Application of The Learning Strategies and Motivation Questionnaire (LEMO) at the University: Reliability and Relation to First-year GPA

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Abstract

As part of efforts to enhance academic achievement in higher education, incoming first-year students are becoming more and more subjected to surveys and assessments, e.g., regarding motivation and learning strategies. The Learning Strategies and Motivation Questionnaire (LEMO; Donche, Van Petegem, Van de Mosselaer, & Vermunt, 2010) is one of these surveys, applied mostly in professional bachelor programmes. The current study examines the reliability and predictive validity of the LEMO questionnaire in a sample of 416 first-year university students. All 13 scales were included in the study, i.e. Concrete Processing, Analysing, Memorising, Critical Processing, Relating-Structuring, External Regulation, Self-Regulation, Lack of Regulation, Amotivation, Controlled Motivation, Autonomous Motivation, Self-Efficacy, and Learning Together. In line with its reliability in previous studies, Cronbach's alfa of most LEMO scales was below .70, which is the minimum threshold for scientific research, as was the Composite Reliability of eight of the 13 LEMO-scales. A confirmatory factor analysis showed that several factor loadings were below .70, resulting in an average variance extracted (AVE) below .50 for 11 of the 13 scales. Most scales had no or only a limited correlation to first-year GPA (FYGPA). Only Self-Efficacy and Analysing correlated ≥ .20 with FYGPA. These two scales explained 10.4% of the variance in study success. Hereby, Self-Efficacy is the most important predictor. The other 11 scales had no significant contribution to the prediction of academic performance in addition to Self-Efficacy and Analysing (ΔR^2 = 3.4%, n.s.). Additional analyses showed that the correlation between the LEMO scales and FYGPA varied according to Bachelor programme.

Keywords: learning strategies, motivation, self-efficacy, self-determination theory, academic achievement, higher education

1. Introduction

Incoming first-year students are increasingly surveyed and tested as part of initiatives that seek to promote study success in higher education (HE). However, a variety of student factors play a role in study success, such as entry characteristics, e.g., demographic variables, personality traits, intelligence and prior education, and factors related to the student-in-training, e.g., motivation/emotion, cognition, behaviour, context, and integration (Credé & Kuncel, 2008; Nauwelaerts, Doumen, & Verhaert, 2023; Richardson, Abraham, & Bond, 2012; Robbins et al., 2004). Accordingly, there are many self-report questionnaires on various student factors, and specifically student-in-training factors, such as the Learning and Study Strategies Inventory (LASSI) (Weinstein, Palmer, & Schulte, 1987), the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1993), the Approaches and Study Skills Inventory for Students (ASSIST) (Tait, Entwistle, & McCune, 1998), the Study Process Questionnaire (SPQ) (Biggs, 1987), the Student Readiness Inventory (SRI) (Le et al., 2005), and many others. This article focuses on the Learning Strategies and Motivation Questionnaire (LEMO) (Donche, Van Petegem, Van de Mosselaer, & Vermunt, 2010), a questionnaire that is often used in Flanders, Belgium, including in the orientation tool for teacher training programmes. This questionnaire focuses primarily on cognitive processing and regulation strategies (Vermunt, 1992, 2005; Vermunt & Vermetten, 2004), motivation concepts from the self-determination theory (Deci & Ryan, 2000; Vansteenkiste, Ryan & Deci, 2008), and academic self-efficacy (Pajares, 1996; Pintrich et al., 1993).

1.1 Relation between Learning Strategies and Motivation and Academic Performance

1.1.1 Motivation

Motivation is important in the context of study success, which is why the current study explores it in more detail. Motivation refers to factors that lead an individual to behave in a certain way at a certain time. Motivation influences the direction of behaviour (i.e., which goals one will pursue), the intensity of behaviour (i.e., how much effort one will put in), and the persistence of behaviour (i.e., how well one will persevere until the goal is reached) over a long period of time (Brysbaert, 2006). Motivation is also related to emotion: people are attracted to activities they perceive as pleasurable and from which they expect pleasurable consequences. In general terms, motivation can be described as the driving force behind goal-directed, sustained action (Cook & Artino, 2016).

However, motivation is often viewed from a specific angle, which is reflected in a multitude of motivation theories. An overview of these theories can be found in Eccles and Wigfield (2002), a comparative overview in Wigfield and Cambria (2010), and Cook and Artino (2016). Eccles and Wigfield (2002) distinguish two aspects of motivation: in order to do a task, it is not only important to think that one can handle the task (Am I able to successfully complete the task?), but also to have a reason to do the task (Why would I do this task?). Among others, theories of self-efficacy, which is a belief in one's own abilities and chances of success, highlight the first aspect (Bandura, 1997; Boekaerts, Pintrich, & Zeidner, 2000). Self-determination theory (Deci & Ryan, 2000; Vansteenkiste et al., 2008) is a theory that focuses on the second aspect: it distinguishes between autonomous motivation, i.e., doing the task out of interest, or because one finds it personally meaningful or valuable, and controlled motivation, i.e., doing the task because of external or internal pressures. Furthermore, the amount of demotivation/amotivation is also considered, e.g., ‘I don't see why I am actually doing this task’.

Student motivation appears to be a significant predictor of academic performance in higher education. Meta-analyses show that particularly academic self-efficacy predicts achievement in higher education, with meta-analytic correlations between .21 and .50 (Credé & Phillips, 2011; Honicke & Broadbent, 2016; Multon, Brown, & Lent, 1991; Richardson et al., 2012; Robbins et al., 2004; Sitzmann & Ely, 2011; Sitzmann & Yeo, 2013; cf. Nauwelaerts, Doumen, & Verhaert, 2023). Motivational aspects from the self-determination theory, i.e., intrinsic and extrinsic motivational concepts, are less directly related to academic performance in higher education (meta-analytic rho $\leq$.16) (Credé & Phillips, 2011; Richardson et al., 2012). This is in line with Howard and colleagues (2021), who reported across ages ranging from primary school to university education, a meta-analytic correlation of .13 for the relation between intrinsic motivation and objective academic performance, between .11 and -.03 for extrinsic motivation indicators (integrated, identified, introjected, external regulation), and -.21 for amotivation. The latter was not included in the meta-analyses regarding higher education, but there was no significant age difference in the study of Howard et al. (2021), which means that the meta-analytic correlation in this study might also be indicative for higher education students.

1.1.2 Learning Strategies

Students use cognitive processing activities such as memorising, and structuring and relating learning content, to process information. These cognitive processing activities lead to knowledge, understanding, overview, assignments, and other learning outcomes (see Vermunt, 1992, 2005). To some extent, students adapt their learning strategy, typically a student-specific combination of processing activities, to the learning context, e.g., to different course units (Vermetten, Lodewijks, & Vermunt, 1999). Students use cognitive regulation activities to direct their learning process, more specifically: self-regulation, where they direct the learning process themselves; external regulation, where they have the learning process directed externally by teachers, the study material; and a lack of regulation relating to difficulties with regulating the learning process (Vermunt, 2005).

Correlations between cognitive processing activities and academic performance in higher education may vary according to the study programme (Vermunt, 2005) and possibly also by the course unit. When looking across studies, there is little evidence for a link between specific cognitive processing activities and academic performance in higher education. Relational structuring shows the most promise at r = .25 (Vermunt, 2005). Vermunt (2005) examined the correlation across study programmes, but it is not a meta-analysis. In line with this correlation, however, there is some evidence in the meta-analyses for partial aspects or related processing activities such as selecting main ideas (rho = .09-.20) (Credé & Kuncel, 2008; Credé & Phillips, 2011; Richardson et al., 2012; see also Fong et al.’s (2021) research, with lower correlations for postsecondary education than for K-12), and elaborating that includes linking new information to already acquired knowledge (rho = .13-.18) (Credé & Kuncel, 2008; Credé & Phillips, 2011; Richardson et al., 2012; Sitzmann & Ely, 2011). In addition, there is also some evidence for critical processing, e.g., r = .22 in Vermunt (2005). In the meta-analyses the correlation varied between

08-.26 (Credé & Phillips, 2011; Fong et al., 2017; Richardson et al., 2012). In contrast, no such evidence was found for memorising, analysing, and concrete processing (Credé & Phillips, 2011; Richardson et al., 2012; Vermunt, 2005). Cognitive regulation strategies (metacognitive regulation), had a meta-analytic correlation between .14 and .22 with achievement in higher education (Credé & Kuncel, 2008; Credé & Phillips, 2011; Richardson et al., 2012; Sitzmann & Ely, 2011). Meta-analytic correlations with metacognition are, however, lower when applying questionnaires than with on-line methods such as a think-aloud protocol (Ohtani & Hisasaka, 2018). When also including on-line methods, these authors reported a meta-analytic correlation of .25 for adult samples.

1.2 Previous Research with the Learning Strategies and Motivation Questionnaire

The LEMO mainly draws from two frames of reference (Vanthournout, Van de Mosselaer, Donche, & Vansteenkiste, 2016): the Vermunt model on cognitive processing and regulation activities (Vermunt, 1992, 2005; Vermunt & Vermetten, 2004), and the self-determination theory regarding motivation (Deci & Ryan, 2000; Vansteenkiste et al., 2008). In addition, self-efficacy related to studying is included in the questionnaire (Pajares, 1996; Pintrich et al., 1993), as well as a scale regarding learning from and with each other (Learning Together; Van de Mosselaer, Donche, Jansen & Van Petegem, 2012).

Several studies regarding the LEMO have been published (see Vanthournout et al., 2016). In this section, the focus is on papers reporting the reliability of the LEMO scales among first-year students or evaluating the predictive validity regarding academic performance in the first year of higher education.

The LEMO (Note 1) is based on some existing scales. Its scales on cognitive processing include Memorising and Analysing, indicators of superficial, step-by-step processing of learning material; Critical Processing and Relating-Structuring, indicators of deep processing; and Concrete Processing. Its scales on regulation activities include Self-Regulation, External Regulation, and Lack of Regulation. All these scales are a shortened version of some scales from Vermunt's Inventory of Learning Styles (1994). The motivation scales in line with the self-determination theory are based on the Academic Self-Regulation Questionnaire, i.e., Autonomous and Controlled Motivation (Ryan & Connell, 1989; Vansteenkiste, Soenens, Sierens, Luyckx, & Lens, 2009), and the Academic Motivation Scale, i.e., Amotivation (Vallerand et al.,1992, 1993; see Vanthournout et al., 2016). Studies examining these original, more comprehensive scales are not included in the review, as the focus was on the reliability and validity of the scales as they were ultimately included in the LEMO.

1.2.1 Reliability

The research first examined the reliability, i.e., Cronbach's alpha, of each LEMO scale among first-year students. Cronbach's alpha indicates the consistency between the items of the same scale (number between 0 and 1) (Tavakol & Dennick, 2011). The better the consistency between items, the closer Cronbach's alfa is to 1. In addition, the higher Cronbach's alpha, the smaller the proportion of a test score that is due to (random) measurement error. According to DeVellis (2003), for scientific research, a Cronbach's alpha starting at .70 is respectable and starting at .80 is very good. A Cronbach's alpha less than .60 is too low, an alpha between .60 and .65 is undesirable, and an alpha between .65 and .70 is minimally acceptable. A very high Cronbach's alpha is required for individual assessments, where there are significant consequences for those involved.

Table 1 summarises the Cronbach's alphas reported in previous LEMO research with first-year students, primarily students from professional undergraduate programmes. The LEMO was completed at multiple time points in some studies, e.g., at the beginning and end of the first year. In that case, all alphas involved were included in the summary. Cronbach's alpha for the motivation scales Amotivation, Controlled Motivation, Autonomous Motivation, and Self-Efficacy is always respectable to very good. However, for External Regulation, Self-Regulation, Analysing, Memorising, and Critical Processing, Cronbach's alpha is often below .70. For Concrete Processing, there was even in all studies a reported value below .70.

Table 1. The reliability of the LEMO in previous studies with first-year students.

LEMO scale	Number of items	Number of alpha's mentioned			Cronbach's alpha		
		PBa*	ABa*	Both*	Median	Range	Percentage under .70
Processing activities							
Concrete Processing	4	5	0	0	.64	.61-.69	100%
Analysing	4	10	1	2	.66	.59-.70	85%
Memorising	4	10	2	2	.66	.55-.76	57%
Critical Processing	4	10	1	2	.69	.64-.76	54%
Relating-Structuring	4	10	2	2	.72	.60-.79	36%
Regulation activities							
External Regulation	6	10	0	2	.61	.57-.76	92%
Self-Regulation	4	10	1	2	.69	.61-.80	69%
Lack of Regulation	4	10	1	2	.73	.68-.80	23%
Motivation							
Amotivation	3	7	0	4	.78	.75-.84	0%
Controlled Motivation	6	7	0	2	.79	.73-.84	0%
Autonomous Motivation	6	7	0	2	.85	.78-.89	0%
Self-Efficacy	4	5	1	2	.875	.81-.99	0%
Other scales							
Learning Together	3	–	–	–	–	–	–

* PBa: professional bachelor; ABa: academic bachelor. Both, or not clear which type of bachelor.

Note. This overview is based on: Catrysse et al. (2015) (same sample as Kyndt et al. (2015, 2019), identical alphas are counted only once; in Kyndt and colleagues (2015), 1 item of Controlled Motivation was removed, while this was not mentioned in the other two publications), Catrysse et al. (2018), Donche & Van Petegem (2008), Donche, Coertjens, Vanthournout, & Van Petegem (2012), Noyens et al. (2019), Vanoverberghe, Noyens, Willems, & Donche (2017), Vanthournout et al. (2011, 2012a, 2012b, 2016, 2017a, 2017b), and Willems, Coertjens, Tambuyzer, & Donche (2019). The motivation scales from Donche and Van Petegem (2008), Noyens et al. (2019), and Willems et al. (2019) were not included in the table since the number of items per scale did not match the LEMO. Some papers report only a range, e.g., for the LEMO taken in 1 Ba -3 Ba or in secondary-higher education, and were therefore not included in the above overview (e.g., Coertjens et al., 2017).

1.2.2 Further Construct Validity

Hair and colleagues (2006) describe the internal consistency of a scale as an important component of construct validity, that is, the extent to which the set of items reflects the latent, underlying factor in question. Other indicators of construct validity can be obtained through confirmatory factor analysis: Confirmatory factor analysis first examines whether the theoretical model is a good fit to the data. Different fit indices are used: RMSEA indicates an adequate fit if $\leq .08$; CFI, on the other hand, should be $> .90$ (Hu & Bentler, 1999; Kline, 2005; MacCallum, Browne, & Sugawara, 1996). Next, the size of the factor loadings is considered. When high standardised factor loadings per item are reported in a confirmatory factor analysis, i.e., .50 or higher, and ideally even .70 and higher, this is an indication of good construct validity. In addition, the square of the factor loading is a measure of the amount of variance explained in an item by the latent, underlying factor. When this is averaged across all items of a particular scale, the average variance explained (AVE) is obtained. AVE should also be sufficiently high, i.e., .50 or higher (Hair et al., 2006), which means that for the underlying factor more variance is explained than error variance remains. Finally, Composite Reliability can be calculated, a measure of internal consistency analogous to Cronbach's alpha, but sometimes slightly higher, since Cronbach's alpha indicates the lower limit of reliability (Hair et al., 2006).

In previous research regarding the LEMO, some confirmatory factor analyses (CFA) were reported. In this section,

we report the results of these analyses only if they are clearly the LEMO scales in question and not a precursor/variant with more or fewer items. The analyses involved usually concern a selection of scales, not the entire instrument.

The majority of reported confirmatory factor analyses including first-year higher education students only mention the relevant fit indices and do not elaborate on other important indicators of construct validity such as the size of factor loadings, AVE, … (see Table 2 for an overview). Most of the fit indices are adequate, although some were obtained after adjustment of the model. Even though most fit indices were adequate, some factor loadings may be too low and should be looked at in more detail. This was the case in the study of Willems and colleagues (2019), who examined the construct validity of the LEMO in 781 first-year Science students (Note 2). All factor loadings for the Relating-Structuring, Memorising, Lack of Regulation, and Self-Efficacy scales were above .50. This was also the case for Self-Regulation, except for 1 item. Ideally, however, the factor loadings should be above .70, which was the case only for three items of the Self-Efficacy scale and 1 item of Relating-Structuring and Lack of Regulation. The AVE was above .50 (i.e., .56) only for Self-Efficacy. For the remaining scales, AVE was below .50 (i.e., .32 for Memorising and Self-Regulation; .41 for Relating-Structuring and Lack of Regulation). Composite Reliability was .65 for Memorising and Self-Regulation, and .74, .73, .83 for Relating-Structuring, Lack of Regulation, and Self-Efficacy, respectively. Hence, further examination of the construct validity is needed.

Table 2. Fit indices of confirmatory factor analyses of LEMO scales in samples with first-year bachelor students

Scales	Authors	N	PBa/ABa	CFI >.90	RMSEA ≤.08
Processing activities (4 scales)	Donche & Van Petegem (2008)	1388	PBa	x	x
Deep processing	Vanthournout et al. (2017a)	560	PBa	x	x
	Catrijsse et al. (2018)	80	ABa	x	x
Surface processing	Vanthournout et al. (2017a)	560	PBa	Only after removing items of Memorising and Analysing	
	Catrijsse et al. (2018)	80	ABa	x	x
Regulation scales (3 scales)	Vanthournout et al. (2017a)	560	PBa	Only after removing items of External Regulation	
Processing and regulation scales (7 scales)	Coertjens et al. (2017)	342	-	x	x
Motivation scales (4 scales)	Kyndt et al. (2019)	630	Both	x	Too high
Motivation scales without Self-Efficacy (3 scales)	Kyndt et al. (2015)	630	Both	x	Too high in third trimester
Separate scale: Amotivation	Noyens et al. (2019)	930	-	x	x
Other combination	Willems et al. (2019)	781	ABa	After addition of three error correlations	

1.2.3 Predictive Validity

In addition to reliability and further construct validity, the predictive validity of the LEMO w.r.t. academic performance in the first year of higher education was also examined.

A number of studies examined its correlation with the percentage of credits acquired (Table 3). Vanthournout and colleagues (2012b) included the LEMO scales by category in a linear regression analysis, i.e., processing activities, regulation activities, and motivation. Each of these categories had a multiple correlation of .20-.25 with study

success in the first year of HE. The LEMO was administered in May. The other two studies in the table (Van Daal et al., 2013; Willems et al., 2019) reported correlations for individual LEMO scales. For the processing activities, a non-significant to small correlation was found with study success; for the regulation scales, only the correlation with Lack of Regulation was statistically significant. With respect to the motivation scales, Self-Efficacy was related to study success in HE. Amotivation was only to a limited extent related to academic performance and the other scales had no significant correlation. The following should be noted. The results of Van Daal and colleagues (2013) reported in Table 3 concern the correlation between the LEMO completed in the second semester and the study results obtained in the first year of HE. In addition, the LEMO was also administered in the first semester in this study: there, only Self-Efficacy and Relating-Structuring were positively related to study success. Furthermore, Willems and colleagues (2019) - unlike the other studies - examined the correlation with study results of the first semester, not with study results of the entire first year.

In addition, some studies examine the joint impact of a number of LEMO scales. Vanthournout and colleagues (2012b) included the scales that were significant in their previous analyses: Relating-Structuring, External Regulation, Lack of Regulation and Amotivation. Together, these scales explained 9% of the variance in percentage of credits obtained in the first year of higher education (multiple correlation of ±.30). In contrast, Willems and colleagues (2019) reported a correlation of .17 with first semester student achievement. The latter study involved LEMO scales (see Table 3), and an additional Self-Concept scale.

Table 3. Previous studies in first-year students regarding the predictive validity of the LEMO for the percentage of credits obtained

LEMO scale	Study Vanthournout, Gijbels, Coertjens, Donche, & Van Petegem (2012)[1]	Van Daal, Coertjens, Delvaux, Donche, & Van Petegem (2013)[2]	Willems, Coertjens, Tambuyzer, & Donche (2019)[3]
Concrete Processing		n.s.	–
Analysing		n.s.	–
Memorising	±.20	n.s.	n.s.
Critical Processing		.15	–
Relating-Structuring		.16	.09*
External Regulation		n.s.	–
Self-Regulation	±.25	n.s.	n.s.
Lack of Regulation		-.24	-.08*
Amotivation		n.s.	-.09*
Controlled Motivation	±.22	n.s.	n.s.
Autonomous Motivation		n.s.	n.s.
Self-Efficacy	–	.41	.17**
Learning Together	–	–	–
Total	±.30	–	.17

Note. A "–" in the table means that the scale was not included in the respective study. * p<.05, ** p<.01. Vanthournout and colleagues only list the percentage of variance explained, but not the p-value associated with the comparison with an empty model. Van Daal and colleagues only state that the correlations are significant, but not the associated p-value. [1] The LEMO was administered to 480 teacher education (professional bachelor's) students in May. [2] This study followed some 798 students, 40% of whom were enrolled in a professional bachelor's programme and 41.3% and 18.7%, respectively, in an academic bachelor's programme at the university or college. The results shown relate to the LEMO administered in semester 2; there were 280-655 students. [3] The LEMO was partly administered at the beginning of the first semester (n = 731; section motivation) and partly in December (n = 592; section processing and regulation activities). A note here is that the number of items of the motivation scales Autonomous

Motivation, Amotivation, and Controlled Motivation is higher than in the LEMO, so it seems to be a variant. The sample consisted of students from the Faculty of Sciences.

Some studies also examined whether the LEMO scales have a contribution on top of other factors. Vanthournout and colleagues (2012b) indicated that in the regression analysis mentioned above, the scale External Regulation is no longer significant after gender is taken into account. Van Daal and colleagues (2013) reported that, of the LEMO-scales, only Self-Efficacy remained as a predictor of the percentage of credits obtained when the following factors were included: type of secondary education and questionnaires regarding the degree of correspondence with secondary education and adaptation to the study programme in higher education (work formats, teaching, etc.). This applies to both the LEMO taken in first and second semester; (n = 254-273). Finally, in the study by Willems and colleagues (2019), the LEMO scales that were examined did not have a significant contribution on top of gender, age, hours of mathematics in secondary education, prior knowledge of mathematics, and prior knowledge of chemistry (0.3% extra explained variance).

In addition to its association with the percentage of credits obtained, some studies also examined the predictive validity of the LEMO for persistence versus dropout. In the study with teacher education students (Vanthournout et al., 2012b), the LEMO scales administered in October were first included by category in a logistic regression analysis (processing activities, regulation activities, motivation): a Nagelkerke R^2 between 1% and 4% was reported for each of the categories. When all LEMO scales except for Self-Efficacy and Learning Together were added simultaneously to the model, only Lack of Regulation (-) and Amotivation (-) were significantly related to persistence (Nagelkerke R^2 = 4%). Van Daal and colleagues (2013) first examined whether each of the LEMO scales were related to persistence (n = 341-393): Critical Processing (semester 2) and Self-Efficacy (semester 1, as well as semester 2) were positively related to persistence, while Self-Regulation (semester 1) and Lack of Regulation (semester 1, as well as semester 2) were negatively related. The remaining LEMO scales were not significantly related to persistence. Next, a logistic regression analysis was conducted for each semester with these LEMO scales and other student factors, including IQ, conscientiousness, study commitment, questionnaire w.r.t. correspondence with secondary education. After taking these other factors into account, only Self-Regulation (semester 1) and Self-Efficacy (semester 2) remained significant predictors of the likelihood of continuing the programme (n = 293-322).

1.3 Research Question

Most research with the LEMO higher education version concerned students in professional undergraduate programmes. Additional research with students in academic programmes is therefore appropriate. In the present study, the LEMO was administered to students from seven undergraduate programmes at Hasselt University. The main objective was to examine the LEMO's reliability, construct validity, and predictive validity among these first-year students. For predictive validity, the weighted grade point average at the end of the academic year was considered.

2. Method

The LEMO was administered in the first semester of the academic year 2012-2013 to first-year bachelor students at Hasselt University, Belgium. It concerns 416 generation students: 209 boys, 207 girls. 90.9% of generation students had the Belgian nationality, 7.7% had the Dutch nationality and 1.4% had another nationality. 23.8% were scholarship students or near scholarship students. 86.3% of the generation students had attended General Secondary Education, 6.5% Technical Secondary Education, 0.2% Vocational Secondary Education and for 7.2% the form of education was 'Indefinite'. The participating students belonged to the following programmes: Biomedical Sciences (n=157), Medicine (n=28), Physics (n=12), Computer Science (n=32), Applied Economics (n=118), Commercial Engineering (n=65) and Mobility Sciences (n=4).

The LEMO comprises 56 items grouped into 13 scales (cf. supra). Students responded to the questions using a Likert scale with five response categories. The average score of the responses to the items was calculated for each scale. The weighted grade point average after the September exams was retrieved from the university's database.

3. Results

3.1 Descriptive Statistics and Cronbach's Alpha

First, the descriptive characteristics and the Cronbach's alpha of each scale were calculated (Table 4). The Cronbach's alphas are below .70 for most scales; only from .70 onwards a Cronbach's alpha is 'respectable' according to DeVellis (2003). A few scales have a low Cronbach's alpha (below .60), i.e., Self-Regulation, Analysing, and Concrete Processing. In previous LEMO research, these scales (almost) always had an alpha below .70 (see Table 1).

An undesirable internal consistency is observed for the scales External Regulation, Critical Processing, and Learning Together (α = .60-65). Memorising and Lack of Regulation have a minimum acceptable internal consistency for research (α = .65-70). The scales also had lower reliability in several previous studies with the exception of Lack of Regulation (see Table 1). The motivational scales and Relating-Structuring have a Cronbach's alpha >.70 (respectable to very good). Also, in previous studies, the Cronbach's alpha for the motivational scales was always greater than .70; Relating-Structuring did have lower reliability in some studies.

Table 4. Descriptive characteristics, Cronbach's alpha, and results of a Confirmatory Factor Analysis on the LEMO (n = 413-416)

LEMO scale	Descriptive characteristics			Internal consistency		CFA	
	M	SD	Range	Number of items	Cronbach's alpha	CR	AVE
Concrete Processing	3.10	0.66	1.50 – 5	4	.59	.62	.33
Analysing	3.52	0.64	1.25 – 5	4	.57	.59	.28
Memorising	3.41	0.73	1.25 – 5	4	.67	.68	.35
Critical Processing	3.23	0.67	1.50 – 5	4	.64	.64	.31
Relating-Structuring	3.53	0.63	1.50 – 5	4	.71	.71	.38
External Regulation	3.76	0.53	1.67 – 5	6	.62	.63	.25
Self-Regulation	2.81	0.68	1.00 – 5	4	.56	.57	.27
Lack of Regulation	2.74	0.72	1.00 – 5	4	.68	.68	.35
Amotivation	1.39	0.60	1.00 – 5	3	.78	.79	.55
Controlled Motivation	2.72	0.80	1.00 – 5	6	.78	.73	.35
Autonomous Motivation	3.61	0.66	1.33 – 5	6	.83	.83	.47
Self-Efficacy	3.15	0.75	1.00 – 5	4	.84	.84	.58
Learning Together	3.13	0.80	1.00 – 5	3	.65	.67	.42

Note. The above table uses the raw scores on the scales (mean of the items), not the standardised scores. CFA = Confirmatory Factor Analysis. CR = Composite Reliability. AVE = Average Variance Extracted.

3.2 Confirmatory Factor Analysis

A confirmatory factor analysis points in the same direction (estimator: robust maximum likelihood; fit indices: RMSEA = .05, CFI = .77; see Tables A and B in the Appendix). While RMSEA is within the desired range (i.e., ≤ .08), this is not the case for CFI (Hu & Bentler, 1999; Kline, 2005; MacCallum et al., 1996): The value of .77 is below the guideline of .90.

In addition to the Cronbach's alpha, the Composite Reliability was calculated. This alternative measure of internal consistency also has .70 as a guideline value (Hair et al., 2010). The results for Composite Reliability are analogous to those for Cronbach's alpha and yield the same conclusions: Only the motivation and Relating-Structuring scales have a value higher than .70 (Table 4).

According to Hair and colleagues (2010), standardised factor loadings should be above .50 and ideally ≥.70. For Analysing, Memorising, Critical Processing, Relating-Structuring, External Regulation, and Lack of Regulation, all factor loadings are below .70, for Concrete Processing and Self-Regulation, this is the case for 3 out of four items. For Analysing, Critical Processing, External Regulation, and Self-Regulation, the factor loadings of at least 1 item are additionally below .50. For Concrete Processing, the factor loading of 1 item is not statistically significant. The factor loadings for the motivation scales are higher: For Self-Efficacy and Amotivation, most factor loadings are above .70 and no factor loadings are below .50. Similar findings were obtained for Autonomous Motivation, where, however, 1 item has a factor loading below .50. For Controlled Motivation, there are two very high factor loadings and four factor loadings below .50. The Learning Together scale has 1 item with a factor loading below .50.

For items from several scales, the factor loadings are lower than desired, resulting in an AVE below the guideline value of .50 (Hair et al., 2010). AVE refers to the average variance extracted: if it is lower than .50, it means that, on average, more error remains in the items than is explained by the underlying factor. This was found to be the case for

11 of the 13 LEMO scales (see Table 4).

3.3 Predictive Validity

Next, the correlation between the LEMO scales and the weighted grade point average at the end of the first year was examined (Table 5). Since students from the Medicine programme went through a rigorous selection process, the correlations were examined both with and without the 28 Medicine students. The correlations remain similar, except for a slightly lower correlation for Autonomous Motivation in the sample without medical students ($r = .12$, $p<.05$). Therefore, only the correlations for the full sample are reported in Table 5.

Self-Efficacy and Analysing have the highest correlation with the weighted grade point average in the first year (.30 and .20, respectively, $p < .001$). In addition, External Regulation, Autonomous Motivation, Amotivation, and Relating-Structuring have a small correlation with study success ($r \leq .17$; see Table 5). The remaining LEMO scales have no significant correlation with study success.

The results for the Self-Efficacy scale are to some extent in line with previous LEMO research (Table 3). In international studies this factor also emerged as an important predictor of study success in higher education (see Nauwelaerts et al., 2023). The results for Analysing are somewhat surprising. As indicated earlier, Analysing here refers to the systematic, step-by-step processing of learning material. Because of the low Cronbach's alpha of Analysing, some caution is warranted with this scale however. Furthermore, the limited, although significant, correlations for Amotivation and Relating-Structuring are in line with previous LEMO research. On the other hand, no significant correlation was found for Lack of Regulation, in contrast to the results in Table 3.

Table 5. Correlations between the LEMO and first-year study outcomes (n = 411)

LEMO scale	Correlation with GPA
Concrete Processing	.02
Analysing	.20***
Memorising	.03
Critical Processing	.04
Relating-Structuring	.10*
External Regulation	.17**
Self-Regulation	.07
Lack of Regulation	-.06
Amotivation	-.15**
Controlled Motivation	.04
Autonomous Motivation	.17**
Self-Efficacy	.30***
Learning Together	.09†

† p<.10; * p <.05; ** p<.01; *** p<.001.

All LEMO scales together explain 14% of the variance in study results, corresponding to a (multiple) correlation of R=.37 (see Table 6). This regression analysis takes into account the relationships between the LEMO scales themselves (see further in Table 8).

Table 6. Linear regression analysis with the LEMO scales as predictors and grade point average in the first year at university as criterion variable (n = 411)

Predictors	β	ΔR^2
		.14***
Concrete Processing	-.03	
Analysing	.11†	
Memorising	-.12*	
Critical Processing	.00	
Relating-Structuring	-.02	
External Regulation	.11*	
Self-Regulation	.04	
Lack of Regulation	.10†	
Amotivation	-.08	
Controlled Motivation	.06	
Autonomous Motivation	.00	
Self-Efficacy	.30***	
Learning Together	.01	

† p < .10, *p < .05, *** p < .001.

After a backward selection procedure to identify the most important LEMO scales, only Self-Efficacy and Analysing remain significant predictors. The two LEMO scales Self-Efficacy and Analysing explain 10.4% of the variance in study success among first-year students (multiple correlation R=.32). The remaining 11 LEMO scales have no significant contribution beyond these two scales (Table 7; *p*=.16; additional explained variance is 3.4%).

Table 7. Stepwise regression analysis to examine the contribution of the remaining LEMO scales on top of Self-Efficacy and Analysing in the prediction of study success (n = 411)

Predictors	β	ΔR^2
		.104***
Step 1		
Analysing	.13**	
Self-Efficacy	.26***	
		.034 (n.s.)
Step 2		
+ other 11 LEMO-scales		

** *p* < .01, *** *p* < .001.

For your information, the table below also lists the intercorrelations between the LEMO scales (Table 8).

Table 8. Interrelationships among the LEMO scales (n = 416)

Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Concrete Processing	1												
2. Analysing	.05	1											
3. Memorising	.00	.38***	1										
4. Critical Processing	.43***	.15**	-.06	1									
5. Relating-Structuring	.34***	.26***	.08†	.52***	1								
6. External Regulation	.03	.31***	.40***	-.10†	.14**	1							
7. Self-Regulation	.28***	.23***	.11*	.27***	.31***	.00	1						
8. Lack of Regulation	-.06	-.06	.01	-.18***	-.30***	-.01	-.08†	1					
9. Amotivation	-.06	-.21***	-.10*	-.07	-.16**	-.19***	-.08	.23***	1				
10. Controlled Motivation	-.08	.02	.12*	-.13**	-.09†	.04	-.07	.20***	.22***	1			
11. Autonomous Motivation	.24***	.36***	.21***	.25***	.34***	.24***	.30***	-.16**	-.38***	-.05	1		
12. Self-Efficacy	.11*	.27***	.14**	.18***	.33***	.17**	.13*	-.50***	-.21***	-.07	.36***	1	
13. Learning Together	.08	.13**	.16**	.00	.05	.24***	.11*	.17***	-.13*	.18***	.22***	.07	1

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Additional analyses

To examine the possibility that the correlations with GPA vary according to study programme (cf. Vermunt, 2005), additional analyses were performed, including the three Bachelor programmes with the most respondents. This is indeed the case for e.g., Memorising, Lack of Regulation, Amotivation, Controlled Motivation, and Autonomous Motivation.

Table 9. Correlations between the LEMO and first-year GPA for the Bachelor programmes Biomedical Sciences, Applied Economics, and Commercial Engineering

LEMO scale	Bachelor programme		
	Biomedical Sciences (n = 156)	Applied Economics (n = 116)	Commercial Engineering (n = 64)
Concrete Processing	-.08	.01	-.03
Analysing	.16*	.18*	.30*
Memorising	.03	.13	.34**
Critical Processing	.01	-.05	.01
Relating-Structuring	.12	.03	.08
External Regulation	.03	.32***	.29*
Self-Regulation	.06	.00	.06
Lack of Regulation	-.22**	.16†	.14
Amotivation	-.09	-.11	-.25*
Controlled Motivation	-.04	.18*	.09
Autonomous Motivation	.11	.13	.33**
Self-Efficacy	.27***	.17†	.25*
Learning Together	.03	.10	.15

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

4. Discussion

The LEMO (Donche et al., 2010) is used in Flanders, among others, as part of initiatives to increase study success in higher education. Thus, the reliability and validity of this questionnaire are important. Previous studies evaluated the reliability and predictive validity of the LEMO among first-year students. Whereas previous LEMO research has mainly focused on professional undergraduate programmes, the current study focuses on university students.

First, reliability. In the current study, the Cronbach's alpha for most scales is below the minimum threshold of .70 (DeVellis, 2003). This is particularly the case for Concrete Processing, Analysing, Memorising, Critical Processing, External Regulation, Self-Regulation, Lack of Regulation, and Learning Together. The motivation scales have good internal consistency, similar to previous studies. Furthermore, also in previous LEMO research, the Cronbach's alpha for most of the scales is regularly below .70 (cf. Table 1). This means that the reliability for quite a few LEMO scales is too low for individual assessments of students, and for research purposes. Additional research into the causes of this low reliability is indicated.

Further investigation by means of confirmatory factor analysis indicates that several factor loadings are quite low, resulting in too low AVE for 11 of the 13 scales. CFAs were also reported in other studies (cf. Table 2). However, these were often only reports of fit indices, and not of factor loadings/AVEs, of a limited number of LEMO scales (not the full instrument). More detailed research on this is indicated.

Regarding predictive validity, the present study examined the correlations between the LEMO scales and the weighted grade point average at the end of the first year. Self-Efficacy and Analysing have the highest correlation with study results at university ($r = .30$ and .20, respectively). The scales External Regulation, Autonomous Motivation, Amotivation, and Relating-Structuring have limited correlation with study success ($r \leq .17$). The remaining LEMO scales have no significant relationship with study success. The two LEMO scales Self-Efficacy and Analysing together explain 10.4% of the variance in study success (multiple correlation of .32); the remaining 11 LEMO scales have no significant contribution on top of these two scales (additional variance explained 3.4%). It should be noted that some caution is needed with the Analysing scale because of its low reliability. Previous research also found little to no relationship between most LEMO scales and study outcomes in higher education. Again, mainly Self-Efficacy emerges as a predictor (and, to some extent, Lack of Regulation). In addition, Vermunt (2005) and additional analyses in the current study showed that the correlations between the LEMO scales and study results in higher education might vary across study programmes. Different study programmes may have different student

populations (e.g., the percentage of male and female students may vary according to the Bachelor programme), and different curricula may require different learning strategies (e.g., Computer Science versus Biomedical Sciences). This needs to be investigated further.

Also internationally, most of the student factors surveyed with the LEMO show little correlation with study results in higher education. Self-efficacy in particular is correlated consistently across studies with study results in higher education (see, e.g., a literature review based on meta-analyses by Nauwelaerts et al., 2023). The predictive validity of the factors surveyed in the LEMO is important when one uses this instrument to give advice in the context of study choice. But also in the context of remediation it is appropriate to focus on student factors that have a substantial, direct relationship with study results.

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Notes

Note 1. An updated version of the LEMO (Vanthournout, Van de Mosselaer, & David, 2017) is meanwhile available, in which mainly Self-Regulation and Learning Together were adapted (replacement of questions). Further research on the reliability and predictive validity of these adapted scales is necessary.

Note 2. A model with all scales was tested, except for the scales Learning Together, External Regulation, Analysing, Concrete Processing, and Critical Processing; the motivation scales (excluding Self-Efficacy) appear to be a variant of the LEMO; in addition, an additional Self-Concept scale was also included in the measurement model. We consider the scales that appear to be in full agreement with the LEMO.

Appendix 1

Table A. Results of the Confirmatory Factor Analysis of the LEMO Scales: Factor Loadings (Completely Standardised Estimates)

Variable	Scale							
Cognitive processing and regulation strategies	1. Concrete processing	2. Analysing	3. Memorising	4. Critical processing	5. Relating -Structuring	6. External Regulation	7. Self-Regulation	8. Lack of Regulation
1_CONC1	.66***							
1_CONC2	.70***							
1_CONC3	.11 (n.s.)							
1_CONC4	.63***							
2_ANAL1		.50***						
2_ANAL2		.63***						
2_ANAL3		.31***						
2_ANAL4		.60***						
3_MEMO1			.60***					
3_MEMO2			.58***					
3_MEMO3			.56***					
3_MEMO4			.61***					
4_CRIT1				.50***				
4_CRIT2				.53***				
4_CRIT3				.59***				
4_CRIT4				.62***				
5_REST1					.64***			
5_REST2					.59***			
5_REST3					.65***			
5_REST4					.59***			
6_EXRE1						.42***		
6_EXRE2						.66***		
6_EXRE3						.32***		
6_EXRE4						.69***		
6_EXRE5						.55***		
6_EXRE6						.21**		
7_SERE1							.70***	
7_SERE2							.30**	
7_SERE3							.53***	
7_SERE4							.45***	
8_LARE1								.54***
8_LARE2								.57***
8_LARE3								.65***
8_LARE4								.58***

Motivation	9. Amotivation	10. Controlled Motivation	11. Autonomous Motivation	12. Self-Efficacy	Other	13. Learning Together
AMOT1	.80***					
AMOT2	.73***					
AMOT3	.68***					
COMO1		.45***				
COMO2		.42***				
COMO3		.91***				
COMO4		.37***				
COMO5		.85***				
COMO6		.23***				
AUMO1			.56***			
AUMO2			.81***			
AUMO3			.41***			
AUMO4			.83***			
AUMO5			.55***			
AUMO6			.81***			
SEEF1				.81***		
SEEF2				.64***		
SEEF3				.80***		
SEEF4				.77***		
LETO1						.74***
LETO2						.38***
LETO3						.76***

Table B. Factor variances and covariances

Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Concrete Processing	1												
2. Analysing	.11	1											
3. Memorising	.00	.57***	1										
4. Critical Processing	.64***	.28**	-.09	1									
5. Relating-Structuring	.50***	.43***	.14	.79***	1								
6. External Regulation	.06	.47***	.55***	-.10	.30**	1							
7. Self-Regulation	.47***	.22†	.07	.50***	.41***	-.03	1						
8. Lack of Regulation	-.11	-.07	.01	-.26**	-.43***	-.09	-.15†	1					
9. Amotivation	-.10	-.29**	-.15†	-.09	-.22***	-.28***	-.06	.32***	1				
10. Controlled Motivation	-.07	-.08	.05	-.15*	-.13†	-.11†	-.06	.23***	.34***	1			
11. Autonomous Motivation	.35***	.46***	.26***	.30***	.41***	.30***	.32***	-.24***	-.40***	-.19**	1		
12. Self-Efficacy	.15*	.41***	.19*	.23**	.43***	.26**	.10	-.67***	-.28***	-.12*	.44***	1	
13. Learning Together	.09	.23**	.20**	.01	.08	.41***	.13	.28***	-.18***	.06	.23**	.02	1

† p < .10, * p < .05, ** p < .01, *** p < .001.