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Statistics Anxiety in Flanders: Exploring Its Level, Antecedents, and Performance Impact Across Professional and Academic Bachelor Programs in Psychology

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Abstract

The current study focusses on the level of statistics anxiety and the motivation to learn statistics in Flanders (Belgium) and determined to what degree these factors and their interaction relates to statistical performance. For this purpose, the Statistics Anxiety Scale and the Statistics Motivation Scale were translated, validated, and administered in professional and academic bachelor students in psychology. The level of SA in Flanders is comparable to other countries, with professional bachelor students being more anxious to make interpretations compared to academic bachelor students, who in turn are more anxious to ask for help. Academic students are more motivated to learn statistics compared the professional bachelor students, mostly in terms of intrinsic motivation. The overall motivation to learn statistics is lower at the end of the semester compared to the beginning of the semester. This is unfortunate, because we observed that high levels of motivation can alleviate the negative impact of statistics anxiety on statistical performance, especially when controlling for general learning abilities.

Keywords:

Statistics Anxiety, Motivation, Flanders, Statistical Performance

Introduction

Statistics courses are a pivotal component of many college and/or university programs. Besides the direct application of statistical knowledge for research purposes, insight into statistics is more generally considered an important steppingstone in the development of critical thinking, and decision and problem-solving skills (Kesici et al., 2011). For a variety of reasons, students typically find their statistics course to be the most anxiety-inducing course in their study program (Caine et al., 1978; Zeidner, 1991). Critically, statistics anxiety (SA) has been claimed to negatively impact the statistics learning curve and ultimately, statistics performance (Macher et al., 2012, 2013, 2015; Onwuegbuzie & Wilson, 2003; Papousek et al., 2012; Zare et al., 2011). To better understand and manage SA, the phenomenon needs to be explored in terms of its prevalence, antecedents, and impact on student performance. This would be useful information for teachers, lecturers and educational policy makers who are involved in facilitating and increasing the level of "data-literacy" at schools and (more generally) in society. In the current study, we explore these elements in the context of higher education in Flanders.

Prevalence and Impact

Defined as an anxiety that occurs when encountering statistics in any form and at any level (Onwuegbuzie et al., 1997), the study of SA is critically dependent on valid and reliable assessment tools. Initially, a popular framework in the context of SA - the six-factor model of Cruise et al. (1985)- considered SA as a multidimensional construct composed of "interpretation anxiety", "test and class anxiety", "fear of asking for help", "computational self-concept", "worth of statistics", and "fear of statistics teachers". Reflecting these factors, a 51-item Statistics Anxiety Rating Scale was proposed to measure SA (Cruise et al., 1985), and was the dominant measure used in the literature for a long time (Cui et al., 2019). Later studies, however, suggested that only the first three subscales of this model (interpretation anxiety, test and class anxiety, and fear of asking for help) are direct indices of SA, whereas the latter three subscales (worth of statistics, computation self-concept, and fear of statistics teachers) assess attitudes towards statistics rather than SA (Chew & Dillon, 2014b; Papousek et al., 2012). To remedy this, a shorter instrument was developed by Vigil-Colet and colleagues (2008) coined the Statistical Anxiety Scale (SAS) – thus taking only three of the original six factors into account. Where the SAS was initially developed and validated in Spanish, the instrument retained its good psychometric properties after being translated to be used in other countries (e.g., Italy, Australia, Singapore, Bangladesh, and the USA). To our knowledge, a Dutch (the official language in Flanders) translation of this questionnaire has not been validated so far (making it one of our research aims; see Research Aim 1 below).

Using the above instruments, SA has been shown to be broadly presenting itself across various countries and their respective educational systems. In their study, Zeidner (1991) found that as many as 70% of Israeli students experienced SA. Similarly, Onwuegbuzie and Wilson (2003) estimated that about 80% of graduate students in Georgia (USA) experience uncomfortable levels of SA. Furthermore, students in the social sciences (e.g., psychology) are especially prone to report high levels of SA (Zeidner, 1991). This may be because these students typically had relatively few hours of mathematics in their high school program, and/or had negative prior experiences with mathematics in high school – both of which are known to be potential antecedents for the development of SA (Onwuegbuzie & Wilson, 2003). Indeed, SA was initially thought to largely overlap with the math anxiety (Mitton, 1987). Yet, despite SA being related to math anxiety (with correlations generally in the range of r = .40-.70), there is a consensus that these constructs refer to distinct phenomena (Baloğlu, 2002; Benson, 1989; Paechter et al., 2017). This warrants a dedicated study of SA.

Efforts to map out the level of SA through valid assessment tools, is motivated by the impact SA has on the way how students are engaged in studying statistics. For example, SA has been associated with procrastination of learning (Onwuegbuzie, 2004), spending less time on studying, and the use of less efficient learning strategies (Macher et al., 2012, 2013). As a result, SA is often considered as a major negative influence on the performance in statistics courses (Onwuegbuzie, 2004). Despite this, studies that directly investigated the link between SA and statistical performance are less univocal. Where several studies reported a small but significant negative correlation between SA and statistical performance (typically ranging between r = -.20 and r = -.30; for an overview see Macher et al., 2015) other studies demonstrated insignificant or even positive correlations (Lester, 2016; Paechter et al., 2017).

Macher and colleagues (2015) explain these contradicting results on the relationship between SA and performance by making a distinction between the direct and indirect effects of SA on performance. A direct link between SA and academic performance pertains to the moment of examination. Anxiety leads to an increase in task-irrelevant thoughts (such as worry or rumination), which reduce the cognitive resources that are necessary to successfully complete the statistical problems (Eysenck et al., 2007). While such direct effects are typically negative, indirect effects can be both positive and negative. For example, SA can have an indirect negative effect on performance via difficulties in time-management and procrastination (Onwuegbuzie, 2004; Rodarte-Luna & Sherry, 2008), but SA can also be positively related to performance via increased effort and motivation when the level of anxiety is manageable (Dunn, 2014; Macher et al., 2015). Importantly however, whereas compelling evidence exists for indirect negative effects, support for the idea that effect of SA on performance can be moderated by the motivation to learn statistics is less established (see Research Aim 4 below).

Besides the complex link between these and other mediating/ moderating factors, it is also possible that the lack of consistent results is due to the lack of proper control variables. Indeed, someone's grades on the statistics exam will be caused by many other variables as well. Among other factors, general intelligence, general curiosity, psychological and physical wellbeing during the (preparation of the) exam can also have an influence. Interestingly, it can be predicted that (some of) these factors are also correlated with someone's mathematical background or motivation to learn statistics. It would therefore be interesting to reinvestigate the link between SA and statistical performance when controlling for this "learning efficiency" factors.

Antecedents of Statistics Anxiety

Several studies have tried to shed a light on the origins of SA. Overall, these antecedents can be categorized into three major factors: situational, dispositional, and cognitive factors (Cui et al., 2019; see Chew & Dillon, 2014 for another classification). Situational factors are present in the external environment or in situations that are related to SA. These include, but are not limited to properties of the curriculum format and teaching styles like e.g. the pace of statistics instructions (Bell, 2005 as cited in Chew & Dillon, 2014b), the class atmosphere (Lesser & Reyes III, 2015), the absence of real-life examples (Neumann et al., 2013), instructor immediacy (Tonsing, 2018), the verbal and/ or non-verbal expressions of the lecturer (Williams, 2010), or the organization (online vs on campus) of the courses (DeVaney, 2010). Given that these factors are to a large extent determined by specific educational systems, it is of relevance to map out the levels of SA across different countries and their different educational systems – with the focus of the current study (Flanders) not yet having been explored in this context (see section below, see Research Aim 2 below).

Dispositional factors are factors that the student brings into the setting and are related to individual differences in, e.g., the attitude towards statistics, the motivation to learn it, prior mathematical experience, or procrastination behavior. With respect to attitude and motivation, it has been found that a negative attitude towards statistics is associated with higher levels of SA (Schau, 2003), and that positive attitudes towards statistics can diminish the negative effects that SA has on statistical performance (Najmi et al., 2018). Relatedly, intrinsic interest in the subject is associated to lower levels of SA. This is probably because interested students show more cognitive engagement when studying and more frequently use efficient learning strategies (Macher et al., 2012). Personal experience with mathematics also plays a role in the development of SA. An insufficient mathematical background, bad experience with math, and math anxiety are all related to SA (Abd Hamid & Sulaiman, 2014; McGrath, 2014). This could be because SA often gives rise to procrastination and vice versa. Higher levels of SA are found in people who procrastinate (due to a general fear of failure or trait anxiety), and higher levels of SA often result in procrastination (Chew & Dillon, 2014b). Additionally, procrastination is often associated with less efficient learning strategies (Vahedi et al., 2012). As such, the relation between procrastination and SA is often characterized as a downward spiral, where procrastination and inefficient learning often lead to bad experiences with statistics (which could trigger SA), which in turn gives rise to procrastination behavior. Another important dispositional factor is the cultural background of the students, as the degree of SA (and probably the link with statistics performance) differs between countries and between subgroups within countries. For example, as a group, Chinese students show lower levels of SA compared to students of the USA and UK (Liu et al., 2011), while international students (in the USA) seem to suffer from higher level of SA compared to their domestic counterparts (Bell, 2008). Although the precise mechanisms underlying these differences are still unclear (Cui et al., 2019), they are typically attributed to differences in the educational system (e.g., whether or not it is common to ask questions during class), the mathematical background of the students (incl. the habit to use calculators), or whether the classes were given in the first language of the students or not (Bell, 2008).

Apart from the situational and dispositional factors, there are also cognitive factors. These factors refer to the cognitive resources (like working memory and executive functions) that are recruited when solving statistical problems. Several attempts have been made to identify the cognitive factors that help us to explain individual differences in SA and the relation with the performance on statistical tasks. In this context, SA seems to be related to basic numerical abilities (Paechter et al., 2017), metacognitive abilities, effective inhibition of task irrelevant information, and verbal reasoning abilities (for an overview see Cui et al., 2019). This field, however, is relatively new and further studies will be needed to identify and to further describe the role of these (and other) cognitive functions as antecedents of SA.

Statistics and Statistics Anxiety in Flanders

In Flanders (Belgium), statistics is also an important course in the Psychology program with the mathematical/ statistical background often being an important element for a student to decide to enroll in the program or not. Compared to (some) other countries, the way how the Psychology programs are organized in Flanders is rather unique. In Flanders, the bachelor's in Psychology has programs at the academic level (at universities) as well as at the professional level (at university colleges). Whereas the academic bachelor prepares students with the appropriate (scientific) knowledge and skills to continue in the master's program, the professional bachelor's program focuses on professional practice providing students with competencies (knowledge, skills, and attitudes) to directly start a profession (e.g., in psychodiagnostics, counselling and/ or coaching, selection and recruitment, etc.).

In their information brochures for novel psychology students, both universities and university colleges explicitly refer to the importance of statistics in their curriculum and the recommended level of mathematical background. Although no explicit mathematical level is required to enroll, higher levels of mathematical background are recommended for the academic bachelor's in Psychology compared to the professional one. For example on the website for future students, the Catholic University of Leuven recommends a (high school) background of 9 hours of mathematics and science a week (https://onderwijsaanbod.kuleuven.be), and Ghent University encourages students who had less than 5 hours/ week of mathematics in high school to test their level of mathematics beforehand, and to consider following an online math course in case their mathematical background turns out to be insufficient (https://www.ugent.be/pp/nl/toekomstige-student/). University colleges on the other hand, recommend lower levels of mathematical background. Thomas More University college recommends a background of minimum of 3 hours of math a week (https://www.thomasmore.be/opleidingen/professionele-bachelor/toegepaste-psychologie/toegepaste-psychologie-een-goede-start), while no recommendation is given by the AP university college (https://www.ap.be/opleiding/toegepaste-psychologie). Therefore, students who received less hours of math per week in high school, as well as students with negative experiences with or attitudes towards mathematics are often more inclined (and sometimes even encouraged) to go to college rather than university. Furthermore, besides in the recommended mathematical background, university colleges and universities also differ in the way how their education is organized. Typically, at the university college the lecturer-student distance is smaller, and courses are organized in smaller groups, with more attention for student coaching (www.onderwijskiezer.be). In universities, teaching occurs in large groups, not seldomly comprising several hundreds of students. To our knowledge in Flanders, SA and the motivation to learn statistics in psychology students have not yet been investigated, especially not when considering differences between professional and academic bachelor students (see Research Aim 3).

Mapping out the level of SA and the motivation to learn statistics in Flanders offers several opportunities. Besides giving an impression about the numbers of students suffering from SA and about their motivation (which could be interesting for lecturers in statistics and future students), the direct comparison between professional and academic bachelor students would be an ideal opportunity to further investigate the influence of dispositional factors on the prevalence of SA in students with a shared study interest (psychology), a shared (first) language and a common educational (high school) culture.

Additionally, the link and interactions between SA, the motivation to learn statistics, mathematical background, and the scores on the exam of statistics are also worth exploring. Studies in Flanders so far mainly focused (in university students) on the link between mathematical background and academic success and found that students with stronger math backgrounds have higher chances to successfully pass their exams in statistics (and have higher chances for academic success in general; Fonteyne et al., 2015). From the studies summarized above, we know that SA and the motivation to learn statistics could be mediating/ moderating factors as well, but more empirical efforts are needed to come to a fuller understanding of how these factors and the interaction between them impact statistical performance. Given the less stringent recommendations with respect to prior mathematical experience for the professional bachelor programs, more heterogeneity can be expected in terms of mathematical background, SA and the motivation to learn statistics (which is ideal when studying correlations and interactions between variables). Afterall, it can be expected that the professional bachelor's in Psychology contains both students with a primary interest in this option (with or without a low mathematical background, SA and a low(er) motivation to learn statistics) but also students who chose for this option, because they question their statistical competences to start the academic bachelor.

Research Goals of the Current Study

The current study was designed to investigate SA and the motivation to study statistics in Flanders. For this purpose, the Statistics Anxiety Scale (Vigil-Colet et al., 2008) and the adapted Academic Motivation scale (Vallerand et al., 1992) were translated into Dutch and administered to first year students enrolled in the professional or academic bachelor's in Psychology program who were for the first time taking the course of "Statistics 1" (the introductory course of statistics).

The aim of the current study was four-fold. The first research goal is to see whether the Dutch translation of the Statistics Anxiety Scale (Vigil-Colet et al., 2008) and the Statistics Motivation Scale (adapted from, Vallerand et al., 1992, see below) were sufficiently reliable and valid. Besides internal consistency of the outcomes, we also used factor analyses to see whether we could replicate the factorial structure which is typically found in the original version and in other translations. Additionally, we performed several correlations to see whether we could replicate the previously reported relations between SA and motivation (Schau, 2003), grades on the exam (Macher et al., 2015), hours of mathematical background (Abd Hamid & Sulaiman, 2014; McGrath, 2014) and math anxiety, to determine whether we could confirm the claim that statistics anxiety is related but different from math anxiety (Baloğlu, 2002; Benson, 1989; Paechter et al., 2017). The second and third goal is to get an idea about the average level (and the distribution) of statistics anxiety and about the motivation to learn statistics in Flemish psychology students in general and (the third goal) to investigate whether there are differences between the professional and academic bachelor students. Finally, the fourth aim is to investigate whether and how SA, the motivation to learn statistics and their interactions are related to the scores on the statistics exam when controlling for general learning abilities and whether they explain additional variance on top of someone's mathematical background. Given the different recommendation for enrollment in both programs, we predict that students in the professional bachelor's program show higher levels of SA and a lower motivation to learn statistics than students in the academic bachelor's program. Because the learning environment of university colleges could act as a protecting factor to develop SA (smaller lecturer-student distances, more attention for student coaching), we predict that the difference in SA between both bachelors will be more pronounced in the first weeks of the semester before these protecting factors have had the chance to become effective. For this purpose, two data-collection waves were organized, one in the beginning of the semester (September), and one at the end (December). Fourth and finally, we predict that besides mathematical background, SA, and the motivation to learn statistics and/ or their interaction also explain a significant proportion of variance in the scores on the statistics exam.

Methods

Participants

The participant pool consisted of 438 first year bachelor students in Psychology who were all for the first time enrolled to Statistics 1 as undergraduate. All students were between 18 and 20 years old. The sample consisted of 272 (62.1%) professional bachelor students taking classes at the Thomas More University of Applied Sciences and 166 (37.9%) academic bachelor students at Ghent University. 298 students gave permission to collect the scores of their statistics exam and the exam of general psychology. The exam scores of 66 participants where not considered, as they also participated (after completion of the questionnaires) in another study which included a psycho-education session about SA and exercises to stimulate a growth mindset. Furthermore, for General Psychology, only the grades from the Thomas More students (who gave their permission, n = 180) were accessible. Two waves of data-collection were organized, which included different subjects (in other words, a between subject design was used). The first wave took place from the end of September till mid-October 2020 (n = 187). The second wave was organized from the end of November till mid-December 2020 (n = 251). A detailed description of demographic information (age, gender, and number of participants from the different institutions, at the different test moments) can be found in Table 1. All students provided their informed consent beforehand and participated either without any compensation or for course credits. The study was approved by the ethical committee of the Faculty of Psychology of Ghent University.

Materials

Three self-report questionnaires were presented: (1) the Statistical Anxiety Scale (2) the Abbreviated Math Anxiety Scale and (3) the Academic Motivation Scale. Using the back translation method (Beaton et al., 2000), the questionnaires were translated into Dutch, since no versions of the questionnaires were available in this language. The translated questionnaires were reviewed by a content expert, a language expert, and two researchers and were also assessed by them for face validity. The translated versions of the questionnaires can be found in Appendices A - C

Statistical Anxiety Scale (SAS)

The Statistical Anxiety Scale was used to measure statistics anxiety (Vigil-Colet et al., 2008). The SAS consists of three subscales, containing eight items each, assessing different aspect of statistical anxiety. The "Examination Anxiety" subscale assesses the anxiety experienced during a statistical examination. The "Anxiety for Asking Questions" subscale assesses the anxiety students may feel when asking statistics related questions to the course teacher, another student, or a private teacher. Finally, the "Interpretation Anxiety" subscale aims to measure the anxiety experienced when students interpret statistical data and understand the formulation used in statistics. Participants were instructed to indicate on 5-point Likert scale (1 = low anxiety to 5 = a lot of anxiety) how anxious they would feel during the described situations involving statistics (e.g., 'Studying for an examination in a statistics course'). Besides these subscales, a general SA index was determined by calculating the average of all 24 item scores. The SAS was constructed in the context of the introductory statistics course for undergraduate psychology students. Previous research indicated good reliability and validity in other languages as well (Cantinotti et al., 2017; Chiesi et al., 2011).

Abbreviated Math Anxiety Scale (AMAS)

Math anxiety was assessed using the Abbreviated Math Anxiety Scale (Hopko et al., 2003). Participants were asked to indicate on a 5-point Likert scale (1 = low anxiety, 5 = high anxiety) how anxious they would feel in each of the nine described math situations. The average score on these nine items was calculated as an index, with higher values corresponding to higher anxiety. The AMAS is characterized by adequate reliability and validity in the original English version as well as in several other languages (Caviola et al., 2017; Cipora et al., 2018). The original English version had an internal consistency of $\alpha = .90$ and a test-retest reliability of rtt = .85 (e.g., Hopko et al., 2003).

Statistics Motivation Scale (SMS).

Finally, to measure the motivation to learn statistics, we adapted the Academic Motivation Scale. This scale is based on the tenets of self-determination theory and measures "extrinsic motivation", "intrinsic motivation" and "amotivation toward education" (Vallerand et al., 1992). To our knowledge, a modified version adapted to the context of statistics has not yet been developed. However, recently the scale has been adapted to the context of mathematics (e.g., Staribratov & Babakova, 2019). To measure academic motivation towards statistics, we started from this math version and replaced the word 'math' with the word 'statistics' in each item of this scale. This modified AMS (hereafter called the Statistics Motivation Scale; SMS) consisted of a total of 15 items (seven, five and three items for the extrinsic motivation, intrinsic motivation and amotivation subscales respectively). Participants were then asked to rate to what extent the statements describe why they study statistics. Each item was measured on a scale from 1 (not at all) to 7 (completely). An example of such a statement is: 'I'm motivated to study statistics…. because statistics lets me discover many new and interesting things.' Besides the subscales, a general motivation index was determined by calculating the average of all 15 item scores. This scale has been found to have a good reliability and validity (Vallerand et al., 1993).

Procedure

All questionnaires were distributed using Qualtrics or Lime survey and were provided to the participants via an e-mail link. A call for participation was announced during the courses of General Psychology (Thomas More) and Statistics 1 (Ghent University) for those subjects who participated freely, or via the course credit website, for those who participated to obtain course credits. The following demographic variables were collected: (1) age, (2) gender, (3) number of hours of math per week in their last year of high school, (4) study program in high school and (5) current study program. Subsequently, the three questionnaires were presented in the following order: SAS, AMAS then SMS. Before beginning the SAS and SMS, participants were instructed to think about their experiences with the "Statistics 1" course of their current study program for answering the questionnaire. Before beginning the AMAS, participants were asked to think about their experiences with a math course in high school when rating the items. The time to complete the questionnaires was approximately 11 minutes. Two waves of data-collection were organized (including different subjects). Importantly, due to restrictions related to the covid-pandemic, all classes (of both the professional and academic bachelor) were organized online from November 1st, 2020. As such, all students were following online classes during the second wave of data-collection.

Results

Descriptive Statistics

A full overview of the descriptive statistics of all variables and demographical information can be found in Table 1. Summarized: As typical for psychology students, most of our sample consisted of females (85%). As expected, on average, the professional bachelor students had less hours of mathematics in high school compared to the academic bachelor students [3.23 hours per week, $SD = 0.93$ vs. 3.99 hours per week, $SD = 1.41$; $t(433) = -6.85$, $p < .001$]. The group of professional bachelor students was also a bit older [18.49 years, $SD = 0.67$ vs. 18.23 years, $SD = 0.52$; $t(433) = -4.30$, $p < .001$]. Importantly, the groups of the first and second data-collection wave did not differ from each other in terms of age and hours of mathematical background [both t's(433) > -1.53, p's > .06].

Q1: What is the Reliability and (construct) Validity of the Dutch Translation of the Statistics Anxiety Scale, and the Statistics Motivation Scale?

Statistics anxiety scale (SAS)

Because the SAS has never been translated to Dutch and used in a Flemish population, it was decided to evaluate the construct validity in three steps. First, an exploratory factor analysis (EFA) was performed to verify the factorial structure of the test. Next the factors found with the EFA were further checked using confirmatory factor analysis (CFA; for a similar approach, see Durak & Karagöz, 2021). All FAs were conducted using JASP (Love et al., 2019). For the EFA, maximum likelihood estimation was conducted on the 24 items of the SAS with varimax rotation. The Kaiser-Meyer-Olkin (KMO) measure was used to verify the sampling adequacy for the analysis. The overall

Table 1
Descriptive statistics

		Professional bachelor						Academic bachelor					
		begin semester			end semester			begin semester			end semester		
Gender	female	96			129			57			92		
	male	24			22			8			7		
	other	1			0			1			1		
		average	*SD*	*n*	*average*	*SD*	*n*	*average*	*SD*	*n*	*average*	*SD*	*n*
Age	(years)	18.33	0.57	121	18.62	0.72	151	18.32	0.56	66	18.17	0.47	100
Mathematics	(hours/week)	3.21	1.02	121	3.25	0.83	151	3.79	1.23	66	4.11	1.50	100
Statistics	points/20	10.38	4.60	79	9.76	4.36	101	8.10	4.39	42	9.72	4.35	18
General Psychology	points/20	11.51	4.01	88	11.59	3.78	143	na			na		
Statistics Anxiety Scale	General	2.79	0.64	121	3.09	0.59	151	3.09	0.60	66	3.02	0.65	100
	Examination	3.93	0.75	121	4.03	0.72	151	4.09	0.66	66	3.97	0.78	100
	Interpretation	2.39	0.78	121	2.47	0.70	151	2.24	0.75	66	2.19	0.69	100
	Questions	2.61	0.97	121	2.78	0.99	151	2.94	0.98	66	2.89	1.01	100
Statistics Motivation Scale	General	3.48	0.96	121	3.27	0.97	151	3.73	1.03	66	3.53	0.96	100
	Extrinsic	3.39	1.18	121	3.13	1.18	151	3.33	1.21	66	3.15	1.25	100
	Intrinsic	2.83	1.15	121	2.64	1.19	151	3.32	1.24	66	2.98	1.16	100
	Amotivation	5.26	1.45	121	5.08	1.35	151	5.43	1.30	66	5.39	1.39	100

KMO value was 0.92 ('marvelous' according to Kaiser & Rice, 1974) and all KMO values for individual items were greater than .82 (which is well above the cutoff of .50; Kaiser & Rice, 1974). Also, the Bartlett's test was significant ($\chi^2(276) = 7138.09$, $p < .001$). Three factors had eigenvalues above 1, and in combination explained 56% of the data. Table 2A reports the factor loadings after rotation. As suggested by Field (2018), only factor loadings > .40 were considered. In this way the pattern of loadings replicated the factorial structure of the SAS that was previously reported (e.g., Durak & Karagöz, 2021). To provide further support for the observed factorial structure, an additional CFA was conducted with the same factorial structure as the one provided with the EFA, with "General Statistics Anxiety" as second order factor. The initial results did not show appropriate fit measures (the χ^2 /df, GFI, IFI, TLI, CFI, RMSEA and SRMS). An inspection of the modification indices and the misfit plot revealed a high residual covariance between Q5 and Q24 (modification index: 244.24)[1] . When the residuals of these items were allowed to correlate in the model, the model fit became statistically significant. An overview of the fit indices can be found in Table 3.

Finally, the validity of the SAS was further investigated by correlating the average SAS score with variables from which it is known that they relate to SA. Because for the SAS five correlations were calculated, the alpha level wat set to $\alpha = .01$ to correct for multiple testing and because the assumption of bivariate normality was violated [Shapiro Wilk's $p < .05$] for the correlation with the hours of mathematics in high school and the AMAS, 95% bootstrap confidence intervals were reported in Table 4. As expected, the average SAS score correlated significantly with math anxiety [$r(438) = .68$, $p < .001$], hours of mathematics in high school [$r(438) = -.18$, $p < .001$], motivation to learn statistics [$r(438) = -.23$, $p < .001$] and the scores on the statistics exam [$r(240) = -.17$, $p < .01$]. Importantly, the SAS did not correlate with the scores on the exam of general psychology [$r(231) = -.12$, $p = .06$]). A full overview of the correlations between all these variables can be found in Table 4. Finally, like previously reported (Rodarte-Luna & Sherry, 2008), we also found significant differences between males and females in their levels of general SA [$t(433) = -2.83$, $p = .005$, $d = .390$] with males *(2.83, SD* = 0.64) being less anxious compared to females (3.07, *SD* = 0.61).

The internal consistency of the average SAS score and the different subscales was determined by calculating Cronbach's Alpha. The Alpha's were .91, .89, .85 and .95 for the average score, exam anxiety, interpretation anxiety and the anxiety for asking questions subscales respectively. Taken together, it can thus be concluded that the Dutch translation of the SAS has appropriate

Table 2

Loadings exploratory factor analyses Statistical Anxiety Scale (A) and Statistics Motivation Scale (B)

(A) Statistical Anxiety Scale (In Dutch)					(B) Statistics Motivaiton Scale (In Dutch)				
	Original scale	Asking help	Examination	Interpretation		Original scale	Intrinsic	Extrinsic	Amotivation
item 1	EA		.42		item 1	EM			.50
item 2	IA			.66	item 2	IM	.75		
item 3	AAH	.85			item 3	AM		.70	
item 4	EA		.72		item 4	IM	.74		
item 5	AAH	.62			item 5	EM	.50		
item 6	IA			.67	item 6	IM	.76		
item 7	AAH	.84			item 7	AM		.83	
item 8	IA			.57	item 8	AM		.82	
item 9	EA		.65		item 9	EM			.69
item 10	IA			.63	item 10	IM	.74		
item 11	EA		.60		item 11	IM	.56		
item 12	AAH	.90			item 12	EM	.60		
item 13	EA		.80		item 13	EM			.86
item 14	EA		.61		item 14	IM	.78		
item 15	EA		.78		item 15	IM	.68		
item 16	IA			.48					
item 17	AAH	.90							
item 18	IA			.64					
item 19	IA			.57					
item 20	EA		.80						
item 21	AAH	.93							
item 22	IA			.78					
item 23	AAH	.77							
item 24	AAH	.64							
% explained variance		20%	17%	16%	% explained variance		30%	14%	12%

EA: Examination anxiety, IA: interpretation anxiety, AAH: Anxiety for asking help
EM: Extrinsic motivation, IM: intrinsic motivation, AM: Amotivation

psychometric properties to be used in a Flemish population.

Table 3

Fit indices of the confirmatory factor analyses for the SAS and the SMS

	χ^2	df	χ^2/df	GFI	IFI	TLI	CFI	SRMR
SAS	829.55	226	3.67	0.83	0.91	0.90	0.91	0.07
SMS	326.38	84	3.89	0.91	0.92	0.90	0.92	0.06
cut-off			≤5	≥0.85	≥0.90	≥0.90	≥0.90	>0.08

Statistics motivation scale (SMS)

Because of the modifications to the original instrument (Vallerand et al., 1992) and the fact that the scale has not yet been used in a Flemish sample, we again conducted both an EFA and a CFA. For the EFA, maximum likelihood estimation was conducted on the 15 items of the SMS with varimax rotation. The Kaiser-Meyer-Olkin measure was used to verify the sampling adequacy for the analysis. The overall KMO value was 0.87 ("meritorious" according to Kaiser & Rice, 1974) and all KMO values for individual items were greater than .69 (which is well above the cutoff of .50; Kaiser & Rice, 1974). The Bartlett's test was also significant [$\chi^2(105)$ = 3223.58, p < .001]. Three factors had eigenvalues above 1, and in combination explained 56% of the data. Table 2B reports the factor loadings after rotation. As suggested by Field (2018), only factor loadings > .40 were considered. In this way the pattern of loadings largely replicated the factorial structure of the original Academic Motivation Scale (Vallerand et al., 1992). With exception of items 5 and 12, which originally belonged to the extrinsic scale and now loaded on the intrinsic scale, all other items were associated with the excepted subscale. When inspecting these items, it is not so unexpected that they load on the intrinsic factor. Afterall these items explicitly ask for both intrinsic and extrinsic motivation ("I study statistics to show myself and others that I'm .....”). Importantly, the CFA confirmed that it is better to consider items 5 and 12 as belonging to both the intrinsic and extrinsic factors. Only when assigning these items to both factors (and allowing them to correlate, as suggested by the modification indices) the CFA model fitted the data sufficiently. An overview of the fit indices of the CFA can be found in Table 3. The validity of the SMS is further confirmed by the correlations that were observed between the overall SMS score and statistics anxiety [$r(438) = -.23$, $p < .001$], math anxiety [$r(438) = -.19$, $p < .001$], hours of mathematics in high school [$r(438) = .19$, $p < .001$], and scores on the exam of statistics [$r(240) = .29$, $p < .001$] and general psychology [$r(231) = .18$, $p = .001$]. Again, the alpha level wat set to $\alpha = .01$ to correct for multiple testing and the 95% bootstrap confidence intervals were reported because the assumption of bivariate normality was violated for the correlation between the SMS score and the hours of mathematics variable [Shapiro Wilk's < .05]. All these correlations were significant and in the expected direction. An overview of these correlations can be found in Table 4.

Finally, the internal consistency of the average SMS score and the different subscales was determined by calculating Cronbach's Alpha. For the calculation of the subscales, items 5 and 12 were included in both the intrinsic and extrinsic scale. The Alpha's were .87, .90, .72 and .85 for the average score, intrinsic motivation, extrinsic motivation and amotivation subscales respectively. Taken together, it can be concluded that, although maybe item 5 and 12 could be revised, the current translation of the SMS has appropriate psychometric properties to be used in a Flemish population.

Q2 : What is the Level of Statistics Anxiety in Flanders?

Since no clear cut-off value to define SAS as a diagnostic category has been reported in the literature, prevalence cannot be quantified. For this reason, we provide the descriptive statistics including the average, the first quartile, the median and the third quartile. As can be seen in Table 5, both average and the median score on the SAS are just above 3, meaning that more than 50% of the students rate their statistics anxiety above the middle of the scale. When zooming in on the different subscales, it becomes clear that the "Examination Anxiety" pulls the average SAS scores, with an average of 4.00 and a median of 4.13. The scores on the other subscales where clearly lower. A repeated measures ANOVA with the three subscales as factor, showed a significant effect *[$F(1{,}79, 782.35) = 702.85$, $p < .001$]*. Post-hoc tests showed that all scales significantly differed from each other *[all $t(874) > abs(9)$, p's $< .001$]*. An overview of the level of SA can be found in Table 5.

Q3: Are There Differences in Statistics Anxiety and

Table 4
Pearson's correlations for the SAS and the SMS

			n	Pearson's *r*	P	Lower 95% CI	Upper 95% CI
Statistics Anxiety	-	Math anxiety	438	0.68	< .001	0.62	0.73
	-	Hours of math	438	-0.18	< .001	-0.29	-0.08
	-	Score statistics	240	-0.17	= .001	-0.30	-0.04
	-	Motivation	438	-0.23	< .001	-0.31	-0.14
	-	Score general psychology	231	-0.12	0.06	-0.26	0.01
Statistics Motivation	-	Math anxiety	438	-0.19	< .001	-0.29	-0.09
	-	Hours of math	438	0.19	< .001	0.10	0.28
	-	Score statistics	240	0.29	< .001	0.18	0.41
	-	Score general psychology	231	0.18	=.001	0.05	0.30

Table 5
The level of Statistics Anxiety

	Average SA	Examination	Interpretation	Asking questions
Valid	438	438	438	438
Mean	3.04	4.00	2.35	2.78
Std. Deviation	0.62	0.73	0.74	0.99
Minimum	1.29	1.25	1.00	1.00
Maximum	4.67	5.00	4.63	5.00
25th percentile	2.64	3.63	1.88	2.00
50th percentile	3.08	4.13	2.38	2.88
75th percentile	3.50	4.50	2.88	3.50

The Motivation To Learn Statistics Between First Year Students of The Professional and Academic Bachelor's in Psychology?

Statistics anxiety

To get an idea about group differences in overall SA, an ANOVA[2] was conducted with the average score of the SAS as dependent and Group (professional or academic) and Test Moment (begin or end of the semester) as independent variables. The ANOVA did not reveal any main or interaction effect [all *F*'s (1,434) < 2.42, all *p*'s >.12, η^2 <.006], indicating that both groups were comparable in terms of general SA at both moments. A more fine-grained analyses, focusing on the different SAS-subscales (i.e., exam anxiety, interpretation anxiety, anxiety for asking questions) revealed another picture. A MANOVA with these subscales as dependent and Group and Test Moment as independent variables revealed a significant effect of Group [Wilks' Lambda = .95, *F*(3, 432) = 7.47, *p* <.001, η^2 = .049]. The associated univariate ANOVA's showed that the multivariate effect was due to group differences in the subscales "interpretation anxiety" [*F*(1, 434) = 10.02, *p* < .002, η^2 = .020] and "anxiety for asking help" [*F*(1, 434) = 4.55, *p* = .03, η^2 = .01]. Interestingly, where the professional bachelor students showed more "interpretation anxiety" (2.43, *SD* = 0.74 compared to academic bachelor students (2.21, *SD* = 0.71), the reversed pattern was found for the "anxiety for asking questions" index with professional bachelor students showing lower levels (2.70, *SD* = 0.99) compared to the academic bachelor students (2.91, *SD* = .99). The (multivariate) main effect of Test Moment [Wilks' Lambda = 1, *F*(3, 432) = 0.32, *p* =.81, η^2 = .001] and the interaction between Test Moment and Group failed to reach significance [Wilks' Lambda = .99, *F*(3, 432) = 0.91, *p* =.44, η^2 = .006]. So, taken together, where psychology students in the professional and academic bachelor do not differ from each other in general levels of SA, they show a different underlying pattern, with professional bachelor students showing higher levels of interpretation anxiety, and academic bachelor students showing higher levels of anxiety for asking questions. Importantly, the levels of anxiety and the underlying pattern did not change throughout the semester. A visual impression of differences in SA between the professional and academic bachelor students can be found in Figure 1.

Motivation to learn statistics

To get an idea about group differences in overall motivation to learn statistics, an ANOVA was conducted with the mean score of the SMS as dependent and Group (professional or academic) as independent variable. This analysis revealed significant main effects of Group [*F*(1,434) = 6.87, *p* <.01, η^2 = .02] and Test Moment [*F*(1,434) = 4.66, *p* = .03, η^2 = .011]. The interaction between both variables failed to reach significance [*F*(1,434) = .01, *p* =.94, η^2 < .001]. The main effect of Group indicates that academic bachelor students showed higher levels of overall motivation to learn statistics (3.61, *SD* = 0.99) compared to the professional bachelor students (3.36, *SD* = 0.97). The main effect of Test Moment indicates that motivation was lower at the end of semester, from 3.57 (*SD* = 0.99) at the beginning to 3.37 (*SD* = 0.97) at the end of the semester. A more fine-grained analysis (using MANOVA) focusing on the different SMS-subscales (i.e., extrinsic motivation, intrinsic motivation and amotivation) revealed a significant effect of the factor Group [Wilks' Lambda = .96, *F*(3, 432) = 6.64, *p* < .001, η^2 = .04]. The associated univariate ANOVAs showed that multivariate effect was due to group differences in the subscale "Intrinsic motivation" [*F*(1, 434) = 12.69, *p* <.001, η^2 = .03] for which the academic bachelor students showed higher levels (3.12, *SD* = 1.20) compared to the professional bachelor students (2.72, *SD* = 1.17). The main effect of Test Moment *[Wilks' Lambda = .99, F*(3, 432) = 1.87, *p* =.13, η^2 = .01] and the interaction between Test Moment and Group failed to reach significance [Wilks' Lambda = 1.00, *F*(3, 432) = 0.64, *p* =.59, η^2 < .01]. So, taken together, academic bachelor students show a higher overall motivation to learn statistics compared to professional bachelor students. This difference is driven by higher levels of intrinsic motivation. Furthermore, the overall motivation declines over the semester, and this in an equal degree in both student groups. A visual impression of differences in SA between the professional and academic BA students can be found in Figure 2.

Q4: Are SA and the Motivation to Learn Statistics Predictors for the Score on the Statistics Exam?

From the descriptive statistics reported above, it becomes clear that the scores on the statistics exam correlates (in the expected direction) with SA, the motivation to learn statistics, and the amount of mathematics someone had in the last year of high school. Importantly however, besides being (potentially) influenced by these factors, scores on the exam will also be influenced by general learning efficiency. For the current study, we considered the scores on the exam of general psychology a proxy for the learning efficiency. It is important to note that scores on the exam of general psychology were only available for the students of Thomas More (from both test moments). Since not all participants gave permission to retrieve their exam scores and/ or they didn't participate in both exams, we could only use the data of 176 students. To avoid the inclusion of too many variables and interactions, the mean scores of the SAS and the SMS (instead of the subscales) and their interaction were used.

To get an idea whether these variables can explain

Figure 1

Boxplots of the SAS, the get a visual impression of the differences between professional and academic bachelor students.

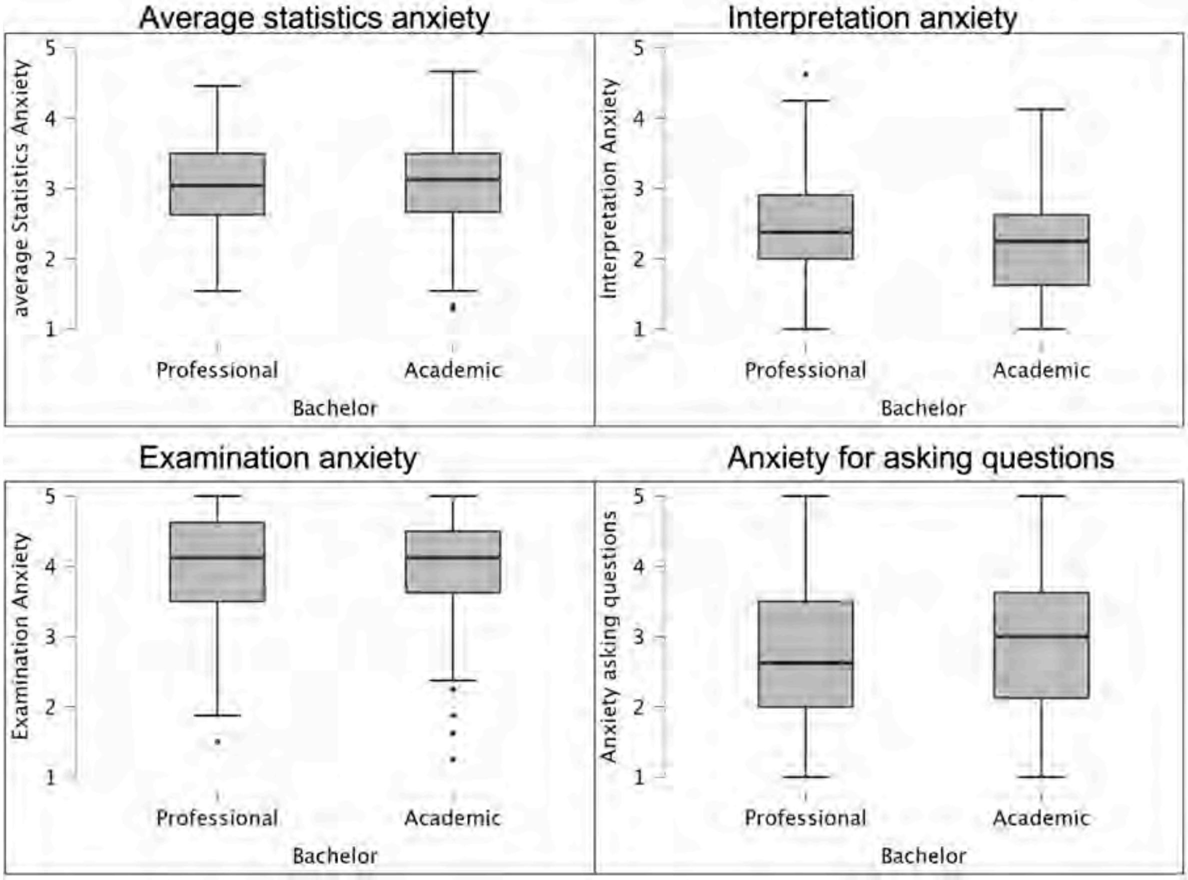
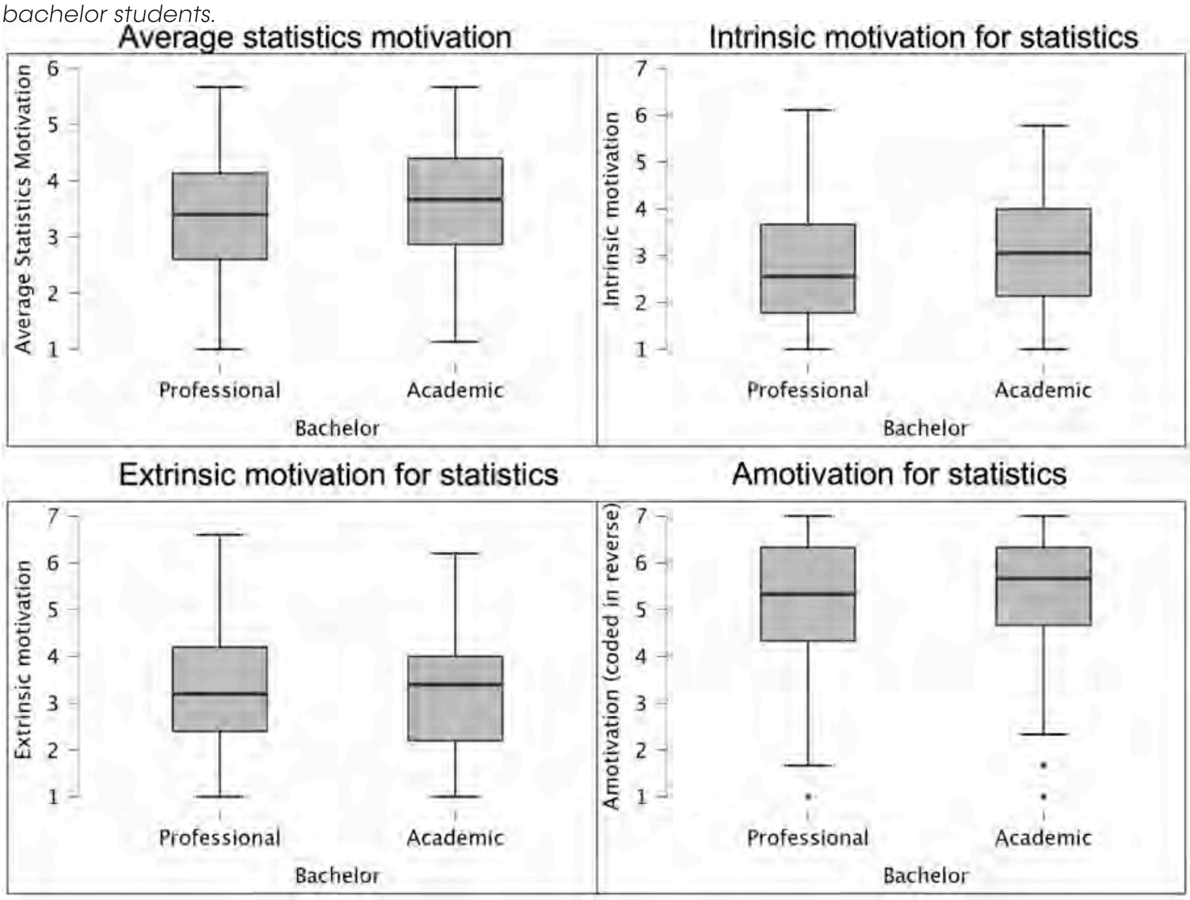


Figure 2

Boxplots of the SAS, the get a visual impression of the differences between professional and academic bachelor students.

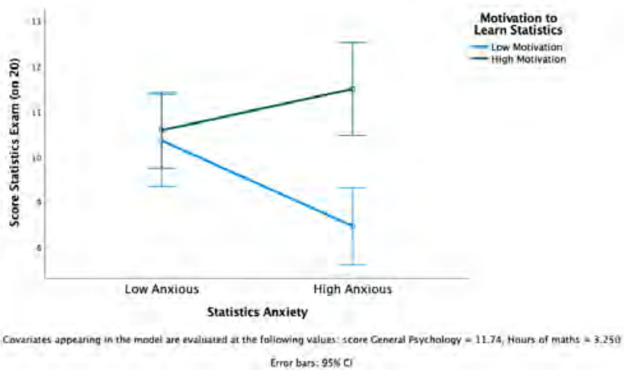


a part of the variance of the scores on the statistics exam, we conducted a (linear) regression analysis with the scores of the statistics exam as dependent variable, and the hours of mathematics in high school, the average SAS score, the average SMS score and the interaction between the SAS and SMS scores as independent variables. To control for this general learning efficiency, we added the scores of the exam of general psychology to the null model. This extended null model was significant [R^2 = .45, $F(1, 174)$ = 142.33, p <.001]. More importantly, the R^2-change was significant [$F(4, 170)$ = 6.41, p < .001], when the null model was compared to the model including hours of mathematics, the average SAS scores, the average SMS score and the interaction between SAS and SMS. This overall regression model was statistically significant [R^2 = .52, $F(5, 170)$ = 37.14, p <.001]. It was found that the scores on general psychology significantly predicted the scores on the statistics exam [β(standardized) = .64, p <.001, partial = .67, semi-partial = .62]. The average SAS score was also a significant predictor [β(standardized) = -.58, p <.01, partial = -.22, semi-partial = .-16] as was the average SMS score [β(standardized) = -.59, p =.04, partial = -.16, semi-partial = .-11]. Finally, also the interaction between the average SAS and SMS scores was significant [β(standardized) = -.83, p <.001, partial = .21, semi-partial = .15]. Importantly, hours of mathematics was no significant predictor of the model [β = .10, p =.06, partial = .14, semi-partial correlation = .10]. Taken together, it can thus be concluded that, after controlling for general learning efficiency, SA, the motivation to learn statistics and the interaction between these variables are significant predictors for the scores on the statistics exam, together explaining a 7% of additional variance.

To be able to better understand the interaction between SA and the motivation to learn statistics, these variables were median-split and entered as factors in a full-factorial ANCOVA with general psychology and hours of mathematics as co-variates[3]. The pattern of results (see Figure 3) was virtually identical compared to the linear regression, with the exception that now, hours of mathematics became a significant predictor [$F(1,170)$ = 4.87, p = .03, η^2 = .03]. Importantly, the interaction between the dichotomized SAS and SMS was again significant [$F(1,170)$ = 8.69, p < .01, η^2 = .05]. Bonferroni corrected post-hoc analyses revealed that the students with high levels of SA and a low motivation obtained lower scores on the statistics exam compared to all other groups [all (abs) t's > 2.81, all p's < .04]. The other groups did not differ from each other. It thus seems that high levels of motivation can alleviate the negative impact of SA on the exam of statistics. Summarized, when leveling students in terms of general learning abilities, psychological factors like SA, the motivation to learn statistics as well as their interaction become convincing predictors for someone's success on the statistics exam (probably more convincing compared to the hours of mathematics obtained in high school).

Figure 3

The interaction between statistics anxiety and the motivation to learn statistics in relation to the scores on the exam of statistics.



General Discussion

The aim the present study was fourfold. (1) Since no validated SA and statistics motivation instrument exist for Flanders (Belgium), we translated the Statistics Anxiety Scale (Vigil-Colet et al., 2008) into Dutch and translated and adapted the Academic Motivation Scale (Vallerand et al., 1992) to measure the motivation to learn statistics (hereafter called the Statistics Motivation Scale or SMS). Here we aimed to validate these instruments for students in Flanders. (2) Next, we aimed to evaluate the level and distribution of statistics anxiety (SA) and the motivation to learn statistics (SM) in psychology students in Flanders. Importantly, because in Flanders the bachelor programs in psychology are organized both at the academic level (at universities) and at the professional level (at universities of applied sciences), (3) we compared both groups in terms of the level of SA and SM. (4) Finally, we aimed to determine the extent to which SA and SM (and/ or their interaction) relates to the scores on the statistics exam (above and beyond the mathematical background of the students). Below we provide comprehensive discussions of our outcomes for each of the research aims separately, and end with an overarching summary.

RA1: What is the Validity and Reliability of the Dutch Translations of the SAS and SMS?

The exploratory and confirmatory analyses conducted on both questionnaires showed that the construct validity of the instruments is acceptable. For both instruments, a 3-factor structure with loading >.40 was confirmed explain 56% of variance for both (which is an appropriate proportion, Scherer et al., 1988). For the SAS, the pattern of loadings was identical to that observed in the original version of the task (Vigil-Colet et al., 2008), with a minor change, that in our model, the error-terms of two items were allowed to correlate. As such, we could replicate the "examination anxiety", "interpretation anxiety" and "anxiety for asking questions" subscales. The correlated error-terms belonged to items that were associated with the "anxiety of asking questions"-factor and measured anxiety towards a private statistics teacher. Our guess is that the shared error-variance is related to the fact that not all students are familiar with a private teacher and had to use their imagination to answer this question. Interestingly, the same correlated error-terms were also observed by (Chiesi et al., 2011), in a validation of an Italian translation of the scale. In future attempts to improve the (Dutch translation of the) SAS, it could be considered to change or rephrase these questions. The construct validity of the SAS was further supported by the fact that we were able to replicate several previously reported findings. For example, in our sample we also found a strong and positive correlation between SA and math anxiety (Paechter et al., 2017). Importantly, the correlation was in terms of magnitude within the same range as those previously reported (r = .40 - .70), so that is can safely be concluded that also in Flanders, both constructs only partially overlap (only ca. 50% of shared variance). In addition, we also found a that subjects with higher levels of SA are overall less motivated to learn statistics (Dunn, 2014), and that students who had more hours of mathematics in high school also report lower levels of SA (Abd Hamid & Sulaiman, 2014; McGrath, 2014). Finally, we observed that females report higher levels of SA compared to males (Rodarte-Luna & Sherry, 2008). Importantly, the correlation between the SAS and the scores of the exam of general psychology was not significant, suggesting that the SAS measures something specific to statistics and not just test anxiety. In terms of reliability, the average SAS score and the scores on the different subscales had a high internal consistency.

The psychometric properties of the Statistics Motivation Scale were also acceptable. The SMS is an adapted version of the Academic Motivation Scale (Vallerand et al., 1992), and here we could largely replicate the factorial structure of the original scale. Except for two items, we found a similar loading pattern, and confirmed the presence of the "intrinsic", "extrinsic" and "amotivation" subscales. These two items originally loaded on the extrinsic subscale, while in our study they load on both the intrinsic and extrinsic subscales (and had correlated error-terms). Interestingly, this "double loading" is not so unexpected as both items start with "I study statistics to show myself and others that I…." and can thus be interpreted as both extrinsic and intrinsic. The validity of this scale is further supported by the correlations between the overall SMS score and statistics and math anxiety, hours of mathematics and the score on the statistics exam, which were significant and in the expected direction. Finally, also the internal consistency of the overall SMS and the different subscales was high.

Taken together, it can thus be concluded that the psychometric properties of both scales are good so that they can be used for future research efforts in Flanders, and that the scores on these scales can be directly compared to scores across other countries. At this moment, we don't have information about the test-retest reliability of both scales, as in the current study a between-subject design was used.

RA2: What is the Level of Statistics Anxiety in Flanders?

In our sample, many students report high levels of statistics anxiety as the average overall score on the SAS was 3.04 (on a scale from 1-5). This is especially the case for "examination anxiety" (EA: 4.00) of which the score was higher compared to the "Interpretation anxiety" (IA: 2.35) and the "anxiety for asking questions" (AAQ: 2.78) subscales. The scores obtained in Flanders, were comparable to those reported e.g. in Spain (Vigil-Colet et al., 2008; EA: 4.25; IA: 2.33; AAQ: 2.54), in Canada (Cantinotti et al., 2017; EA: 4.41, IA: 2.27, AAQ: 2.48), in Singapore and Australia (Chew & Dillon, 2014a; EA:4.12; IA: 2.64; AAQ: 2.54)), or in Brazil (Hernandez et al., 2015; EA= 3.62; IA:2.00; AAQ: 2.51).

The level of SA was similar in the beginning and at the end of the semester. So, in contrast to previous studies (e.g., Birenbaum & Eylath, 1994; Williams, 2013), we could not replicate the finding that general levels of statistics anxiety decrease when the statistics course progresses. It should be kept in mind, however, that our study was conducted in suboptimal circumstances to investigate the development of SA over time. First, due to restrictions imposed during the covid-pandemic, the classes switched to online (from which it is known that is can impact SA, DeVaney, 2010) teaching halfway the semester. Furthermore, the best way to investigate changes over time, is to use a within-subject design. We, however, used a between-subject design because this allowed us to obtain larger sample sizes. As such, it can't be ruled out that the stable levels of SA throughout the semester are due to different subsamples of students for whom the levels of SA change in the opposite direction. Future research (using a within-subject design) will be needed to shed further light on this issue.

Finally, although the levels of SA are undoubtably high (especially the examination anxiety) in our Flemish population, we don't know to what degree they are related to (general) trait anxiety or test anxiety. Although SA is related to trait/state anxiety, only a part of the variance in (the subcomponents of) SA can be explained by trait/state anxiety (correlations < .48, Walsh & Ugumba-Agwunobi, 2002). For this, it can be (carefully) suggested that in our sample the high levels of SA cannot be reduced to general levels of anxiety. Of course, to get a full picture of the mediating role of trait/ state anxiety in these numbers, it will be necessary to include such a measurement in future studies.

RA3: Are there Differences in Statistics Anxiety and the Motivation to Learn Statistics between First Year Students of the Professional and Academic Bachelor's in Psychology?

Above, we reported on the levels of SA when combining the data of the professional and academic bachelor students. When considering the overall levels of SA (taking the average SAS score), the professional bachelor students do not differ in SA compared to academic bachelor students. Interestingly however, the lack of group differences in the overall score are caused by opposite group differences at the level of the SA subscales. Where professional bachelor students show higher levels of "interpretation anxiety", they show a lower "anxiety for asking questions". Group differences were also visible in terms of motivation. Overall, the academic bachelors showed higher levels of motivation, and this was mainly due to higher levels of intrinsic motivation. These values of SA remain stable over time for both groups. The overall motivation to learn statistics, however, declined throughout the semester and this to a similar degree in both groups of students.

As mentioned in the introduction, interesting differences were found when comparing the levels of SA between countries (Baloğlu et al., 2011; Liu et al., 2011) or between groups with different (cultural) backgrounds within a country (Bell, 2008). These group differences are often attributed to differences in the educational system, different habits in using e.g., hand calculators or to the fact that students' native language differed from the languages used during instruction (Liu et al., 2011). In the current study, we show that meaningful difference can also be found between groups that share a similar study interest, have a comparable educational and cultural background, but who differ in the finality of their study program: the professional practice, or the academic master.

As mentioned above, the professional and academic bachelor programs in psychology differ from each other in several important situational and dispositional antecedents of SA. As mentioned in on the website "onderwijskiezer.be" (from the Student Guidance Centre (CLB), a center supported by the Flemish government, which provides future students with information for their choice of study), university colleges differ from universities in, among others, the distance between the students and the lecturer (which is typically smaller in the university colleges), in the way how the content of the courses fits the background knowledge obtained in high school (with a closer link at the university colleges), the size of the class groups (typically smaller at university colleges) and in the range of coaching and mentoring (with a larger and more personalized offer at university colleges). In addition, compared to the professional bachelor's in psychology, higher levels of mathematical background are recommended to enter the academic bachelor's in psychology program. Given these differences, is not unexpected that students in the professional bachelor have less anxiety to ask questions, while the academic bachelor students have less interpretation anxiety.

It is interesting to see that the levels of SA (the overall level and the subscales) do not change throughout the semester, and this for both groups. Indeed, this may be especially remarkable for the students of the professional bachelor, as it could be expected that the situational factors proper to the university college could work as a protecting or alleviating factor for the (development of) SA. It is important to note however, that the data-collection of the second wave took place during the covid-lockdown when all classes were organized online. This could have made the impact of the university college "atmosphere" less impactful. It would be interesting to investigate the evolution of SA during a "regular" academic year when all the classes were given on campus.

The situational and dispositional differences between the professional and academic bachelor programs can also be used to understand difference in terms of the motivation to learn statistics. Where the professional bachelor programs prepare students to become evidence-based professionals, academic bachelor programs typically attract students with stronger scientific interests. From this, it is again not surprising that the intrinsic motivation to learn statistics is higher in the academic bachelor students. Overall, the motivation to learn statistics decreased over the semester. Again, the abnormal semester (because of the covid-restrictions) makes it difficult to draw final conclusions. It would thus be interesting to investigate the evolution of SA during a "regular" academic year when all the classes were given on campus.

Taken together, we found meaningful differences between professional and academic bachelor students, both in terms of SA and in the motivation to learn statistics. Although the pattern of findings is not surprising, future efforts will be needed to pinpoint to the exact antecedents which are responsible for the difference. The current results are already important as they acknowledge that there exist important differences in the SA profile of different groups of students, and that for attempts to alleviate SA in their students, lecturers should consider the characteristics and background of their audience.

RA4 : Are SA and the Motivation to learn Statistics

Predictors for the Score on the Statistics Exam?

The relation between SA and the score on the exam of statistics has previously been investigated with mixed results. Where several studies reported a small but significant negative correlation between SA and statistical performance (typically ranging between r = -.20 and r = -.30; for an overview see, Macher et al., 2015) other studies demonstrated insignificant or even positive correlations (e.g., Lester, 2016; Paechter et al., 2017). One potential reason could be the lack of a proper control condition for general learning abilities. Afterall, the grades on a statistics exam are determined and influenced by a multitude of factors which are not limited to SA, the mathematical background, and the motivation to learn statistics. For this reason, we decided to investigate the relationship between these latter factors and the score on the statistics exam after controlling for these general leaning abilities. Here we operationalized these abilities by the scores on the exam of general psychology because this is also a course with a strong theoretical focus, but without the need for direct statistical calculation and interpretation.

We found, even when not controlling of these general learning abilities, a significant correlation between the scores on the statistics exam, the motivation to learn statistics and the hours of mathematics in high school. Interestingly, when introducing these factors and the interaction between SA and the motivation to learn statistics into a linear regression with the scores of statistics as dependent variable and when controlling for the general learning abilities. SA, the motivation to learn statistics, and their interaction remain significant predictors (explaining 7% of variance above and beyond the general learning ability), while the mathematical background failed to reach significance as a predictor. This interaction showed that SA only has a negative impact on those students who have a low motivation to study statistics. In other words, a proper motivation could act as a protecting factor for those students who experience high levels of SA.

Taken together, these findings are interesting because they add novel insights into the factors that predict someone's score on the statistics exam. Were previous studies pointed to the importance of a solid mathematical background for academic success in general, and the success on the exam of statistics in particular (Fonteyne et al., 2015), the current study indicates that it is also important to look at more psychological factors, especially when equating the students in terms of general learning ability. Given the high level of SA (see above) in psychology students, these are thus factors that should not be ignored by statistics lectures/ professors. Our study shows that motivation can act as a protecting factor to compensate for SA. Therefore, effort should be paid to (course/ class) interventions that can increase a student's motivation to learn statistics. In this context it is worrisome that in our sample, the motivation to learn statistics declined by the end of the semester (but this can be due to the covid-restrictions). Typically, anxiety and low motivation are faster and easier to tackle compared to an insufficient mathematical background. In fact, several tips to alleviate SA can be found in the list of situational factors listed in the introduction (like e.g. the pace of statistics instructions (Bell, 2005 as cited in Chew & Dillon, 2014b), the class atmosphere (Lesser & Reyes III, 2015), the absence of real-life examples (Neumann et al., 2013), instructor immediacy (Tonsing, 2018), the verbal and/ or non-verbal expressions of the lecturer (Williams, 2010), or the organization (online vs on campus) of the courses (DeVaney, 2010). When these interventions are not successful, a specifically dedicated training program to tackle SA can be considered, as several efficient programs to help student to get rid of/ or to deal with SA have been developed (Boaler et al., 2018; Smith & Capuzzi, 2019).

These tips and recommendations can not only be implemented by the statistics lecturer at the university or university college, but also by the math teacher in high school. We found high levels of SA in 1st year students already in the beginning of the academic year. This suggests that SA might have its roots earlier the school career of the students. In many countries, pupils are introduced to statistics during the math classes, and this already in the early years of high school (in Flanders e.g., the concepts average, median and modus are already discussed during the math classes in 2d grade, when the children are 12-13 years old). The results of our study indicate that, besides general mathematical background, (the interaction of) anxiety and motivation are significant predictors for statistics performance at the university or university college. Given the importance of statistics, it would be beneficial if the math teachers in high school would have an idea about the level of SA in their pupils and about their motivation to learn statistics. This would allow them to select and implement appropriate interventions to alleviate SA and to increase the motivation to learn it (if needed) early in the school career. The validated Dutch versions of the SAS and the SMS can be helpful tools in this context as they be used to detect the presence of SA and/ or to evaluate the impact of the implemented interventions. Afterall, it would be a big step forward if students can start their statistics courses in higher education with a good motivation and a healthy dose of self-confidence.

Summarized

In the current study we show that the Dutch translation of the Statistics Anxiety Scale (SAS) has good psychometric properties so that the obtained results can be properly interpreted and compared to the results obtained in other countries. In Flanders, psychology students report high levels of SA, with a level comparable to that observed in other countries. From the different SA subscales, the highest scores were observed for the "examination anxiety (EA)".

Although no differences were found in the general level of SA, professional and academic bachelor students differed in the degree of "interpretation anxiety (IA)" and "anxiety of asking questions (AAQ)". Where the professional bachelor students reported higher levels of IA, the academic bachelor students reported higher levels of AAQ. Importantly, these levels remained stable throughout the semester. The professional and academic bachelor students also differed from each other in their motivation to learn statistics, which the academic bachelor students showing higher levels of intrinsic motivation. Interestingly, the levels of motivation declined throughout the semester. This is unfortunate, because when controlling for general learning ability, the motivation to learn statistics interacts with SA when predicting someone's grades on the exam of statistics. A good motivation to learn statistics can alleviate the negative relation between SA and score on the exam of statistics.

Footnotes

[1] Interestingly, both questions are the only two asking for anxiety towards a private statistics teacher and were highly correlated (r = .84). Probably not all students had experience with a private teacher.

[2] Here and for the other ANOVA and MANOVA's, the Levine's test and/ or Box-*M* were never significant.

[3] These covariates are independent from both the SAS and SMS factors (an assumption of ANCOVA), as indicated by the lack of a significant differences between the high and low SAS and SMS groups for these covariates.

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Appendix A: the Dutch (translated) version of the AMS

Instructions in Dutch & (freely translated to) English (in Italic)

Denk bij volgende vragen telkens aan je ervaringen met het vak Statistiek 1 van je huidige opleiding.
(Think about your experiences with the Statistics 1 course of your current education.)

Gelieve aan te duiden in welke mate de volgende situaties je angst zouden bezorgen op een schaal van 1 (= geen angst) tot en met 5 (= heel veel angst).
(Please indicate to what extent the following situations would cause you anxiety on a scale from 1 (= no anxiety) to 5 (= a lot of anxiety).)

1. *Studeren voor een examen statistiek. (Studying for a statistics exam.)*
2. *Een tabel in een wetenschappelijk artikel interpreteren. (Interpreting a table in a scientific article.)*
3. *Individuele hulp vragen aan een docent statistiek voor de leerstof die ik niet zo goed begrijp. (Asking a statistics tutor for individual help with the subject matter I don't understand very well.)*
4. *De dag vóór mijn examen beseffen dat ik sommige oefeningen niet kan oplossen waarvan ik voordien dacht dat ze gemakkelijk zouden zijn. (Realizing the day before my exam that I cannot solve some exercises that I thought would be easy.)*
5. *Een privéleraar vragen om een statistisch onderwerp uit te leggen dat ik niet begrijp. (Asking a private teacher to explain a statistical subject that I do not understand.)*
6. *Een wetenschappelijk artikel lezen dat statistische analyses bevat. (Reading a scientific article that contains statistical analyses.)*
7. *Een docent vragen hoe ik een table voor kansrekenen moet gebruiken. (Asking a teacher how to use a probability table.)*
8. *Een wiskundig bewijs proberen te begrijpen. (Trying to understand a mathematical proof.)*
9. *Een examen statistiek afleggen. (Taking a statistics exam.)*
10. *Een advertentie over auto's lezen dat figuren en tabellen bevat over benzineverbruik en co2 uitstoot. (Reading an advertisement about cars that contains figures and tables about petrol consumption and co2 emissions.)*
11. *Het lokaal binnengaan om een statistiekexamen af te leggen. (Going into the classroom to complete a statistics exam.)*
12. *De docent om hulp vragen bij het maken van een oefening. (Asking the teacher for help with an exercise.)*
13. *De dag vóór het examen vaststellen dat je niet genoeg tijd had om de cursus te herhalen. (Finding out the day before the exam that you did not have enough time to rehearse the course.)*
14. *Wakker worden op de dag van het examen statistiek. (Waking up on the day of the statistics exam.)*
15. *Net voor de start van het examen statistiek beseffen dat je een bepaald type oefening niet hebt voorbereid. (Realizing just before the start of the statistics exam that you did not prepare a certain type of exercise.)*
16. *Een wiskundig bewijs overschrijven van het bord terwijl de docent dit bewijs aan het uitleggen is. (Copying a mathematical proof from the board while the teacher is explaining it.)*
17. *Een docent om hulp vragen bij het begrijpen van een afdruk met statistische resultaten. (Asking a teacher for help in understanding a printout with statistical results.)*
18. *Proberen om de kansen op winst bij een loterij te begrijpen. (Trying to understand the chances of winning in a lottery.)*
19. *Zien hoe een medestudent zorgvuldig de tabel met statistische resultaten bestudeert van een oefening die hij net heeft opgelost. (Watching a fellow student carefully study the table of statistical results of an exercise he has just solved.)*
20. *Naar een examen statistiek gaan zonder dat je genoeg tijd had om de leerstof te herhalen. (Going*

to a statistics exam without having had enough time to repeat the material.)

21. *Een docent om hulp vragen wanneer je een tabel met statistische resultaten probeert te interpreteren. (Asking a teacher for help when trying to interpret a table with statistical results.)*
22. *Statistische analyses proberen te begrijpen die in de samenvatting bovenaan een wetenschappelijk artikel staat. (Trying to understand statistical analysis that appears in the summary at the top of a scientific article.)*
23. *Naar het bureau van de docent gaan om vragen te stellen. (Going to the teacher's office to ask questions.)*
24. *Een privéleraar vragen om uitleg te geven over hoe je een bepaalde oefening maakt. (Asking a private teacher to explain how to do a certain exercise.)*

- Examination Anxiety Subscale: items 1, 4, 9, 11, 13, 14, 15, 20
- Asking for help Anxiety Subscale: items 3, 5, 7, 12, 17, 21, 23, 24
- Interpretation Anxiety Subscale: items 2, 6, 8, 10, 16, 18, 19, 22

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Appendix B: the Dutch (translated) version of the AMAS

Instructions in Dutch & (freely translated to) English

Denk bij volgende vragen telkens aan je ervaringen met het vak wiskunde tijdens het middelbaar.

For the following questions, always think about your experiences with the subject of mathematics during high school.

Gelieve aan te duiden in welke mate de volgende situaties je angst zouden bezorgen op een schaal van 1 (= geen angst) tot en met 5 (= heel veel angst).

(Please indicate to what extent the following situations would cause you anxiety on a scale of 1 (= no anxiety) to 5 (= very much anxiety).)

1. *Gebruik maken van de tabellen achteraan in het handboek wiskunde. (Using the tables at the end of the math textbook.)*
2. *Denken aan het wiskunde examen de dag voordat het examen plaatsvindt. (Thinking about the math exam the day before the exam takes place.)*
3. *Meevolgen hoe een leerkracht een wiskundig probleem uitwerkt op het bord. (Following along as a teacher works out a math problem on the black board.)*
4. *Een examen wiskunde afleggen. (Taking a math exam.)*
5. *Luisteren naar een wiskundeles. (Listening to a mathematics class.)*
6. *Een taak krijgen met veel moeilijke wiskunde oefeningen die tegen de volgende les moet ingediend worden. (Getting a task with lots of difficult math exercises to be submitted by the next class.)*
7. *Naar een medestudent luisteren die uitlegt hoe je een wiskundeprobleem oplost. (Listening to a fellow student explaining how to solve a math problem.)*
8. *Een quiz over wiskunde krijgen zonder dat je dit op voorhand wist. (Being given a pop-quiz on math without knowing it in advance.)*
9. *Een nieuw hoofdstuk in het wiskundeboek beginnen. (Starting a new chapter in the math book.)*

Appendix C: the Dutch (translated) version of the SMS

Instructions in Dutch & (freely translated to) English

Denk bij volgende vragen telkens aan je ervaringen met het vak Statistiek 1 van je huidige opleiding.

(Think about your experiences with the course Statistics 1 of your current program.)

Gelieve aan te duiden in welke mate onderstaande stellingen beschrijven waarom u statistiek studeert op een schaal van 1 (= helemaal niet) tot en met 7 (= helemaal).

(Please indicate to what extent the statements below describe why you study statistics on a scale from 1 (= not at all) to 7 (= completely).)

1. *Om later als ik afstudeer gemakkelijk een goedbetaalde job met aanzien te vinden. (To easily find a well-paying job with prestige, later when I graduate.)*
2. *Voor mij is statistiek zoals een spel: ik vind het leuk om te doen en ik leer nieuwe dingen bij. (For me, statistics is like a game: I like doing it and I learn new things.)*
3. *Ik kan niet begrijpen waarom we met statistiek moeten bezig zijn en eerlijk gezegd kan het me ook niet veel schelen. (I can't understand why we need to be involved with statistics and frankly I don't care much either.)*
4. *Omdat ik het leuk vind om goed te zijn in statistiek. (Because I like to be good at statistics.)*
5. *Om mezelf en anderen te bewijzen dat ik intelligent ben. (To prove to myself and others that I am intelligent.)*
6. *Voor de kick die ik ervaar wanneer ik interessante en uitdagende taken in statistiek oplos. (For the thrill I experience when I solve interesting and challenging tasks in statistics.)*
7. *Vroeger leek statistiek zinvol, maar nu vraag ik me af of het zin heeft om ermee verder te gaan. (Statistics used to seem useful, but now I wonder if it makes sense to continue with it.)*
8. *Eerlijk gezegd weet ik het niet. Soms heb ik het gevoel dat ik mijn tijd verspil met statistiek. (Honestly, I don't know. Sometimes I feel like I'm wasting my time with statistics.)*
9. *Omdat statistiek zal helpen om mijn droombaan te vinden. (Because statistics will help me find my dream job.)*
10. *Voor het plezier dat ik beleef wanneer ik mezelf overtref in statistiek. (For the pleasure I get when I outdo myself in statistics.)*
11. *Omdat statistiek me toelaat om veel nieuwe en interessante dingen te ontdekken. (Because statistics allows me to discover many new and interesting things.)*
12. *Op deze manier kan ik mezelf en anderen bewijzen dat ik statistische opdrachten zelf kan oplossen. (In this way I can prove to myself and others that I can solve statistical tasks on my own.)*
13. *Omdat als ik nu statistiek leer mijn kansen voor het vinden van een leuke job zullen vergroten. (Because if I learn statistics now, my chances of finding a nice job will increase.)*
14. *Omdat ik het leuk vind om statistische problemen op te lossen. (Because I like solving statistical problems.)*
15. *Omdat het bezig zijn met statistiek voor persoonlijke voldoening zorgt waardoor ik ook goed wil zijn in andere vakken. (Because being busy with statistics, gives me personal satisfaction which makes me want to be good in other subjects as well.)*

- Intrinsic Motivation Subscale (IM): items 2, 4, 5, 6, 10, 11, 12, 14, 15
- Extrinsic Motivation Subscale (ER): items 1,5, 9, 12, 13
- Amotivation Subscale (A): items 3, 7, 8