Psychometric Validation of the Academic Motivation Scale in a Dental Student Sample

Cesar Orsini, DDS, MEd; Vivian Binnie, BDS, PhD; Phillip Evans, MSc, MEd; Priscilla Ledezma, DDS, MEd; Fernando Fuentes, DDS, PhD; Maria J. Villegas, DDS

Abstract: The Academic Motivation Scale is one of the most frequently used instruments to assess academic motivation. It relies on the self-determination theory of human motivation. However, motivation has been understudied in dental education. Therefore, to address the lack of valid instruments to assess academic motivation in dental education and contribute to future research in the field, the aim of this study was to analyze the psychometric properties of this instrument in a sample of dental students. Participants were 989 Chilean undergraduate dental students (86% response rate) who completed a survey containing a Chilean face-valid version of the Spanish Academic Motivation Scale and three other motivation-related instruments to assess the survey's construct and criterion validity. Later, 76 of the students (out of 100 invited) took the survey again to assess its test-retest stability. The instrument's construct validity was supported by the superior goodness of fit of the seven-subscale Academic Motivation Scale over competing models through confirmatory factor analysis and by the expected correlations among its subscales. The concurrent criterion validity was supported by the confirmation of correlations between its subscales and external criteria. Adequate internal consistency and test-retest correlations were also found. The evidence from this study suggests that the Academic Motivation Scale is a preliminarily valid and reliable instrument to assess motivation in the predoctoral dental context. Future research in this area is needed to confirm or refute these results.

Dr. Orsini is a doctoral candidate in Health Professions Education, College of Medical, Veterinary, and Life Sciences, University of Glasgow, Glasgow, UK, and Researcher, Teaching and Learning Centre FEN, University of Chile, Santiago, Chile; Dr. Binnie is Clinical Senior University Teacher, Dental School, College of Medical, Veterinary, and Life Sciences, University of Glasgow, Glasgow, UK; Prof. Evans is Professor of Medical Education, Medical Education Development Centre, Medical School, Gifu University, Gifu, Japan; Dr. Ledezma is Secretary of Studies, Dental School, University San Sebastian, Santiago, Chile; Dr. Fuentes is Director, Dental School, University San Sebastian, Santiago, Chile; and Dr. Villegas is a Private Dental Practitioner, Santiago, Chile. Direct correspondence to Dr. Cesar Orsini, 27 Hillhead Street (Ground Floor), Glasgow, UK, G12 8PX; +447799485024; corsini@fen.uchile.cl.

Recent evidence suggests that intrinsically motivated students are likely to be engaged in deep-level study strategies[1] and to display enhanced conceptual learning,[2] creativity,[3] cognitive flexibility,[4] enhanced self-esteem,[5] and better psychological well-being.[6-9] By contrast, lack of motivation has been associated with low competence, poor well-being,[10] and inadequate psychological adjustment to university life.[11] Previous researchers have claimed that understanding students' profiles and motivations is relevant to dental education.[12-14]

Many perspectives and theories have been proposed to better understand academic motivation, including those addressed in Graham's study.[15] However, one of the most popular theories in education, which has generated a considerable amount of research, is the Self-Determination Theory.[16,17] This theory investigates quality of motivation and roles of self-determined and controlled behaviors in academic environments and suggests a multidimensional construct, i.e., that behavior can be amotivated, extrinsically motivated, or intrinsically motivated. As shown in Figure 1, these dimensions exist as a continuum from non-self-determined conduct to a fully self-determined form of behavior.[16] Progression from amotivation to intrinsic motivation has been associated with positive academic and psychological consequences.[8,18]

Amotivation is the absence of intent to pursue an activity, while extrinsic motivation refers to pursuing an activity out of a sense of obligation or as a means to an end.[17] Extrinsic motivation has been subdivided into three types of regulation that can be ordered along the self-determination continuum.[16] The lower form is external regulation, in which students participate to obtain rewards or to avoid punishment. In introjected regulation, individuals begin to internalize the reasons for their actions; however, their behavior is still regulated by external demands or requirements from the environment to avoid internal conflict. Finally, there is identified regulation, in which behavior becomes valued and important and
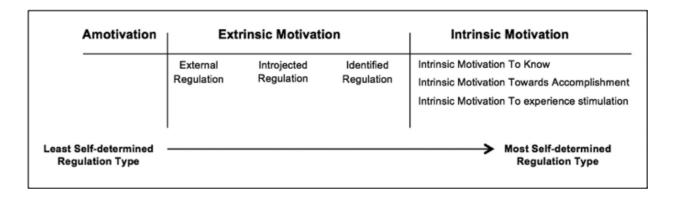
Figure 1. Self-determination continuum of motivation from least to most self-determined regulation type

Source: Adapted from Ryan RM, Deci EL. Intrinsic and extrinsic motivations: classic definitions and new directions. Contemp Educ Psychol 2000;25:54-67.

seems similar to a form of self-determined regulation, although the conduct still represents an instrument to achieve something.

The most self-determined form of behavior is intrinsic motivation, which represents the drive to pursue an activity simply for the pleasure or satisfaction derived from it.[19] It is considered a global construct with three subdivisions[18] (i.e., not following a continuum but categorized as subtypes): intrinsic motivation to know, which relates to concepts such as curiosity or motivation to learn;[20] intrinsic motivation towards accomplishments, which reflects commitment to an activity for the pleasure and satisfaction gained when one attempts to accomplish or create something;[16,17] and intrinsic motivation to experience stimulation, which indicates engagement for fun, excitement, and positive sensations.[18,21]

There has been an increasing need for a standardized, valid, and reliable instrument to study students' academic motivation attributes. As such, the most comprehensive instrument derived from self-determination theory so far is the Academic Motivation Scale.[21] This scale was developed in 1989 for French-Canadian higher education settings[18] and was later validated in English,[21] Spanish,[22] and Turkish.[19] It has seven subscales, one for each of the aforementioned types of regulation, and it is aimed at adolescents and adults in academic post-secondary environments.[23]

To validate the instrument, previous studies in other educational contexts have tested the construct and criterion validity and reliability of the

scale.[18,19,21-28] Those studies have found satisfactory internal consistency values (Cronbach's alpha 0.80) and high levels of temporal stability (test-retest mean of 0.75). The results of confirmatory factor analyses have supported the initially proposed seven-subscale structure, and the construct validity has been fulfilled through the establishment of several correlations among the seven subscales, confirming the presence of a continuum pattern with minimum deviations. This pattern represents the continuum of the Self-Determination Theory, in which adjacent scales show positive correlations, and the subscales at the opposite ends of the continuum show the highest levels of negative correlations.[18,21] Furthermore, the Academic Motivation Scale has been integrated into empirical models that incorporate determinants (e.g., teachers' behaviors) and consequences of academic motivation (e.g., dropout, positive emotions, academic performance), providing support for its concurrent validity that other scales still lack.[10,29]

The instrument has been applied in various cultures and educational contexts: for example, most students have reported external causes associated with vocational issues as their purpose for attending university, and females have been found to seem more intrinsic and self-determined than males.[18,21,22,27,28] However, these phenomena have not been previously studied in dental education. Therefore, the aim of this study was to analyze the psychometric properties of this instrument in an undergraduate dental student sample in order to address the lack of valid instruments that assess academic motivation in dental

education and contribute to future research in the field. The study objectives were fourfold. First, the scale's construct validity was assessed by examining the goodness of fit of the proposed seven-factor model and by analyzing correlations among the seven subscales as ways to examine the continuum pattern of the Self-Determination Theory.[18,21] Second, the scale's reliability and test-retest stability were estimated. Third, the scale's criterion (concurrent) validity was assessed by examining correlations between the instrument's subscales and scores from other variables deemed to represent motivational antecedents and consequences. The final objective was to determine the overall motivation of the dental student sample, in addition to differences in gender and year of study.

Methods

The Institutional Review Board of the Dental School of the University San Sebastian and the Medical School of the University of Glasgow reviewed and approved the research protocol (reference number: 0039-2001300103). The study was conducted in April and May 2014 at the Dental School of the University San Sebastian in Santiago, Chile.

This dental school has a six-year, discipline-based curriculum. The first two years are comprised of basic sciences, followed by a preclinical third year and clinic-based fourth, fifth, and sixth years. All students from year one through year six were invited to participate voluntarily. Confidentiality and anonymity were respected, and students had the option of withdrawing at any time with no consequences. Students gave their written consent authorizing the administrative department to provide their cumulative GPA solely to the authors, matched to the first seven digits of their ID number so that researchers could not access their names.

Data Collection

One teacher per academic year administered the questionnaire; this individual had been previously trained to address any questions. This structure allowed the absence of researchers and reduced the observer effect.[30] Students were informed that we were interested in better understanding the reasons why they attend the university and that there were no right or wrong answers. The questionnaire package contained demographic data and four instruments presented in Spanish. It took approximately 20 minutes to complete the questionnaire, but there were no time limitations. The survey took place on the university premises at the end of a class and with previous permission from the class's teacher. After one month, a randomly selected group of 100 students were invited to answer the Academic Motivation Scale in a second iteration to assess the scale's stability. We asked the students to provide data concerning age, gender, year of study, and the first seven digits of their ID number (to match test-retest and surveys with cumulative GPA).

The Academic Motivation Scale (Spanish version) instrument consists of 28 items divided among seven subscales (amotivation, external regulation, introjected regulation, identified regulation, intrinsic motivation to know, intrinsic motivation towards accomplishment, and intrinsic motivation to experience stimulation) of four items each.[22] All items included the question "Why do you go to university?," which was to be answered by selecting a response from a seven-point scale ranging from 1=does not correspond at all to 7=corresponds exactly, with a middle value of 4=corresponds moderately. The subscale scores could range from 4 to 28. A high score on a subscale indicated high endorsement of that particular motivation type. The instrument is available from the corresponding author.

Students were asked to respond to three additional instruments, all of which have previously shown acceptable levels of internal consistency.[22,31-33] The first instrument corresponds to the Deep and Surface Motives Subscales (ten items) of the Revised Study Process Questionnaire (R-SPQ-2F) (Spanish version), which measures two dimensions: deep- and surface-learning approaches.[32,34] The second instrument corresponds to the Academic Subscale (three items) of the abbreviated Five-Factor Self-Concept Questionnaire (Spanish version).[31] A high score indicates a higher self-concept towards the academic context. Finally, students were asked to answer the Positive Subscale of the Positive and Negative Affect Schedule (PANAS) (Spanish version), consisting of ten items that describe feelings of positive emotions.[33,35] Students were asked to indicate how they experienced each of these emotions in the university setting on a rating scale.

Based on these instruments and their correlations with the Academic Motivation Scale, our hypotheses for this study were as follows. On the one hand, we expected a significant positive correlation between the Academic Motivation Scale's intrinsic subtypes and identified regulation with the

R-SPQ-2F deep motives subscale, academic subscale of the Five-Factor Self-Concept Questionnaire, and the positive subscale of the PANAS. On the other hand, a significant positive correlation was predicted between amotivation and external regulation with the R-SPQ-2F surface motives subscale. Additionally, we expected significant negative correlations between amotivation and external regulation with the R-SPQ-2F deep motives, academic subscale of the Five-Factor Self-Concept Questionnaire, and the positive affect subscale of the PANAS. Finally, no significant correlations were expected between the external criteria and the introjected regulation subscale.

Previous researchers have suggested the importance of testing the Academic Motivation Scale in different Latin American academic contexts due to inherent linguistic differences[22,23,27] (at the time of this study, it had been tested in Paraguay[27] and Argentina[23]). Therefore, prior to their application, the Spanish versions of the Academic Motivation Scale and the other three concurrent instruments scales were revised by a panel of faculty who were native Spanish speakers from Chile to assess their cultural equivalence. Minor changes were made and subsequently presented to a group of ten recently graduated students who expressed no observations or misunderstandings. This process resulted in face-valid Chilean-Spanish instruments.

Data Analysis

Data were analyzed with SPSS v22.0.0 and AMOS v20.0 software (SPSS Inc., Chicago, IL, USA), and the alpha level was set at ≤0.05. First, the goodness of fit of the collected data to the seven-subscale model was compared to one-, three-, and five-subscale models through several indices of confirmatory factor analysis (CFA). A single scale model assumes that academic motivation is a one-dimensional construct. A three-subscale model consists of intrinsic motivation, extrinsic motivation, and amotivation. A five-subscale model includes the three types of extrinsic motivation, one global intrinsic motivation factor, and amotivation.[18,21,23,26,28] The analyses were performed through the maximum likelihood estimates method. As no single measure is definitive, other researchers recommend the use of different indices simultaneously.[36,37] We tested the chi-square statistic (X^2), the ratio of X^2 to degrees of freedom (X^2/df),[38] Fit Indices (comparative fit index, normed fit index, goodness-of-fit index, and

incremental fit index), and Residual Analyses (the standardized root mean square residual and the root mean square error of approximation). Overall, these fit statistic indices aim to test the underlying motivation theory, considering the implications of whether the proposed models are consistent with the data.

Second, Pearson correlation coefficients were calculated for the mean scores of each of the subscales of the Academic Motivation Scale to assess whether the collected data followed the Self-Determination Theory's continuum pattern. Both the Cronbach's alpha test of internal consistency and the correlation of temporal test-retest stability were calculated for each subscale of the Academic Motivation Scale. Pearson's correlation coefficients were calculated for the mean scores of each subscale of the Academic Motivation Scale and the three concurrent instruments, plus cumulative GPA, to test our hypotheses about the instrument and external criteria.

Means and standard deviations were computed for each subscale. To assess gender differences, independent-mean t-tests, effect sizes (Cohen's d value), and BCa Bootstrap confidence intervals were calculated. To assess year of study differences, ANOVA, effect size tests (omega value ω), and posterior post hoc testing (Hochberg GT2 and Games-Howell tests) were conducted. The Levene test was used to estimate equal variances; when the result was significant, the F-ratio was adjusted using the Welch's F.

Results

A total of 989 students participated in the survey (86% response rate), with an average age of 22.5 (SD=3.25). There were 613 (62%) females and 376 (38%) males. The distribution per year of study was as follows: 145 (15%) first year, 239 (24%) second year, 228 (23%) third year, 198 (20%) fourth year, 126 (13%) fifth year, and 53 (5%) sixth year. After one month, 76 students (38 females and 38 males with a mean age of 24.5 [SD=2.08]) answered the Academic Motivation Scale in a second iteration.

Construct Validity

Table 1 provides the results of confirmatory factor analysis of the competing models, showing an overall superior fit of the data to the seven-subscale model. For all the proposed models, the p-value for the X^2-statistic was found to be significant, thus rejecting all models. Nevertheless, this test is described as being influenced by large sample sizes (as sample

Table 1. Goodness of fit indicators of proposed models for Academic Motivation Scale

	1 Dimension Scale	3 Subscales	5 Subscales	7 Subscales	Standard for Acceptance
Fit statistic					
X^2	6013.01	3010.26	1933.12	910.78	NA
df	350	347	340	309	NA
p-value	<0.0001	<0.0001	<0.0001	<0.0001	0.05
X^2/df	17.18	8.68	5.69	2.95	<3
Fit index					
CFI	0.54	0.78	0.87	0.95	>0.90
NFI	0.53	0.76	0.85	0.93	>0.90
GFI	0.59	0.79	0.86	0.94	>0.90
IFI	0.54	0.78	0.87	0.95	>0.90
Residual analysis					
SRMR	0.12	0.10	0.06	0.04	<0.05
RMSEA	0.13	0.09	0.07	0.04	<0.08

X^2=chi-square test, df=degrees of freedom, X^2/df=ratio of chi-square to degrees of freedom, CFI=comparative fit index, NFI=normed fit index, GFI=goodness-of-fit index, IFI=incremental fit index, SRMR=standardized root mean square residual, RMSEA=root mean square error of approximation, NA=not applicable

size increases, power increases, and the test of fit becomes more stringent).[37] Therefore, the ratio of X^2 to degrees of freedom (X^2/df), which reduces the sensitivity to large sample sizes, was examined and showed acceptable values for the seven-subscale model. Fit indices and residual analyses also showed strong evidence to support the seven-subscale model. In other words, the data obtained from our dental student sample supported the use of the originally proposed seven-subscale construct to measure academic motivation. These results match those from previous studies in other fields.[18,21,22,25,27,39]

The internal relationships among the Academic Motivation Scale subscales support the current seven-subscale structure and the continuum pattern of the Self-Determination Theory (Table 2). The three subtypes of intrinsic motivation showed the strongest significant positive correlations in the continuum (from 0.59 to 0.69, p<0.01). Correlations between adjacent subscales showed stronger, more positive, and more significant coefficients (e.g., between intrinsic motivation to know and identified regulation; r=0.56, p<0.01) than between subscales farther apart, which showed weaker positive or even negative correlations (e.g., between intrinsic motivation to know and amotivation; r=-0.33, p<0.01).

Nevertheless, two deviations from the predicted model were found and must be highlighted. First, introjected regulation showed a stronger positive correlation with intrinsic motivation towards accomplishment (r=0.54) than with identified regulation (r=0.45), which is in between these two subscales

Table 2. Correlations coefficients between subscales of Academic Motivation Scale

Subscale	AM	EMER	EMIN	EMID	IMTA	IMES	IMTK
AM	–	0.01	-0.03	-0.25*	-0.33*	-0.18*	-0.33*
EMER		–	0.58*	0.42*	0.21*	0.13*	0.14*
EMIN			–	0.45*	0.54*	0.35*	0.36*
EMID				–	0.56*	0.47*	0.56*
IMTA					–	0.59*	0.69*
IMES						–	0.62*
IMTK							–

AM=amotivation, EMER=external motivation external regulation, EMIN=external motivation introjected regulation, EMID=external motivation identified regulation, IMTK=intrinsic motivation to know, IMTA=intrinsic motivation to accomplish, IMES=intrinsic motivation to experience stimulation
*p<0.01

Note: Intrinsic motivation subtypes do not follow the continuum and should be interpreted as a global construct.

as one follows the continuum. Second, amotivation showed a stronger negative correlation with identified regulation (r=-0.25) than with intrinsic motivation to experience stimulation (r=-0.18), which is farther apart when following the continuum.

Reliability

Internal consistency scores were between 0.75 and 0.83, except for identified regulation with an acceptable, but lower, score of 0.65 (Table 3). The correlation coefficient scores of pretest and posttest were between 0.70 and 0.78. Table 4 shows the correlations between the seven subscales and the tested external criteria (the three additional instruments and cumulative GPA). As hypothesized, the three intrinsic motivation subtypes and identified regulation showed the strongest positive and significant correlation coefficients with deep motives, academic self-concept, and positive affect. Amotivation showed significant negative correlations with the aforementioned con-

structs; external regulation showed non-significant and close to zero correlations; and, surprisingly, introjected regulation showed weak but significant positive scores. On the other hand, the most significant positive correlations with surface motives corresponded to amotivation, followed by external regulation and introjected regulation and finally by the three intrinsic motivation subtypes and identified regulation, which showed significant negative correlations.

Overall, these results confirmed our hypotheses and also supported the continuum of self-determination based on external criteria, providing evidence of the scale's concurrent validity. An example of how the continuum is reflected by these external criteria is shown in the correlations among deep motives and the seven motivation subscales (Table 4). Here, intrinsically motivated students showed the strongest positive correlations with deep motives, followed by identified regulation, introjected regulation, external regulation, and finally by amotivation with a nega-

Table 3. Internal consistency and test-retest correlations for each subscale of Academic Motivation Scale

AMS Subscale	Alpha Sample 1 (n=989)	Alpha Pretest Sample 2 (n=76)	Alpha Posttest Sample 2 (n=76)	Test-Retest Correlation Sample 2 (n=76)
AM	0.83	0.74	0.86	0.75
EMER	0.75	0.70	0.70	0.78
EMIN	0.81	0.80	0.79	0.75
EMID	0.65	0.63	0.66	0.70
IMTK	0.78	0.78	0.80	0.72
IMTA	0.80	0.78	0.78	0.71
IMES	0.80	0.82	0.82	0.74

AMS=Academic Motivation Scale, AM=amotivation, EMER=external motivation external regulation, EMIN=external motivation introjected regulation, EMID=external motivation identified regulation, IMTK=intrinsic motivation to know, IMTA=intrinsic motivation to accomplish, IMES=intrinsic motivation to experience stimulation

Table 4. Correlation coefficients between each subscale of Academic Motivation Scale and motivational correlates

	R-SPQ-2F		Abbr. AF5 Academic Self Concept	PANAS Positive Affect	GPA
	Deep Motives	Surface Motives			
AM	-0.18**	0.40**	-0.15**	-0.33**	0.08*
EMER	0.01	0.15**	0.05	0.03	-0.11**
EMIN	0.26**	0.10	0.10**	0.20**	-0.08**
EMID	0.32**	-0.07**	0.18**	0.25**	-0.04
IMTK	0.56**	-0.19**	0.21**	0.42**	-0.02
IMTA	0.50**	-0.16**	0.24**	0.42**	-0.02
IMES	0.53**	-0.16**	0.19**	0.35**	0.03
Cronbach's coefficient α	0.68	0.65	0.81	0.87	–

AM=amotivation, EMER=external motivation external regulation, EMIN=external motivation introjected regulation, EMID=external motivation identified regulation, IMTK=intrinsic motivation to know, IMTA=intrinsic motivation to accomplish, IMES=intrinsic motivation to experience stimulation
*p<0.05, **p<0.01

tive correlation. This evidence for the continuum of self-determination based on external criteria is also observed with the academic self-concept and positive affect subscales and inversely with the surface motives subscales. Consistent with previous research results,[26,39] inconclusive correlations were found between the motivation scale and academic performance in terms of cumulative GPA.

Students reported that their primary reason to attend university was driven by identified regulation, followed by intrinsic motivation to know and intrinsic motivation towards accomplishment, with amotivation being the least endorsed subscale (Table 5). Female students scored significantly higher in all subscales, with the exception of intrinsic motivation to experience stimulation (higher but not significant) and amotivation (males scored significantly higher). However, these scores represented small-sized effects, with the exception of introjected regulation and intrinsic motivation towards accomplishment for females, which were small to medium. It must also be stressed that the predictive value of the significant correlations between the subscales and cumulative GPA was not significant.

In contrast, all subscales showed significant mean differences per year of study (Table 6). How-

Table 5. Means (standard deviations) for total participants, males and females, and gender differences derived from Academic Motivation Scale BCa Bootstrap (95% CIs reported)

	Mean (SD)			Mean Gender Difference				
AMS Subscale	Total Participants (n=989)	Females (n=613)	Males (n=376)	Mean Difference	95% Difference BCa CI	t	p-value	Effect Size (Cohen's d)
AM	6.22 (3.88)	5.99 (3.58)	6.53 (4.15)	-0.54	[-1.08, -0.02]	-2.06	0.037	-0.14
EMER	22.50 (5.03)	22.85 (4.76)	21.97 (5.37)	0.91	[0.28, 1.63]	2.66	0.010	0.17
EMIN	21.48 (5.22)	22.12 (4.85)	20.51 (5.60)	1.61	[0.95, 2.37]	4.55	0.001	0.31
EMID	24.60 (3.21)	24.88 (3.15)	24.20 (3.10)	0.69	[0.25, 1.16]	3.32	0.001	0.22
IMTK	23.61 (3.55)	23.89 (3.31)	23.24 (3.79)	0.66	[0.21, 1.15]	2.74	0.011	0.18
IMTA	23.06 (4.07)	23.54 (3.77)	22.33 (4.34)	1.20	[0.66, 1.80]	4.38	0.001	0.30
IMES	17.80 (4.71)	18.07 (4.61)	17.41 (4.84)	0.63	[-0.23, 1.27]	2.01	0.062	0.14

AMS=Academic Motivation Scale, AM=amotivation, EMER=external motivation external regulation, EMIN=external motivation introjected regulation, EMID=external motivation identified regulation, IMTK=intrinsic motivation to know, IMTA=intrinsic motivation to accomplish, IMES=intrinsic motivation to experience stimulation

Table 6. Mean (standard deviation) and mean comparison of Academic Motivation Scale (AMS) subscales for students per year of study derived from AMS

	Mean (SD)						Year of Study Means Comparison		
AMS Subscale	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Year	F-test	p-value	Effect Size (ω)
AM	5.65 (3.48)	6.16 (3.86)	6.40 (4.25)	6.92 (4.39)	6.12 (3.16)	4.85 (1.91)	6.33	<0.0001	0.11
EMER	22.31 (4.62)	23.32 (4.75)	22.91 (5.24)	21.87 (5.27)	21.44 (5.30)	22.34 (4.38)	3.40	0.005	0.11
EMIN	22.77 (4.56)	22.21 (5.13)	21.33 (5.10)	21.25 (5.21)	19.77 (5.53)	20.10 (6.02)	6.39	<0.0001	0.16
EMID	24.70 (3.47)	24.91 (3.19)	24.87 (3.12)	24.40 (3.06)	23.86 (3.32)	24.23 (2.95)	2.45	0.032	0.09
IMTK	24.94 (3.32)	23.24 (3.74)	23.48 (3.45)	23.61 (3.55)	22.83 (3.40)	24.00 (3.19)	6.20	<0.0001	0.16
IMTA	24.02 (3.83)	22.88 (4.12)	23.00 (4.10)	23.26 (3.83)	21.93 (4.30)	23.45 (4.12)	3.93	0.002	0.12
IMES	18.73 (4.89)	17.26 (5.13)	17.68 (4.39)	18.24 (4.35)	17.46 (4.57)	17.67 (4.90)	2.28	0.045	0.08

AM=amotivation, EMER=external motivation external regulation, EMIN=external motivation introjected regulation, EMID=external motivation identified regulation, IMTK=intrinsic motivation to know, IMTA=intrinsic motivation to accomplish, IMES=intrinsic motivation to experience stimulation

ever, they all represented small-sized effects. In post hoc tests, the most relevant findings showed that final-year students were significantly less amotivated than second- (p=0.005), third- (p=0.001), fourth- (p≤0.0001), and fifth-year students (p=0.015). For intrinsic motivation, first-year students reported higher scores for intrinsic motivation to know than second- (p≤0.0001), third- (p=0.001), fourth- (p=0.008), and fifth-year students (p≤0.0001). First-year students also had higher scores for intrinsic motivation towards accomplishment relative to fifth-year students (p≤0.0001) and for intrinsic motivation to experience stimulation relative to second-year students (p=0.046).

Discussion

The results of this study indicate that the Academic Motivation Scale has acceptable levels of validity and reliability within the Chilean undergraduate dental context. These properties were assessed by testing the construct validity (degree to which the instrument measures what it claims, or purports, to be measuring based on the underlying theory), reliability (overall consistency of a measure), and concurrent (criterion) validity (how well a variable predicts an outcome based on information from other variables assessed simultaneously) of the scale.[30,40]

The scale's construct validity was supported by the superior goodness of fit of the data to the seven-subscale model and by internal correlations among each subscale, reflecting the continuum of self-determination. This result highlights the importance of including all the types of motivation, which is supported by previous studies.[18,21,22,24,26-28,39] It also has to be said that no previous research has found a 100% accurate continuum pattern. Deviations ranged from minor,[18,19,21,22,27] such as the ones we found in the introjected regulation and amotivation subscales, to more significant ones,[26,39,41] that question the instrument's underlying constructs. Further research should test the scale's construct validity and perhaps analyze and adjust the introjected regulation and amotivation subscales.

Reliability was supported by the acceptable internal consistency and adequate test-retest correlations. The lower but acceptable scores of identified regulation could be the result of an overlap and generation of ambiguity with the intrinsic motivation subtypes, as identified regulation is the most self-determined type of extrinsic motivation.[18,21,22,26,27,39]

In addition, our results support what has been referred to as the most important step in instrument validation,[40] which is its relationship to external criteria, as this step provides evidence that the scores represent what they expect to represent. As predicted, the most self-determined (identified regulation and intrinsic motivation) and least self-determined (amotivation, external regulation, and introjected regulation) forms of regulation followed the hypothesized relationships with external criteria and provided additional support for the instrument's criterion validity, reflecting an alignment with the continuum of self-determination. One exception was cumulative GPA; however, our results corroborate the findings of a great deal of previous work in which the instrument has not predicted GPA.[11,26,39] The one exception was a study in which self-reported GPA was collected, which may have introduced potential bias.[24] This inconsistency in our results may be due, on the one hand, to assessment types that may not reflect students' self-regulation or, on the other hand, to the fact that motivation is not a permanent state and students may adopt different types of regulations depending on influences from the teaching environment.[8] Therefore, this would suggest that concurrent GPA would be a more appealing construct to analyze. It also has to be said that performance is not solely influenced by motivation and several other variables must be taken into account.[11,42]

The Self-Determination Theory is explained and operationalized by seven subscales. According to this theory, dental students in our sample reported being primarily motivated to attend university by identified regulation, followed by the intrinsic motivation to know and intrinsic motivation towards accomplishment and finally by amotivation as the least endorsed subscale, which is consistent with previous research.[18,22,24-27] Moreover, this autonomous self-regulation profile reflects what previous authors have noted: that dental and medical students have natural motivation to learn and to know the environment that surrounds them.[43,44]

With regards to gender differences, and contrary to previous research in which females scored higher and significantly in the intrinsic motivation subtypes and males scored higher in the extrinsic and amotivation subscales,[11,21,22,27,28] our findings did not show evidence of females having a more autonomous self-determined profile, as they scored higher than males in all intrinsic forms of regulation but also higher in the extrinsic subscales. Regarding differences by year of study, we found significant

differences in all subscales. The third and fourth years, in which students have their first contact with patients, showed the highest amotivation scores. These findings could correlate to the high dropout rates by the end of the third year in medicine and dentistry in Chile[45] and might indicate the need for an early patient contact learning strategy as well as introduction of curricular changes that may lead to a more self-determined student profile, such as horizontal and vertical integration, problem-based learning, and learning in small groups, among others.[44] Further research should study the predictive validity of the scale in relation to dropout rates for the introduction of motivational remedy strategies especially for students who report high scores towards either the most or least self-determined forms of regulation (external regulation, introjected regulation, and amotivation). However, the questions that arise are the following: Why do the preclinical and clinical years show a drop regarding the most self-determined forms of regulation? Is there a lack of support towards intrinsic motivation moving along the curriculum? Further research is needed to answer these questions. Nevertheless, all mean group comparisons should be interpreted with caution as they represent small effect sizes.

Based on all the above, this research has several practical implications that could benefit dental education by providing the opportunity to better understand students' motivation. Traditionally, academic motivation has been thought as a unitary construct differing only in amount. However, self-determination theory and particularly the Academic Motivation Scale support the study of motivation from a multidimensional perspective based on different quality types of motivation,[8] which have been suggested to produce different cognitive, affective, and behavioral consequences.[29,46] Therefore, dental students might have an equal degree of motivation, but how is this motivation characterized? Are they extrinsically or intrinsically motivated? What are the possible associated determinants and consequences? And above all, how can faculty and administrators create the conditions for students to be self-determined and adopt an autonomous self-regulation towards academic activities? This study provides certain insights, but further research on academic motivation in dental education is needed to address these questions.

Moreover, the validation of this instrument in dental education suggests the possibility of measuring motivation by itself rather than by inferring it from other variables. For instance, a previous study measured motivation based on behavioral (e.g., time spent on a particular task) or affective (e.g., interest) variables rather than studying motivation as an independent construct.[47] If that were so, a student who spends hours on a specific task would be assumed automatically to be intrinsically motivated, without considering that the time spent on that particular task could be the result of an extrinsic form of regulation (such as external or introjected), which is driven by different determinants than the more self-determined forms of regulation and may also lead to different affective, behavioral, or cognitive outcomes.[8,29] Using behavioral or affective variables as an index of motivation and, at the same time, as a consequence produces a problem of conceptual circularity.[29] One would be inferring a certain type or amount of motivation based on other variables and, at the same time, interpreting those variables as motivational outcomes. Therefore, measuring motivation as the "why of behavior"[48] independently of its determinants and consequences makes it possible to determine when a certain type of regulation produces a certain outcome and when it will not.[29]

Despite the relevant findings, there are two important limitations to this study. First, generalizability cannot be assumed as this sample, though large, comes from only one dental school in one city of Chile. Second, all measures are self-reported and may introduce sources of potential bias. Although the instrument has reported high reliability and validity, self-reports constitute an inherent limitation due to possible influences such as social desirability, response biases, and lack of corroboration from other sources. Future research should be aimed at confirming or refuting our results with different samples and in different dental academic contexts.

Conclusion

The aim of this study was to test the psychometric properties of the Academic Motivation Scale with a group of Chilean dental students. As academic measures of motivation have not been widely used and reported in dental education, we intended to contribute by providing a preliminary valid measuring instrument to support and expand the study of academic motivation in dental education. Our results meet the recognized criteria for instrument validation. First, content validity was supported by the well-studied Self-Determination Theory. Second, the goodness of fit of the data to the proposed

seven-subscale model was superior compared with the competing models, and correlations among the subscales reflected the self-determination continuum with only two minor exceptions, thus supporting the instruments' construct validity. Third, adequate internal consistency and test-retest correlation were found. Finally, the criterion concurrent validity was supported by the predicted correlations of the instrument's subscales and external criteria, which also followed the self-determination continuum. Therefore, the evidence from this study suggests the Academic Motivation Scale as a preliminary valid and reliable instrument, providing support for its use in dental education research on academic motivation. This instrument provides the opportunity to study students' quality of motivation, with the possibility that future research will identify the most influential determinants and consequences of each type of regulation. Therefore, faculty, administrators, and researchers might identify these motivational profiles and modify activities, teaching strategies, or even the curriculum by including variables that might lead to more self-determined types of regulation, as these have been correlated with more positive educational and psychological outcomes. Moreover, this instrument provides the possibility of measuring motivation as a variable per se and not as a behavioral or affective construct. This fact may contribute to identifying remedial strategies that might enhance students' self-determination in academic activities or promote an autonomy-supportive teaching style.

Acknowledgments

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