Velkommen til MNT konferansen 2017

Kvalitet i høyere utdanning har stort fokus, og Kunnskapsdepartementet har presentert stortingsmeldingen «Kultur for kvalitet i høyere utdanning». Nasjonalt samarbeid innenfor MNT-fagene *(matematikk, naturvitenskap og teknologi)* bidrar på ulike måter til utvikling av MNT-utdanningers kvalitet og relevans. MNT-konferansen har som formål å fremme MNT-utdanningenes kvalitet og relevans gjennom å bidra til forskningsbasert og vitenskapelig tilnærming til undervisning og læring i fagene, slik vi kjenner det fra forskning. Bevisst gjennomføring er kjernen i utvikling av pedagogisk kompetanse knyttet til en SoTL-tilnærming, Scholarship of Teaching and Learning. Praksis følges av observasjon og refleksjon, baseres på teori, og planlegges basert på kontinuerlig utvikling av kunnskap, samt deles og utvikles videre i dialog og samspill. Konferansen gir underviserne en mulighet til å dokumentere og dele sine pedagogiske erfaringer og er en møteplass mellom undervisere, ledere og andre som er aktive innenfor MNT-utdanning og utdanningenes interessenter. I 2017 er tema for konferansen "Transformative Education", et begrep som beskriver at læring forandrer studentens perspektiv og forståelse. Gjennom utdanningstiden skal studenten utvikle seg fra student til profesjonell naturviter, teknolog eller lærer.

Hoveddelen av konferansen er paralleller med diskusjon av artikler. Et sammendrag og endelig bidrag er vurdert av en review-komite etter følgende kriterier: relevans for formål og tema, potensial for å stimulere til diskusjon om undervisning og læring, interessant, generaliserbart og anvendbart for undervisere i høyere utdanning generelt og MNT-utdanning spesielt, refleksjon og diskusjon, forankret i pedagogisk resonnement samt vitenskapelig formelle vurderingskriterier.

I tillegg til vitenskapelige artikler er de 5 sentrene for fremragende utdanning innenfor MNT-feltet invitert til å presentere seg, både på stand, i en fellessesjon og med skriftlig dokumentasjon. Disse sentrene inngår: BioCEED - Senter for fremragende utdanning i biologi, CCSE - Center for Computing in Science Education, ENgage - Centre for Engaged Education through Entrepreneurship, ExcITEd - Excellent IT Education, MatRIC - Centre for Research, Innovation and Coordination of Mathematics Teaching.

Statsråd Torbjørn Røe Isaksen presenterer Stortingsmeldingen «Kultur for kvalitet i høyere utdanning». Professor Sian Beilock er konferansens Keynote-speaker. En rekke studenter, vitenskapelig ansatte og ledere fra MNT-feltet bidrar til gjennomføringen av programmet som ledes av Roger Midtstraum, leder av UHR-MNT. I tillegg bidrar UiO og Nasjonalt Senter for Realfagsrekruttering med presentasjoner. Alle konferansedeltakerne oppfordres til å bidra aktivt i diskusjoner om de ulike bidragene. Vi takker alle bidragsytere og ønsker at alle deltakere blir inspirert til videre arbeid med utdanningskvalitet i MNT-feltet.

Et open access tidsskrift, Nordic Journal of STEM Education, er etablert. Artiklene som presenteres på konferansen vil også presenteres på tidsskriftets nettside som spesialutgave. I etterkant av konferansen vil det være mulig å videreutvikle konferansebidragene til artikler som kan sendes inn til fagfellevurdering for eventuell publisering av full artikkel i tidsskriftet.

På vegne av Programkomite og Reviewkomite,
Reidar Lyng og Mette Mo Jakobsen, ansvarlige redaktører

Konferansen arrangeres av Universitets- og høgskolerådet, UHR ved UHR-MNT, nasjonal fagstrategisk enhet for MNT-feltet, Nasjonalt senter for realfagsrekruttering, NSR og Universitetet i Oslo, UiO Matematisk-naturvitenskapelige fakultet.

Programkomiteen har bestått av: Mette Mo Jakobsen, UHR; Bjørn Åge Tømmerås, UiB; Solveig Kristensen, UiO; Hilde Færevik, NSR; Marit Wangen, NSR; Hanne Sølna, UiO; Sølvi Haavik, UiO; Eirin Bruholt, UiO.

Review-komiteen har bestått av: Mette Mo Jakobsen, PhD, Universitets- og Høgskolerådet; Reidar Lyng, PhD Førsteamanuensis NTNU, Redaktør for Nordic Journal of STEM Education; Roy Andersson, Førsteamanuensis og pedagogisk konsulent, Lunds Tekniska Högskola, Førsteamanuensis II, bioCEED, UiB; Inger Christin Borge, Førstelektor, UiO; Tiina Komulainen, PhD Førsteamanuensis, HiOA

Some factors affecting the grades of technology students

Øyvind Weiby Gregersen, *Norwegian University of Science and Technology (NTNU)* oyvind.w.gregersen@ntnu.no, Geir Øivind Kløkstad *University of Agder (UiA)* geir.klokstad@uia.no, Sigbjørn Hervik, *University of Stavanger (UiS)* sigbjorn.hervik@uis.no, Hans Ekkerhard Plesser, *Norwegian University of Life Sciences (NMBU)* hans.ekkehard.plesser@nmbu.no and Ivar Pettersen, *Norwegian University of Science and Technology (NTNU)* ivar.pettersen@ntnu.no

ABSTRACT: In this study factors that affect the grades of Norwegian technology students have been investigated. The total data set contained 355.706 individual exams from 63 different engineering master programs during the 2010 to 2014 period.

Regression analysis showed that the single factor having the largest impact on students' grades at university was their average grade from high school. Students who had on average one unit better grade from high school got on average 1.4 to 1.7 units better grades in the first year at university and even on their master thesis they got 0.76 units better grades.

Strong correlations in the awarded grades for single students were also observed between the different years of five-year integrated study programs. These findings show that the universities are consistent in the evaluation of the student's work.

When we adjusted for the effect of grades received in high school and earlier stages of university studies, we still found significant variation between study programs on how the master thesis were graded. The effect was as high as 0.4 grade units away from the average level. Such differences may both be explained by local cultures in grading, but could also reflect the quality of the student supervision during the master thesis work.

In 2014 new grade descriptions was implemented in the STEM area and new instructions distributed to the examiners. A significant reduction in the average grade was found, but the effect was not strong, only -0.14 grade units.

Keywords: Grading, Technology, Master programs, Relative grading

1 INTRODUCTION

This investigation of the use of grades in the master of technology studies in Norway was done as a part of the long-term work of The Norwegian Association of Higher Education Institutions (UHR) to ensure correct use of the ECTS grading scale across Norwegian institutions. The Norwegian grading system is supposed to be absolute, i.e. a certain grade, e.g. C, should represent the same quality of achievement no matter which university or university college awarded the grade. However, previous studies (Mjøen and Tjelta 2010, Strøm *et al* 2013) showed that there are strong differences in how grades are used in Norway. Internationally there is a growing literature on how universities are grading their students. Common topics are grade inflation (e.g. Sabot and Wakeman-Linn 1991, Yang and Yip 2003, Johnson 2003, Achen and Courant 2009), systematic differences in the use of the grading scale between university departments (Achen and Courant 2009) and connection between grading and the funding system for universities (de Paola 2011, Bauer and Grave 2011). In the current study we wanted to investigate if the trends regarding differences between institutions and relative grading seen overall for Norway (Mjøen and Tjelta 2010, Strøm *et al* 2013) also are present in master of technology studies and we wanted to investigate more closely which factors are affecting the grades of the students.

2 METHODS

Data were collected from all master of technology study programs in Norway that award 20 or more degrees per year. For each program anonymized grading information for each individual exam for the period 2010 through 2014 were registered and coupled to the student's study program. The total data set contained 355.706 individual exams from 63 different engineering study programs (integrated 5 year programs and 2 year programs). In addition, information about the student's workload, average admission grades and the programs graduation efficiency was taken from Studiebarometeret (2014) in addition each institution provided information regarding use of internal and external examiners and implementation of the new grade description in 2013. An overview of the number of programs and number of examined master students are given in Table 1.

Table 1: Overview of the master programs and number of master students graduated (2014) investigated in the 2010-2014 period in this study.

Institution	Programs	# master students/year (2014)
Høyskolen i Buskerud og Vestfold (HVB)	3	28
Høyskolen i Ålesund (HiALS)	3	14
Høyskolen i Gjøvik (HiG)	3	33
Høyskolen i Narvik (HiN)	3	42
Høyskolen i Telemark (HiT)	3	69
Norges miljø og biovitenskapelige universitet (NMBU)	6	116
Norges teknisk naturvitenskaplige universitet (NTNU)	28	1426
Universitetet i Agder (UiA)	4	75
Universitetet i Stavanger (UiS)	6	135
Norges Arktiske Universitet (UiT)	4	27
Total	1098	1965

The connection between the university grades, the students high school grades, their work load and other parameters were investigated through regression analysis. Several different regression models were tested where the university grades in a specific subject or the average e.g. for all master level subjects were used as the dependent variable. Different sets of independent variables were then used such as the students age, gender and average grades from high school etc. The statistical significance and impact of each independent variable were reported. All regression coefficients presented are at least significant on the 95% significance level unless otherwise stated. Grades A through F were converted to numerical values before analysis (A: 5, F: 0). Unless mentioned otherwise, all data were obtained from *Felles studentsystem (FS)* and provided by participating institutions.

3 RESULTS AND DISCUSSION

3.1 High school grades

The most important factor influencing the grades the technology students receive are their grades in high school. In this study, we found that the students on average get 1.5 units better university grades in basic courses if they have one unit better grade in high school (Table 2). This effect is stronger than what was observed by Strøm et al (2013) who found that the Norwegian students got on average 0.85 units better university grades per unit high school grade. Even for the grade on the master thesis the effect of the high school grade was as strong as 0.76 units better grade per unit high school grade.

Table 2: Results from a regression analysis between high school grades and the grades in basic university courses for engineers. The factor 1.5 means that a student with on average one unit better grades in high school got on average 1.5 units better grades in the university.

All basic courses	Mathematics 1	Physics 1	Computer science 1	Master thesis
1.5	1.7	1.4	1.5	0.76

3.2 Student work load

For student work load, we did not have access to individual data, but we did have average data for each study program from the Studiebarometeret (2014). In figure 1 the average grade of the student's master thesis is plotted against the average non-scheduled work of the students per week. As can be seen there is a weak tendency that the students working more achieve higher grades. However, the work load of the students is positively correlated with their average high school grades so it is hard to discern the effect of talent from the effect of hard work.

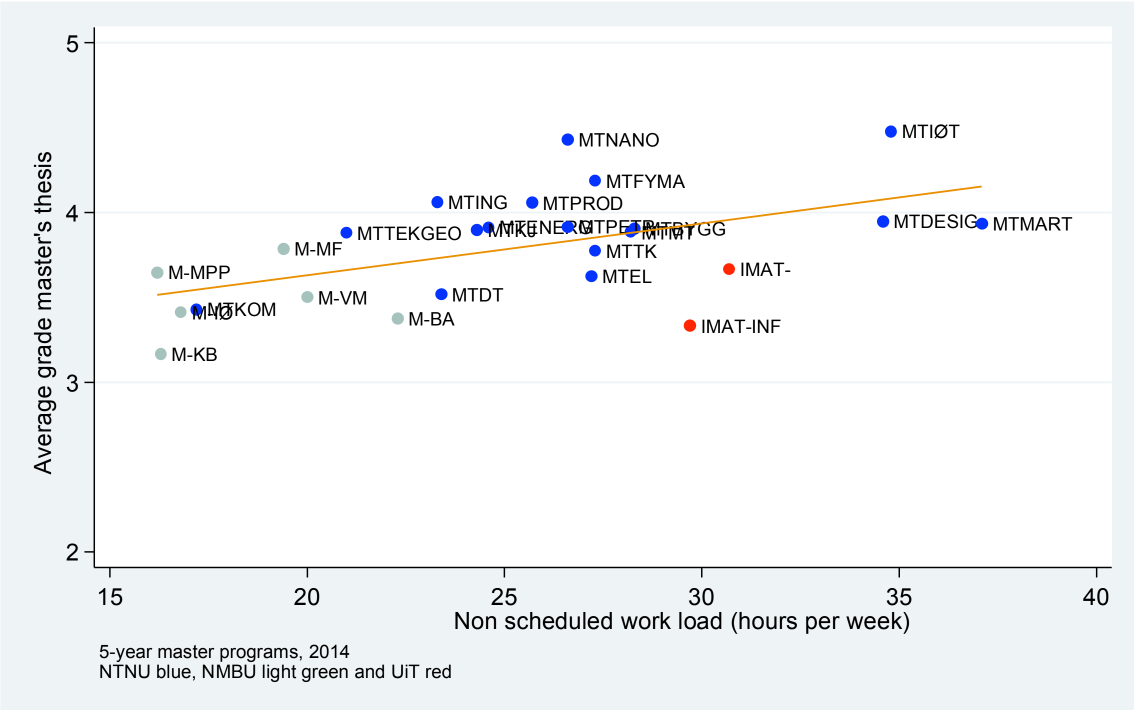

Fig. 1: The effect of self-study time of the students in different study programs on the average grade of the master thesis

3.3 Individual grade development throughout five-year programs

Table 3 shows that there is a strong correlation between the grades each individual student achieves throughout his/her studies. The effect is strongest in directly adjacent parts of the study program, but also students who do better in their first year are likely to perform better on their master thesis.

Table 3: Correlation between grades at different stages through the university education for individual students. A number of 0.5 means that if you have on average one unit better grade on a lower level, you will on average do 0.5 units better on the next level.

	Master thesis	Master courses	2. year courses	1. year courses
Master thesis	1			
Master courses	0.48	1		
2. year courses	0.31	0.52	1	
1. year courses	0.28	0.45	0.69	1

3.4 Grading differences between stages of studies

In this study, we found that the students consistently get better grades through their studies (Figure 2). This finding is in agreement with what Achen and Courant (2009) found in the United States. They point out that in upper division courses, the students are on average more motivated for and talented in the courses they take and teaching quality is generally better (smaller classes, more interested students and professors). However, Achen and Courant also point out that the motivation for giving good grades in upper level classes can be higher to attract students and to recruit postgraduate students to the research field.

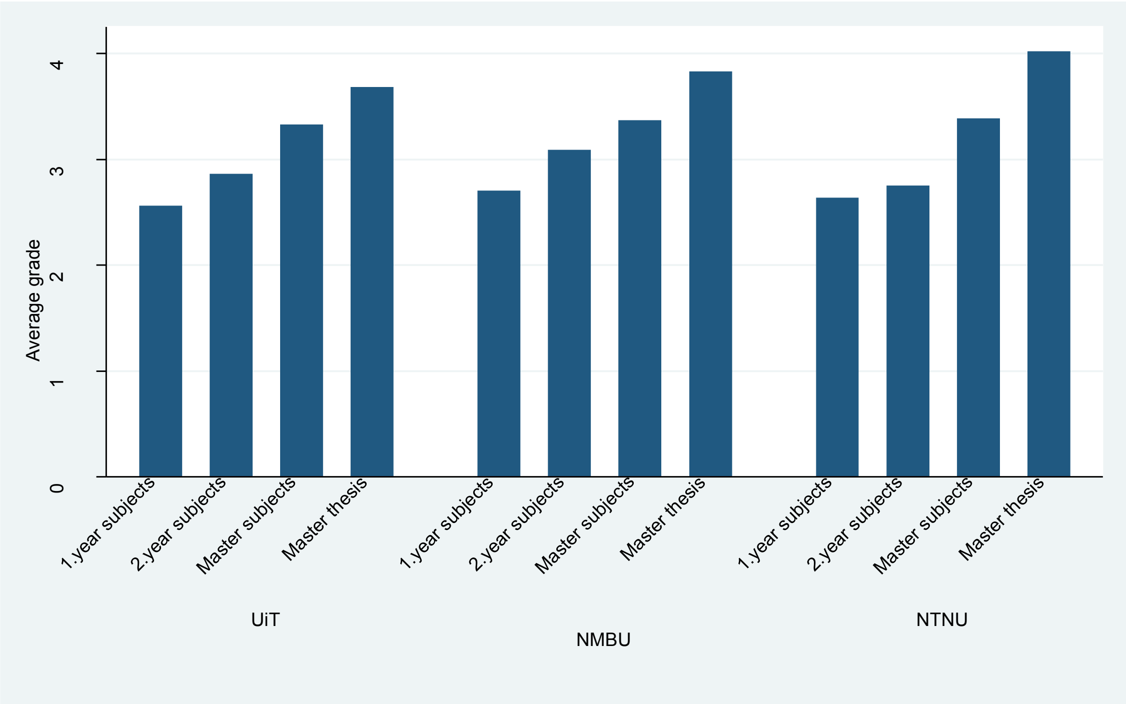

Fig. 2: The average grade awarded in the engineering exams as a function of course level (first year, second year, master level, master thesis) for the three universities UiT, NMBU and NTNU.

3.5 The effect of grades on graduation efficiency

Universities and university colleges are facing significant pressure from the government to improve the graduation rate in their programs. One factor which is thought to influence whether a student choose to stay in or leave a certain study program is how well the student perform during the first two semesters. Figure 3 shows that some 40-60% of the students who quit, change study program or have the admission to the study program terminated (due to lack of progress) received an F in their initial mathematics course. As these students are quite talented (since they fulfilled the stringent admissions requirements for engineering programs), this is a strong indication that teaching the students a good study routine and technique so that they do decently early in the studies is an important objective for the universities.

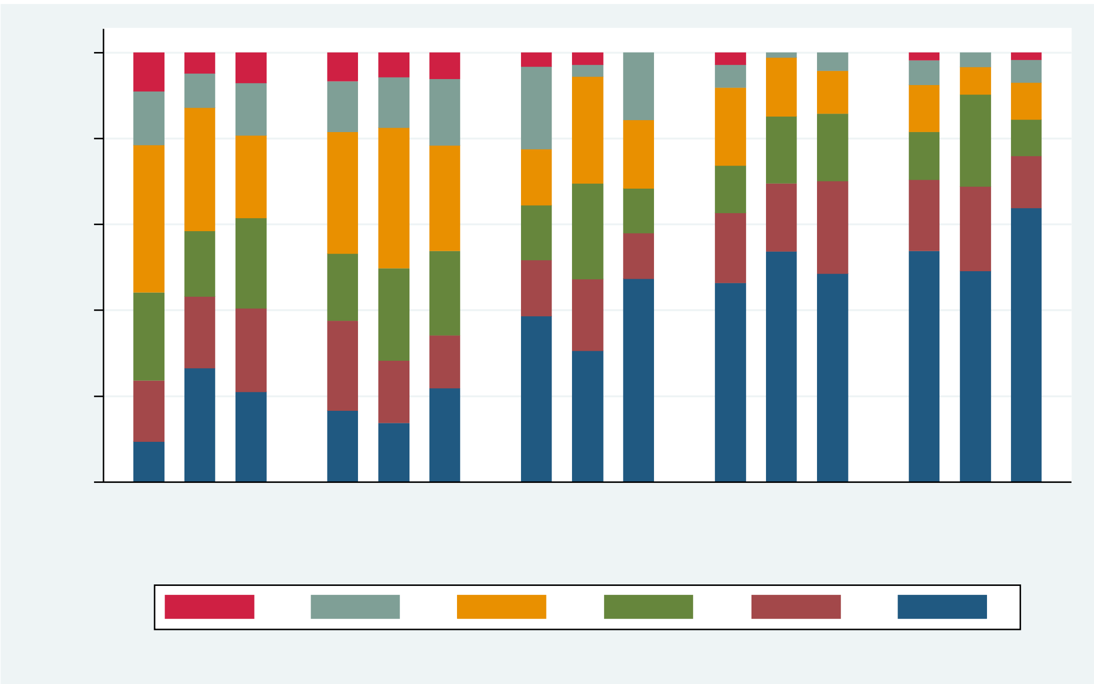

Fig. 3: The distribution of grades for students who are active or have graduated and for those who have dropped out or transferred to another study program.

3.6 Relative or absolute grading

In Norway the grading system by definition is absolute, i.e. the students shall not be compared to each other but be compared to an outside objective standard for what is to be expected. The use of external examiners and the use of investigations of the grading regimes (UHR's karakterundersøkelser) between the universities in different subject areas are two measures to make grading practice reasonably absolute. However, seen from the perspective of each single professor, it easily happens that the amount and difficulty of the curriculum, and not least the difficulty of the exam is adapted to give a decent spread in results for the students you happen to have. The effect of this is that study programs that receive students with strong grades from high school tend to give tougher exams compared to study programs where the admission requirements are weaker. Strøm et al (2013) documented this well for the entire university sector in Norway: They found that high admission requirements correlated negatively with how easy it is for the students to get good grades at a certain university. Another point of evidence pointing in this direction is the strong impact the average high school grades have on the grades received at university for individual students (1.5 units per unit for basic courses). This effect is not very surprising as the study programs investigated here receive students who have from 4.1-5.2 (on a scale from 1-6, where 6 is best) as average grades for the group and in all cases quite high minimum grades for the individual students (particularly true for NTNU). These students are then spread out over an A-F grade scale with a typically more or less Gaussian distribution around C. Thus a factor of above 1 in the grades at university per grade at high school is expected.

In our data it was observed that this effect may be particularly pronounced for courses with many students. Table 4 shows the outcome of a regression analysis where the effect of the logarithm of the number of students following a course on the average grade, fraction of A and fraction of F was investigated. The model was adjusted for the level of the course, study program and institution. As can be seen courses with more students typically award a lower fraction of A's, more F's and a lover average grade. This may indicate that the probability of relative grading is larger when there are more students, however it is also possible that the teaching quality or effectiveness of teaching is reduced when there are more students.

Table 4: The effect of the logarithm of student number in a course on the grading of the students

	Average grade	Fraction A	Fraction F
Number of students (ln)	-0.18	-0.015	0.022

3.7 Differences in grading of master thesis between departments

Both on national level (Strøm *et al* 2013) and on international level (Achen and Courant 2009), it has been shown that different departments use the grading scale differently. Both studies find that "hard" subjects like mathematics and physics typically gives out a lower grades compared to more "soft" subjects. Achen and Courant (2009) link this both to the fact that mathematics and physics exams typically are easier to grade, the answer is either right or wrong, but interestingly they also argue that it is easier for a department to give low average grades in compulsory courses as compared to electable courses.

In this study an important objective was to investigate if there are systematic differences in the grading of technology master thesis that cannot be explained by the differences in admission grades of the students. To do so a regression model was made where the arguments were the admission grade of the students and the study program as a binary variable. Figure 4 shows that there are as much as ± 0.4 grades in difference in the master thesis grades between the programs. This difference could either be understood as some of the programs doing a consistently better job in supervising the master students; however, it seems more likely that the difference is mainly caused by different local traditions in how to use the grading scale. It should be noted that these trends may change with time and in particular change with the new grade definitions introduced for STEM-subjects from the spring of 2014.

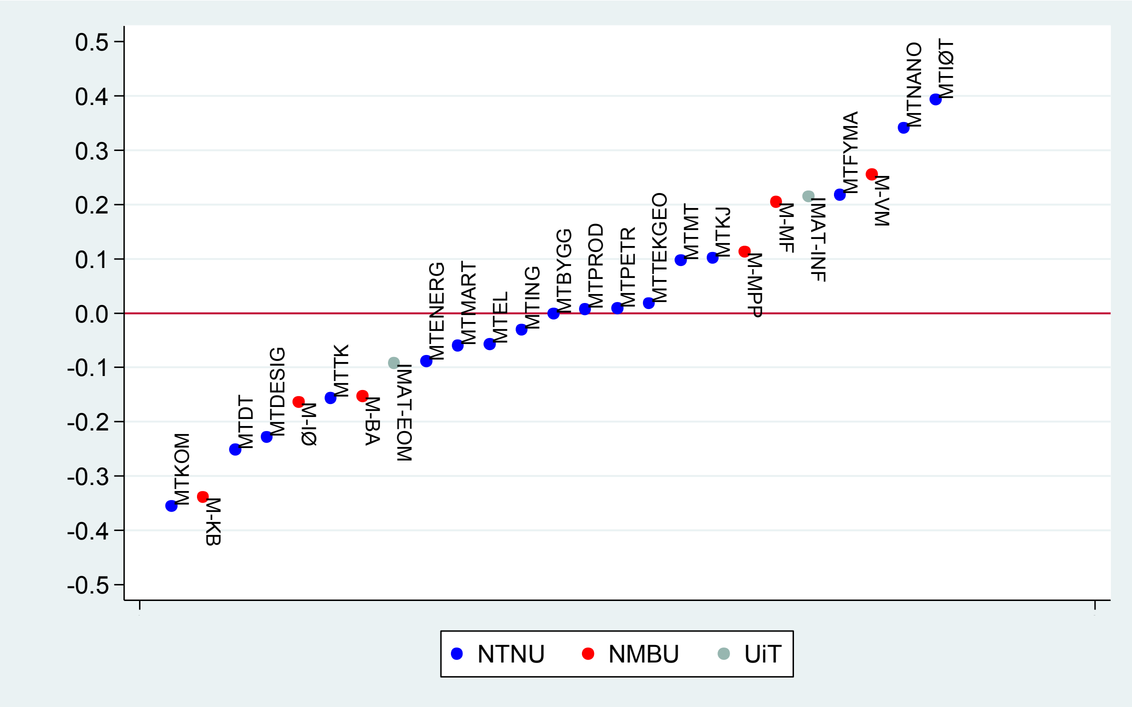

Fig. 4: Program contribution to the grade of the master thesis for the different engineering master programs. A positive score of 0.1 means that the students receive on average 0.1 grade units on their master thesis above what is expected based on their admission grades.

3.8 New STEM grade descriptions

In 2014, new grade descriptions were implemented in the STEM area and new instructions distributed to the examiners. The purpose of this was to move towards a fuller use of the grading scale for master theses. A significant reduction in the average grade was found, but the average effect was not strong, only -0.14 grade units (Table 4). Considerable variation between the universities in the effect of implementing this change was also seen.

Table 4: The change in average grade on master theses in 2014 compared to the average for the institution during 2010 to 2013.

	All	HiALS	HiG	HiN	HiT	NMBU	NTNU	UiA	UiS	UiT
Change in average master grade 2014*	**-0.14**	**1.03**	**-0.61**	-0.26	**-0.69**	**-0.53**	**-0.10**	-0.02	-0.08	-0.27

* Coefficients in bold show a significant change in 2014 compared to the 2010-2013 period.

4 CONCLUSIONS

The main factors affecting the grades of Norwegian engineering students have been investigated. The factor influencing the grades of individual students the most is their average grade from high school. A one unit better grade from high school, predicts on average 1.5 units better grades on the first year university courses and 0.76 units better grades on the master theses. We also found strong correlations between the grades received by individual students at different stages during their five years of master studies. This shows that the universities are consistent in the evaluation of good and weak performances across years and subjects.

The strong effect of the student's high school grades also shows that to use the grading system as an absolute grading system (as it is supposed to be), and not a relative one, it is necessary that study programs with strong students on average award better grades and study programs with weaker students on average award poorer grades. This seems not to be the case today (Strøm *et al* 2013).

Another important result is that there are consistent differences between study programs in how master theses are graded. These differences cannot be explained by the student's high school grades. The most likely explanation is different local cultures in the use of the grading system, however different quality in master student supervision is also a possible factor influencing this result.

The new STEM grade descriptions introduced in 2014 gave a reduction in the average grade awarded of -0.14 grade units. There is significant variation between the institutions in the effect of the new descriptors. This together with systematic differences between study programs in how the grading scale is used should be followed up by each institution.

REFERENCES

Achen A.C. and Courant N.P.(2009), "What are grades made of?", Journal of Economic Perspectives, 23, pp77-92. https://www.aeaweb.org/articles?id=10.1257/jep.23.3.77

Bauer T.K. and Grave B.S. (2011), "Performance-related Funding of Universities – Does more Competition Lead to Grade Inflation?", Ruhr Economic Papers, Nr 288. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1954693

de Paola M. (2011), "Easy grading practices and supply-demand factors: evidence from Italy", Empirical Economics, 41 pp227-246. https://www.researchgate.net/publication/226998891_Easy_grading_practices_and_supply-demand_factors_Evidence_from_Italy

Johnson, V.E. (2003), "Grade inflation: A Chrisis in College Education". Springer.

Mjøen, J. and Tjelta M. (2010), "Grading standards, student ability and errors in college admission", Scandinavian Journal of Educational Research, 54, pp221-237. http://dx.doi.org/10.1080/00313831003764503

Sabot R. and Wakeman-Linn J. (1991), "Grade Inflation and Course Choice." Journal of Economic Perspectives, 5(1): pp159-170. https://www.aeaweb.org/articles?id=10.1257/jep.5.1.159

Strøm B., Falch T., Gunnes T. and Haraldsvik M. (2013), «Karakterbruk i høyere utdanning», SØF-rapport no. 03. https://www.regjeringen.no/globalassets/upload/kd/karakterbruk_og_kvalitet_i_hoyere_utdanning.pdf

Studiebarometeret (2014): http://www.studiebarometeret.no/no/

Yang H. and Yip C.S. (2003), "An Economic Theory of Grade Inflation. Working Paper" http://econ.ohio-state.edu/hyang/grade-inflation.pdf .