that he will make the homework later on if it is provided with ETI.

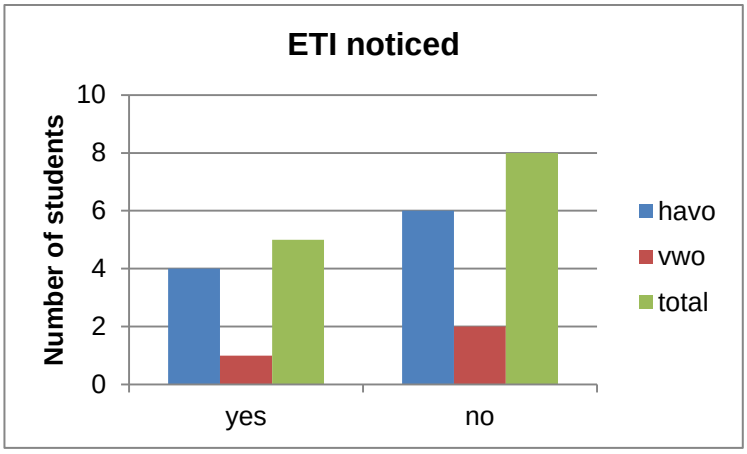

Fig. 6.15: Histogram of the number of students that received an ETI and did or did not notice the ETI for both students of the havo 4 class and the vwo 5 class.

Despite the majority of students reacted positively on question if they find ETI pleasant, only 34% of the students said that they would make the homework sooner, 59% will not make in sooner and 7% answers the question with “maybe”, as shown in Fig. 6.17. Reasons that are given against making it sooner are that the duration and size of homework will not change, the time the student takes is normally longer than the ETI, it discourages if ETI is too long, an ETI does not matter, students indicate that they are just lazy and will not make homework, and a student thought that he could make the homework on a later time point based on the ETI. Arguments that are given for making it sooner are that is easier to make planning, students know better how much time they can spend and exercises can be made easier between other activities. One student that did answer the question with “maybe”, indicated that it depends on the time of the ETI if he will make it.

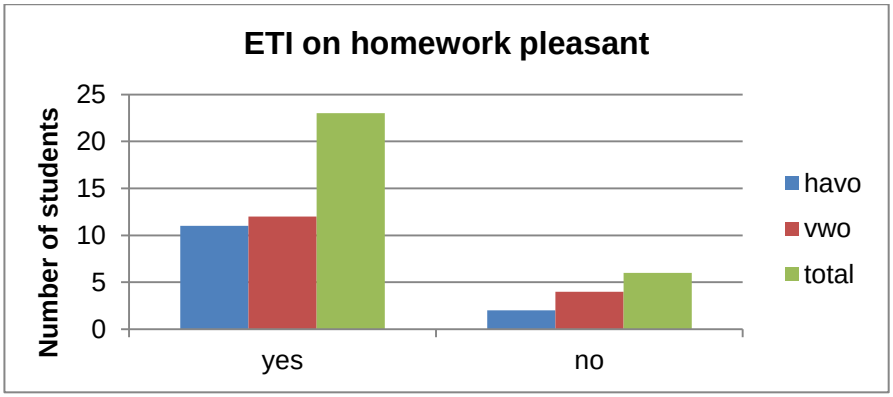

Fig. 6.16: Histogram of the number of students that find an ETI pleasant or not for both students of the havo 4 class and the vwo 5 class.

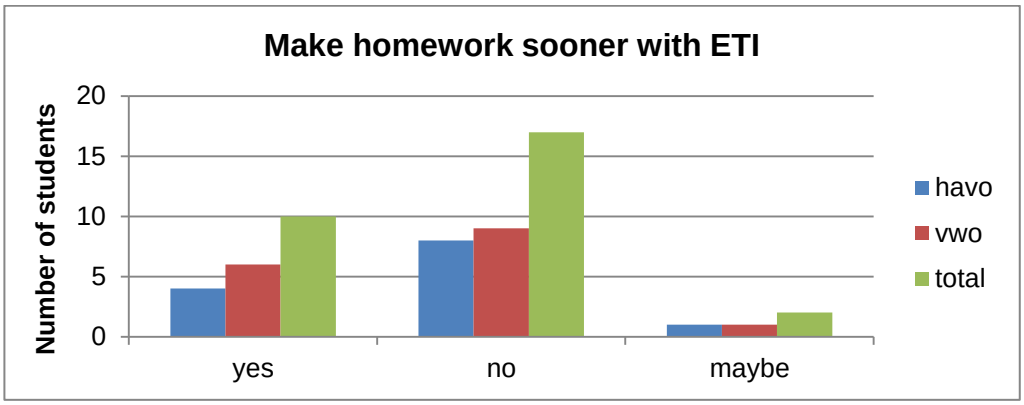

Fig. 6.17: Histogram of number of students of havo 4 class and vwo 5 class that answered to the question if they would make homework sooner with ETI.

Students were also asked what kind of homework they prefer. First they were asked if they prefer open questions or multiple choice questions. Most of students (65%) prefer multiple choice questions above open questions. However this big difference is mainly caused by the havo students of which 80% prefer multiple choice questions. Of the vwo students it is only 50% of the students who prefer multiple choice questions. Results are shown in Fig. 6.18. On the question what type of questions they find more useful, 77% of the students answer with open questions, 16% answer multiple choice questions and 6% answer that they do not have a preference, which is illustrated in Fig. 6.19.

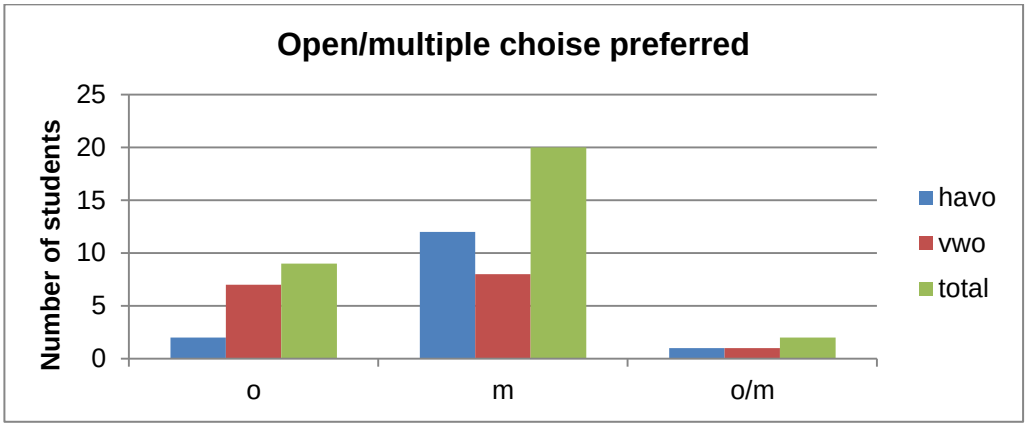

Fig. 6.18: Histogram of the number of students that prefer open questions (o), multiple choice question (m) or for which is no preference (o/m).

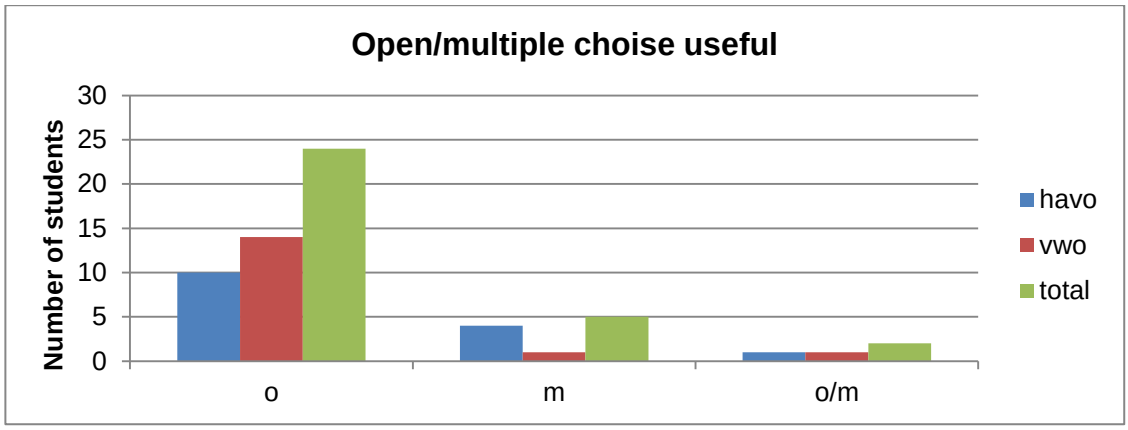

Fig. 6.19: Histogram of the number of students that think open questions (o), multiple choice questions (m) or both (o/m) are more useful.

Next, the students were asked if they prefer homework on paper and with a book or homework with the computer. The results are shown in Fig. 6.20. For both the havo students (67%) and vwo students (75%) the majority prefers homework on paper and with a book above homework via the computer. Additionally, some of the students answer the question on how homework can be improved by saying that homework should not be given as computer exercises.
Furthermore, the students were asked how much time they spend on their homework for physics on the computer and in total. The outcome of these questions is presented in Fig. 6.21 and Fig. 6.22 respectively. These histograms show that especially the vwo students spend only a small percentage of their time on the homework assignments. On average vwo students said that they took 55 minutes per week homework for physics classes and on average 14 minutes per week on homework exercises on the computer. For the havo class, students said that on average they spend 25 minutes on homework for physics, of which 17 minutes on computer homework. This means that most of homework time is spend on the computer homework. One should take into account that the havo students were given measures in the form of staying behind and scoring bonus points for their end test, which are influencing these results.

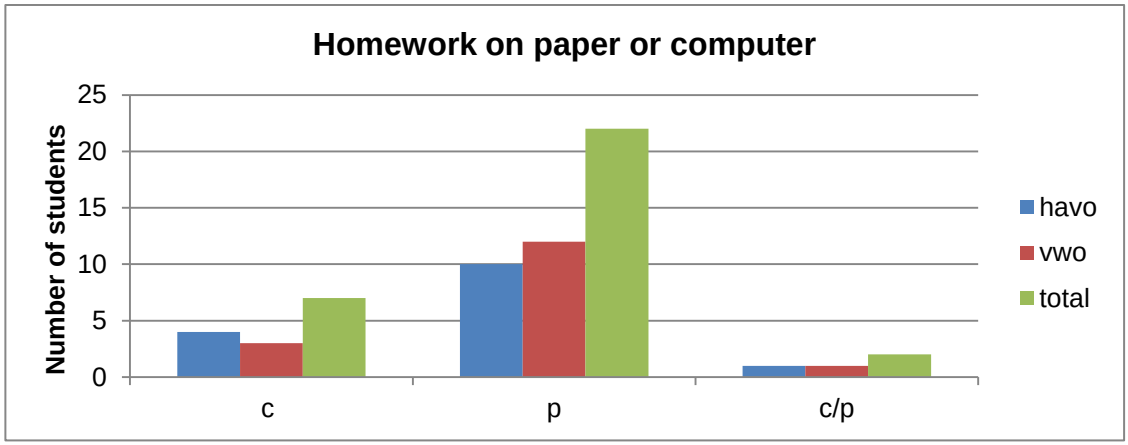

Fig. 6.20: Histogram of the number of students that prefer homework on paper and with book (p) or homework on computer (c) or students that do not have a preference (c/p).

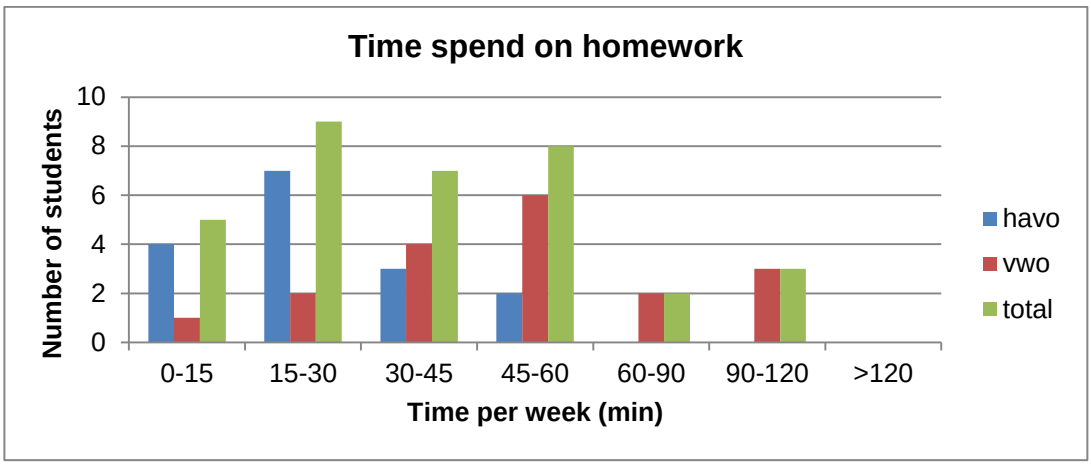

Fig. 6.21: Histogram of answers on question how long students spend per week on their homework for physics.

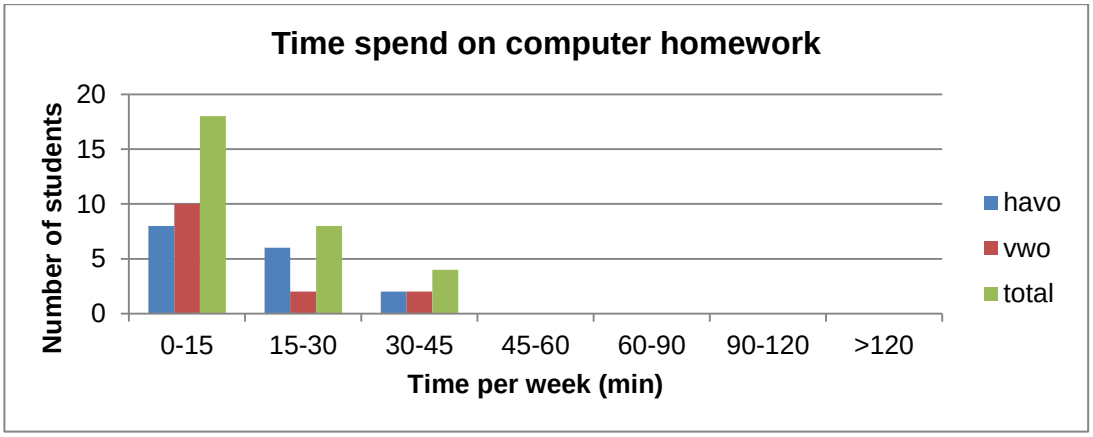

Fig. 6.22: Histogram of answers on question how long students spend per week on their computer homework for physics.

In addition, students were asked if they found the homework too short, reasonable or too long. The outcome of this question is presented in Fig. 6.23, which show that 88% of all the students found that the homework was reasonable, 0% found it too short and 12% found it too long. Of the question how long homework for physics should take per week, the results are shown in Fig. 6.24. The answers of the students are widely spread and vary from 0 minutes to a few hours per week. The average of the answers of 12 vwo students is 88 minutes per week and the average of the 12 havo students is 55 minutes per week.

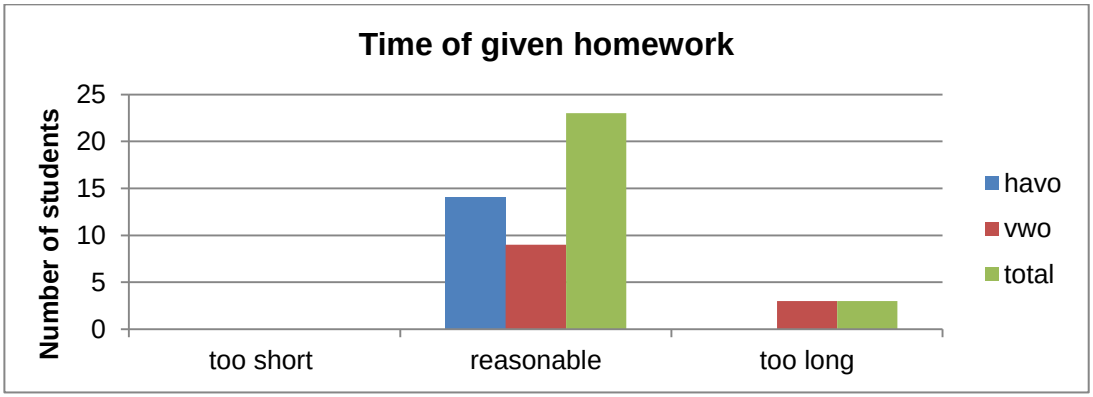

Fig. 6.23: Histogram of answers on question if students found the homework too short, reasonable or too long.

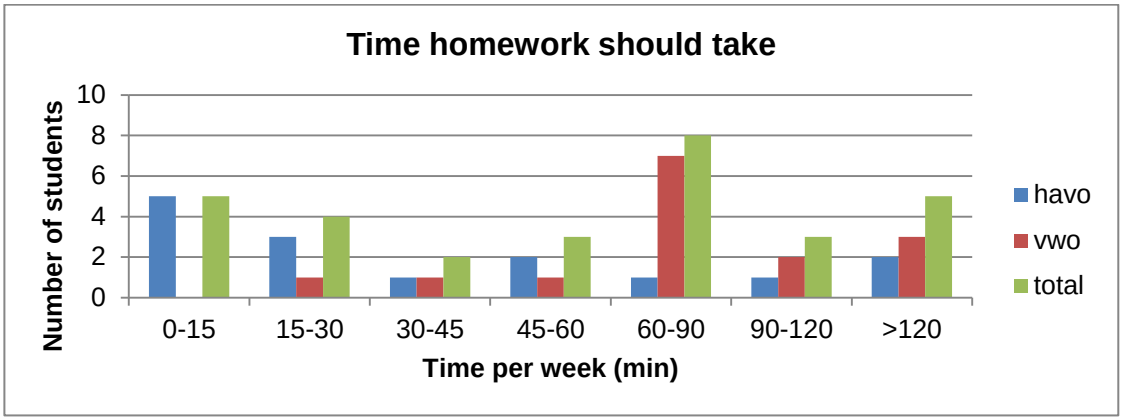

Fig. 6.24: Histogram of answers on question how long homework for physics should take.

The students were also asked in an open question what they think about the homework via the computer program ProProfs, how it was provided to them and what they think can be improved. The most valuable answers for improvement of possible continuing research are presented in this section. Multiple students indicate that they don't like the homework via the computer. Next to that, a lot of students indicate that the school email is not often used and therefore they don't read it. Furthermore, it was mentioned that answers could not be saved to look back and discuss during the lesson. Additionally, some students say that it would be an improvement if homework is directly related to a page number in the book or to a subject from the lesson. Moreover, students indicate that homework should not be too long and preferably in one session, or at least send once and not in separate emails. It was also mentioned that the computer homework is more suitable for arguing questions than for questions with calculations.

6.8 Opinions and experiences

Teachers

The opinion of DW and CZ are given in this section. DW notices that the questions that are mostly asked are small questions without too much calculations. Regarding DW the homework questions are a good addition to the larger exam-like questions with much more calculations, because they are missing in this homework. This is not a problem and possibly even desirable as these questions are meant as warming up questions. Furthermore, the direct feedback after the homework is fine and necessary and it gives a nice overview of the questions, answers and solutions, which makes it easy

to check the given answers. However, DW notices that if he makes the homework by filling in only '1', he still gets the reward of the answers to the questions. Therefore, it is important that also the teacher is checking the answers. A student that doesn't make the homework seriously, should be given notice for this and possibly get another set of homework questions. Hence, the teacher should be checking the homework and should show the students that he knows that students made their homework or not. Especially at the beginning of a school year or at the beginning of such a project the teacher should pay attention to this. Regarding DW the teachers check is necessary for this research to give it any chance of success, unless the expectation is there that students will make the homework earlier with time indication also without checking. Furthermore, DW thinks that it would be an improvement to start the research at the beginning of a school year. Consequently, this method will then be part of the normal procedure to the best of the students' knowledge. Thereby, DW finds the time indication very valuable. In combination with measuring the time and the given answers, a lot of useful information can be gained. On the other side, DW realizes that analyzing all the answers of the students is very time-consuming. Therefore, multiple choice questions would be a good alternative. Then it would also be possible to pay attention to the misconceptions in the next lesson after the homework was given. In general, DW's impression is that much information can be gained by continuing this research.
Regarding CZ no strong conclusions can be drawn from this research. Just not enough data can be obtained in relatively short research like this. For follow-up research he proposes to add a third and fourth group next to the control group and experimental group in which homework is strictly checked every lesson and where measures of staying behind are applied. Also bonus points can be added to the homework, but this is not the intention of this research. To let students more likely make their homework, the research should be performed in the beginning of the year. In this way, students can make a calculation and know what they need to move up to the next class. The students calculate in the risk of not making the homework and its consequences.

Reflections on using ProProfs

In principal the computer program ProProfs can be well used for this research. However, there are a few remarks, which will be mentioned in this section. First of all, it takes quite some time to make the homework assignments. Questions and answers to the question should be imported. When having the questions and answers in digital form, they can be copied and pasted into the program. However, the layout should be checked, especially the calculations, mathematical operators, Greek symbols and the text with sub- and superscript. When not having the questions/answers in digital form, they should be typed into the program. Additionally, when importing the answers/feedback, it is important to select the option of required question and to activate the option media, by clicking on the '+'-sign in front of the text 'media'. The options are illustrated in Fig. 6.25. When not activating the button, the answer will be presented as plain text, without structure. When activating the media button, it is possible to give more structure to the answers, like for example using bullet points and place text on different lines. However, it is still not possible to create subscript or superscript and Greek symbols inside the program. This type of text should be imported by copy-paste actions from another computer program like Microsoft Word. For this research, the questions were typed into the program and the answers and subscript or superscript and Greek symbols in the questions had to be copied and pasted into the program. It can easily take three to five minutes to create one question plus answer. If homework should be made for many different groups for which different homework is needed, it can become very time-consuming to make all the homework sessions. When one homework session (called "quiz" in ProProfs) is finalized, it can be copied and the copy can be adapted by inserting for example a line with the ETI. Therefore, the time to create two quizzes for the experimental group and the control group is not much longer compared to creating one quiz. An alternative option to import questions is to insert a complete image of the question and a separate image of the answer into the program. However, when using this option separate files for all questions and answers are required. Alternatively, also publishers can provide this kind of material as an add-on to their book or material can be made and shared by teacher development teams.

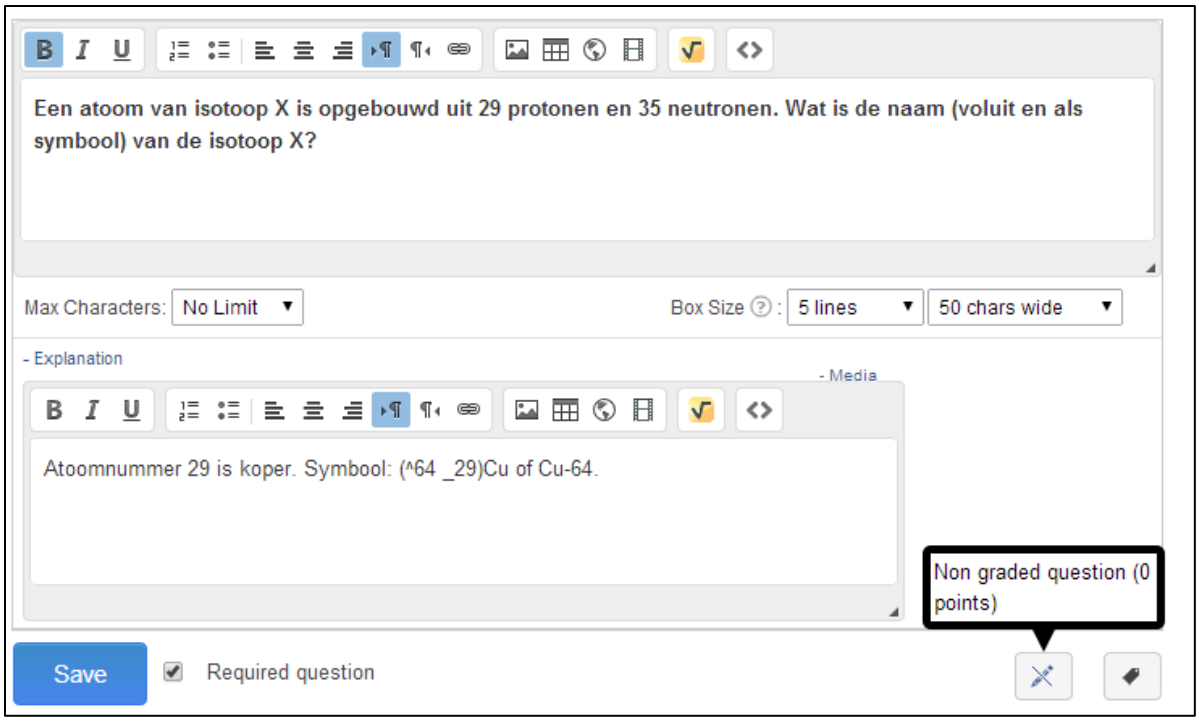

Fig. 6.25: Print screen image for imported question in the computer program ProProfs.

Fig. 6.26: Example of a score report from ProProfs when not unticking the option of 'Show certificate', where in this case the questions were only answered by a hyphen (-).

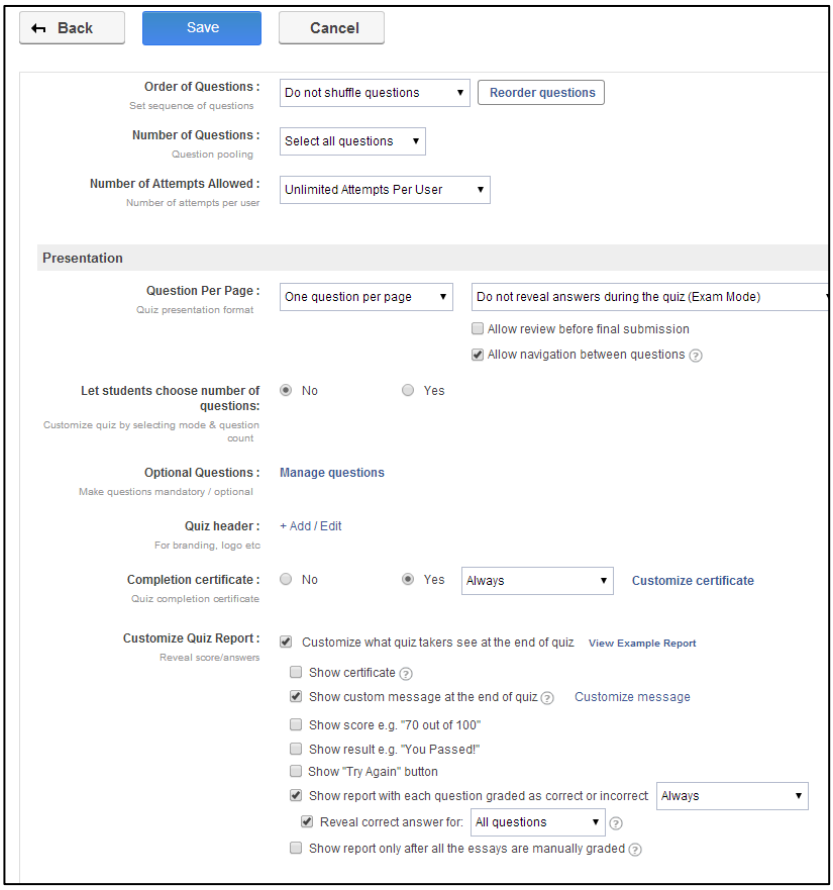

Fig. 6.27: Overview of general quiz setting in the computer program ProProfs.

Goed dat je het huiswerk gemaakt hebt! Hieronder kun je de antwoorden op de vragen bekijken.

Resultaten

Essay — 0Punten Vraag (Niet geselecteerde vragen)

V.1) Radioactief cesium (Cs-137) heeft een halveringstijd van 30 jaar. Leg uit hoe lang het duurt voordat de activiteit van deze radioactieve stof is afgenomen tot minder dan 1%.

Uw antwoord :
-

Uitleg
100%^(1/2)^7=0,78%, dat is minder dan 1% (gevonden door te proberen welke macht van 0,5 onder de 0,01 uitkomt). Dat zijn dus 7 halveringstijden, t = 7·30 = 210 jaar.

Essay — 0Punten Vraag (Niet geselecteerde vragen)

V.2) Radioactief kobalt (Co-60) heeft een halveringstijd van 5,3 jaar. Een bron met deze radioactieve stof had een beginactiviteit van 40 kBq. De huidige activiteit van deze bron is 5 kBq. Bereken de ouderdom van deze bron.

Uw antwoord :
-

Uitleg
Voor de activiteit A van een radioactieve bron geldt A=A_0·(1/2)^n met n=t/t_(1/2) .
Dus A/A_0 =5/40·100%=12,5%, dus n=3.
n=t/t_(1/2), dus geldt t=n·t_(1/2)=3·5,3=16 jaar.

Essay — 0Punten Vraag (Niet geselecteerde vragen)

V.3) Een radioactieve bron heeft een activiteit van 160 kBq. De activiteit is 8,0 uur later afgenomen tot 10 kBq. Bereken de halveringstijd van de radioactieve stof in deze bron.

Uw antwoord :
-

Uitleg
A/A_0 =10/160*100%=6,25%, dus n=4.
n=t/t_(1/2) , dus geldt t_(1/2)=t/n=8/4=2 uur.

α-straling kan meer schade aanrichten dan β- en γ-straling, maar dringt minder ver door (je kunt het makkelijk tegenhouden).

Essay — 0Punten Vraag (Niet geselecteerde vragen)

V.4) In de aardkorst bevinden zich radioactieve stoffen, zoals uranium (U-238), thorium (Th-232) en kalium (K-40). Informatie over deze radioactieve stoffen staat in Binas. Welke soorten kernstralingen zenden deze radioactieve stoffen uit?

Uw antwoord :
-

Uitleg
Zoek in Binas het juiste symbool met het juiste massagetal bij elkaar (kolom 2 en 3). Lees af in de laatste kolom welk deeltje er uitgezonden wordt:
U-238 zendt α- (en γ-)straling uit
Th-232 zendt α- (en γ-)straling uit
K-40 zendt β- (en γ-)straling uit.

Essay — 0Punten Vraag (Niet geselecteerde vragen)

V.5) In de aardkorst bevinden zich radioactieve stoffen, zoals uranium (U-238), thorium (Th-232) en kalium (K-40). Informatie over deze radioactieve stoffen staat in Binas. Welke halveringstijden hebben deze radioactieve stoffen?

Uw antwoord :
-

Fig. 6.28: Example of a score report from ProProfs when using the options like in Fig. 6.25, where in this case the questions were only answered by a hyphen (-).

In Fig. 6.25 the option 'Non graded question' is seen. By activating this option, no points are ascribed to the question. Students receive a score report after they finish the question. However, when using open questions, the students do not get points except when answering the exact same answer as the imported answer. Therefore, only for multiple choice questions, true/false questions or check boxes this point system works. To prevent the students from receive a score report like in Fig. 6.26, only activating the 'Non graded question' is not enough and also the option 'Show certificate' in the settings (see Fig. 6.27) of the quiz should be unticked. Then the report that the students receive is only an overview of the answers per question as presented in Fig. 6.28. It is also possible to show a custom message at the end of the quiz by activating this option in the quiz settings. An example of a custom message is also shown at the top of the score report in Fig. 6.28.

6.9 Realism of time indication

To see if the time indication was realistic or not, the indicated time in the form of the ETI is plotted against the measured t_t in Fig. 6.29. The ETI falls for 80% of the homework sessions within the error bars of the measured t_t. However, this is mainly caused by the high standard deviations, which means that there is a lot of difference from student to student in their t_t on homework. When looking to the individual results, it was noticed that the t_t for some homework sessions was much higher than the ETI. Again, the reason for this might be the fact that students start working on their homework exercise and then stop without saving and next continue the session on a later time point. These unrealistically high values (>7200 s) for the t_t were excluded from the results and plotted in Fig. 6.30.

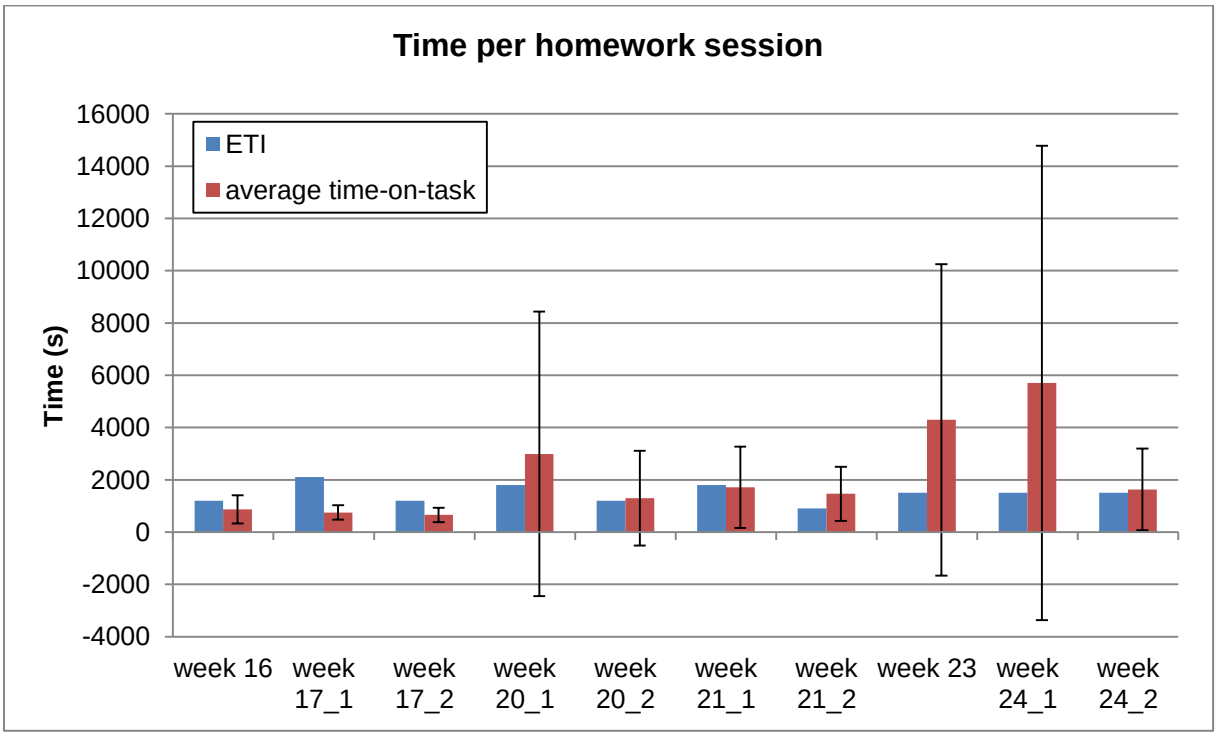

Fig. 6.29: Average time taken per homework session compared to the expected time indication.

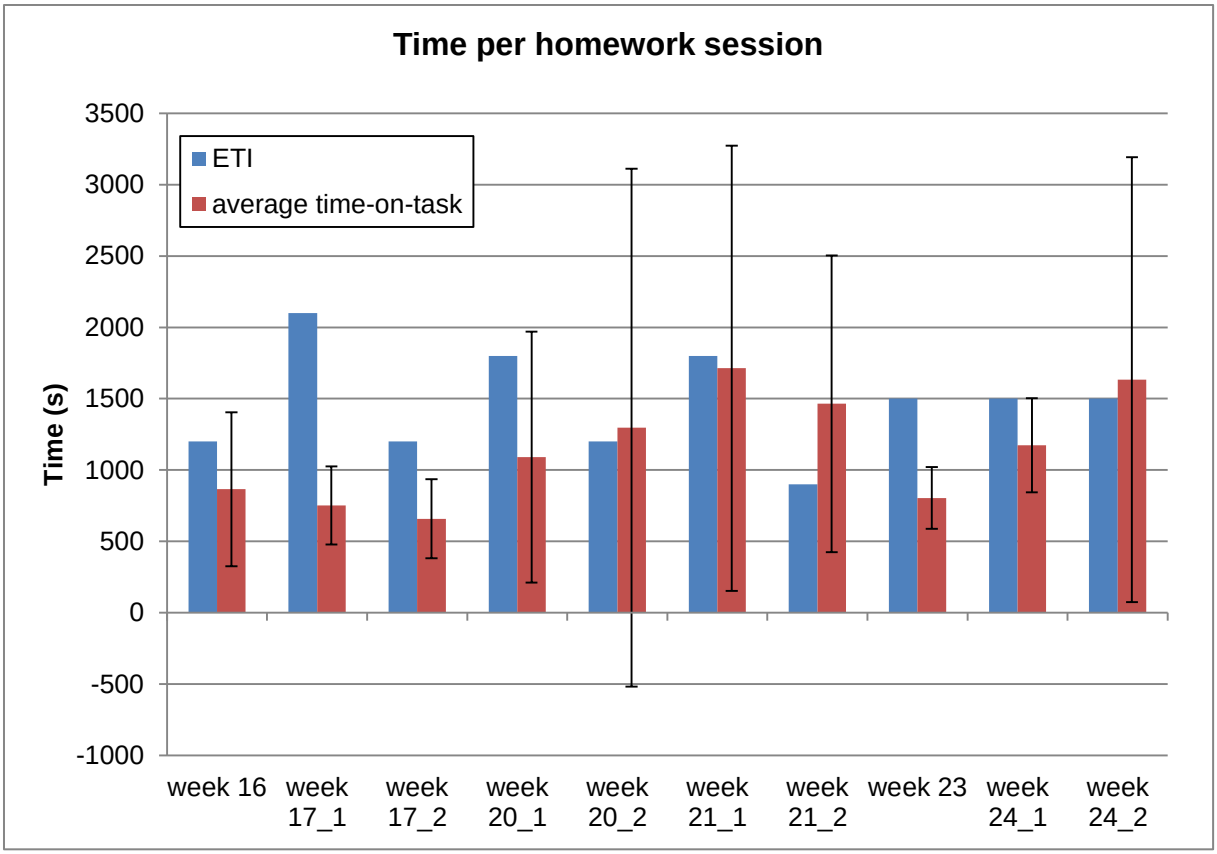

Fig. 6.30: Average time taken per homework session compared to the expected time indication, where the unrealistically high values for t_t were excluded.

Chapter 7 Discussion

This research was performed on a havo 4 class and a vwo 5 class. This was done for practical reasons, because these classes were taught by HM. Because this research was restricted to two classes, not enough data was obtained to answer the question what the effect is of the use of ETI's on the behaviour of students with respect to homework assignments in the context of high school physics classes. Therefore, the goal of this study was to investigate how to set up a proper research that can answer this question. Experiments were performed and analysed to test the working of the chosen method and materials. Furthermore, a survey was taken from the students and teachers were asked for their opinion to provide input and recommendations for follow-up research. The chosen methods and materials, homework in general, the measurement results and the student survey are discussed in the following paragraphs.

7.1 Discussion on used method and materials

To be able to answer the research question, more data should be obtained in follow-up research, for example by expanding this research to different classes of different teachers. Consequently, the amount of time in preparing the homework for these groups should not be too long. To make all the assignments via the computer program ProProfs might be too time-consuming. An alternative way of performing this research would be to only look at the p of the students and not at the t_t, because it is ultimately more important what students learn and not how much time students spend on their homework. In this case, it would not be necessary to make the homework with the computer. In the case of not providing the homework via the computer, it is also possible to use already available homework material and add an ETI for the group of students who will get homework with ETI. Next to that, it will be also easier for the students to make open questions with calculations on a paper instead of using the computer program ProProfs, which is not very suitable for this type of questions. On the other hand, when not measuring the t_t, it is more difficult to state that a change in p is a result of the use of ETI. Alternatively, students can be asked to hand in the homework and write down their time perception and take this as a measure for the t_t. In that case the results of the measured t_t are less reliable and the experiment might be influenced by the fact the students who received an ETI are already more focussed on the time and will therefore give in principal different answers to the time perception than students without ETI. Moreover, when handing out the homework to the students it will be very likely that students that belong to the group without ETI will observe the ETI from the homework of the students which receive homework with ETI. Another way of measuring the influence of ETI's is to let the student make their work at school instead of giving them homework. In that case, the t_t can be measured by an observer or by video. This would result in a more reliable measure for t_t. Conversely, this way of measuring t_t can have influence on the behaviour of the students. Moreover, students do not make homework anymore in this setting. Therefore, the best option to measure the effect of ETI on t_t and p on homework, is via the computer, as was also concluded from the design (see Chapter 4). As a consequence, when continuing this research via the computer, it should be accepted that this is a time-consuming method, especially when measuring on a large number of different classes.

Concerning the time to analyse data, Method 2 would be preferable above Method 1. Regarding Method 2, the students will be divided into two fixed groups, one group which receives homework with ETI and one group which receives homework without ETI. Only the end result of the test will be used as a measure for the p, which saves a lot of time comparing with Method 1 in which each individual homework session should be examined. Using method 1, every student receives homework with ETI and without ETI, giving the advantage that the group with and without ETI contains the same students. Nevertheless, this also means that students will not get ETI's for a longer period of time. Moreover, students can ask questions why they sometimes get an ETI and sometimes not. Therefore, method 2 would be the preferable method to use for follow-up research.

If measurements will be continued by using ProProfs, it is important that the measured data from this program is reliable. The time per question and the total time were measured off line with a digital stopwatch and compared with the measured data from ProProfs. From this, it can be concluded that the time per question was measured with ProProfs was not reliable when giving the students the options of stopping, saving and resuming the homework sessions. This was also the case for the option to go switch between questions (go backward or forward to another question). The total time on

the homework sessions was also not completely correct. However, this time only deviated 5-15 seconds from the measured time with digital stopwatch on measurements that were done. When not using all the above named options, the time per question and the total time measured with digital stopwatch and ProProfs correspond within the error of 1-2 seconds. This means that the measured time with ProProfs is reliable when not using options like stopping, saving, resuming and switching between questions. When giving the students not the option to save and continue later on, it is also more likely that the students finish the homework session (if the homework session is not too long). This will also result in more measured data, because unfinished homework sessions are not measured by ProProfs. Nevertheless, it should be possible to fix the bug in the ProProfs program, giving the students the options of stopping, saving and resuming the homework sessions and switching between questions.
During this research it was chosen to use a realistic ETI. To find out if the ETI was realistic, the measured t_t was compared with the ETI. It was found that indeed for most of the homework sessions the values correspond within the error bars of the t_t. However, it should be noted that the values for the error bars are relatively high, even when excluding the unrealistically high values (>7200 s) for the t_t. Sometimes the standard deviations are even higher than the average, which result in negative values for the t_t, which is off course not possible. However, more important is the high spread in values for t_t illustrating the t_t is really student dependent. Despite the ETI was chosen realistic, this means that also for a lot of students the ETI was too long or too short. Therefore, it is a fair question to ask if the ETI's should not be different for every student. Possibly, smart software could measure how fast a student makes exercises. For example, the software could be given a mark as a default value, after which it can calculate an ETI and adapt this ETI after each homework sessions by multiplying it by a certain factor resulting from the previous made homework sessions. This factor will become more accurately after each homework session. When deciding to use this software, this algorithm should be checked during the experiment. On the other hand, the t_t that was measured also very much depends on how serious the students made their homework. When looking at the individual answers of the students, it is clear that sometimes students do not put much effort in making the exercises. Students then answer the question with a hyphen or a question mark. Therefore it is also not completely fair to compare the ETI with the t_t that was measured. For an experienced teacher it should be well possible to make a realistic ETI for an average student. Moreover, if a student notices that the ETI's are not realistic for him, he can make an estimate of the time the next homework session will take him, based on the given ETI of this homework sessions and the ETI's of previous homework sessions. To minimize the errors in ETI, homework sessions should not be made too long. If the homework sessions with ETI's are too long, then the ETI might also have an unwanted negative effect, which followed also from the remarks of students in the student survey. Also ETI's per question are possible, however, it is more useful to have an overview of the time at the start of a homework session of all the questions.

7.2 Discussion on homework

As already mentioned in the theory section, there is still an on-going debate on the influence of homework on achievement or performance p. Some studies [9, 12, 13] show a positive relationship between homework and p, whereas others [14] doubt these results. In this study, the homework is a means to an end. In other words, homework was used as a way to measure the influence of ETI's on t_t and p. Next to that, there is a difference in perception of homework between teachers and students. Where teachers often find it very important that students make their homework, students are often not enthusiastic about making their homework as was also experienced during this research. At the start of this research, students were not making the homework. Measures (staying behind and bonus points) were needed to let students of the havo 4 class make their homework. The students have made homework not in the weeks the homework was provided, but after they got measures of staying behind or getting bonus points for exam. These measures were given to the havo 4 students in both groups (with and without ETI). Nevertheless, the measures had influence on the experiment. Therefore, for further research, preferably those measures are not taken when measuring the effect of ETI on homework. In the vwo 5 class these measures were not taken, resulting in a class which did hardly make any homework. To give follow-up research any chance of success, the students should make the homework, to obtain enough data. Therefore, it will be desirable and may be necessary to check each homework session of each student, at least at the start of this research. In this way, students know that their work is checked. Moreover, it is important to directly start with homework via the computer, such that it is part of the protocol and homework via the computer becomes a habit for students. Furthermore, the student homework should be preferably part of the student guide of the students. Measures might be needed before the measurement, creating a homework culture in which

it is normal that students make their homework. The use of ETI's could then be seen as an optimisation tool for the students to make their homework. On the other hand, it is also possible to not use any measures during follow-up research. In that case only the influence of ETI's on p and t_t is measured with respect to homework assignments. If students then not make their homework in both the experimental and control group, this is also a result, namely that the ETI's are not resulting in students making more homework. Alternatively, it is also possible the measure the effect of ETI's on p and t_t during follow-up research in the classroom instead of using homework for that.
One could say that the measures that were taken seem to be more effective than the use of ETI's. However, staying behind when not making homework or bonus points for making homework are not the measures teachers always want to take to let students make their homework. A simple ETI on homework is a more subtle measure and can therefore be preferable.

7.3 Discussion on measured results

In this section only the results of the havo 4 class will be discussed. Because of little data that was obtained from the vwo 5 class, it was decided to not analyse the homework of this class in detail.
From the measurements were the time perception is compared with the t_t, the number of attempts is too small to draw conclusions on the effect of ETI on time perception. The numbers really depend on a few students and how good they can judge the time spend on their homework. Consequently, more data should be obtained. On the other hand, from the time perception that was measured it can be concluded that in some cases the measured t_t is not very realistic, because students are indicating they worked on their homework for a much shorter time than the t_t measured. A few times the t_t was a couple of hours, where the students indicated that they were working on their homework for half an hour or 1½ hour. A possible explanation for the big difference is that students have opened the homework session, stopped with working on it without closing the program, and later on continued on the same homework session. In that case the program measures a different time than the time the students work on their homework (engaged time). This indicates that it is also important to ask students on time perception, because it can be used as a sort of filter of the results. It remains still debatable if and how results should be filtered and which of the results should be included in the analysis. For example, the results can be evaluated both with including all the measurements and with excluding the results which have a bigger difference than 100% between the measured t_t and time perception. The time perception was not measured for all the homework sessions. Therefore, data analysis with excluding the results based on measured time perception is not done the measurements in this study, except for determining the realism of the time indication. It is also possible to exclude only a few questions, but as the measured time per question is not very reliable, this was also not done here.
From measured data of Fig. 6.5 and Fig. 6.6, there is no clear indication of a difference between finishing homework with ETI and finishing homework without ETI. Again, more data should be obtained to draw conclusions on the fact that there is a difference in finishing homework between homework with ETI and homework without ETI. Looking at the results of Fig. 6.7, there seems to be a clear difference between the group of students with ETI and without ETI during the last weeks. However, the error bars, which represent the standard deviations of the measured t_t, show that there is no significant difference in t_t between the students with or without ETI. The high values for the average t_t are again caused by a few unrealistically high values for t_t.
The effect of ETI on homework was measured using two different methods. For method 1, the student were each week randomly appointed to a group with or without ETI. From Fig. 6.9 no clear difference can be seen in finishing homework between homework received with ETI and homework received without ETI. Consequently, there are no clear indications that students spend more time on their homework with ETI. To be able to see a real effect, more data is should be obtained. When looking at Fig. 6.10, it should be noted that the time per homework session was not same. When analysing regarding Method 1, where t_t with ETI will be compared with t_t without ETI, it is important the amount of time the students should spend on their homework with ETI should be the same as for the homework without ETI, which was not the case here. For that reason, these results are not analysed further. Moreover, more data should be obtained. However, as mentioned before, preferably not with method 1 considering the time of the analysis.
The results of method 2 are presented in Fig. 6.11 - 6.13. Fig. 6.11 shows that some students made some of their homework while others made nothing. However, larger groups (experimental and control) are needed to represent the whole population of students and to be able to conclude something on the influence of ETI's on homework from these results. Also with this method some unrealistically high value for t_t were measured, illustrating by the high error bars in Fig. 6.12 and Fig.

6.13. These unrealistically high numbers were included, but excluding this numbers would give a complete different result, because of the low amount of measured data. This is also the reason, that no conclusions can be drawn from this data and that more research is needed. From the first results no clear indication could be found that there is a univocal influence of homework with ETI or homework at all. The arrows that indicating the development of t_t and p are pointing in all kind of directions. Again, it is clear that more measurements are needed. For follow-up measurements it is important to not measure the t_t reference for only one time, which was done here. It would be more reliable to measure an average t_t over a longer period such that also horizontal error bars can be added to the blue dots which represents the reference value for t_t and p. In this period the students should be given homework without ETI. If this is not done, there is a possibility that students do not make the homework sessions and no reference is available, which was the case in this research. Also more end tests should be taken after the use of ETI's to get a more reliable measure for p. Consequently, the determined development of the p, after giving the students homework with ETI for a longer period, will be more reliable and also vertical error bars can be added to the measured results. Moreover, comparing multiple end test results before and after giving the students an ETI on their homework, gives cleaner results, considering the different topics and possibly slight different levels of the different end tests.

7.4 Discussion on student survey

The results of the student survey showed that most of the students (79%) react positively on the question if they find an ETI on homework pleasant. This indicates that it might be worthwhile to further investigate the influence of ETI's on homework. On the question if they would make the homework sooner with an ETI, the majority reacted negatively (59%).This directs to the fact that ETI's will not have much impact on making the homework. However, it might be the case that student will not make the homework sooner, but will spend more time on their homework. Moreover, students can indicate that they will not make the homework sooner, but in practice there might be a different result. Thereby, there is also a large group (34%) which indicate that they will make the homework sooner. Every student that puts more time on his or her task resulting from the use of an ETI would be a profit.

Multiple choice questions are more suitable to ask via ProProfs. Therefore, the students were also asked via the student survey what type of questions they prefer and which questions would be more useful regarding to them. Most of the students indicate that they prefer multiple choice questions, which might be caused by the fact that they think it will take them less time. However, a large majority of the students thinks that open questions are more useful. Besides, many of the homework for subjects in physics will not be very suitable for multiple choice questions. At least, next to the multiple choice questions also homework with open questions and calculations should be given to the students.

An important fact which might have caused that students did not make their homework, was that students indicate in the student survey that they did not make their homework because it was send to the school email address. These school email address accounts were hardly read by the students and they indicate that also therefore homework was forgotten and not made. Multiple students indicate that the homework can be improved by not using the school email address. As an alternative, a private email address can be used if this research will be continued. Students have also asked to put a link on the school online learning environment. This was not possible, because the students from the different groups (with ETI and without ETI) should receive different homework sessions, which means different links. What would be possible is to send the students one link to either a private classroom with ETI or a private classroom without ETI, using the ProProfs program. This would also prevent the teacher to send separate emails for every homework sessions, which was done during this study. Moreover, in this way the students do not get lost in the different emails they receive and keep an overview to all the homework that was finished and homework that still needs to be done. On the other hand, this would be a disadvantage regarding the observation of the ETI. During this research only a minority of the students that received homework with ETI did notice the ETI. To improve this, the ETI can be provided in the email itself and not only after opening the homework. This might also improve the impact of the use of ETI, because students already notice the ETI before opening the homework. This might influence their decision of start making the homework. Another possibility is to use a progress bar which indicates the relative time of the exercises to be made. This decreases the possibility of students missing the ETI. However, a progress bar does not indicate the time prior to the homework session, but only during the homework session. Therefore, the progress bar could be used in combination with an ETI prior to the homework session. In count-down timers in traffic lights, an ETI as a progress bar in combination with the indication of the total time also resulted in positive change of

behaviour of the pedestrians. To test the effect of the progress bar and an ETI before the homework session separately, different experimental groups should be used, in which students receive only an ETI prior to the homework or only a progress bar.
Via the student survey a majority of the students indicate that they prefer homework with a book and on a paper above the homework via the computer. For follow-up research this should be taken into account. It might be needed to let students get used to homework via the computer.

Chapter 8 Conclusions and recommendations

This study was meant as an investigation of how to set up a proper research that could answer the research question "*What is the effect of the use of expected time-on-task indicators (ETI's) on the performance and time-on-task of students with respect to homework assignments in the context of high school physics classes?*". As expected the amount of students that were analysed during this study is not enough to answer the research question. More data should be obtained to draw conclusions on the effect of ETI's on the performance p and time-on-task t_t of students with respect to homework assignments in the context of high school physics classes. It was hypothesized that ETI's can have different effects on students behaviour, depending on the type of student. However, because of the little amount of obtained data, the analysis in this study of ETI's on t_t and p was done on an individual basis instead of ascribing the students to a certain student type. To do a more detailed analysis of the effect of ETI's on t_t and p of different type of students follow-up research on more students is needed. Conclusions and recommendations on if and how follow-up research should be continued are given in this chapter.

First of all, answers of the student survey indicate that there might be a positive effect of the use of ETI in homework and that it might be worthwhile to continue this research. Most of the students (79%) say that an ETI on the homework would be pleasant. A smaller part of the students (34%) indicate that they would make the homework sooner. Additionally, it might be possible that they would spend more time on it. Therefore, it would be worthwhile to further investigate the effect of the use of ETI's on the behaviour of students with respect to homework assignments in the context of high school physics classes. However, it should be considered well how this research will be continued and how much time it will take. To be able to draw conclusions on the research question in a more general way, rather than looking at the effect of ETI's on individuals, much more data needs to be obtained. Consequently, this means that much more homework should be made, which results in much longer time for making the homework assignments. Despite the long analysing time and preferred homework on paper by the students, the homework via the computer is the best way to measure the effect of ETI's on homework. To minimize the length of preparation and analysing time, it is advised to use Method 2 when continuing the research. This means that students are split up in two fixed groups, one experimental group which is given homework with ETI and one control group which is given homework without ETI. The results of end tests can then be used as a measure for the p. It is important to let students also make homework without ETI for multiple times before the experiment, such that this can be used as a reliable reference for their t_t. In combination with the results of previous tests this can be used to evaluate the effect of ETI's on t_t and p on homework assignments in the context of high school physics classes.

Second, when continuing the research with the computer, the computer program ProProfs can be used for this. As long as the students are not given the options of saving and resuming and switching between questions, this program gives reliable data on the measured t_t in total and per question. Sometimes, the measured t_t is very high, indicating that students stop during homework and not close the program and continue later on. To be able to exclude these measured data, it is also important to measure the time perception of the students. In this way it possible to exclude data of which the time perception differs very much from the measured t_t. Concerning the relatively long time to make the homework assignments and the difficulties of inserting Greek symbols, sub- and superscript via ProProfs, it might be worthwhile to look for a different computer program. Alternatively, also publishers can provide homework material as an add-on to their book or material can be made and shared by teacher development teams.

Third, as mentioned before, for continuing research it will be very important to obtain much more data. Therefore, enough students should make their homework. During this research, many students did not make homework and measures were needed to let students do make their homework. It was also indicated by the students that they make more homework in general than with the computer. The students should get used to the fact that they should make the homework via the computer. One way to realise that, is to make the homework once together with the students during a lesson. In this way students cannot say that the computer program does not work and they immediately know how to use it. Furthermore, an email address should be used that is often used by the students. School email addresses were almost never used by the students and it was indicated by the students as one of the reasons why they forgot to make the homework. Moreover, it is advisable to include the homework in the study guide, such that it is compulsory for students. A different approach would be to test the influence of ETI's on t_t and p without making the homework compulsory. If then hardly any student is

making the homework the conclusion is that the ETI is not effecting the behaviour of the students with respect to homework. As an alternative, the influence of ETI's on t_t and p can be measured in the classroom instead of measuring it via homework.
Fourth, for this research it is very important that students notice the ETI. Now, the ETI was shown at the start of the homework session. It might be much clearer when the ETI is showed in the email itself. In this way, also the ETI is shown before opening the homework, resulting in a possibly bigger influence of the ETI. Students will then notice the ETI before starting the homework, which gives the information in advance, influencing their decision on making the homework or not. Alternatively, a progress bar can be used next to the ETI in the email. This reduces the change that students do not notice an ETI. A progress bar only presents the relative time, so it might have a different influence. Therefore, the effect of progress bars together with an ETI prior to the homework indicating the total time of the homework should be tested separately and in a combined setting using different experimental groups.
Fifth, the homework that was given was determined as reasonable by a large majority of the students. Nevertheless, the ETI was not always corresponding to the t_t of the students. Though, what strikes the most are the large standard deviations in the histograms, illustrating the large spread in t_t of the students. This means that the t_t of student varies a lot and it arises the question if it would not be good to use student dependent ETI's. However, ETI's per student would in practice hardly feasible, unless smart software is used to determine and adapt the ETI per student during the research. On the other hand, the ETI's can still be used by the student as an estimate, when students perceive that the ETI's of previous homework sessions are not realistic for them. At least short (maximum 30 minutes) homework sessions should be made with an ETI based on teacher experience to minimize the spread of t_t between students. The students indicated that the length of the homework during this research, which varied from 15 to 30 minutes, was reasonable.
Sixth, it is important that students make their homework seriously. It is important that the teacher checks the answers of the students. Homework sessions that were not made seriously by for example only filling in question marks, should be excluded from analysis. To prevent that students will do this again, the teacher should talk to the student about this and possibly give the student an alternative and similar homework session.
Finally, the data off all the measured groups was collected and analysed using histograms with standard deviations. In this case, it was decided to not analyse the all the measured data in detail, because not enough data was obtained. When more data is measured and obtained, a Student's t-test can be applied to see if there is a significant difference between the experimental group with ETI and the control group without ETI. Furthermore, the effect size of ETI's on t_t and on p can be determined to judge the effect of using ETI's.

Bibliography

1. J. Hattie, *Visible learning : a synthesis of over 800 meta-analyses relating to achievement* (Routledge, London; New York, 2009).
2. K. Lipovac, M. Vujanic, B. Maric, and M. Nesic, "The influence of a pedestrian countdown display on pedestrian behavior at signalized pedestrian crossings," Transportation Research Part F: Traffic Psychology and Behaviour **20**, 121-134 (2013).
3. O. Keegan and M. O'Mahony, "Modifying pedestrian behaviour," Transportation Research Part A: Policy and Practice **37**, 889-901 (2003).
4. G. Antonides, P. C. Verhoef, and M. van Aalst, "Consumer Perception and Evaluation of Waiting Time: A Field Experiment," Journal of Consumer Psychology **12**, 193-202 (2002).
5. H. J. Walberg, R. P. Niemiec, and W. C. Frederick, "Productive Curriculum Time," Peabody Journal of Education **69**, 86-100 (1994).
6. J. A. Sloboda, J. W. Davidson, M. J. A. Howe, and D. G. Moore, "The role of practice in the development of performing musicians," British Journal of Psychology **87**, 287-309 (1996).
7. R. E. Ornstein, *On the Experience of Time* (Harmondsworth, 1969).
8. K. S. Choe, "Children's representation of long duration: when memory and attention meet in processing time," J Genet Psychol **174**, 117-136 (2013).
9. H. Cooper, J. C. Robinson, and E. A. Patall, "Does homework improve academic achievement? A synthesis of research, 1987-2003," Rev Educ Res **76**, 1-62 (2006).
10. H. Cooper, "Synthesis of Research on Homework," Educ Leadership **47**, 85-91 (1989).
11. H. Cooper and B. Nye, "Homework for Students with Learning-Disabilities - the Implications of Research for Policy and Practice," J Learn Disabil **27**, 470-479 (1994).
12. T. P. DeBaz, *A Meta-analysis of the Relationship Between Students' Characteristics and Achievement and Attitudes Toward Science* (Ohio State University, 1994).
13. R. A. Paschal, T. Weinstein, and H. J. Walberg, "The Effects of Homework on Learning - a Quantitative Synthesis," J Educ Res **78**, 97-104 (1984).
14. A. Kohn, *The Homework Myth: Why Our Kids Get Too Much of a Bad Thing* (Da Capo Life Long, 2006).
15. E. Jongsma, "Homework - Is It Worthwhile," Read Teach **38**, 702-704 (1985).
16. "Lifescribe Smart Pen", retrieved 03-12-2013, http://www.livescribe.com/nl/
17. "Poll Everywhere" (2013), retrieved 03-12-2013, http://www.polleverywhere.com/.
18. "Socrative", retrieved 03-12-2013, http://www.socrative.com/.
19. "SMART Response™ VE interactive response system", retrieved 03-12-2013, http://smarttech.com/response.
20. "ProProfs Quiz Maker", retrieved 03-12-2013, http://www.proprofs.com/quiz-school/.

Acknowledgements

With finishing this master thesis I would like to thank a few people who helped me doing this research. I started this research together with Hans Kanger. Therefore, I would like to thank especially Hans for the good cooperation and setting up this research with me. Together we formed the basis for this research. Hans, hopefully you can use my report as input for your continuing research if you decide to continue research on this topic. Next to that, I would like to thank Cok van Zuilen, my supervisor at the Piter Jelles Montessori High School. You helped me a lot during my internship and with our discussions you gave me very good suggestions how to execute this research. Also thanks to Dennis van der Woude for giving me the confidence in taking over his class and performing this research in this class. Both Cok en Dennis, also thanks for your opinions on this research. Similarly, I would also like to thank Piter Jelles to allow me to perform the research on their schools and Alexander Bloem and Niesje Mooiman for helping me realising this. Furthermore, thanks to Henk Pol for supervising me during this research. I really appreciated the fruitful discussions together with you and Hans Kanger. Furthermore, also thanks to Jan van der Veen, who was willing to help me finalizing this master thesis and taking over the responsibilities of Henk Pol, when he was not able to do this. I appreciated it very much that you helped me so quickly after knowing that you would supervise me and that I could therefore finish my thesis relatively fast. Additionally, I would to thank the institute ELAN for the payment of the program ProProfs which allowed me to perform this research in a decent way. Also thanks to all the students of 4 havo of Piter Jelles Montessori High School and 5 vwo of Piter Jelles Gynmasium, who gave me a lot of input and results for this research. Further, I would also like to that my family which made it possible for me to do this research, by letting me stay at their homes during the internship. Heit, Mem, Klaas, Marieke, Rinse, Hylke, Jitske en Ids, tige tank foar de stipe dy't jim my jûn hawwe en de tiid dy't ik by jim troch brocht kinnen ha. Finally, I would like to thank my fiancee Willy. Skat, sûnder dy hie ik myn ûndersyk seker net sa goed dwaan kinnen. Do hast my altyd stipe mei myn kar foar it ûnderwiis neist myn promoasje en ik fyn it geweldich datsto altyd foar my klear stiest wannear ik dit nedich ha.

Appendix A Survey on homework in combination with ETI's

Heb je jouw huiswerk via de computeropgaven gemaakt? Zo niet, waarom niet? Zo ja wat vond je van het huiswerk via de computer?

Wat zou er verbeterd moeten worden mocht je meer van het huiswerk gaan maken?

Wat heb je liever?

○ Open vragen	○ Multiple choice vragen

Wat heb je liever?

○ Huiswerk vanuit je boek met schrift erbij	○ Huiswerk via de computeropgaven

Wat denk je wat nuttiger is?

○ Open vragen	○ Multiple choice vragen

Waren de computeropgaven over het algemeen?

○ Te kort	○ Redelijk	○ Te lang

Hoe lang zou het huiswerk per week mogen zijn volgens jou?

Hoeveel tijd heb je gemiddeld per week besteed aan je huiswerk voor het vak natuurkunde?

In het algemeen	*Via de computeropdrachten*
○ 0-15 minuten	○ 0-15 minuten
○ 15-30 minuten	○ 15-30 minuten
○ 30-45 minuten	○ 30-45 minuten
○ 45-60 minuten	○ 45-60 minuten
○ 60-90 minuten	○ 60-90 minuten
○ 90-120 minuten	○ 90-120 minuten
○ langer dan 120 minuten	○ langer dan 120 minuten

Heb je nog suggesties om het huiswerk via de computer te verbeteren?

Is het je opgevallen dat er bij de huiswerkopgaven via de computer een tijdsindicatie is geven van de tijdsduur van deze opgaven?

Appendix A Survey on homework in combination with ETI's

Vind je het prettig als er van te voren wordt aangegeven hoeveel tijd het huiswerk ongeveer duurt? Waarom wel of waarom niet?

Zou je eerder huiswerk gaan maken als er wordt aangegeven hoeveel tijd het huiswerk ongeveer duurt? Waarom wel of waarom niet?

Appendix B Permission for research

This research was performed on students of two classes. For permission of this research for the havo 4 class, the following message was placed in the parents bulletin:

De leraar in opleiding bij natuurkunde, Harmen Mulder, doet in het kader van zijn opleiding een onderzoek bij de leerlingen naar de relatie tussen het maken van het huiswerk en het al of niet duidelijk door de leraar aangeven van de benodigde tijd voor dit huiswerk. Over de resultaten van dit onderzoek zullen wij in het ouderbulletin te zijner tijd berichten. Mocht u bezwaar hebben tegen de deelname van uw zoon/dochter aan dit onderzoek dan kunt u dit per mailbericht kenbaar maken bij de conrector van de Montessori high School via abloem@pj.nl.

For permission of this research for the vwo 5 class, the following message was sent to the parents:

Geachte ouder(s)/verzorger(s),

Graag zou ik mij aan u willen voorstellen. Mijn naam is Harmen Mulder en ik bezig de lerarenopleiding (Master Science Education and Communication) aan de Universiteit Twente af te ronden. Voor deze opleiding loop ik stage bij het Stedelijk Gymnasium/Montessori High School en zal ik de komende maanden lesgeven in de klas van uw kind(eren) voor het vak natuurkunde. Daarnaast doe ik, in samenwerking met het Stedelijk Gymnasium/Montessori High School en de Universiteit Twente, onderzoek naar de leerprestaties van leerlingen. Dit onderzoek zal volledig anoniem zijn en uw kind zal er geen hinder van ondervinden. Mocht u toch bezwaar hebben tegen deelname van uw kind aan dit onderzoek kunt u dit kenbaar maken via onderstaand strookje.

Met vriendelijke groet,
Harmen Mulder

…….. (naam ouder/verzorger) maak bezwaar tegen deelname van ……. (naam kind), klas …….. aan bovenstaand onderzoek.

Handtekening:

Appendix C Email of measure of staying behind

The following email was sent to the students after they hardly did make their homework:

Beste leerling,

Ik heb via mijn computerprogramma gezien dat er bijna tot geen huiswerk is gemaakt voor het vak natuurkunde. Voor de toets zal het echter zeer belangrijk zijn dat jullie dit wel gaan maken. Daarom heb ik het volgende met Cok van Zuilen afgesproken: ***iedereen moet al zijn/haar huiswerk gemaakt en ingeleverd hebben vóór maandag 12 mei.*** *Dit gaat dus om het huiswerk wat ik tot nu toe naar jullie heb opgestuurd. Ik zal op deze dag controleren wie het huiswerk gemaakt heeft. Van degenen die het niet af hebben zal ik de naam doorgeven aan Cok.*
Daarnaast zullen ook de opgaven die tijdens de les moesten zijn gemaakt af moeten zijn voor maandag 12 mei. Cok zal tijdens de les ook jullie schriften controleren om te kijken of alle opgaven, die tijdens de vorige lessen moesten zijn gemaakt, af zijn. Mocht jullie huiswerk en de opgaven voor in de les niet af zijn, dan zal de consequentie zijn dat jullie dinsdag 13 mei bij Cok zullen moeten nablijven. Ik hoop uiteraard dat dit niet nodig zal zijn en dat jullie het huiswerk en de opgaven voor in de les gemaakt hebben voor maandag 12 mei.

Met vriendelijke groeten,
Harmen

Appendix D Example of homework sent by email

The students were sent an email, which is presented below, for each homework session.

Hierbij de link naar jouw huiswerk voor week 24 deel 1:

http://www.proprofs.com/quiz-school/story.php?title=NzMxMzE0ACK8

Je kunt inloggen met je voornaam, achternaam en emailadres. Vervolgens kun je de vragen één voor één beantwoorden en kan het huiswerk tussentijds worden opgeslagen. Nadat je de vragen hebt beantwoord krijg je de antwoorden op de vragen te zien.

Veel succes ermee!

Appendix E Example of ETI on homework

Below an example of homework for the havo class is presented including an ETI.