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A Longitudinal Study of the Relations between Workload, Grades and Student Ratings in a First Year Engineering Course*

RUNAR UNNTHORSSON and GUDMUNDUR V. ODDSSON
Centre for Productivity, Performance and Processes, Faculty of Industrial Engineering, Mechanical Engineering and Computer Science, University of Iceland. E-mail: runson@hi.is

This paper presents a study of the relations between workload as measured by the lecturer, student grades on a final test and student satisfaction as measured in a course survey in a first year engineering course. The study covers 10 years, from 2004 to 2014, and grades/scores from 827 students. During this time the lectures were given by the same lecturer using the same textbook and the study only reports on the exam part of the course. The purpose of this study was to evaluate whether the general assumption of 'more is better' is valid for the relation between workload and the final results, i.e., grades and satisfaction. The workload was estimated by measuring the time it took the lecturer to solve the homework assignments and the student satisfaction was estimated by using results from annual student ratings made each year. The grades used were from the final exams only, not the final course grade. The results reveal that there are no relations between the workload, final exam grade and satisfaction, when compared two by two (workload vs. grade, workload vs. satisfaction and grade vs. satisfaction).

Keywords: workload; grades; student ratings; longitudinal study

1. Introduction

The authors and many of their colleagues have been assuming that more homework and practice will result in good grades but observations have indicated that workload has not affected the end results. Our world is saturated with the notion of 'more is better' even if we continuously try to say otherwise. This is also evident in academia and higher educational teaching. For some time it has been dawning up on us that there is something rotten in the state of Denmark. For a decade the authors have reduced the workload by intuition without noticeable results in exam grade. The reduction was about 40% and was done by both shortening assignment and reducing their number. It is the purpose of this article to analyse this scientifically. We look back on those 10 years, analyse the data and try to validate our intuition. This article reports on a longitudinal study on an engineering course, similar to what Bham, et al. [1] reported on a GIS course and Ozaktas [2] tale of teaching ethics to engineers for 16 years.

Studies have shown that time spent on individual study does not correlate with good grades [3]. Peters, et al. [4] found no relationship between homework and grades. This was supported by Kember, et al. [5] who found that long hours do not always give good grades. Some studies report a slight correlation between the students reading time and their academic performance [6]. There seem to be no studies on the correlation between workload, satisfaction and grades in engineering or science.

1.1 Research questions

The purpose of this research was to determine if there is a relationship between workload, exam grades and student ratings. We intended to test the following three hypotheses:

1. H_1: There is a relation between workload and exam grade.
2. H_2: There is a relation between workload and student rating.
3. H_3: There is a relation between exam grade and student rating.

2. Methodology

This research was carried out by first conducting a literature study to find previous research in this area and then an analysis of 10 year data on the teaching first year engineering students in an introduction course in technical drawing.

2.1 The literature study

To find previous studies on the relationship between workload, grades and student satisfaction we searched the Thomson Reuter's Web of Science (the ISI index) with the two following set of criteria:

TS = (Student* NEAR Workload* NEAR (perc* OR asses* OR measur* OR eval*)) AND SU=("EDUCATION SCIENTIFIC DISCIPLINES" OR "EDUCATION EDUCATIONAL RESEARCH")

* Accepted 16 July 2015.

This search criteria resulted in 183 hits (on the 16th of December 2014) and adding TI = (workload*) gives 22 results. These articles went through abstract review. The criterion for selection to full article review was relevance to the topic of this article and engineering. Thirteen articles were found relevant. Then a backward literature search was performed adding another 5 articles to the full review process.

2.2 Data collection

In order to test the 3 hypotheses, 3 datasets were used. The datasets were acquired from a first year's undergraduate course in engineering drawing. During the years 2004–2014, the number of students in the engineering drawing course varied between 70 and 90 students each year, adding up to of 827 students. During the decade, the course had the same lecturer, the learning objectives were the same and clearly stated. The course structure did not change and the same English textbook was used throughout the period. Three TA's worked with the lecturer during the period, all former students.

The course syllabus and structure remained unchanged through the study and the students were assessed in a three hour written final exam. Each year, the students had access to all earlier final exams and the weekly assignments were compiled from the last year final exam. Both the final exam and all the weekly assignments were in the native language. Dataset 1 consists of the final exam grades.

The course was attended by students in industrial engineering and mechanical engineering. Most students were in the 2nd semester (1st year) of their BSc studies. The course is 6 ECTS points (150–180 hours), runs each spring and is presented in non-English language. The course introduces the core concepts, methods of engineering drawing and presentation of technical information. There are two lecture hours and two lab hours (with TA's) per week. Homework consists of 10 weekly assignments that must be submitted as hard copies that can be done either individually or in small groups of 2–3 persons. The homework is graded by TA's and given back with comments before next assignment is handed in. Dataset 2 consists of all the weekly assignments used during the 10 years.

Dataset 3 consists of the results from the yearly online course evaluation which the students were asked to participate in, to assess the student's satisfaction of the course.

2.3 Data analysis

Statistical tests are used in the paper in order to test two types of hypotheses: that two means are statistically different and whether the slope of a line fitted to a dataset is statistically different from 0 (horizontal). The following is a description of the two tests.

For testing whether means are statistically different the Tukey's honestly significant difference test (HSD) is used. The Tukey's HSD tests the two tailed null hypothesis:

$$H_0 : \mu_1 = \mu_2 = \mu_3 = \ldots = \mu_m,$$

where m is the number of the means being compared. The null hypothesis assumes that the groups which are associated with each mean are normally distributed and the variance is the same within each group. The Tukey's HSD test statistic q_s for comparing two means is calculated using Equation 1.

$$q_s = \frac{|\mu_i - \mu_j|}{SE} \tag{1}$$

where, μ_i and μ_j are the means to be compared and SE is the standard error for the difference between the two means

$$q_s = \frac{|\bar{X}_i - \bar{X}_j|}{S_{p,i,j}\sqrt{\frac{1}{n_i} + \frac{1}{n_j}}}, \tag{2}$$

where $\bar{X}_i$ and $\bar{X}_j$ are estimates of the group means and n_i and n_j are the number of values in each group used for estimating the two means. $S_{p,i,j}$ is a weighted mean of the variance of each group and is calculated using

$$S^2_{p,i,j} = \frac{n_i - 1}{n_i + n_j - 2} S^2_i + \frac{n_j - 1}{n_i + n_j - 2} S^2_j, \quad \mathrm{i} \neq \mathrm{j},\ \mathrm{i},\ \mathrm{j} = 1, \ldots, \mathrm{m} \tag{3}$$

where S^2_i and S^2_j are estimates of each group's variance and calculated using

$$S^2_i = \frac{\sum_{k=1}^{n_i} \left(x_k - \frac{\sum_{z=1}^{n_i} x_z}{n_i} \right)^2}{n_i - 1} \quad \text{and} \quad S^2_j = \frac{\sum_{k=1}^{n_j} \left(x_k - \frac{\sum_{z=1}^{n_j} x_z}{n_j} \right)^2}{n_j - 1} \tag{4}$$

The Tukey's HSD is essentially a t-test with an adjusted p-value. The adjustment is to correct for type I errors which are more likely to occur when multiple pairwise comparisons are made. The adjustment is included in the distribution of the critical value which the test statistic q_s is compared to—the studentized range distribution. In other words, the test statistic q_s is compared to a value from the studentized range distribution to determine whether the null hypothesis is supported. The test statistic's degrees of freedom are equal to the total number of observations minus the number of means, or $v = \sum_{k=1}^{m} n_k - m$ degrees of freedom. In the paper a 95% confidence interval is used which means that we will reject the null hypothesis if the adjusted p-values are less than 0.05.

For testing whether the slope of a fitted line, $Y = \beta_0 + \beta_1 X$, is statistically different from zero the t-test is used. In this case the null hypothesis is

$$H_0 : \beta_1 = 0, \tag{5}$$

where β_1 is the slope of the line and β_0 is the point where the line of intersects the Y-axis. The slope of the line must be estimated and the estimated slope is denoted by $\hat{\beta}_1$. It is calculated using

$$\hat{\beta}_1 = \frac{s_{xy}}{s_{xx}} = \frac{\sum_{i=1}^{n} x_i y_i - \frac{\left(\sum_{i=1}^{n} y_i\right)\left(\sum_{i=1}^{n} x_i\right)}{n}}{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}} \tag{6}$$

Where n is the number of values used to estimate the slope. The test statistic t for the estimated slope follows Student's t-distribution if the null hypothesis is supported and has $n - 2$ degrees of freedom. It is calculated using

$$t(v) = \frac{\hat{\beta}_1}{\sqrt{\frac{\hat{\sigma}^2}{s_{xx}}}} = \frac{\hat{\beta}_1}{\sqrt{\frac{\hat{\sigma}^2}{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}}}, \tag{7}$$

where v is the number of degree of freedom and $\hat{\sigma}$ is the estimated variance. It is estimated using

$$\hat{\sigma}^2 = \frac{\sum_{i=1}^{n} y_i^2 - n\bar{y}^2 - \hat{\beta}_1 s_{xy}}{n - 2}, \tag{8}$$

where $\bar{y}$ is the estimated mean. It is estimated using

$$\bar{y} = \frac{\sum_{i=1}^{n} y_i}{n} \tag{9}$$

When the test statistic has been calculated it is compared with a critical value, X, obtained from the Student's t-distribution. The critical value X depends on the selected confidence interval and the number of degrees of freedom. In the paper a 95% confidence interval is used which means that we want 95% probability that the test statistic $|t(\nu)|$ is less than the critical value, X, obtained from the Student's t-distribution. In other words; the null hypothesis is rejected if $|t(\nu)| > X$. The null hypothesis will also be rejected if the p-value is equal to or smaller than 0.05 because when calculated correctly the p-value should not suggest higher confidence level. For simplicity we use X = 2 in this paper but the value of X should lie in between 2 and 3 when the degrees of freedom are higher than 3 and X is higher for 1–3 degrees of freedom. This means that the paper has slightly stronger requirements than set by the t-test.

2.4 Variables and measures

The variables studied are the workload, the final exam grade and the student rating of the course. The final exam performance was assessed in a three hour written exam that accounts for 40% of the final grade and the students must pass in order to finish the course. The minimum grade for passing is 50 out of 100. The comparison in this work is only on examination performance. The performance was measured as an average examination grade. Please note that the exam grade was never 'scaled' and there were never any 'distribution curve' adjustments.

In this study the focus is only on the student's workload that varied between the years. The total workload is the total time that a student needs to solve the homework assignments; i.e., reading the course text, attending lectures and solving the assignments. Throughout the 10 years the lecturer changed the total workload by both reducing the number of problems in the homework assignments and by shortening the required time for solving the problems. The time required for reading the course text and attending lectures was kept constant and therefore that time is not part of the workload studied in this paper.

In order to estimate the workload the lecturer solved all the homework assignments and recorded the time needed. It was assumed that the students were a factor longer and that the factor is the same through all the years. We did not evaluate the factor here. The workload was evenly distributed to 10 weekly homework assignments. The lecturer solved the homework assignments by solving all the home assignments from the 10 years in random order. The reason for this approach was to minimize the error resulting from either solving many similar problems in a row; e.g. first home assignment for all the years, or solving all the home assignment for each year at a time.

The workload only includes the work which was assessed in the final exam—the drawing theory and methodology. The final exam did not assess the student's knowledge of the drawing software AutoCAD which was used in the course. The AutoCAD knowledge was assessed through the weekly assignments and a final project. This is the same approach as used when the final exams are generated. We hoped that this would give us a cleaner measure of workload so any error would be systematic in nature and hence included in the factor.

The student satisfaction was estimated by using results from annual student ratings of the course made each year. The questions asked in the student ratings were changed in 2012 so to get a uniform measurement we took four of the aspects, which were present in all the years, and weighted them together. The aspects are: teaching, course structure, course usefulness and academic encouragement. These aspects are constructed from several questions which are evaluated on a Likert scale (from 1 to 5).

2.5 Assumptions

The results are based on three assumptions that relate to appropriate measurement, time factor and student ratings. We assume that the final exam measures the students learning appropriately. We also assume that the students are a factor longer in finishing the homework but that factor is the same through all the years and that student ratings are meaningful [7] even though the method of collecting them is questionable. At our university it is voluntary for the students to answer the evaluation. This would not be an accepted sampling methodology for questionnaires. Furthermore, the authors have made a composite variable for the student ratings, based on four of six aspects that are measured in the questionnaire. The two aspects that were excluded are student evaluation of workload and their attitudes towards studying the course material. These were excluded because the former is evaluating the workload (and how challenging the course is) and the latter is evaluating the student preparedness which is only marginally related to the specific course. This is in line with Kember, et al. [8] and their definition of workload (or time spent) versus perceived workload.

3. Literature review

The searches for literature return 18 articles. Kember, et al. [8] find that perceived workload is not equal to the hours worked and that workload, time spent on study, learning approaches and learning outcomes for a complex relationship. In later research Kember [9] finds that high workload perception and surface approach to learning are interrelated in a complex manner. The author then moves on to structure previous research with structural equation modelling (SEM) where then find a teaching and learning environment have impact on perceived workload [10].

The distinction of good and bad workload has been made many times and Marsh [11] tries to define what the difference is. The conclusion is that good workload leads to learning and bad does not. Marsh [11] does however not present a more detailed definition. Chambers [12] suggests a more rigid way to measure workload, including type of text mapping to reading speed, i.e., difficult text 40 word per minute (wpm), intermediary at 70 wpm and easy text at 100 wpm. Wilson, et al. [13] discuss how questionnaire can be used to evaluate workload and quality of teaching. Greenwald and Gillmore [14] find that higher grades come from courses that are better liked and that higher grades have a negative relation to workload (lighter workload lead to higher grades). [15] re-analyse the Greenwald and Gillmore [14] work to find the opposite, a positive relation between workload and evaluation, and only slight correlation between evaluation and grades.

Student motivation has impact on perceived workload. When student can connect course to their major they will be more willing to study hard and perceive the workload not as high as when courses are considered ‘pointless’ [16]. Linking workload to frustration is something Whinghter, et al. [17] did in their study and found that positive link exists if students had low level of mastery goal. Kyndt, et al. [18] found that a high enough workload is needed to motivate students but there is a threshold that teachers should not surpass, especially when students are externally motivated. This is supported by Nijhuis, et al. [19] that find clarity of goals and perception of workload are positively related. Prichard, et al. [20] reported on how training students in group work lower the subjective (perceived) workload. The training also helps the students in performing better in various academic exercises.

Attendance in lecture is found to correlate with grades and furthermore, attendance seems to be positively related to other study time spent on course. Workload was estimated from students reporting on time spent in lectures and other study related activities [21]. Ruiz-Gallardo, et al. [22] looked at how to control workload and found four main factors to influence workload reduction: selection of curriculum content, skill training, assignment reduction and selection of provided materials.

Dee [23] debunks the assumption that high workload will lead to poor instructor evaluation and highlights the need to look at course evaluation, interaction and teaching methods. This is in line with Kember and Leung [10] research. Remedios and Lieberman [24] support this and find that the largest determinant for positive evaluation of a course is quality teaching. They conclude with “(f)actors such as grades and course difficulty seemed to play at most a very small role” but do not find link between workload and grades [24]. Kyndt, et al. [25] found that student must experience the feeling of ‘having time’ to be able to plan their studies. The authors also found that the perception of workload can be influenced with motivation.

Table 1. A summary of results of all variables used

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. students	69	72	64	55	62	65	89	96	96	79	80
Exam grade [out of 100]	55	58	55	57	59	50	50	55	54	56	54
Student ratings [out of 100]	70	60	67	70	69	76	68	74	76	69	67
Workload [in minutes]	795	700	655	610	610	515	510	675	690	625	630

4. Results

Our findings show that there is not a measurable relationship between the three variables, that is, none of the null hypotheses for the regression lines can be rejected using the t-test with a 95% confidence interval. In other words, the three variables, the average final exam grade, the average student ratings and the workload are not correlated. In this section, we will present the variables, their properties, how they evolved through the period and determine if the variables are correlated. The study covers students participating in an introductory engineering technical drawing course. The number of students varied between 55 and 96 as shown in Table 1. There are three years (2010-2012) that show an increase in the number of students but otherwise the number is relatively steady.

4.1 The final exam grades

We calculated the final exam grades average, checked the grade distribution and checked the averages for correlations. The final exam grades of the 827 student over the years 2004 to 2014 were given by the same lecturer. The average grades are shown in Table 1 and in Fig. 1.

Visual inspection of Fig. 1 implies that the grades were steady throughout the decade. A t-test was used to test the null hypothesis for the slope coefficient; i.e., that the slope of the regression line is zero. The test statistic was determined to be $|t(9)| = 0.964$ and the p-value 0.360. Hence, according to the t-test, the null hypothesis cannot be rejected.

In order to investigate this further a Tukey's HSD multiple pairwise comparison of the final exam grade averages was carried out. The results are shown in Table 2 and indicate that the grades averages and their distributions are statistically steady throughout the whole decade. The shaded cells in Table 2 indicate pairs which the Tukey's HSD test cannot reject the null hypothesis—that their means are the same. Hence, the test only rejects the null hypothesis for the following 3 pairs: 2005 & 2010, 2008 & 2009 and 2008 & 2010. There could be several explanations for this. The results for the year 2009 were only 7 months after the 'credit crunch' of

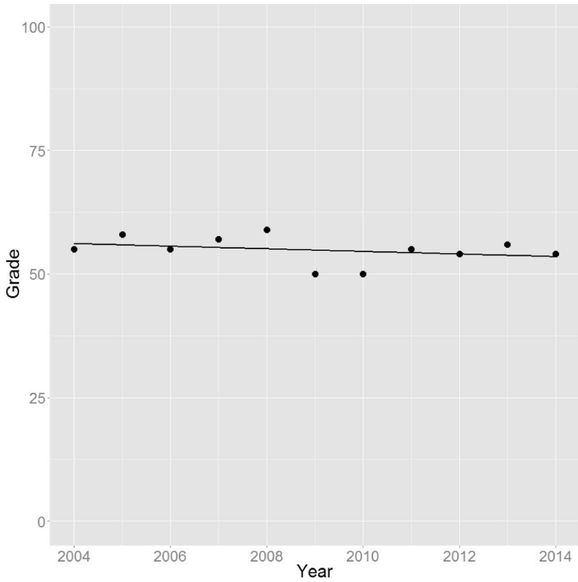

Fig. 1. Averages of final exam grades throughout the decade with a fitted linear regression line.

2008 and these were times of great uncertainty. Furthermore, in 2009 the universities were encouraged to open their doors for the unemployed and there was a great influx of students for the 2010 academic year. This could have impacted the student body and the final exam performance. The boxplot in Fig. 2 shows a graphical representation of the grade distribution for each year and can be used to better understand the results presented in Table 2. The boxplot shows the median (thick black line), the range where 50% of the grades reside (the box), the range where 75% of the grade are (the vertical lines) and the suspected outliers (the points)..

4.2 The student ratings of the course

We calculated a single variable from four different aspects of the student course ratings. The aspects are assessment of the teaching, course structure, course usefulness and academic encouragement as shown in Table 1 and Fig. 3.

According to the computed regression line shown in Fig. 3, the student satisfaction seems to have been

Table 2. Tukey multiple comparisons of means (95% family-wise confidence level)

Year	p adj									
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2005	0.98									
2006	1.00	1.00								
2007	1.00	1.00	1.00							
2008	0.79	1.00	0.90	1.00						
2009	0.86	0.13	0.77	0.43	0.03					
2010	0.69	0.04	0.58	0.25	0.01	1.00				
2011	1.00	0.96	1.00	1.00	0.70	0.80	0.58			
2012	1.00	0.79	1.00	0.98	0.40	0.96	0.87	1.00		
2013	1.00	1.00	1.00	1.00	0.98	0.41	0.20	1.00	0.99	
2014	1.00	0.91	1.00	1.00	0.58	0.93	0.81	1.00	1.00	1.00

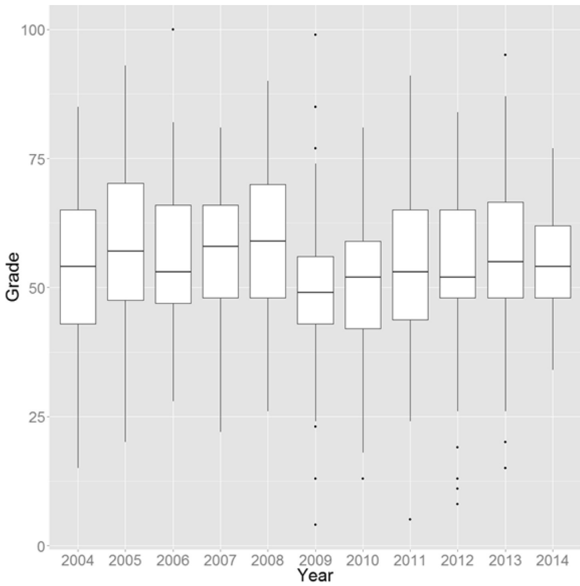

Fig. 2. Boxplot of final exam grades, per year

relatively steady throughout the whole decade. A t-test was used to test whether the slope of the regression line is zero. The test statistic was determined to be $|t(9)| = 1.163$ and the p-value 0.275. Hence, according to the t-test, the null hypothesis that the slope of the regression line is zero cannot be rejected.

4.3 Workload

The workload was estimated by the lecturer by solving all the homework assignments and recording the time required for each assignment. We assume that the students take longer to execute by a factor and that factor is the same through all the years. We, however, do not attempt to evaluate the factor here. The workload estimation only includes work that was assessed in the final exam and only the time required for solving the assignments; i.e., excluding reading the course text and attending the lectures. The workload estimation is shown in Table 1 and Fig. 4.

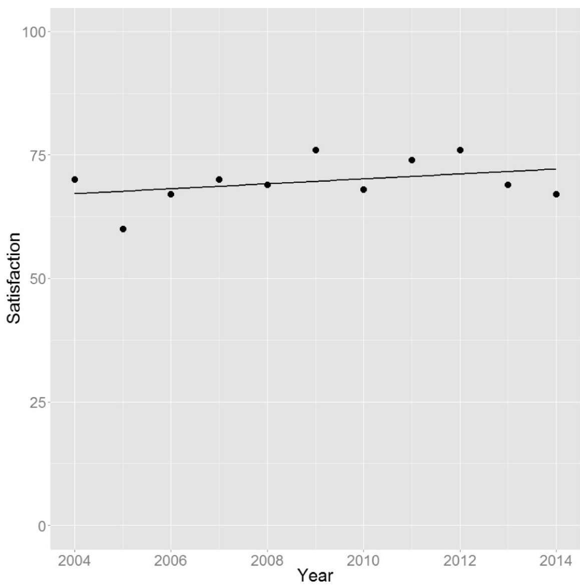

Fig. 3. Student satisfaction (based on student course ratings) with a fitted linear regression line.

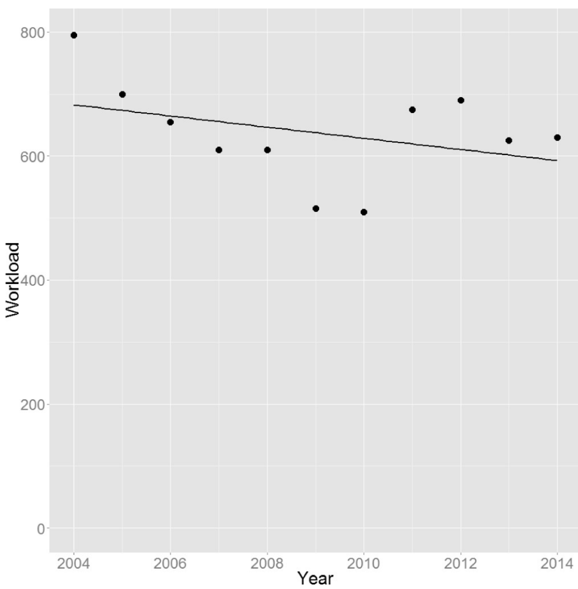

Fig. 4. Course workload related to final exam with a fitted linear regression line.

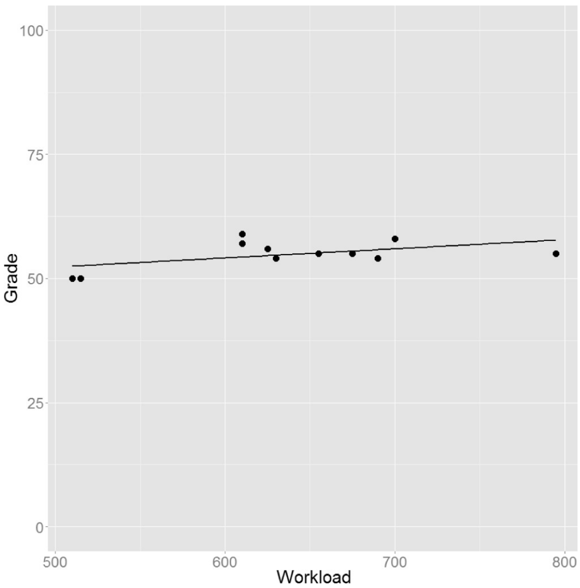

Fig. 5. Scatter plot of the final exam grade vs. Workload with a fitted linear regression line.

The workload fell steadily for the first 6 years and then levelled out at around 600 min. The change from maximum of 795 minutes in 2004 to the minimum of 510 minutes in 2010 is a reduction of almost 40%. The 'drop' in workload to a minimum is in the same years (2009 and 2010) as the 'drop' in average exam grade. This could indicate a correlation.

4.4 Analysing the correlations between the variables

We set out to find out if there is a relationship between the variables and we can conclude that there is virtually no correlation. Scatter plots showing the relationship between three variables are shown in the next three figures. First, in Fig. 5, we compare the exam grade against the workload. A regression line is also shown in the figure.

There seems to be no apparent relation between those two variables. To verify this we used t-test to determine whether the regression line is horizontal. The test statistic was determined to be $|t(9) = 1.84|$ and the p-value 0.0988. Hence, we cannot use the t-test to reject that the slope of the regression line is 0. But it is on the verge and by using a 90% confidence interval the t-test would reject the hypotheses. For this reason, we can conclude that there is a weak correlation.

Second, we drew a scatterplot of the satisfaction and the workload and added a regression line. Figure 6 shows the results and visual inspection did not reveal relation between those two variables. A t-test was used to confirm our interpretations and the test statistic was determined to be $|t(9) = -0.513$ and the p-value 0.620323. Hence,

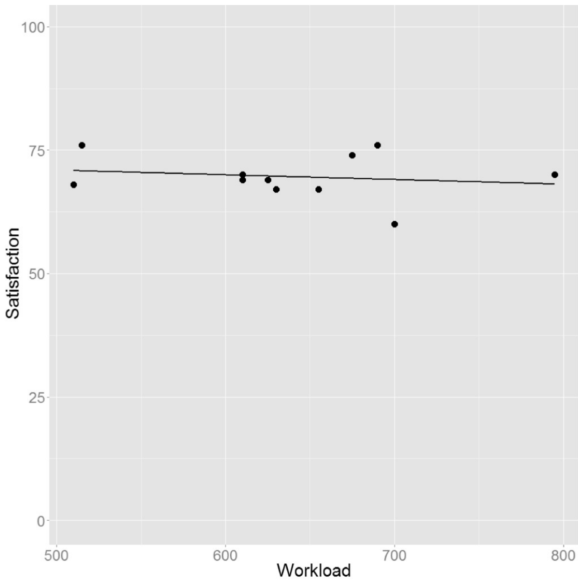

Fig. 6. Scatter plot of student's satisfaction vs. Workload with a fitted linear regression line.

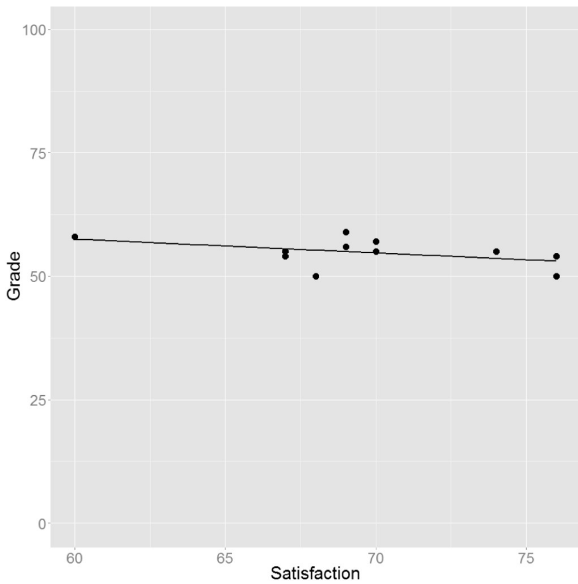

Fig. 7. Scatter plot of student's satisfaction vs. The final exam grade with a fitted linear regression line.

the t-test cannot be used to reject that the regression line is horizontal.

The last variable pair to study was the final exam grade and satisfaction. A scatterplot of the variables and a regression line are shown in Fig. 7.

Figure 7 suggests that that there is no relation between the variables. This is supported by t-test with test statistic $|t(9) = -1.503$ and p-value 0.167072.

T-test was used to determine whether the null hypothesis—that the slope is zero—for each of the variable pairs could be rejected. The results were that the t-test did not reject any of the null hypotheses. However, there is a weak correlation between workload and grade—as suggested by a t-test using 90% confidence interval.

5. Discussion

The results show that there is not a relation between the three variables. This means that our initial intuition was correct and reducing workload does not impact the exam grade. The question then becomes 'why'? Maybe it is an assumption that there should be a relation or maybe the workload is not related to performance. Our findings are therefore in line with earlier research [3–6]. We estimated the workload by recording the time it took the lecturer to solve all the homework assignments. We assumed that it would take the students a factor longer to solve the assignments but, did not attempt to evaluate the factor. Ruiz-Gallardo, et al. [22] on the other hand found that ". . . the average student took 266% more than the time assigned for the subject". Our results are in line with other research in that higher workload does not lead to higher grades.

There are few possible limitations to the research which have not been mentioned specifically. It was not assessed if the student actually did the work themselves. They did hand in the assignments but, they may have been solved by someone else. The students were allowed to work together on the homework assignments which may affect the final exam performance.

Maybe the underlying problem is that the students are copying homework from other students or that they solve the homework with the course material beside them without understanding (or trying to understand) the topics. The negative side of working in groups on homework assignments can be viewed in three aspects. First, if the group members delegate tasks instead of working together then the structure of the group work is not optimal. Secondly, if some group members are present during the group work but passive then they will not benefit much from the work. Finally, if some students do not participate at all in the group work but, only put their names on the homework assignment afterwards then they will not benefit at all from the work.

The main conclusion of the research is that more is not necessarily better; i.e., more workload from homework assignments does not lead to better performance in final exam. One possible explanation for this may be inefficient study methods. This was pointed out by Kember, et al. [5] that found ". . . poor grades in spite of long study hours mirror an inefficient surface approach". We agree with Kember et al. because we have noticed few issues which support this. We feel that they have problems gaining knowledge from the course textbook which is kind of 'old fashion' in its presentation of the material. The students do not read the book (or even buy it) but instead they depend on the lecturer's slides and the solved problems to acquire the relevant knowledge. On the other hand, the lecturer is assuming (and depending on) that the students read the book as the lecturer does not cover all aspects. The students solve the homework assignments and believe that they cover fully all the course's material and that solving the assignments is sufficient for acquiring the necessary knowledge. But knowledge is not enough. Students also need to build up skills and competencies. Allowing students to work in groups may result in that the skills and competencies are not built up.

There seem to be a language problem present. We have observed two kind of language related issues, the understanding of instruction (both oral and written) in the students' native language and the 'link' to the English textbook. Students that do not attend lectures / lab hours and only read the English textbook do not get training in the native language and the associated jargon. Those students could run into problem in the final exam. Homework assignments include problems from prior final exams and their purpose is both to train understanding of instruction and to build up competences.

These issues are probably not isolated but come in some combinations. For example, there are cases where students that worked in a group and relied on their fellow student for decoding the instructions. As a consequence, these students did not get training in understanding instruction and be able to execute them.

Maybe we are looking for explanations in 'simple things' when the problem is more fundamental, a lack of motivation. Maybe the students do not see the goals of the course and are not very motivated in learning the curriculum. The course is early in the study and the student might not see the 'point' of learning technical drawing, might even find it very irrelevant.

The course requires new kind of thinking, new set of skills dealing with a graphical language which most students have never been exposed to before. They underestimate what is required in order to get full understanding, skills and competences in the course's curriculum. They apply the same learning styles [26] that they have used in traditional academic courses. Group work and traditional academic study methods do not suit all curriculums. No one would think of teaching typewriting in a group and the same applies here. Each student must train the skills on their own. Group work is good for discussing and reflecting but not to train skills.

6. Conclusions

The results are consonant with other research results in that increased workload does not necessary result in better performance on a final exam. In this paper we analysed a first year's undergraduate course in engineering drawing. We looked for relations between workload, exam grade and student satisfaction using data that was collected over a 10 year period. There were 827 students during this period and the course was run in a native language (non-English).

The paper's results are that there is a very weak relation between the variables. A t-test using 95% confidence interval could not be used to reject the null hypothesis—that the slope of a regression line between different pairs of variables is zero.

During 6 consecutive years the workload was decreased, from 795 minutes to 510 minutes which is 64% of the first year. However, the exam grade and the student's satisfaction during this time did not change.

We discussed several possible causes that could explain this lack of relation, such as how students work together, group work structure, how students retrieve information from the course material, how students understand instructions, workload due to other courses, lack of skill training and finally lack of interest. But this warrants further study.

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Gudmundur Oddsson is an Assistant Professor at the University of Iceland. He has Ph.D in Industrial Engineering, 10 years of experience as IT project leader in the industry and has been researching and consulting on product configuration for 5

years. His interests are in manufacturing and process improvements, effectiveness and efficiency of production systems, the productivity of knowledge workers and the use of knowledge-based system to support the aforementioned.

Runar Unnthorsson is an Associate Professor at the University of Iceland. He has a Ph.D in Mechanical Engineering. Eight years of experience as an entrepreneur and business developer. His interests lie in the applications of acoustics for non-destructive testing, spatial feeling of environment (real or virtual), performance engineering and processes for improving methods.