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The Academic Functioning Scale: validity and reliability

Pauline A Hendriksen[1], Isabel RM Moormann[1], Elisabeth Y Bijlsma[1], Kiki EW Mulder[1], Evi C van Oostrom[1], Marjolijn CE Verheul[1], Ferdi Engels[1], Johan Garssen[1,2], Lydia E Devenney[3], Joris C Verster [1,4,5,*]

[1]*Division of Pharmacology, Utrecht Institute for Pharmaceutical Sciences, Utrecht University, 3584CG Utrecht, The Netherlands.*

[2]*Danone Global Research & Innovation Center, 3584CT Utrecht, the Netherlands*

[3]*Faculty of Arts & Social Sciences, The Open University, Walton Hall, MK7 6AA, Milton Keynes, UK.*

[4]*Centre for Mental Health and Brain Sciences, Swinburne University, Melbourne, VIC 3122, Australia.*

[5]*Cognitive Neurophysiology Department of Child and Adolescent Psychiatry, Faculty of Medicine, TU Dresden, D-01307 Dresden, Germany*

Corresponding Author:** ***Joris C Verster, *Division of Pharmacology, Utrecht Institute for Pharmaceutical Sciences, Utrecht University, 3584CG Utrecht, The Netherlands, Centre for Mental Health and Brain Sciences, Swinburne University, Melbourne, VIC 3122, Australia, Cognitive Neurophysiology Department of Child and Adolescent Psychiatry, Faculty of Medicine, TU Dresden, D-01307 Dresden, Germany*

Abstract: *The self-assessment of academic functioning is important as it reflects behaviors associated with academic success. Importantly, assessment of academic functioning can inform changesto researchers, educational practitioners, and policymakers. Two studies were conducted to test the validity and reliability of the Academic Functioning Scale (AFS). In Study 1, the AFS was administered to 108 students along with questions pertaining to grades and time spent on study per week. Factor analysis identifiedsubscales, which were correlated with grade point average (GPA) and time spent studying. In Study 2, the test-retest reliability of the AFS was assessed among 120 students by computing intraclass correlations and conducting Bland-Altman analyses. The results revealed three subscales: academic input, academic output, and role satisfaction. Academic output correlated significantly with GPA, and academic input with time spent studying. Study 2 demonstrated good reliability of the AFS. In conclusion, the AFS is a valid and reliable tool for measuring academic functioning, suitable for assessing interventions, teaching and learning strategic planning, and research purposes.*

Keywords: *Academic performance; academic functioning; success; grade point average; student satisfaction; interactions; academic achievement*

1. INTRODUCTION

University education serves as a prerequisite for employment in many professional domains [1]. However, not all students experience academic success. For instance, non-completion rates of bachelor's degrees within the assigned time frame are notably high, at 61% [2]. Therefore, it has become increasingly important to monitor academic functioning, i.e., the various behaviors contributing to academic success [3,4].

Academic functioning is commonly assessed using Grade Point Average (GPA), standardized test scores, or Academic Year Percentage (AYP) [5-7]. These metrics provide valuable insights; for example, universities that require higher entry GPAs tend to have better achievement and retention rates among first-year students [8]. However, relying solely on these metrics does not offer a comprehensive insight into other behaviors that contribute to academic functioning, such as study time or interactions with other students and teachers.

Amid the COVID-19 pandemic, the emergency switch to online teaching and learning prompted researchers, educators, and policymakers to consider its impact on students' academic functioning.

Given the diverse academic goals among students and the evolving educational landscape, a measurement scale encapsulating academic functioning beyond GPA and AYP was warranted. Therefore, the Academic Functioning Scale (AFS) was developed to measure academic performance, social interactions, and satisfaction with academic life among university students. The items were developed by the authors (P.H. and J.V.) based on the premise that academic functioning can be defined according to the context-input-process-output (CIPO) model [9]. According to this model, education is viewed as a production process, whereby input results in output. Although the model was designed to assess institutions, here, we applied the model to assess academic functioning of individual students. In this context, it was hypothesized that academic functioning encompasses the combination of academic input (e.g., time spent learning and reading, and interactions with teachers and students) and academic output (e.g., academic performance in terms of grades and delivered products). Additionally, the satisfaction of being a student was assessed.

The primary aim of the AFS was to obtain a rating of academic functioning. Only proxies of academic functioning were assessed, whereas underlying factors that might influence academic functioning (such as study motivation, engagement, and expectations, attendance rate, socio-economic background) were not included in the scale. The AFS was first used by Merlo and Hendriksen [10–12]. The 10 items of the scale pertain to quality, time, grades/output, knowledge, reading, writing, conversations with teachers, interactions with students, balance of study and private life, and role satisfaction in relation to academia. While many scales individually assess student engagement, academic efficacy, or achievement [13-16], the AFS is the first short scale addressing the broad scope of behaviors that encompass academic functioning. Beyond items related to academic input and output, other items relate to peer-to-peer interactions and student-faculty interactions. Social interactions are a fundamental part of university life, and research demonstrated that they are related to academic success [17-19]. Finally, overall satisfaction with academic life was assessed.

Assessments of (components of) academic functioning are a key benchmark used by universities to measure institutional performance, modify, or continue educational models and pedagogy, and determine government policy [20]. Therefore, valid, and reliable scales are needed. In the present paper, we assess the validity and reliability of the AFS. The initial version of the AFS included a Likert type response format [10-12], similar to those used to measure student engagement and academic achievement [16,21-22], to allow a comparison with pre-COVID-19 academic functioning. The initial version of the AFS has been translated and used in Dutch [10-12], English [10-12], German [23], and Spanish language [24]. For the current validation studies, and to enable momentary assessments of academic functioning, the answering format of the AFS was replaced by a 0 (very poor) to 10 (excellent) score. It was hypothesized that academic functioning can be defined according to the context-input-process-output (CIPO) model, and therefore, the analyses would yield a model comprising the factors academic input and academic output. Given the pre-selected items, a third added factor would be role satisfaction. Here, results of two studies are presented to support the validation of the AFS.

2. Materials and Methods

2.1. Study 1

In December 2021, N=108 students from the department of pharmaceutical sciences at Utrecht University, The Netherlands, participated in the study, completing two surveys. The Science-Geo Ethics Review Board of Utrecht University approved the study (protocol code: S-21525, approvaldate: November 21, 2021). All participants provided written informed consent and received 20 euros for their participation. Surveys were available in both English and Dutch. Demographic data collected included age and sex, along with responses to the AFS.

The AFS comprised 10 items related to academic performance, social interactions, and satisfaction with academic life [12]. The 10 items included “overall performance quality”, “amount of time invested in study”, “study grades/output”, “academic achievement/amount of knowledge gained”, “reading articles/textbooks”, “writing assignments/ articles”, “contact with teachers or supervisors”, “interactions with other students”, “balance between study and private life”, and “the extent you enjoy being a student”. Participants rated each item on 11-point scales ranging from 0 (very poor) to 10 (excellent).

Participants were contacted to provide their actual study grades obtained for the exams they completed. Grades range from 0 (very poor) to 10 (excellent), and a score of 5.5 or higher was required to pass the course. The GPA (0 – 10) was computed for each participant. In addition, students reported the average number of hours they studied per week.

Statistical analyses were conducted using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 29.0. Armonk, NY, USA: IBM Corp.). Mean and standard deviation (SD) of each variable was computed and normality was verified by visual inspection and the Kolmogorov–Smirnov test. To identify subscales of the AFS, a principal component factor analysis (Varimax with Kaizer Normalization) was conducted. The validity of the AFS was evaluated by correlating the subscale outcomes with the students' GPA and number of hours they spent studying per week. Cronbach's alpha was calculated for the subscales to determine internal consistency.

2.2. Study 2: test-retest reliability

Study 2 was conducted to evaluate test-retest reliability of the AFS. The study was approved by the Science-Geo Ethics Review Board of Utrecht University (Approval code: S-23044, approval date: 21 June 2023), and all participants provided written informed consent. Students of the Bachelor of Pharmacy (Dutch language) and CPS (English language) were invited to participate in the study. They completed the same survey on paper twice (between October and November 2023). The time between completion of the two surveys was one to two weeks. Demographic data included sex and date of birth, to match the two subsequent surveys. In addition, participants completed the AFS. Test-retest reliability was determined by (a) computing the Spearman's correlations between the test and retest assessments, (b) computing intraclass correlations between the test and retest assessments (applying a single-measurement, absolute-agreement, 2-way mixed-effects model [25]), and (c) applying the Bland-Altman limits of agreement method [26,27].

3. RESULTS

Out of the N=108 students who completed the study, the mean (SD) age was 21.5 (2.6) years, with 71.3% of the sample being female. Mean (SD) scores on the AFS are listed in Table 1. Table 1 further shows the outcome of the factor analysis. The factor analysis revealed 3 factors (i.e., subscales) that accounted for 64.8% of variance (R^2), which were labeled academic output (R^2 = 37.6%), academic input (R^2 = 13.7%), and role satisfaction (R^2 = 13.5%).

Table1. *Item scores and results of the factor analysis.*

Academic Functioning Scale	**Item score**	**Factor loading**		
Subscales and items	**Mean (SD)**	**Academic output**	**Academic input**	**Role satisfaction**
Overall performance quality	7.2 (1.2)	**0.904**	0.018	0.182
Study grades/output	7.2 (1.2)	**0.830**	0.166	0.056
academic achievement/amount of knowledge gained	7.3 (1.4)	**0.768**	0.294	0.253
Writing assignments/ articles	4.8 (2.4)	0.050	**0.704**	0.023
Contact with teachers or supervisors	5.9 (1.3)	-0.027	**0.676**	0.383
Reading articles/textbooks	5.6 (2.1)	0.309	**0.626**	0.028
Amount of time invested in study	6.7 (1.9)	0.470	**0.591**	-0.094
Balance between study and private life	6.0 (1.9)	0.157	-0.108	**0.819**
Interactions with other students	6.9 (1.8)	0.006	0.363	**0.708**
The extent you enjoy being a student	6.9 (1.5)	0.483	0.064	**0.645**

Mean (SD) and factor loadings are shown.

To evaluate internal consistency, Cronbach's alpha was computed for the three subscales (see Table 2). The outcome suggests that the subscales have an acceptable (>0.6) to good (>0.8) internal consistency [28-29].

Table2. *Internal consistency.*

Internal consistency	**Cronbach's alpha**	
Subscale	**Test**	**Retest**
Academic output	0.86	0.81
Academic input	0.64	0.69
Role satisfaction	0.66	0.68

Note: Good internal consistency is assumed if Cronbach's alpha ≥ 0.8. A Cronbach's alpha > 0.6 is considered acceptable.

Convergent validity is the degree to which two measures that theoretically are related to each other, are in fact related. To evaluate convergent validity of the AFS, correlations between academic output and GPA, and between academic input and the time spent on study per week were computed (See Figure 1). Significant Pearson's correlations were found between academic output and GPA (r = 0.538, p < 0,001), and between academic input and the time spent on study per week (r = 0.449, p < 0.001). A significant correlation was also found between academic input and academic output (r = 0.432, p < 0.001) and between academic output and the time spent on study per week (r = 0.263, p = 0.019). The correlations between academic input and GPA (r = 0.175, p = 0.142) , and between GPA and the time spent on study per week (r = 0.002, p = 0.987) were not statistically significant.

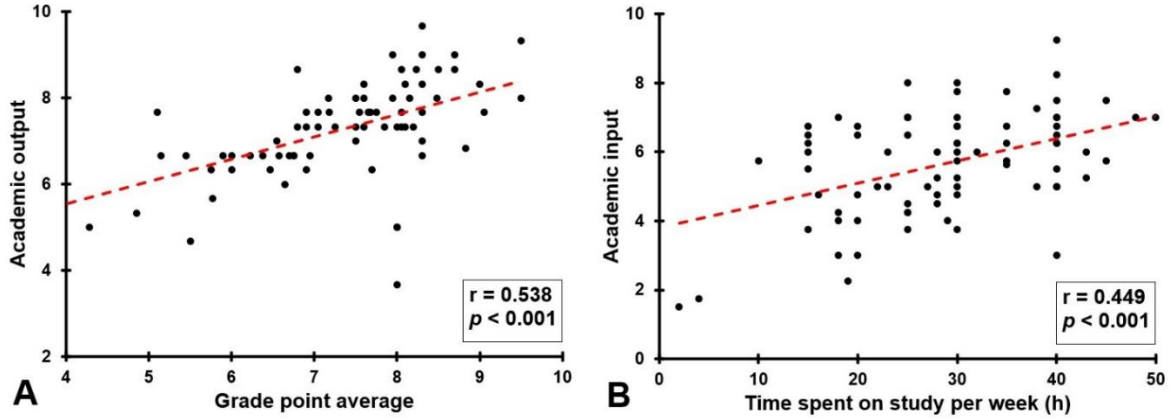

Figure1. *Relation of academic input and academic output with grade point average and time spent on study.*

3.2. Study 2: Test-retest reliability

Study 2 was conducted to further evaluate test-retest reliability of the AFS. Of the N=120 students that participated in the study, N=108 students completed both the test and retest assessment. Their mean (SD) age was 20.4 (1.4) years old, and 74.1% of the sample was female. The mean (SD) time between the test and retest assessment was 11.1 (3.5) days (range: 7 to 16 days). The outcome of the test and retest assessments is summarized in Table 3. The correlations between the test and retest outcomes were statistically significant. Intraclass correlations are summarized in Table 4. Evaluation of the 95% confidence intervals of the ICCs reveals that the subscales have a moderate to good test-retest reliability. Final confirmation on test-retest reliability was obtained via the Bland-Altman limits of agreement analysis. The results are summarized in Table 5. The Bland-Altman analysis confirmed agreement between the test and retest assessment (i.e., >5% of difference scores are outside the limits of agreement interval) for all three scales.

Table3. *Correlations between the test and retest assessments.*

Subscale	Test	Retest	r	p-value
Academic output	7.2 (1.0)	7.2 (1.1)	0.829	<0.001*
Academic input	6.4 (1.2)	6.5 (1.2)	0.743	<0.001*
Role satisfaction	7.0 (1.3)	7.1 (1.1)	0.681	<0.001*

Mean (SD) and Spearman's correlations are shown.

Table4. *Intraclass correlations (ICCs) between the test and retest assessment.*

		95% CI		
Subscale	**ICC**	**Lower**	**upper**	**Agreement**
Academic output	0.837	0.771	0.886	Good
Academic input	0.736	0.636	0.812	Moderate to Good
Role satisfaction	0.710	0.601	0.792	Moderate to Good

Note: A single-measurement, absolute-agreement, 2-way mixed-effects model was used to calculate ICCs. Abbreviations: ICC = intraclass correlation, CI = confidence interval. Note: 95% CI values less than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability,

values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability [25].

Table5. *Bland and Altman limits of agreement analysis.*

Subscale	Difference Mean (SD)	LA interval (lower, upper)	% outside the LA interval	Agreement
Academic output	-0.08 (0.6)	-1.26, 1.10	2.8%	Agreement
Academic input	0.11 (0.9)	-1.65, 1.87	4.7%	Agreement
Role satisfaction	-0.02 (0.9)	-1.78, 1.74	4.6%	Agreement

Note: The difference mean score (DIFF) of the test and retest outcomes and the corresponding standard deviation (SD) were computed. According to the limits of agreement method, there is agreement between the assessments if 95% of the DIFF score lies between (DIFF - 1.96 x SD) and (DIFF + 1.96 x SD). Agreement is concluded if less than 5% of the difference scores is outside the limits of agreement (LA) interval [27].

4. DISCUSSION

The results of the present studies demonstrate that the AFS exhibits good reliability and validity. The identification of three distinct subscales through factor analysis – academic output, academic input, and role satisfaction – provides a comprehensive measure. Notably, academic output emerged as the highest loading factor, explaining 37.6% of the variance, followed by academic input and role satisfaction, which accounted for 13.7% and 13.5%, respectively. The items with the highest factor loadings within academic output included overall performance quality, study grades/output, and academic achievement/amount of knowledge gained. Conversely, academic input encompassed items such as writing assignments/articles, contact with teachers or supervisors, reading articles/textbooks, and the amount of time invested in study. Role satisfaction was characterized by factors like the balance between study and private life, interactions with other students, and the enjoyment of being a student.

The test-retest and intraclass correlations indicated moderate to good reliability and agreement among variables [25]. Bland-Altman analysis confirmed reliability by demonstrating agreement between the test and retest assessments. Regarding internal validity, academic input, output, and role satisfaction exhibited adequate Cronbach's Alpha levels. External comparison with the grade point average and time spent on study suggests that the subscales may be used for predictive purposes of the assessment of academic input and output.

Strengths of the current studies include the sufficient sample size [30], relevant student samples, and the participants' unawareness of the study's purpose. Participants were not informed about the retest session, reducing the likelihood of recall bias. However, the current studies also have certain limitations. For instance, all data were self-reported, potentially affecting its accuracy and introducing recall bias. Nonetheless, the impact of recall bias is deemed limited, as students are likely to accurately remember important details such as their GPA. Additionally, surveys were administered in two languages, which could introduce methodological issues related to text translation. Nevertheless, the use of concise items minimized potential translation-related challenges. The successful application of the AFS in multiple languages, including Dutch, English, German, and Spanish, and in different parts of the world suggests its potential for cross-cultural comparisons. [11,31-32].

The practical implications of these findings extend to academic interventions aimed at enhancing student success. By identifying specific areas of academic functioning through the AFS subscales, educators and policymakers can tailor interventions to address students' unique needs. For example, interventions may focus on improving study habits, facilitating effective communication between students and teachers, or fostering a supportive learning environment to enhance role satisfaction. The practical implications of the AFS further extend beyond research settings to inform decision-making in educational institutions and policymaking. By utilizing the scale, stakeholders can assess program effectiveness, tailor support services, and make data-driven decisions to optimize student outcomes.

Further research should explore academic functioning using non-self-reported measures. For example, analyzing the frequency of engagement with online materials, university resources or university-obtained grades may provide additional insight into the relationship between objective subjective measures of the academic functioning scale. Moreover, future research could benefit from longitudinal studies to validate the AFS measures over time and track changes in academic

functioning. This could offer insights into the stability of academic functioning and the effectiveness of interventions. Finally, future research could explore additional factors influencing academic functioning, examine the AFS's utility across diverse student populations and educational contexts, and refine the scale based on user feedback. By doing so, researchers can continue to advance our understanding of academic functioning.

5. Conclusion

Based on the context-input-process-output (CIPO) model [9], the AFS was developed to measure academic functioning comprehensively. The findings from the two studies validate the AFS as a reliable and valid self-report tool suitable both research and educational purposes. The three identified subscales – academic input, academic output, and role satisfaction – demonstrate the scale's robustness. Given its successful application across multiple languages and cultural contexts, the AFS is a promising tool for cross-cultural academic research. Future studies should continue to explore its validity and reliability, considering cross-cultural differences and expanding its application to diverse educational settings.

Author Contributions

Conceptualization, J.V., K.M., P.H., I.M. M.V., E.v.O., and J.G.; methodology, P.H. and J.V.; formal analysis, J.V.; investigation, K.M., P.H., M.V., I.M., and E.v.O.; writing—original draft preparation, P.H., L.D. and J.V.; writing—review and editing, J.V., K.M., P.H., I.M., M.V., E.v.O., L.D., F.E., E.B., and J.G. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

The two studies were conducted according to the guide lines of the Declaration of Helsinki, and approved by the Science-Geo Ethics Review Board of Utrecht University (Study 1: study code: S-21525, date of approval: November 21, 2021; Study 2:, study code: S-23044, approval date: 21 June 2023).

Informed Consent Statement

Informed consent was obtained from all participants.

Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

Over the past 3 years, J.V. has acted as a consultant/advisor for Eisai, KNMP, Med Solutions, Mozand, Red Bull, Sen-Jam Pharmaceutical, and Toast!. J.G. is part-time employee of Danone Nutricia Research and received research grants from Nutricia research foundation, Top Institute Pharma, Top Institute Food and Nutrition, GSK, STW, NWO, Friesland Campina, CCC, Raak-Pro, and EU. The other authors have no potential conflicts of interest to disclose.

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