The role of students' motivation and self-regulation during online biology education

Research paper

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Abstract

Covid-19 has forced many countries into a lockdown, closing down malls, events, and even schools. This situation has forced us to shift towards online-education which was uncharted territory for schools, probably for most of the teachers and all of the students. As time passed on, schools had to develop measures to ensure that students would still receive an appropriate level of education. Using the limited amount of information on online education during lockdown available, schools had to decide which measures are most relevant to combat a possible learning backlog, without putting too much pressure on the teachers. Now that vaccinations have begun and the lockdown will hopefully soon be over, it would be wise to gain insight from this situation. We have to ensure that in the future, online education will be as effective as possible. I have taken a look into the effect of online biology education on 11 – 17-year-old students' four variables of motivation: self-regulation, self-efficacy, task value, and learning goal orientation using the SALES-questionnaire by Velayutham et al. (2011). Secondly, I have studied the effect of these four variables on performance during online biology education. It turns out that students, contrary to what might be expected, are still motivated to perform at school during online education. Secondly, this research has shown that self-regulation is correlated with performance during online education. A recommendation for school could be the development of a plan to support students in their self-regulation, especially during online education.

Table of Contents

Introduction

With a huge part of the world, including the Netherlands, quarantined following the Covid-19 pandemic, many schools had to close their doors affecting education worldwide. Regular in-school-education had to make an overnight shift to online-education (Dhawan, 2020). Institutions in the Netherlands didn't question how successful online education is, as this was the only option for education. In my own experience as a teacher, where we drastically shifted to Zoom for communication and Google Classroom for exercises, in these first weeks it became evident that these educational tools were, unsurprisingly, not prepared and not ready for a shift towards online education. Plagued by updates, system errors, and failed internet connections I would not call this a success. Secondly, teachers at my school were not prepared and had only 3 days to prepare for an entirely new, unknown situation. Although the implementation of digital tools in learning has been a goal for educational institutes in the Netherlands for a long time, thus far the actual use of technology was mostly limited to Powerpoint and smartboard (van der Spoel, Noroozi, Schuurink, & van Ginkel, 2020). Nevertheless, these same few weeks were indicative of the professionality of teachers and the willingness to adapt for the good of the students. This show of goodwill was unfortunately not a recipe for absolute success. Pre-Covid-19 research has shown that students are skilled enough to successfully take part in online learning, but the downside was the inability of teachers to create online lessons and a lacking perception of technology usage in education (Aslan & Zhu, 2015). The integration of the pedagogical potential of digital tools into online education might, however, prove to develop a truly beneficial online learning environment. I am happy to report that a lot has improved over the year and more research is being done to improve online-education.

In the last year especially, quite a lot of research has been done on the experiences and preferences of teachers on online teaching (Dhawan, 2020; Noor, Isa, & Mazhar, 2020; Song, Wu, & Zhi, 2020; van der Spoel et al., 2020; Zhang, Wang, Yang, & Wang, 2020). A research study on experiences of teachers and principals in primary and secondary schools in China with online teaching showed that teachers show interest and motivation into adapting towards online teaching. However, many teachers believe online teaching only to be somewhat effective. Teachers experience a lower quality of education compared to regular at-school education (Song et al., 2020). Next to problematic issues like internet errors, software malfunction and issues with the webcams, lack of experience and lack of training seem to be the key points for improvement according to teachers. Especially these last two points are where schools and teachers may need to improve. Although quite a lot of research studies have been done on the experiences of teachers in online education, I find that there is surprisingly little research on the implications of online learning from a student-viewpoint and this is especially the case for primary, secondary, and high school students.

Focus of this research

I aim to gain insight into how high school students experience biology education during the lockdown in the Netherlands. Last year (2020), covid-19 has had quite an impact on students' performance at school, where the government had to cancel the national exams and were more lenient with the grades from school exams. This year, students don't get the same luxury but do get some compensation for their troubles, meaning they are allowed to fail 3 subjects instead of the usual 2. This excludes the subjects Dutch, English, and mathematics. I am a teacher myself and I teach biology to students ranging from 12 to 18 years old on HAVO and VWO levels, therefore this will be the target group for this research as well. HAVO and VWO are the two highest levels in secondary education in the Netherlands. I have heard a lot of complaints from my students about online-education. These complaints range from too much homework to teachers not even showing up during the online meetings but also more insightful critique like missing group work, a lack of interaction between teacher and students but all critique seems to have the same underlying message; they are less motivated during online education. Some students truly feel like they won't be able to pass high school just by online learning. For this research, I am interested in how performance, in the form of grades, is correlated with students' motivation during online-education.

Relevance of this research

There are several reasons why this research is relevant, especially now. Millions of students are forced to stay at home and have online education. In my own experience, but also according to research, to some extent, this can lead to a backlog in capabilities and knowledge of a lot of students (Song et al., 2020). It should however be noted that there is no clear causation as, for example, there is no control group that has a regular form of education and there are a lot of factors that can influence overall performance during online education. Nevertheless, this situation also gives rise to a lot of situations and data sets that may provide insight into what we can do to improve online education in the future.

There is already quite a lot of information on possibilities and opportunities that, according to research, help teachers improve their online teaching skills. I don't question this research, however, online-education during lockdown was still somewhat uncharted territory before Covid-19 came to be. Most research on online education is substantiated using data from pre-covid 19 (Ebner et al., 2020; Gewin, 2020; Kopp, Gröblinger, & Adams, 2019; Santelli, Stewart, & Mandernach, 2020; Stark, 2019; Taylor & Maor, 2000; Zhang et al., 2020), and often using facultative courses for students or courses on a university level (Adedoyin & Soykan, 2020; Adnan & Anwar, 2020; Ebner et al., 2020; Kopp et al., 2019; Mishra, Gupta, & Shree, 2020; Santelli et al., 2020; Stark, 2019; Sun, Tang, & Zuo, 2020; Taylor & Maor, 2000). As my focus is on high school level students ranging from 12 to 18, during obligatory online biology courses, preferably during the covid19 pandemic, this is a very specific topic. Secondly, there is a lot of research on online teaching, ways to keep students engaged, and how teachers experience online teaching (Gewin, 2020; Noor et al., 2020; Rasmitadila et al., 2020; Song et al., 2020; van der Spoel et al., 2020). It seems, to me, evident that this won't be the last time that we are forced to practice online education. Therefore, I find it very important to learn from this situation so that we are prepared the next time something like this occurs.

Student experiences

First and foremost, there has been an evaluation at the school where I teach, which was partly the inspiration for this research. The aim of this evaluation was to gain insight into the experiences of students. Many of my students experience a lack of communication between students, parents, teachers, and principals during online education. This lack of communication is often experienced as sheer chaos. Other issues that are often mentioned are connection issues, lack of experience in online education, and many others relating to technology, in line with research (Adnan & Anwar, 2020; Dhawan, 2020; Rasmitadila et al., 2020; Song et al., 2020; Sun et al., 2020). Nevertheless, these references are all centered around the viewpoints of teachers and principals themselves, ignoring the experiences of the students. As mentioned before, there is some research on the experiences of students (Somenarain, 2010; Yates, Starkey, Egerton, & Flueggen, 2020), but it is very limited and usually on a different target group than the age range from twelve to eighteen like at my school. In a lot of countries, the biggest problems of online education, according to students, are the internet and technology struggles (Adnan & Anwar, 2020; Sun et al., 2020). While this still is a problem for online education for some households in the Netherlands (van Deursen & van Dijk, 2019), I think that at my school and in the Netherlands in general, access to internet and technology is less of a problem compared to many other countries (Ahmed, Cho, Jaidka, Eschstaedt, & Ungar, 2020). The most common complaints in the evaluation were the lack of interaction, the fear of failing exams, the lack of engagement, and the overall lack of motivation. For that reason, I am mostly interested in the level of motivation during online education and whether this is correlated with performance.

Students' needs

As mentioned before, a lot of research that is being done to determine what students need to keep education at the highest possible level during online education is teacher- or even principal-centered, with no access to the actual experiences of the students. It is often true that teachers do know best what is necessary for the students to thrive and I'm not doing this research to debunk this statement. Nevertheless, the lack of research on obligatory online education with a lack of social interaction is an almost entirely new situation with a few exceptions. An earthquake in Christchurch in 2011 and Hurricane Katrina in New Orleans in 2005, but even in those examples the necessary measures were for a shorter period of time, on a university level and on some occasions on a facultative base (Omar, Liu, & Koong, 2008; Todorova & Bjorn-Andersen, 2011).

Therefore, I am interested in finding how students from secondary education experience online education, especially regarding their motivation. I believe that students know best what they require to be motivated and to learn. The self-determination theory assumes that students, just like every human being, are interested in their learning and knowledge-development (Niemiec & Ryan, 2009). Developing a learning environment solely from the perspective of the teachers or principals can thus undermine the sense of relatedness between student and teacher and disrupt the autonomy of the student. Furthermore, this theory by Ryan and Deci states that without relation and autonomy, there will be no performance (Ryan & Deci, 2000). I think that ignoring the ideas and wishes of the students in their education is undermining their autonomy possibly resulting in a decline of competence.

Online education from a students' perspective

As mentioned before, I aim to gain insight into the views of online biology education from a students' perspective. Most teachers are no real 'experts' on this topic as this is a novel situation. In my humble opinion, the closest thing to an expert at this moment are the students themselves. Before the start of this research, I've asked some of my students from an age of around 15 years old about their experiences with online education and the good and bad aspects that teachers differ in during online education and it became clear that students did have clear and sensible viewpoints on this matter. Opinions might differ between students themselves and compared to their teachers, but this is no reason not to listen. As Cook-Sather beautifully puts it in her research:

> "Because we have lived longer and have a fuller history to look back upon, we certainly know more about the world as it has been thus far. But we do not know more than students living in the dawn of the 21st century about what it means to be a student in the modern world" (Cook-Sather, 2002).

To me, this quote is now more relevant than ever. In a new form of education in which teachers and principals have but little experience, we need to look into how we reconceptualize the role of all the participants in education and need to, if students deem this necessary, alter certain aspects of online education together with the students instead of for the students. At the school where I teach, many measures are taken to help students cope during online education like shorter classes to give students extra time to work for themselves, extra hours for students who struggle with a specific course to get tutoring, and so on. These measures are not substantiated, nor proven to be helpful as the tutoring is facultative and there is no control over students during their extra "work-hours". I wouldn't be surprised if the shortened classes turn out to be counterproductive instead. Some students often feel disconnected from teachers and schoolwork (Certo, Cauley, & Chafin, 2003). This can only have grown over the last couple of months during the pandemic. Allowing students to have some level of participation might give them a sense of autonomy.

Motivation as a key to performance

In this research, I define motivation as the energy, direction, and persistence to produce positive results from learning (Ryan & Deci, 2000). Motivation can be divided into intrinsic-, or the human tendency to explore and learn for the satisfaction of the outcome, and extrinsic motivation where one learns for a separable outcome (Ryan & Deci, 2000). For example, intrinsic motivation to learn is learning for self-improvement and overall enthusiasm. Extrinsic motivation to learn is learning for good grades, rewards, or approval of teachers, friends, and family (Ryan & Deci, 2000). It is probable that high school students during covid19 are less intrinsically motivated to study, given that they miss the social aspects of school. They also lack the extrinsic consequences of stalling the workload and many of my students get distracted by social media, family matters, streaming services, and so on. In research on high school students in New Zealand, 39% chose motivation as the biggest threat to performance during online education (Yates et al., 2020). To make matters worse, research has shown that motivational variables play a major role in predicting student performance in online courses compared to face-to-face courses (Credé & Phillips, 2011). Secondly, during online courses, motivational variables such as persistence are more strongly correlated to course performance than learning strategies (Credé & Phillips, 2011; Stark, 2019). Online education can, in some cases, lead to higher intrinsic motivation,

as it gives students the chance to be more flexible and plan their work (Stark, 2019). My experience as a secondary education teacher leads me to believe that, especially for students from 11 to 17 years old, in general they are less intrinsically motivated and unable to properly plan their work and fail to properly handle the responsibilities. Nevertheless, if an increased intrinsic motivation improves students' persistence and performance during online education, a follow-up thought would be how we improve the intrinsic motivation of students during online education. Nevertheless, Ryan and Deci (2000) underline that extrinsic motivation is also not inherently non-autonomous. Extrinsically motivated learners who show high levels of autonomy often show internalization and integration due to self-regulation (Ryan & Deci, 2000). Using extrinsic motivation triggers to motivate students might therefore still be useful during online education, as long as students keep their autonomy (Ryan & Deci, 2000)(Ryan & Deci, 2000)(Ryan & Deci, 2000).

Research has shown that failure at school is often attributed to a lack of motivation and abovementioned self-regulation resulting in an inability to kindle the engagement of students (Hanrahan, Language, & Grove, 2002; Velayutham, Aldridge, & Fraser, 2011). To put it simply, this lack of motivation, either intrinsic or extrinsic, results in lower grades. The three pillars that are, according to research, associated with students' adaptive motivational beliefs are self-efficacy, task value, and learning goal orientation (Velayutham et al., 2011; Zimmerman, 2002). These variables are based on the self-determination theory, achievement goal theory, and the social cognitive theory (Ames, 1992; Bandura, 1985; Ryan & Deci, 2000; Urdan & Schoenfelder, 2006; Velayutham et al., 2011). Self-regulation, self-efficacy, learning goal orientation, and task value are discussed below.

Self-regulation

Self-regulation is the self-directive process by which learners transform their mental abilities into academic skills (Zimmerman, 2002). Zimmerman describes learning as something that is not just a result of teaching, but it is viewed as an activity that students do for themselves in a proactive fashion due to self-regulation. Proactive learners are more aware of their strengths and weaknesses that enable them to set personal goals and monitor the effectiveness of their work in achieving their goals (Zimmerman, 2002). Three components of self-regulation that are important for classroom performance are planning, monitoring, and modifying their use of cognitive strategies as well as management and control of effort in academic tasks (Velayutham et al., 2011). To learn, people observe their actions, judge their processes and outcomes based on their standards, and react accordingly (Bandura, 1985). Research showed that students with a higher level of self-regulation show a higher level of motivation (Pintrich & De Groot, 2003).

Self-efficacy

The 'standards' I mentioned in the section above, are acquired based on previous performances and trust in one's efficacy (Bandura, 1985). Self-efficacy is the ability of students to have faith in their capabilities which has a positive effect on their incentive to learn (Bandura, 1977; Velayutham et al., 2011). Self-efficacy influences students' performance by increasing their effort (Bandura, 1977). This self-efficacy might even be a decent predictor for performance in education (Bandura, 1977). This article by Bandura indicates that motivation and self-efficacy are intertwined in the sense that motivation and self-efficacy strengthen each other. Self-efficacy affects students'

activities, persistence, and effort which in turn might have a positive effect on self-regulation as well. When students learn while trusting in their skills, students expect positive outcomes and in turn work towards those positive outcomes.

Task value

The way tasks, or learning activities and content, are designed has a strong influence on how students approach learning and planning (Ames, 1992). More diversity in tasks, tasks that students perceive as useful and meaningful, or tasks that students find challenging and interesting have value for students. Students are more likely to learn and thus perform when they value their tasks (Ames, 1992; Pintrich & De Groot, 2003; Velayutham et al., 2011). Although the theory of task value may resemble self-efficacy, the emphasis of task value lies in how students perceive the task, whereas self-efficacy is related to how students perceive their skills in doing the task. Moreover, task value enhances the intrinsic motivation of students which might improve their persistence, which in turn enhances their cognitive abilities which can result in students being confident in their abilities and thus improves their self-efficacy (Eccles & Wigfield, 2002; Pintrich & De Groot, 2003; Velayutham et al., 2011). Another finding postulates that task value not only improves academic performance but also enhances scientific interest (Tuan, Chin, & Shieh, 2005; Velayutham et al., 2011), which might not be the goal for this research but, as someone with a fascination for science, I find that an important goal for education nonetheless.

Learning goal orientation

The theory of learning goal orientation emphasizes the development of competence for students by prioritizing learning, understanding, and mastering tasks (Velayutham et al., 2011). Just like task value and self-efficacy, this has a positive effect on interest towards science and improves science achievement (Tuan et al., 2005). Goal orientation has been divided into two categories; learning goal orientation or "the goal to develop ability" and performance goal orientation or "the goal to demonstrate ability" (Urdan & Midgley, 2003; Velayutham et al., 2011). These two can often be separated respectively by the concepts of intrinsic motivation and extrinsic motivation. As a teacher, I see a lot of students learning to pass their grades, extrinsic motivation, instead of working towards comprehending science subjects, intrinsic motivation. By improving the learning goal orientation, students will have a higher intrinsic motivation which can lead to higher performance (Eccles & Wigfield, 2002; Niemiec & Ryan, 2009; Pintrich, Smith, Garcia, & Mckeachie, 1993). Research has shown that a teacher can positively impact students' learning goal orientation by working towards understanding and mastery instead of high grades (Urdan & Midgley, 2003). Students should have a clear 'goal structure' which students should work towards to master a course.

The four variables and the research instrument

It should be noted that, although I will research self-regulation and the three cornerstones for motivation independently, these four factors influence each other greatly. For example, Velayutham et al. (2011) mentioned that self-efficacy has a positive effect on self-regulation and so on. In this research, I will use the SALES questionnaire by Velayutham et al. (2011) which stands for students' adaptive learning engagement in science. Adaptive learning engagement can be translated to delivering personalized learning to engage each student most effectively. Therefore, self-regulation, self-efficacy, task value, and learning goal orientation provide high adaptive

learning engagement and thus a higher motivation. Although more peer-reviewed questionnaires to study motivation are available, I believe that the SALES questionnaire is more convenient than, for example, the MLSQ from Pintrinch et al. (1993). Although this questionnaire is mostly used for the same kind of research and only has 2 major variables, it has 15 sub-variables and 81 items (Credé & Phillips, 2011; Pintrich et al., 1993). Secondly, the SALES-questionnaire has higher reliability and has at least been proven to still be reliable when translated to Turkish so I am optimistic about translating it to Dutch as well (Inaltun & Ateş, 2015; Velayutham et al., 2011).

Main research question

What is the correlation between online education and 11-17-year-old students' motivation for biology courses in the Netherlands?

Research sub-questions

- How do secondary education students experience online biology-education regarding their self-efficacy, task value, self-regulation, and learning goal orientation?
- What is the relation between performance and motivation during online biology education?

Methodology

For this research, I collected data from a school in the northern parts of the Netherlands. The school is in a small city in the Netherlands where students are mostly Caucasian. I did not select for specific factors or variables; the target group is already quite specific with students from 11 to 17 years old in biology education (n=121). The number of students per age, grades, and per gender can be found in table 1. In this research, I picked students by using probability sampling where all students are asked to respond via e-mail (Denscombe, 2014). As mentioned above, I only asked teachers of students from 11 to 17 with biology courses to distribute the questionnaire to reach as many students as possible that study biology. Including myself, there were four teachers involved. To be able to determine the reliability and make comparisons, I collected data like age, class, gender, and grades. Grades were collected as a means to assess the students' performance during online education. The grades from the period of online education are on a scale from 1-10 with 10 being the perfect score, 1-5 is an insufficient grade and 6-10 is sufficient to pass. In this study, the questionnaire was handled entirely anonymously to ensure that there are no confidentiality concerns and I specifically looked at the situation of the students at this school without any generalization. The participant characteristics can be found in table 1. Unfortunately, the age groups in my sample were unevenly distributed with a vast majority of students being 12-14 years old.

Table 1

Age, grades, and gender of the participants (N=121).
Grades are round as following: 6,4 -> 6 and 6,5 -> 7 and so on.

Participants					
Age		Grades (rounded)		Gender	
11	1	5	19	Male	48
12	41	6	55	Female	70
13	48	7	39	Rather not say	3
14	19	8	7		
15	8	9	1		
16	3				
17	1				

Research instrument

For this research, I used a questionnaire with peer-reviewed and validated questions (Velayutham et al., 2011). This survey specifically looks into self-regulation and motivation of students in science education. The questions can be found in the appendix. I decided to use the SALES questionnaire because it is thoroughly validated, and it has a high reliability. A Cronbach alpha of over 0.9 for each of the four factors, substantiates these statements (Velayutham et al., 2011). Secondly, this research showed that learning goal orientation, task value, self-regulation, and self-efficacy are strongly correlated with science performance (using the rounded grades of students) which is shown using a Pearson correlation. My surveys were handed in Dutch to the students, but I translated them to the best of my capabilities.

My survey used the SALES questionnaire by Velayutham et al. which is proven to be reliable in various studies (Bedford, 2017; Chua & Karpudewan, 2017; Inaltun & Ateş, 2015; Velayutham et al., 2011; Velayutham, Aldridge, & Fraser, 2012; Velayutham & Aldridge, 2013). The survey uses a Likert 1-5 scale. Different than the original survey from Velayutham, I started the survey with a notification that the questions were to be answered in regard to online biology education instead of science education. I started with some questions to assess variables like class, gender, age, grades, and a reminder that the data would be solely used for research purposes and would remain anonymous. I delivered the survey to the students by using google forms. The survey questions can be found in the appendix (Velayutham et al., 2011). There is a total of 32 statements, 8 statements per variable. I have, however, added a few introductory questions. Each statement is positively formulated, indicating that the answer '5' shows a very high level of motivation and a '1' shows a very low level of motivation.

Data analysis

Given that I used questions using a Likert scale with a numerical code, this is an ordinal data set that I analyzed using Excel and Stata. It has been a puzzle to determine which statistical analysis to use, as there is a lot of discussion on whether it is appropriate to use parametric tests on Likert scale data (Sullivan & Artino, 2013; Velayutham et al., 2011, 2012). Nevertheless, in regard to this discussion, I decided to follow the original paper of this questionnaire and other research in using the Cronbach alpha test if my data appears to be normally distributed. First, I checked for multilinear normality, skewness, and kurtosis. Afterward, I checked for reliability by using a Cronbach's alpha coefficient (Velayutham et al., 2011). Following this research by Velayutham et al., (2011), I separated the group per class, because the SALES questionnaire should be able to distinguish between classes and used an ANOVA test with the Cronbach's alpha to determine the reliability.

Results

First of all, I wanted to determine the level of agreement to the different statements. These can be seen in table 2. Strongly agree shows a high level of motivation while strongly disagree shows a low level of motivation. N=121 and there are 8 statements per variable thus we would expect 968 answers given. Some statements were however skipped or missed by students and thus can't be taken into account.

Table 2

Agreement on statements about motivation during online education
Note: SE (Self-efficacy), TV (Task-value), SR (Self-regulation) and LG (Learning goal orientation). This table shows the level of agreement students have in regard to the questions that can be found in appendix 1. The mean shows the level of agreement of all students combined in regard to the variables of motivation. St dev = standard deviation.

Questions	strongly disagree	disagree	neutral	agree	Strongly agree	Mean	Std dev.
SE	4	55	238	406	232	3,85	0,57
TV	42	156	415	257	77	3,37	0,68
SR	23	122	354	324	118	3,41	0,58
LG	15	115	303	385	137	3,52	0,68

I compared the data points such as the mean and the standard deviation with results from the research of Inaltun & Ateş (2015) to establish whether there is a difference between the motivation of students during online education and regular education as can be seen in table 3. The raw data of previous research on the SALES questionnaire is lacking, making it impossible to do an analysis.

Table 3

Sum of means of self-efficacy, task value, self-regulation & learning goal orientation in my- and Inaltun et al. research with n=30 (Inaltun & Ateş, 2015).
The mean of all answers to each specific statement was taken. The means for all statements with a variable are added up to make a sum of means.
Note: The raw data of this research and from other research with the SALES questionnaire is missing and therefore it is impossible to do statistical tests for difference (Bedford, 2017; Chua & Karpudewan, 2017; Inaltun & Ateş, 2015; Velayutham & Aldridge, 2013).

	This research	Inaltun et al.
Sum of Mean SE	30,5	29,3
Sum of Mean TV	25,3	28,3
Sum of Mean SR	30	26,3
Sum of Mean LG	28,2	33,7

I have used an ANOVA test to differentiate the motivational variables between classes. This was done to determine how reliable the data is compared to previous research, but primarily whether my data and the translated version of the SALES questionnaire are reliable. As can be seen in table 4, the reliability is much lower compared to previous research with the SALES questionnaire. Nevertheless, the Cronbach's alpha still indicates that the results can distinguish between classes and does have internal consistency.

Table 4

Results from this research compared to Velayutham et al., (2011)
Cronbach's alpha is used to determine whether the results can differentiate between classes. This is used as a way to determine internal consistency (Velayutham et al., 2011). Cronbach's alpha over 0.7 is reliable (Cohen, 1988).

	number of items	Cronbach's Alpha (This research)	Cronbach's alpha *(Velayutham et al., 2011)*
SE	8	0.75	0.92
TV	8	0.77	0.92
SR	8	0.79	0.9`
LG	8	0.80	0.91

Secondly, I compared the correlation between motivational variables and performance of students with the results of Velayutham et al. (2011). Using the Pearson R test, I showed that, contrary to Velayutham et al., (2011), only self-regulation was correlated with performance.

Table 5

Results from this research compared to Velayutham et al. (2011)
Note: The results (Velayutham et al., 2011) show significant correlation with scientific performance measured with grades. The * indicates a significant correlation between motivation and performance. R < 0.3 = very weak correlation, 0.3 < R < 0.5 = moderate correlation, R> 0.5 = strong correlation (Cohen, 1988).

	number of items	Pearson R (This research)	Pearson R *(Velayutham et al., 2011)*
SE	8	0.13	0.69*
TV	8	0.12	0.43*
SR	8	0.47*	0.54*
LG	8	0.3	0.68*

As mentioned above, Likert-scale data is ordinal data ranging in this case from 1 to 5. I already mentioned that, nowadays, many experts claim that it is more than reliable to use parametric tests on ordinal data. ANOVA tests usually rely on normal data. Nevertheless, I would like to, just like in other research using the SALES-questionnaire (Inaltun & Ateş, 2015; Velayutham et al., 2011, 2012; Velayutham & Aldridge, 2013), use an ANOVA test. With a sample size of over 5, many experts claim that it is reliable to do parametric tests if the Likert-scale data is normally distributed (Sullivan & Artino, 2013). Therefore, I did a test for normality using a kurtosis and skewness test with a histogram using Stata. This test can be found in table 6 and figure 1.

The probability of skewness is higher than 0.05 and is therefore asymptotically normally distributed. The same goes for kurtosis although this difference is minimal. Chi-square is 0.1039 showing a significance at a 5% level so the residuals show a normal distribution. This was confirmed by a multilinear regression test that can also be found in the appendix.

Figure 1.

*Histogram showing the normality of the residuals calculated using Stata.*
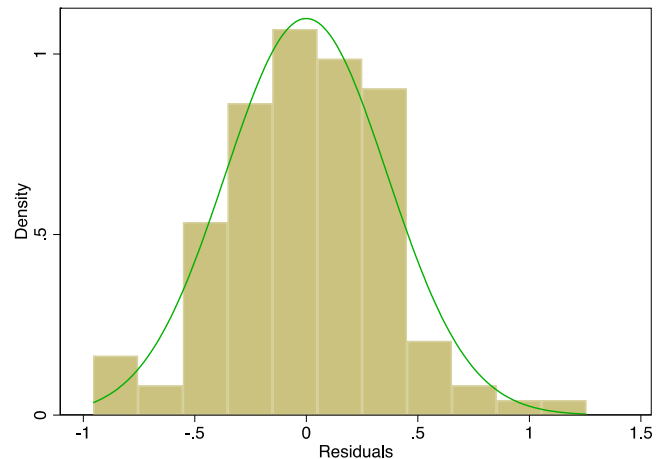
Secondly, I tested for a correlation between performance and motivation using an ANOVA. First, I created a boxplot for the different grades of students linked to their mean self-efficacy, self-regulation, task value, and learning goal orientation as can be seen in figure 2. Although self-efficacy seems to overall be pretty constant, the mean of the other variables seems to increase for students with higher grades. However, I decided to do an ANOVA to test whether this difference was significant which can be found in the Appendix. The task value, learning goal orientation, and self-efficacy, in contrast to the results from Velayutham et al., did not have a significant effect on grades. Self-regulation is correlated with performance during online education, as can be seen in table 5 and the appendix. Self-regulation has a p-value < 0.05 and Learning goal orientation has a p-value of 0.052. Although it's technically over 0.05, indicating that there is no significant correlation, the difference is so minimal that I would recommend looking into this variable in future research.

Figure 2

Boxplot showing on the y-axis the mean level of motivation and on the x-axis the grades of the students.
Note: For this graph, I rounded the grades. A 6.4 becomes a 6 and a 6.5 becomes a 7 etc.
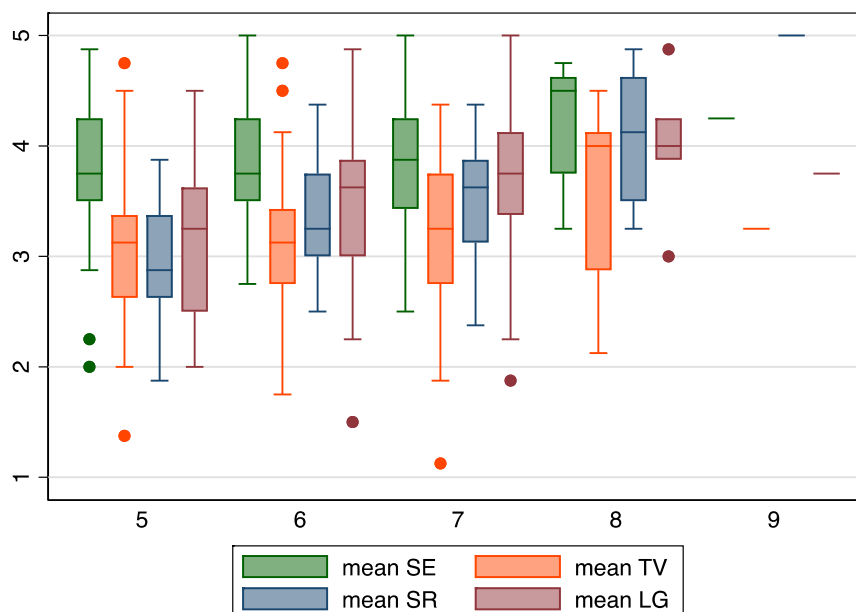
I have also taken a look at other factors influencing the motivational variables and the results can be seen in figure 3 in the Appendix. Gender shows no significant differences. Age does, however, the sample size of students from 15-17 is very small and thus unreliable for further analysis (Sullivan & Artino, 2013).

Discussion and conclusions

Covid-19 has forced many countries to develop a protocol where regular education has shifted to online education to keep the infection rate as low as possible. I, however, have doubts about the effectiveness of online education as, in my opinion, there has been little consideration for the motivation of students during online education. Motivation is a strong predictor for performance; thus, I believe it would be detrimental if motivation was negatively affected by online education, especially if motivation is also correlated with performance during online education. In this study I wanted to determine the motivation and self-regulation of students during online biology education using the SALES-survey designed by Velayuthem et al. (2011) and whether motivation is correlated with performance during online education.

Research tool

To do this research in the Netherlands, I had to translate the SALES-survey to Dutch. To test whether this questionnaire was reliable, I did a Cronbach's alpha test. The Cronbach's alpha scores were quite a bit lower than the scores in previous research, as can be seen in table 4, indicating that it could be improved on a bit (Inaltun & Ateş, 2015; Velayutham et al., 2011). Nevertheless, it turned out to be reliable on all motivational variables and thus could be used for further analysis.

The SALES-questionnaire is partly based on several theories like the efficiency value model, the achievement goal theory, and the self-determination theory (Ames, 1992; Bandura, 1985; Eccles & Wigfield, 2002; Ryan & Deci, 2000; Urdan & Schoenfelder, 2006; Velayutham et al., 2011). Although the SALES-questionnaire is proven to be a reliable tool to determine motivation on several variables as shown in previous and this research, I think it's lacking one variable. The learning goal orientation from Bandura et al., (1985), the self-efficacy, and task value from Eccles & Wigfield (2002) and the self-regulation and self-efficacy from the SDT theory from Ryan & Deci (2000) are represented in the questionnaire. However, the SDT surrounds three variables; autonomy in learning, which can, in my opinion, be translated as self-regulation, self-efficacy which relates to competence, and finally relatedness. The latter is missing from this questionnaire, even though research has shown that it is an important factor for motivation and performance (Ryan & Deci, 2000). I might add that I would not be surprised if this is a variable that is heavily affected by online education and should definitely be further researched. Online-education has, according to my experiences, negatively affected the social interaction with both the teachers, mentors, and classmates. This could have disturbed the relatedness of students which has a negative effect on overall performance (Ryan & Deci, 2000).

Secondly, I wanted to show the motivation of students during online education in a quantitative fashion. As described in my introduction, my students often complain about their lack of motivation during online education which makes sense, given that they lack interaction with friends and teachers and don't get a lot of opportunities for groupwork. This anonymous questionnaire, to quantify self-regulation and motivation which was divided into three variables (i.e., self-efficacy, task value, and learning goal

orientation), showed that the motivation of students was not that different from the motivation of students in other research studies during on-site education (Inaltun & Ateş, 2015). It should be noted that that particular research was done with a sample of university-level students with an age difference of around ten years compared to my sample and is therefore not that comparable as students from different ages also differ in motivation for learning (Artino & Stephens, 2009). Unfortunately, neither the raw data nor the means or the medians were given in other research using the SALES survey and therefore I won't be able to compare my data to other data from more samples (Bedford, 2017; Velayutham et al., 2011, 2012; Velayutham & Aldridge, 2013).

When my students are asked whether they are motivated in online education during the pandemic, their answer is usually: no. Motivation is often seen as a level of wellbeing however it is also an important aspect of academic progress (Yates et al., 2020). Would you ask a student about their wellbeing during quarantine, you would probably get a similar answer to the previous question. Would you, however, ask whether they want to learn their subjects to get good grades, pass their high school and impress their parents, which I describe as academic motivation, you might just get a different response. My research seems to indicate that academic motivation of students is not so badly damaged as many teachers, parents, and politicians might have feared. I found that most students are neutral to the statements about motivation in the survey. Although this is not as high as I hoped, it does indicate that most students do still want to improve their skills, gain knowledge and get good grades. Unfortunately, there is not much data to compare this to regular on-site motivation. For future research, it would be interesting to use a control- and test group to determine whether there is a difference in motivation and self-regulation between online and in-school education.

Previous research

Interestingly, the statements of the survey that students are most in agreement with, are the self-efficacy statements, also compared to research by Inaltun & Ateş (2015), indicating that self-efficacy is an important factor for motivation of students during online education. Students are in the least agreement with the task value statements. I found this interesting because these statements are most linked to intrinsic motivational factors, such as whether the items in biology are interesting, useful in real life et cetera (Velayutham et al., 2011). The scores of the students at task value in this research are also quite a bit lower than the students from Inaltun and Ateş (2015). This might be due to the lack of interaction of online education. However, as I mentioned before it might just be due to other factors like the age of the participants which is, in my opinion, more likely the case. Nevertheless, both self-efficacy and self-regulation are higher compared to previous research (Inaltun & Ateş, 2015). Although it is most likely to be different given the difference in test groups, it might be explained by online education as well. To make any definite statements, it would be interesting to use control- and test groups to determine whether the difference in motivation is due to online education or other factors.

My results showed that the motivational variables are weak to moderately correlated with performance. This is not in line with the research by Velayutham et al. (2011) who found a moderate to strong positive correlation where learning goal orientation and self-efficacy were most strongly correlated with performance (Velayutham et al., 2011). There are multiple possible explanations for this difference. First of all, I expected a

difference in motivation between my results and those of Velayutham et al. (2011), as I hypothesized that students are less motivated during online education possibly resulting in less time learning and lower grades. Contrary to my hypothesis, only self-regulation is correlated with performance.

Self-regulation

The only variable linked to performance during online education is self-regulation. I believe that this correlation makes sense because in my experience pupils, especially the lower grade pupils, are usually not very adept in self-regulation and primarily rely on their teachers for their regulation and monitoring of their work. This is always an issue and therefore a strong influence on performance, however in times of online education where students barely see their teacher, the lack of external regulation may negatively influence their performance if they are also lacking in self-regulation (Artino & Stephens, 2009; Bradley, 2019; Delen & Liew, 2016). More so than during regular on-site learning, students require assistance in their self-regulation as this is a pretty strong predictor of performance according to my results. Following these results, I believe it to be of utmost importance to, instead of the questionable measures schools have taken to improve learning during online education, schools should focus on structuring and improving self-regulation in high-school students. Students will benefit from self-regulation skills as this makes students improve their cognitive abilities and thus achieve effective learning (Boor & Cornelisse, 2021). If taught well, students can do this pretty much without too much input from their teachers when teachers can avoid three common issues: disruptions in curricular structure and rhythm, lack of feedback, and absence of time to reflect with the teacher on their self-regulation (Boor & Cornelisse, 2021). Especially for the last one, students often fail to attribute an undesirable outcome to an adopted learning strategy. Middle school students do require some monitoring and reflecting with their teacher on their learning (Wandler & Imbriale, 2017). Students who are more aware of and more experienced in their self-regulation and monitoring, the students who scored high on SR in this study's survey, are perhaps more likely to achieve high performance during online education (Wandler & Imbriale, 2017; Zimmerman, 2002).

My recommendations to middle- and high schools are the following. First of all, I would highly recommend for schools to develop or implement a decently structured online learning environment to ensure the abovementioned curricular structure (Boor & Cornelisse, 2021; Wandler & Imbriale, 2017; Zimmerman, 2002). This would help support the self-regulation of students by giving them a basis. In regard to the self-determination theory (SDT), letting students be self-regulatory learners improves their autonomy which in turn results in enhanced performance (Ryan & Deci, 2000). Unfortunately, there will always be students who don't experience biology or other school courses as enjoying and will therefore not show intrinsic motivation. Showing students how to be self-regulated learners will strengthen their internalization and integration. Extrinsically motivated learners can still perform when they are self-regulating learners (Ryan & Deci, 2000). Students should be taught how to set feasible goals, proper time management, taking notes, and prepare for tests (Wandler & Imbriale, 2017). Even when it is taught at first, when students possess the self-regulatory skills along with some support of autonomy, this will positively affect their performance (Ryan & Deci, 2000). Thirdly, students should be required to keep a log on their goals, planning, and actually achieved goals (Wandler & Imbriale, 2017). These logbooks are to be monitored once a week where teachers or mentors provide

detailed personal feedback (Artino & Ioannou, 2005). Lastly, once students have proven to be sufficient self-regulators, students need to get the responsibility to monitor for themselves, with just a weekly chat with their teacher or mentor on their progress and their self-regulation (Artino & Ioannou, 2005; Wandler & Imbriale, 2017). To be fair, this would require a lot of time and manpower. However, every middle- and high school in the Netherlands gets on average 1.2 million additional euros. This money is to be spent on making sure that students won't have too much of a backlog on learning (Rijksoverheid, 2021). In my opinion, promoting self-regulation and assisting with monitoring would be a just cause. For this to be feasible, students will need a lot of training, and schools require the manpower and knowledge to provide this training. However, using the available money, I believe many schools do have, or can acquire, the means to assist students in self-regulation.

Learning goal orientation

Velayutham et al. (2012) showed that essentially all motivational variables; self-efficacy, task value, learning goal orientation, and self-regulation are linked but especially learning goal orientation has a positive effect on self-regulation (Velayutham et al., 2012). Contrary to self-regulation, learning goal orientation is not correlated with performance. Learning goal orientation was however very close to significant during online education, emphasizing the importance of also focusing on learning goal orientation in further research. Students who are more aware of their learning goals are inexplicably better at choosing the appropriate self-regulation strategies to meet such goals (Delen & Liew, 2016). Meeting these goals often results in better performance, thus I expected it to be significantly linked to performance in this study's online education survey. Goal orientation in learning is often divided into several categories. Although these differ between papers, all research has shown that students with a learning goal orientation have a better performance compared to students with a performing goal orientation, an avoiding goal orientation, or a proving goal orientation (Eccles & Wigfield, 2002; VandeWalle, Cron, & Slocum, 1996; Velayutham et al., 2011; Wolters, Yu, & Pintrich, 1996). Where students with a learning goal orientation are primarily intrinsically motivated, students with a performing, avoiding, or proving goal orientation are primarily extrinsically motivated. Learning goal orientation, in turn, improves performance (Velayutham et al., 2012; Wolters et al., 1996). Research showed that students adopt the goals that are stressed by their teachers and their schools (Anderman, Austin, & Johnson, 2002). When schools encourage social comparison and competition, performance goals are prominent and when schools stress improvement and effort, mastery goals are significant (Anderman et al., 2002). Which form of goal orientation is most effective during online education is uncertain, but it would be interesting to study in future research. The paper by Anderman et al. (2002) made clear that goal orientation for a large part is centered in the classroom, but research by Matuga (2009) showed that when students enter an online course, many shifted from performance goal orientation to learning goal orientation (Anderman et al., 2002; Matuga, 2009). Students were, therefore, less focused on good grades during online education and more on learning itself which according to research was correlated to better performance (Delen & Liew, 2016; Eccles & Wigfield, 2002; VandeWalle et al., 1996; Velayutham et al., 2011; Wolters et al., 1996). This would even further lead to the hypothesis that learning goal orientation and performance should be correlated, which they are not. It would be interesting to look further into the effect of learning goal orientation on performance during online education for future research.

Self-efficacy and task value

It is surprising to me that self-efficacy and task value are not significantly linked to performance in this research. The absence of a correlation between performance and self-efficacy, task value, or learning goal orientation might be explained by the fact that these motivational variables of all students are affected by online education similarly. Nevertheless, a quick look at figure 2 shows that self-efficacy, learning goal orientation, and task value are the highest for students with high grades, 8 or 9, and lowest for students with low grades. The sample size of students with grades 8 and 9 was very low as shown in table 1. For further research, it would be interesting to look further into this correlation, or lack thereof, with a bigger sample size.

Further remarks

In future research, it would be interesting to gain more insight into the motivation of more students from around 16, 17 years old. Motivation and self-regulation can fluctuate over time. Motivation can decrease during puberty and self-regulation is often increased as students grow older (Anderman et al., 2002; Artino & Stephens, 2009; Dishman, McIver, Dowda, & Pate, 2018; Ramdass & Zimmerman, 2011). Therefore, it would be interesting to compare 11-14-year-old students to 15-18-year-old students. Unfortunately, my sample size for the latter age group was too small to make any definitive statements however there seems to be a stronger correlation between self-efficacy and performance. Perhaps this lack of correlation for 14-year old's is due to a limited level of self-reflection while older students usually have better insight into their areas of improvement. As mentioned in my introduction, the majority of research into these motivational variables was executed using college- and grad students.

For further research, I recommended a bigger sample size for the different age groups than my sample size for 16-17-year-old students, which was, unfortunately, lower than I was aiming for since they were busy with their exams. Secondly, it would be interesting to distinguish between classes with different teachers. Each teacher has different strategies to motivate their students and Velayutham et al. (2012) has shown that classes have a significantly different level of each motivational variable and self-regulation. Implementing mixed-method research where the strategies for the various teachers are reported, might be an interesting source of insight into future online-education.

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Appendix

SALES Questionnaire (Velayutham et al., 2011)
Learning goal orientation
1. One of my goals is to learn as much as I can
2. One of my goals is to learn new science contents
3. One of my goals is to master new science skills
4. It is important for me that I understand my work
5. It is important for me to learn the science content that is taught
6. It is important to me that I improve my science skills
7. It is important that I understand what is being taught to me
8. Understanding science ideas is important to me

Task Value
9. What I learn can be used in my daily life
10. What I learn is interesting
11. What I learn is useful for me to know
12. What I learn is helpful to me
13. What I learn is relevant to me
14. What I learn is of practical value
15. What I learn satisfies my curiosity
16. What I learn encourages me to think

Self-efficacy
17. I can master the skills that are taught
18. I can figure out how to do difficult work
19. Even if the science work is hard, I can learn it
20. I can complete difficult work if I try
21. I will receive good grades
22. I can learn the work we do
23. I can understand the contents taught
24. I am good at this subject

Self-regulation
25. Even when tasks are uninteresting, I keep working
26. I work hard even if I do not like what I am doing
27. I continue working even if there are better things to do
28. I concentrate so that I will not miss important points
29. I finish my work and assignments on time
30. I do not give up even when the work is difficult
31. I concentrate in class
32. I keep working until I finish what I am supposed to do

SALES questionnaire translated to Dutch

Introductory questions
- Ik geef toestemming dat mijn anonieme resultaten worden gebruikt voor onderzoeksdoeleinden. (ja-nee)
- Wat is je geslacht? (man-vrouw-overig-zeg ik liever niet)
- Wat is je leeftijd?
- In welke klas zit je?
- Welk cijfer sta jij gemiddeld op biologie?

Learning goal orientation
1. Eén van mijn doelstellingen is om zoveel te leren als ik kan
2. Eén van mijn doelstellingen is om nieuwe inhoud van biologie te leren
3. Eén van mijn doelstellingen is om nieuwe vaardigheden te beheersen
4. Ik vind het belangrijk om mijn werk te begrijpen
5. Ik vind het belangrijk om de biologie-inhoud wat mij wordt aangeleerd te leren
6. Ik vind het belangrijk om mijn biologische vaardigheden te verbeteren
7. Ik vind het belangrijk om te begrijpen wat mij wordt aangeleerd
8. Ik vind het belangrijk om wetenschappelijke ideeën te begrijpen

Task value
9. Wat ik leer kan ik in het dagelijkse leven gebruiken
10. Wat ik leer is interessant
11. Wat ik leer is nuttig voor mij om te weten
12. Wat ik leer helpt mij
13. Wat ik leer is relevant voor mij
14. Wat ik leer heeft een praktisch nut
15. Wat ik leer verzadigd mijn nieuwsgierigheid
16. Wat ik leer moedigt mij aan om na te denken

Self-efficacy
17. Ik kan de geleerde vaardigheden beheersen
18. Ik kan uitvogelen hoe je moeilijke opdrachten moet doen
19. Zelfs wanneer biologie moeilijk is, kan ik het leren
20. Ik kan moeilijke taken volledig afronden als ik het probeer
21. Ik ga goede cijfers halen
22. Ik kan het werk wat we behandelen leren
23. Ik kan de geleerde stof begrijpen
24. Ik ben goed in dit vak

Self-regulation
25. Zelfs wanneer het werk oninteressant is blijf ik werken
26. Ik werk hard, zelfs wanneer ik het niet leuk vind
27. Ik blijf werken, zelfs als er betere dingen zijn om te doen
28. Ik concentreer me zodat ik de belangrijke punten niet mis
29. Ik krijg mijn werk en taken op tijd af
30. Ik geef niet op, zelfs wanneer het werk moeilijk is
31. Ik concentreer me in de les
32. Ik blijf werken tot datgene wat ik moet doen af is

Table 6

Cronbach's alpha test for reliability using Stata.
The alpha values in the right column show cronbach's alpha values of over 0.7 showing the reliability of the data. The value in the low right corner: 0.8243 shows the reliability of the data set as a whole and the 4 values above show the reliability for each variable. Meanse = mean of self-efficacy, meantv = Mean of task value, meansr = mean of self-regulation and meanlg = mean of learning goal orientation. Cronbach's alpha of over 0.7 is reliable.

```
Test scale = mean(unstandardized items)

                                                         average
                                  item-test   item-rest  interitem
Item          Obs  Sign  correlation  correlation  covariance    alpha

meanse        121    +       0.8400       0.7172    .2114646     0.7515
meantv        121    +       0.8345       0.6738    .1980816     0.7675
meansr        121    +       0.7737       0.6105    .2363789     0.7958
meanlg        121    +       0.7976       0.6106     .215053     0.7987

Test scale                                          .2152445     0.8243
```

Table 7

Test for skewness and kurtosis to test for normality using Stata.
The residuals of the variables are calculated. Probability of skewness, probability of kurtosis Chi^2 >0.05 indicating a normal distribution.

```
. sktest resid

              Skewness/Kurtosis tests for Normality
                                                      ——— joint ———
    Variable       Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)   Prob>chi2

       resid       121      0.4044        0.0532        4.53       0.1039
```

Table 8

Test for heteroscedasticity
Chi2 is under 0.05 indicating that there is presence of heteroscedasticity, indicating that we can't use linear regression but instead need a multilinear regression.

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
        Ho: Constant variance
        Variables: fitted values of meanse

        chi2(1)      =      8.49
        Prob > chi2  =    0.0036
```

Table 9

Multilinear regression using Stata.
A multilinear regression was run to predict the grades for the various motivational variables. The variable self-regulation, (meansr), significantly predicts grades, $F_{(4,116)} = 0.56$, $p < 0.05$ for meansr, $R^2 = 0.23$.

```
. regress roundgrades meanse meantv meansr meanlg
```

Source	SS	df	MS			
Model	18.848192	4	4.712048			
Residual	64.8377584	116	.558946193			
Total	83.6859504	120	.69738292			

Number of obs	=	121
F(4, 116)	=	8.43
Prob > F	=	0.0000
R-squared	=	0.2252
Adj R-squared	=	0.1985
Root MSE	=	.74763

roundgrades	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
meanse	−.0388192	.1879068	−0.21	0.837	−.4109923	.333354
meantv	−.1605358	.1554347	−1.03	0.304	−.4683939	.1473222
meansr	.7189499	.1509935	4.76	0.000	.4198883	1.018011
meanlg	.0681248	.1313841	0.52	0.605	−.1920979	.3283475
_cons	4.277371	.5148756	8.31	0.000	3.257594	5.297147

Table 10

ANOVA in Stata on the effect of self-regulation and learning goal orientation on grades
An Anova was executed to determine the significant correlation between each variable on grades. Task value and self-efficacy were not correlated with grades (P>0.05). Learning goal orientation was close but also not correlated with grades (P=0.052 > 0.05). Self-regulation is correlated with grades (P< 0.05).

```
. anova meansr roundgrades
```

	Number of obs = 121	R-squared = 0.2371
	Root MSE = .51831	Adj R-squared = 0.2108

Source	Partial SS	df	MS	F	Prob>F
Model	9.6832882	4	2.420822	9.01	0.0000
roundgrades	9.6832882	4	2.420822	9.01	0.0000
Residual	31.162904	116	.26864572		
Total	40.846192	120	.34038493		

```
. anova meanlg roundgrades
```

	Number of obs = 121	R-squared = 0.0772
	Root MSE = .664418	Adj R-squared = 0.0453

Source	Partial SS	df	MS	F	Prob>F
Model	4.2812953	4	1.0703238	2.42	0.0520
roundgrades	4.2812953	4	1.0703238	2.42	0.0520
Residual	51.208347	116	.44145127		
Total	55.489642	120	.46241369		

Figure 3

Boxplots on the effect of age and sex on motivation
Boxplot was used to show the difference in motivational variables between age groups, class and gender. "Man" = male, "Vrouw" =female and "zeg ik liever niet" = I would rather not say. Self-efficacy is the highest in both males and females and there are no real obvious differences in both age groups and sex. Statistical analysis confirmed this observation (P>0.05). The sample size of the age groups: 11, 15, 16 & 17 are too small for an anova and are therefore unreliable, see table 1.