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Study approaches mediate associations between learning environment and academic performance

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ABSTRACT

Background: While study approaches have been directly associated with students' academic performance, learning environment factors may play a more indirect role. The aim of this study was (i) to assess learning environment factors as predictors of students' average exam grades, and (ii) whether study approaches mediated associations between learning environment factors and exam grades.
Methods: Three annual surveys (2017–2019) yielded data from a total of 263 Norwegian occupational therapy students. Learning environment factors were assessed with the Course Experience Questionnaire, and the Approaches and Study Skills Inventory for Students were used to assess study approaches. Linear regression analyses and mediation analyses were performed.
Results: Higher levels of 'student autonomy' were directly associated with lower averaged grades whereas higher levels of 'appropriate workload' were associated with higher averaged grades. There were statistically significant total indirect effects of 'clear goals' and 'appropriate workload' on grades; these effects occurred through the study approach variables. However, all learning environment variables showed one or more relationships with academic performance that was mediated by study approach variables.
Conclusion: Learning environment variables appear to be complexly associated with academic performance, both directly and indirectly.

Introduction

Academic performance, commonly expressed through exam grades, denote students' level of competence acquired in a study course or program. While grades may serve as a crude form of feedback on students' learning process [1], they also ultimately serve as means to inform future employers about a student's competence in relation to others' in a competitive labour market [2]. Thus, ambitious students often strive for good grades—for short term personal gratification, for the work opportunities they may give rise to in the future, or for variations of these and other reasons.

Stable background factors, such as intelligence and personality traits [3] as well as socioeconomic status [4], have been shown to be consistently associated with students' academic performance across fields of study. In addition, promoting equal chances in the education system for students of differing social backgrounds is crucial for sustainable development [5]. However, to help students succeed in higher education, educators need to address the modifiable factors at play that contribute to shape students' learning. In the terminology introduced by Biggs' [6], these constitute the 'process' factors and include, in the broadest of terms, the students' own attitudes, strategies, and behaviours related to the studies, as well as teaching and curricular strategies that serve to support or hinder the students' learning.

In relation to student factors, 'approaches to studying' denote the existence of different patterns of

attitudes, strategies and behaviours related to learning and studying [7,8]. The deep approach is used by students who, driven by theoretical interest, seek to make personal sense of what they study, and understand the way different ideas relate to one another. Conversely, the surface approach is used by students who may be hung up on details and unable to grasp how ideas are connected—the bigger picture is lost to students relying on surface study behaviours. A third approach, the strategic approach to studying, denotes the well-organised behaviours of self-directed students who are driven by ambition to get good grades and who know what it takes to get them. While few would rely solely on one approach to studying, most students may lean more strongly towards one approach than others, with varying outcomes [7].

A multitude of studies have found that students' study approaches are associated with their academic performance (e.g. [9–11]), including studies of occupational therapy students [12,13]. Studies have shown that particularly the strategic approach seems fruitful for obtaining good grades, whereas the surface approach has been related to poorer grades and thus, should be avoided [11,13,14]. While the association between academic performance and deep approach has been theoretically [15–17] and empirically supported [18–20], recent studies have called this notion into question and generally proposed that the effects of different study approaches often rely on what is assessed in the relevant exam [21,22].

Learning environment factors may also play a role in determining students' academic performance, as they constitute the framework within which the student is encouraged or discouraged to engage effectively with the studies [23–25]. For example, while clarity of the goals and standards in a given course is believed to promote students' deep and strategic study approaches, a lack of clarity may result in students reading aimlessly, not knowing what to focus on. An appropriate and well-designed workload is also believed to promote deep and strategic study strategies, as it would allow the students to spend a sufficient amount of time on each topic. Conversely, a workload that is too high may rather promote the use of surface approach behaviours, resulting in students trying to get to the bottom of the reading list without having the time to immerse themselves in the study materials [12,26].

While direct associations between learning environment factors and academic performance are viable, recent cross-sectional studies with occupational therapy students have found that such associations are often not statistically significant when controlling for the effects of study approaches [13,27]. Indirect associations—learning environment factors having an effect on academic performance through their impact on students' approaches to studying—may be more viable, as some studies have suggested [28–30]. The point of departure for this study is the possibility of such mediated relationships between learning environment factors and the students' performance.

Associations may also vary depending on the nature of the underlying data. Normally, cross-sectional studies employ data from a single point in time, as was also the case in previous studies originating from the current research project [13,27]. Aggregated data, in this study signifying 'average measures for each individual based on data collected at several time points', may increase the sample size and thereby statistical power, making associations between variables more easily detectable. Moreover, the use of aggregated data may provide more reliable and stable measures compared with the snapshots provided from data collected at single time points. In view of the above, the aim of this study was (i) to assess averaged measures of learning environment as predictors of occupational therapy students' average exam grades throughout their education program, and (ii) to assess whether study approaches mediated associations between learning environment factors and exam grades.

Methods

Context and design

The study concludes a 3-year investigation of one cohort of Norwegian occupational therapy students, in which students from all six occupational therapy education programs in Norway were included. Class sizes differed between 24 and 77 students. The undergraduate study program had a duration of 3 years, and all six study programs were full-time studies with field placement constituting a considerable portion of the program.

Previous articles from the research project include studies of the students' perceptions of the learning environment [31–36], the students' approaches to studying [37–39], associations between the perceived learning environment and study approaches [24,26], as well as associations between the perceived learning environment, approaches to studying, and the students' academic performance [13,27]. With the exception of the longitudinal studies [32,40,41], the studies originating from the project used data from within single years of study. In the current study, we averaged the students' ratings on learning environment

perceptions, their approaches to studying, and their grades during the course of their study. Thus, the study has a cross-sectional design using aggregated measures across a three-year education program. As we aimed to use all available data, mean scores were averaged across the valid data entries. Therefore, for participants who had completed the questionnaires once, their ratings on this assessment were used for analysis. For participants who had completed the questionnaires two or three times, their mean ratings across completed assessments were used for analysis.

Participants

In each of the study years, occupational therapy students enrolled in one of the involved education institutions were approached in their respective classrooms with an invitation to take part in this study. There were no specified exclusion criteria. The questionnaires were identical in all three study years and were completed by paper and pencil. The response rates varied across education institutions and across study years [40]: Of the 305 eligible students, 187 students participated in the first study year (response rate 61.3%), 168 students in the second year (response rate 55.1%), and 200 in the third year (response rate 65.6%) [42]. Altogether, 263 students participated in one or more of the three annual surveys.

Power calculations

The G*Power program (Version 3.1.9.7) and the F-test family (Linear Multiple Regression: Fixed Model, R^2 Deviation from Zero) was used to conduct an a priori power analysis [43,44]. According to the analysis, a minimum sample size of 160 participants would be sufficient to detect differences with an actual power of 95% (effect size $f^2 = 0.15$, $p = 0.05$).

Measures

Information regarding the students' *sociodemographic background* (years of age, gender), educational priority (having occupational therapy as the top prioritised line of education at enrolment, or not) prior higher education experience (having prior higher education experience, or not) and time spent on independent studying (hours spent on self-studying during a typical week) was collected as part of the questionnaire. For this study, time spent on independent studying was calculated as the mean weekly hours across the three study years.

The *Course Experience Questionnaire* (CEQ) [45] was used to assess the perceived learning environment. The long version of the instrument [46,47], which was used in this study, has 36 items distributed onto six scales, including 'clear goals and standards' (e.g. 'It's always easy here to know the standard of the work expected'), 'student autonomy' (e.g. 'There are few opportunities to choose the particular areas you want to study'), 'good teaching' (e.g. 'The teaching staff of this course motivate students to do their best work'), 'appropriate workload' (e.g. 'The workload is too heavy'), 'appropriate assessment' (e.g. 'To do well on this course all you really need is a good memory'), and 'generic skills' (e.g. 'This course has helped me develop the ability to plan my own work'). The Norwegian translation of the long version has previously been validated [48], and this was used in the present study.

Scores on each item reflect that the participants agree (5), agree somewhat (4), are not sure (3), disagree somewhat (2) and disagree (1) with the item content. Higher scale scores indicate that the education program is perceived to (a) have clearly established and disseminated goals; (b) have high levels of student autonomy; (c) have teaching that engages and involves the students; (d) have a workload that is not too high; (e) have assessment forms that promote and support learning; and (f) support the transfer of content knowledge and skills to the relevant work context. The internal consistency (Cronbach's α) of each of the scales was assessed with first year data and was shown to be 0.73 (clear goals and standards), 0.63 (student autonomy), 0.70 (good teaching), 0.69 (appropriate workload), 0.45 (appropriate assessment), and 0.83 (generic skills) [36]. Owing to its low internal consistency, the appropriate assessment scale was not used in the analyses. For this study, all scale scores were calculated as the mean value across the completed assessments.

The *Approaches and Study Skills Inventory for Students* (ASSIST) [17] was used to assess study approaches. A previously validated Norwegian translation of the instrument was used [49]. The instrument consists of 52 statements to which the respondent rates his or her level of agreement (1=disagree, 2=disagree somewhat, 3=unsure, 4=agree somewhat, 5=agree). The instrument has a three-factor structure which has been replicated in the current sample [39] as well as in a cross-cultural study of undergraduate occupational therapy students [50]. The items are organised into three main scales (the deep, strategic, and surface approaches to studying). Scale scores are calculated by adding the scores on the relevant items. As assessed in the first study year, the internal consistency between scale items was 0.71 ('deep approach'), 0.84

Table 1. Scales and example items from the CEQ and ASSIST.

	Scales	Example items
Course experience questionnaire	Clear goals and standards	The aims and objectives of this course are not made very clear.*
	Student autonomy	Students have a great deal of choice over how they are going to learn in this course.
	Good teaching	The staff make a real effort to understand difficulties students may be having with their work.
	Appropriate workload	The sheer volume of work to be got through in this course means you can't comprehend it all thoroughly.*
	Generic skills	This course has helped me develop the ability to plan my own work.
Approaches and study skills inventory for students	Deep approach	I try to relate ideas I come across to those in other topics or other courses whenever possible.
		When I have finished a piece of work, I check it through to see if it really meets the requirement.
	Strategic approach	I think I'm quite systematic and organised when it comes to revising for exams.
		I look carefully at tutors' comments on course work to see how to get higher marks next time.
	Surface approach	I'm not really interested in this course, but I have to take it for other reasons.
		I like to be told precisely what to do in essays or other assignments.

Note. The CEQ scale 'Appropriate assessment' was excluded from the current study. *The item has reversed coding.

('strategic approach'), and 0.76 ('surface approach'). For this study, all scale scores were calculated as the mean value across the completed assessments. Sample items from the CEQ and the ASSIST are shown in Table 1.

The students' average *academic performance* were based on the current qualitative description of exam grades [51]: fail = 1, sufficient = 2, satisfactory = 3, good = 4, very good = 5, and excellent = 6. More detailed description of the performance associated with each grade is shown in Table 2. For this study, the students' average exam grade across all three study years was used.

Statistical analysis

The descriptive analyses were carried out utilising IBM SPSS for Windows, version 26 [52]. These analyses were performed on all variables, using means (M) and standard deviations (SD) for continuous variables and frequencies and percentages for categorical variables. Multiple linear regression analyses, demonstrating associations between learning environment variables and grades, were also performed using SPSS. The linear regression analysis was also used to provide a model fit measure, i.e. the proportion of the total variance explained by the regression model (R^2) [53]. The ANOVA (analysis of variance) method was

Table 2. The general qualitative descriptors of grades in Norwegian higher education.

Grade	Description	Qualitative description of evaluation criteria
A	Excellent	An excellent performance, clearly outstanding. The candidate demonstrates excellent judgement and a high degree of independent thinking.
B	Very good	A very good performance. The candidate demonstrates sound judgement and a very good degree of independent thinking.
C	Good	A good performance in most areas. The candidate demonstrates a reasonable degree of judgement and independent thinking in the most important areas.
D	Satisfactory	A satisfactory performance, but with significant shortcomings. The candidate demonstrates a limited degree of judgement and independent thinking.
E	Sufficient	A performance that meets the minimum criteria, but no more. The candidate demonstrates a very limited degree of judgement and independent thinking.
F	Fail	A performance that does not meet the minimum academic criteria. The candidate demonstrates an absence of both judgement and independent thinking.

utilised to evaluate the overall suitability of the model and ascertain the extent to which the predictor variables contributed to explaining the observed variability in the dependent variable [54]. No multicollinearity was shown, as demonstrated by VIF values below 2.0 for all variables [55]. Residuals ranged between −3.87 and 2.04, slightly exceeding the commonly used threshold [−3, 3] for residuals in the lower end [56].

The subsequent mediation analyses were conducted with the open-source software JASP Team (Version 0.17.3, 2023), which incorporated the Lavaan package in R. In general, mediation analysis enhances the understanding of the mechanisms by which at set of variables influence the outcome [57]. In this case, we examined whether associations between occupational therapy students' perceptions of the learning environment and their academic performance were mediated by their approaches to studying. The aim was to identify any indirect effects of the predictor variables on the outcome, and the mechanisms channelling these effects. Statistical significance was established at $p < 0.05$. The Maximum Likelihood Estimation (ML) method was employed to estimate the parameters and path coefficients that are most likely to generate the observed data and to ensure the accuracy and reliability of the model in explaining the relationships among predictor variables, mediators, and the outcome variable [58].

Research ethics

Approval for collecting and storing the data was granted by the Norwegian Centre for Research Data (October 12, 2017, project no. 55875). The students were informed that completion of the questionnaires was voluntary, their responses would be treated in confidence, and

there would be no negative consequences from opting not to participate in the study. Written informed consent was provided from all participants. The students were also informed that it was possible to withdraw their consent at any time without providing any reason for it.

Results

Descriptive statistics

The total sample was comprised of 263 students with a mean age of 23 years, where 79% were female. Sixty-three percent of the students reported that occupational therapy was their top priority line of study at the time of enrolment, and 42% had some higher education experience prior to beginning the occupational therapy studies. During their time in the education program, the students spent on average 8.7 h per week on independent studying. Table 3 displays the characteristics of the sample, including their grades and ratings on the ASSIST and CEQ scales within each study year and across the three study years.

Associations between learning environment factors, study approaches, and exam grades

The regression model was first run entering the five learning environment variables as predictors of the students' exam grades. Higher ratings on 'student autonomy' were found to be significantly associated with poorer average exam grades (β = −0.16, $p < 0.05$), whereas higher ratings on 'appropriate workload' were

associated with better average exam grades ($\beta = 0.16$, $p < 0.05$). All other associations were not statistically significant. This model was not statistically significant, explaining 3.8% (adjusted R^2: 1.8%) of the variance in the students' exam grades.

In the second model we entered the approaches to studying as additional predictors. This model was statistically significant ($F = 4.83$, df = 8, $p < 0.001$), indicating that the learning environment variables along with the study approach variables collectively exerted a significant effect on the outcome variable, explaining 14.3% (adjusted R^2: 11.4%) of the variance in the students' exam grades. Higher ratings on 'student autonomy' were found to be significantly associated with poorer average exam grades (β = −0.16, $p < 0.05$), whereas none of the other learning environment variables were significantly associated with grades. The averaged ratings on the study approach scales were all significantly associated with grades. Negative associations were shown for the 'deep approach' (β = −0.16, $p < 0.05$) and the 'surface approach' (β = −0.31, $p < 0.001$), whereas higher averaged ratings on the 'strategic approach' were associated with better grades ($\beta = 0.16$, $p < 0.05$). The results of the regression analyses are shown in Table 4.

Associations between learning environment factors and exam grades mediated by study approaches

The findings of the total effects analysis are presented in Table 5, which provides an overview of the combined direct and indirect effects of the learning

Table 3. Characteristics of the students participating in the survey in each study year and averaged across years of study.

Variables	1st year		2nd year		3rd year		Across years	
							n	M ± SD
Sociodemographic variables								
Age							262	23.00 ± 4.90
							n	%
Male gender							55	20.90
Female gender							207	78.70
Educational priority							165	62.70
Prior higher education							111	42.20
	n	M ± SD	n	M ± SD	n	M ± SD	n	M ± SD
Weekly hours self-study							258	8.73 ± 6.00
Learning environment								
Clear goals	185	16.56 ± 3.91	168	16.93 ± 3.20	200	17.06 ± 3.62	262	16.66 ± 3.29
Student autonomy	186	18.63 ± 4.16	167	18.07 ± 3.82	200	18.01 ± 4.67	262	18.10 ± 3.63
Good teaching	185	27.21 ± 6.23	168	25.13 ± 5.42	200	26.01 ± 6.06	263	25.94 ± 5.33
Appropriate workload	186	15.15 ± 3.71	168	15.39 ± 3.64	200	15.28 ± 3.95	263	15.07 ± 3.43
Generic skills	186	22.87 ± 4.14	168	23.70 ± 3.16	200	24.56 ± 4.56	263	23.63 ± 3.71
Study approaches								
Deep approach	186	56.56 ± 8.63	168	57.42 ± 7.73	199	57.55 ± 7.91	263	57.12 ± 8.05
Strategic approach	186	72.07 ± 10.32	168	72.06 ± 9.74	199	72.14 ± 9.02	263	71.25 ± 9.20
Surface approach	186	47.34 ± 9.24	168	44.92 ± 8.58	199	44.76 ± 9.55	263	46.37 ± 8.67
Academic performance								
Grade point average	236	3.95 ± 0.91	224	4.25 ± 0.76	213	4.14 ± 0.90	240	4.04 ± 0.78

Note. Age is age in years when beginning the current study program. Educational priority is having occupational therapy as the top priority line of study at enrolment (1, reported in the table) versus not (0). Prior higher education is having previous experience from higher education (1, reported in the table) versus not (0). Weekly hours of self-study is average number of hours per week spent on independent studying (continuous). Ratings on learning environment factors and study approaches are mean scale scores. Academic performance is grade point average (1 = fail, 6 = best grade).

Table 4. Linear regression analysis displaying associations between learning environment variables, study approaches, and averaged exam grades ($n = 240$).

Independent variables	Model 1				Model 2			
	Beta	95% CI	β	p	Beta	95% CI	β	p
Learning environment								
Clear goals	0.01	−0.03 to 0.05	0.03	0.67	−0.02	−0.06 to 0.02	−0.07	0.36
Student autonomy	−0.04	−0.07 to 0.00	−0.04	0.049	−0.04	−0.07 to −0.00	−0.16	0.03
Good teaching	0.01	−0.02 to 0.04	0.07	0.43	0.02	−0.01 to 0.04	0.11	0.22
Appropriate workload	0.04	0.01 to 0.07	0.16	0.02	0.01	−0.02 to 0.05	0.06	0.41
Generic skills	−0.01	−0.04 to 0.03	−0.03	−0.31	−0.01	−0.05 to 0.02	−0.05	0.52
R² change *(p)*		0.038 (0.10)				0.105 (<0.001)		
Study approaches								
Deep approach					−0.02	−0.03 to −0.00	−0.16	0.02
Strategic approach					0.02	0.00 to 0.03	0.16	0.02
Surface approach					−0.03	−0.04 to −0.02	−0.31	<0.001
Explained variance						0.143 (<0.001)		

Note. Dependent variable is averaged exam grade, ranging from 1 (fail) to 6 (top grade).

Table 5. Total effects of the learning environment variables on the students' averaged exam grades.

			Estimate	Std. Error	z-value	p	95% CI Lower	95% CI Upper
Clear Goals	→	Averaged grades	0.010	0.024	0.402	0.688	−0.038	0.058
Student autonomy	→	Averaged grades	−0.049	0.022	−2.214	0.027	−0.093	−0.006
Good teaching	→	Averaged grades	0.018	0.017	1.032	0.302	−0.016	0.052
Appropriate workload	→	Averaged grades	0.051	0.021	2.464	0.014	0.010	0.091
Generic skills	→	Averaged grades	−0.007	0.023	−0.289	0.773	−0.051	0.038

Note. Delta method standard errors, normal theory confidence intervals, ML estimator.

Table 6. Total indirect effects of the learning environment on averaged exam grades through study approaches.

			Estimate	Std. Error	z-value	p	95% CI Lower	95% CI Upper
Clear Goals	→	Averaged grades	0.032	0.010	3.317	<0.001	0.013	0.051
Student autonomy	→	Averaged grades	−0.003	0.009	−0.305	0.761	−0.019	0.014
Good teaching	→	Averaged grades	−0.003	0.006	−0.497	0.619	−0.014	0.009
Appropriate workload	→	Averaged grades	0.033	0.011	2.841	0.004	0.010	0.055
Generic skills	→	Averaged grades	0.008	0.009	0.849	0.396	−0.010	0.026

Note. Delta method standard errors, normal theory confidence intervals, ML estimator.

environment variables on the students' averaged exam grades. Echoing the results from the multiple regression analysis there was a statistically significant inverse association between 'student autonomy' and students' grades. This suggests that an increase in 'student autonomy' was associated with lower academic performance. In contrast, ratings on 'appropriate workload' were positively and significantly associated with better grades. None of the other variables exhibited statistically significant total effects on the students' averaged grades when accounting for both direct and indirect pathways.

The total indirect effects are displayed in Table 6. This analysis investigated the collective impact of the learning environment variables on the students' averaged exam grades through the study approach variables. There were statistically significant total indirect effects of 'clear goals' and 'appropriate workload' on grades. These effects occurred through the mediating variables ('deep approach', 'strategic approach', and

'surface approach'). The variables 'student autonomy', 'good teaching', and 'generic skills' did not exhibit any statistically significant total indirect effects on grades, suggesting that their impact on the outcome primarily occurred through direct pathways rather than mediation.

The results from the mediation analysis (specific indirect effects) are displayed in Table 7 and the paths are visually depicted in Figure 1. 'Clear goals' were positively associated with grades through the 'strategic approach' (estimate = 0.048, $p = 0.023$), while negatively associated through the 'surface approach' (estimate = −0.065, $p < 0.001$). 'Student autonomy' was positively associated with grades through the 'strategic approach' (estimate = 0.048, $p = 0.015$) and through the 'surface approach' (estimate = 0.041, $p = 0.022$). 'Good teaching' was positively associated with grades through the 'deep approach' (estimate = 0.032, $p = 0.042$). 'Appropriate workload' was negatively associated with grades through the 'surface approach'

Table 7. Path coefficients displaying associations between predictor variables and the outcome through the mediator variables.

Predictor	Mediator	Outcome	Estimate	Std. Error	z-value	p	95% CI Lower	95% CI Upper
Clear Goals	→ Deep approach	→ Averaged grades	−0.022	0.022	−0.991	0.321	−0.064	0.021
Clear Goals	→ Strategic approach	→ Averaged grades	0.048	0.021	2.277	0.023	0.007	0.089
Clear Goals	→ Surface approach	→ Averaged grades	−0.065	0.019	−3.393	<0.001	−0.102	−0.027
Student autonomy	→ Deep approach	→ Averaged grades	−0.013	0.020	−0.660	0.510	−0.053	0.026
Student autonomy	→ Strategic approach	→ Averaged grades	0.048	0.020	2.443	0.015	0.009	0.087
Student autonomy	→ Surface approach	→ Averaged grades	0.041	0.018	2.284	0.022	0.006	0.076
Good teaching	→ Deep approach	→ Averaged grades	0.032	0.016	2.038	0.042	0.001	0.062
Good teaching	→ Strategic approach	→ Averaged grades	0.003	0.015	0.210	0.834	−0.026	0.033
Good teaching	→ Surface approach	→ Averaged grades	−0.005	0.014	−0.401	0.688	−0.032	0.021
Appropriate workload	→ Deep approach	→ Averaged grades	0.020	0.019	1.056	0.291	−0.017	0.056
Appropriate workload	→ Strategic approach	→ Averaged grades	−0.023	0.018	−1.261	0.207	−0.058	0.013
Appropriate workload	→ Surface approach	→ Averaged grades	−0.125	0.016	−7.647	<0.001	−0.157	−0.093
Generic skills	→ Deep approach	→ Averaged grades	0.072	0.021	3.496	<0.001	0.032	0.112
Generic skills	→ Strategic approach	→ Averaged grades	0.057	0.020	2.869	0.004	0.018	0.096
Generic skills	→ Surface approach	→ Averaged grades	−0.031	0.018	−1.736	0.083	−0.067	0.004
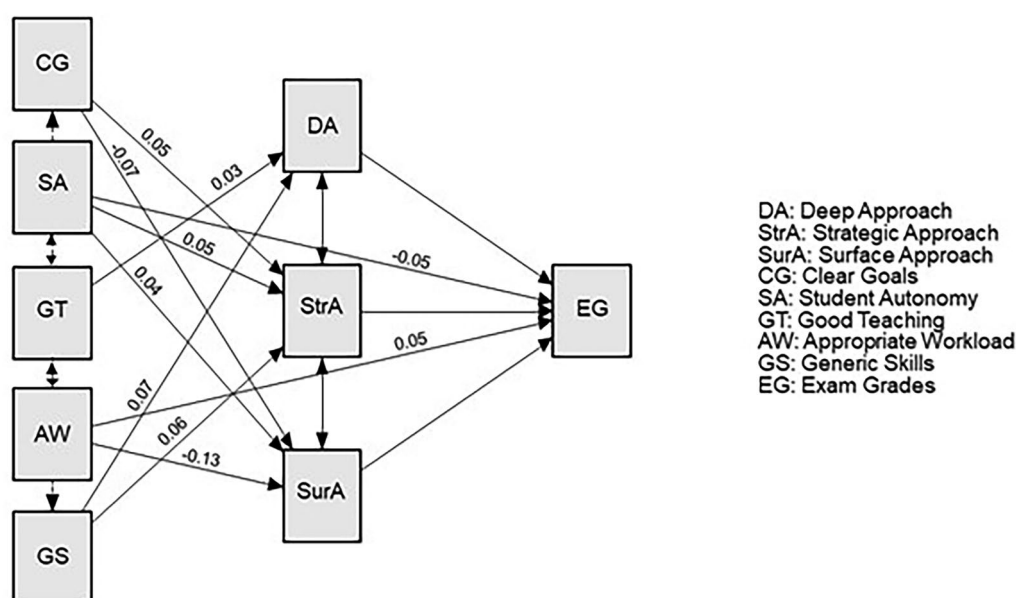
Figure 1. Path plot of associations between learning environment factors and exam grades mediated by study approaches.
Note. $p < 0.05$ for all displayed pathways.

(estimate=-0.125, $p < 0.001$). Finally, 'generic skills' was positively related to grades through the 'deep approach' (estimate = 0.072, $p < 0.001$) and the 'strategic approach' (estimate = 0.057, $p = 0.004$). No other mediated relationships between learning environment factors and grades were statistically significant.

Discussion

Summary of results

This study, using aggregated measures of learning environment factors, study approaches, and academic performance, found that ratings on 'student autonomy 'were inversely related to the students' academic performance, whereas higher ratings on 'appropriate

workload' were positively related to exam grades. In addition, there were numerous indirect associations between the learning environment variables and the students' exam grades, broadly suggesting that the learning environment has considerable influence on students' grades, both directly and through their impact on study behaviours.

Direct effects on students' academic performance

Perceptions of 'student autonomy' were inversely related to the students' exam grades. The finding implies that when students perceived an increased level of autonomy in their learning process, there was a tendency for their scores on exams to exhibit a decline. In contrast, in cases where students perceived

a diminished level of autonomy and experienced a greater sense of external direction or control in their learning process (i.e. control by faculty and/or by the study curriculum), their examination scores were inclined to exhibit an increase. These results appear to be in line with those of various studies (e.g. [59,60]). They suggest the existence of a potential trade-off between the experience of autonomy and the attainment of academic achievements. Students who perceive themselves as having greater autonomy in selecting their study methods, pace, or approach may place a higher value on personalised learning experiences, potentially resulting in diminished performance on examinations. Conversely, students who adopt a more structured or guided approach to learning may attain superior examination outcomes because of their adherence to established study methodologies or external guidance [61,62].

Perceptions of an 'appropriate workload' were positively related to better exam grades. This result makes sense as an appropriate workload can inspire students to work steadily week by week and presumably prepare for the exams in a structured manner. However, this effect was no longer significant when controlling for the study approach variables.

In addition, we note that all study approaches were significantly associated with academic performance. Higher scores on the 'strategic approach' were associated with better academic performance, as were lower scores on the 'surface approach'. Both of these results concur with other studies [21,63,64], as well as with previous results from the current research project where the data were analysed year-by-year [13,27]. However, the current study also showed that higher 'deep approach' ratings were significantly associated with poorer exam grades. While in opposition to theory and some studies [65,66], the result lends support to the notion that outcomes of employing a specific study approach are not universal. Haarala-Muhonen and co-workers [67] added nuance by arguing that students who combine high deep approach with low strategic approach are inclined to perform more poorly academically. This has also been described as the dissonant learning profile, or the deep unorganised profile [68]. In addition, possible effects of distinct study approaches should also be considered in context of what is assessed (assessment content) and how (practices and procedures). Thus, there may be program-specific factors, such as the content and organisation of exams, that have poorly rewarded students with a predominantly deep study approach. In view of the possible explanation concerned with assessment content and procedures, the contents and

practices related to assessments in the occupational therapy program may need reconsideration.

Effects of the learning environment on academic performance mediated by study approaches

Although this study showed a direct effect of higher deep approach scores on lower average grades, students who experienced the teaching as good received better exam grades through engaging in the deep approach to study. One possible explanation may be that these students more easily find motivation to go deeper into the syllabus and do a more thorough job with their assignments, when inspired and assisted by the lecturer. Possibly, good teaching may also be construed as providing students with a structured framework for their subsequent independent studies. Thus, students who perceive a strong sense of direction provided by the teaching may be better able to obtain good exam results from their own engagement in deep studying. Building on Parpala and co-workers [68], such students may benefit from the combination of deep studying and a sense of structure, even if the structure is provided externally as an element of teaching.

In a learning environment where there also is a focus on developing students' generic skills, such as problem-solving-, communication- and collaboration skills, different forms of learning activities will most likely be used. This can stimulate both a strategic and deep approach to learning and can, in turn, lead to better grades. Moreover, associations between having a stronger sense of developing generic skills and higher ratings on deep and strategic study approaches were among the consistent findings in previous studies from the current research project, where the data were analysed year-by-year [24,26].

When the aim of the teaching and the purpose of the subject is clear, there is increased opportunity for students to understand the assignments and study in a well-organised manner. Thus, more clarity in the goals and purposes of a course may inspire students to use a strategic approach to learning, often rewarded by receiving better grades. In contrast, if goals and standards are not presented clearly to the students, the students may be confused and demotivated and rather apply a surface approach to studying, which often leads to poorer exam grades [11,13,14].

The processes by which student autonomy is related to grades may be more complex and possibly hinge on student maturity and ability to use autonomy productively, as indicated by the indirect effects through the strategic and surface study approaches. While mature

students may be able to channel a high degree of autonomy into independent, organised studying and avoid surface behaviours, resulting in good grades, less mature students may not [12,69]. Thus, the mediation may be moderated by other factors, such as students' maturity. In general, mediation analysis entails complex interactions among predictor, mediator, and outcome variables. The presence of apparently contradictory associations demonstrates the complex interactions and possible reduction, or enhancement, of effects caused by mediation pathways [70–72].

The positive effect of appropriate workload on better exam grades was no longer significant when controlling for the study approach variables. However, the significant indirect effect of 'appropriate workload' via the surface study approach was negative, introducing considerable complexity to the results. Given that more surface approach behaviours are linked with poorer academic performance, as shown in this and other studies [13,14,18,73,74], the results indicate that stronger perceptions of an 'appropriate workload' are linked with poorer grades when channelled through the surface approach. Possibly, some students may feel that the study program is easy and presents them with no real challenge. While this perception may result in high scores on 'appropriate workload', it may also result in a laidback attitude expressed through higher surface approach behaviours, and therefore in poorer grades. More mature students perceiving the course to have an appropriate workload may instead use this as an opportunity to immerse themselves in the assigned study topics, and thereby obtain better grades. Thus, in line with our interpretation of the indirect effect of student autonomy, the results of the mediation analyses are complex and not without contradictions. Future studies may test the same models with other samples in other settings. Viable routes for future studies also include moderated mediation models to assess for whom (i.e. which subgroups of students) the pathways seem to be valid.

Study limitations

In this study, we used aggregated measures of learning environment factors, study approaches and grades. The results of the study partly confirm, partly expand, and partly oppose the results obtained the previous studies from this project, where the data were analysed year-by-year. While the use of aggregated data can be considered a strength, as it provides a generalised picture of the relevant associations, its weakness may be a lower degree of correspondence to the 'real-life' study environment in a given cohort of students.

A previous study from this project demonstrated that of the 305 eligible students, 187 students participated in the first study year (response rate 61.3%), 168 students participated in the second year (response rate 55.1%), and 200 students participated in the third study year (response rate 65.6%), and 118 (49.2%) students participated consistently at all three measurement occasions [42]. Thus, missing responses were prevalent. To address this problem, we averaged scores from all participants across measurement occasions, allowing the inclusion of students with incomplete data (i.e. valid data from less than three measurements). We consider this to be a strength as well as a limitation – a strength because it enabled us to use as much of the available data as possible, and a limitation because we cannot know the degree to which the average scores for participants with missing data correspond to their actual perceptions.

The study is based on self-report data and is therefore subject to the potential biases involved in such data. In addition, although the ASSIST scales were shown to have good structural validity and internal consistency in a previous study from this research project [39], there may be inherent limitations concerned with operationalisation; i.e. how the students made sense of item content and the degree to which their operationalizations corresponded with the concepts as measured by the scales. Thus, one should consider the possibility that the paradoxical association between lower grades and higher scores on the deep approach scale may have been affected by diverse interpretations of the items comprising this scale.

The study included multiple testing of associations, which constitutes an increased risk of Type I error (i.e. reporting significant associations where no such associations exist). Lastly, we need to emphasise that the participants in the study were undergraduate students representing only one type of study program (occupational therapy), and only one country. For these reasons, our ability to generalise the results to the general population of students, is limited.

Conclusion and implications

The aim of this study was to assess learning environment factors as predictors of occupational therapy students' average exam grades, and to assess whether study approaches mediated associations between learning environment factors and exam grades. The study showed that higher levels of 'student autonomy' were directly associated with lower grades whereas higher levels of 'appropriate workload' were associated with higher averaged grades. In addition, all learning

environment variables showed one or more relationships with academic performance that was mediated by the study approach variables. While some of the mediated associations are well aligned with previous theory and research and therefore easily interpretable, others appear complex and intriguing, suggesting a need for further research. We conclude that learning environment variables are complexly associated with academic performance, both directly and indirectly.

Findings from our study provide important information for the improvement of occupational therapy curricula. Through a better understanding of the interplay between the learning environment, students' study approaches and their academic achievements, educators in occupational therapy may develop curricula that promote productive approaches to learning, encouraging students to think critically and engage in reflective practice. They may further develop and utilise instructional techniques that include problem-based learning and practical activities, maximising learning opportunities for aspiring occupational therapists. Furthermore, they may identify and put efficient support services into action, such as study skills workshops and personalised academic support, which may facilitate students in developing their study habits and optimising their academic skills. Finally, educators may consider how assessments and exams are set up to reward students with varying study approaches. Considering that the aim of the occupational therapy programs is to educate reflective and independent occupational therapy professionals who make a valuable contribution to society, it seems that more effort may be made to develop assessment forms that better reward students who demonstrate skills precisely in the areas of reflection and independence.

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Data availability statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ongoing publication from the research project.

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