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Grit and Cognitive Load in Students with Different Achievement Goal Orientation Profiles

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Abstract

The aim of this study was to identify goal orientation profiles among students from different academic fields and examine differences among these profiles in terms of students' grit and perceived cognitive load during an authentic knowledge assessment situation. A total of 309 students completed a goal orientation questionnaire and a brief grit scale (assessing perseverance of effort and consistency of interest) one week prior to a midterm exam. Immediately after the exam, they reported on intrinsic, extraneous, and germane cognitive load experienced during the exam. Latent profile analysis identified three groups of students with different goal orientation profiles: success-oriented students (27.8%), indifferent students (53.9%), and work-avoidance students (18.3%). In the final step of the latent profile analysis, the Bolck-Croon-Hagenaars (BCH) approach was applied to identify differences in grit and cognitive load between the goal orientation profiles. Results indicated that success-oriented students reported higher grit, as well as greater germane cognitive load, reflecting higher mental effort investment in general, but also in the specific knowledge assessment situation. Indifferent and work-avoidant

students showed no significant differences. No significant differences were found among goal orientation profiles in perceptions of intrinsic and extraneous cognitive load, i.e., the perceived complexity and clarity of exam tasks. The findings are discussed in the context of linking motivational concepts with cognitive load theory.

***Keywords**: grit, cognitive load, performance, achievement goal orientations, profiles*

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Introduction

Achievement motivation is crucial to student success at all educational levels, including higher education. While the pressure to achieve high grades at the university programmes may be less apparent than in high school, successfully completing assignments and exams remains essential for academic advancement and degree attainment. Students deal with educational challenges differently, and the goals they set in achievement contexts shape their approach to and perception of grading tasks.

Tendencies to prefer certain types of goals and outcomes over some others in achievement-related settings are referred to as achievement goal orientations (Niemivirta at al., 2019). Two main types of goal orientations are commonly distinguished. The first is mastery orientation (or learning orientation), which reflects a student tendency to focus on the development of abilities and mastering the task. The second type is performance orientation, where the individual is focused on outcomes and demonstrating their abilities (Ames, 1992). Individuals with a mastery orientation are motivated by the intrinsic value of learning, such as acquiring new knowledge and skills, as well as by desire to understand the material (Dweck & Leggett, 1988). In contrast, when endorsing performance orientation, students' primary goal is to outperform others. In trichotomous achievement goal framework, performance orientation is separated into approach and avoidance tendencies. Whereas the goal of performance-approach orientation is to demonstrate competence, performance-avoidance orientation reflects the tendency to avoid demonstrating incompetence in comparison to others (Elliot & Church, 1997). In a 2x2 model of achievement goals (Elliot & McGregor, 2001), both mastery and performance orientations are divided regarding their valence dimension into positive ("approaching success") and negative ("avoiding failure") orientations. Mastery avoidance goals reflect the tendency to avoid failure in learning and the deterioration of skills. Mastery avoidance goals are rarely examined and have weaker empirical support compared to other orientations (Maehr & Zusho, 2009). Some conceptualisations of achievement goal orientations also identify work-avoidance as a distinct goal orientation, characterised by the tendency to avoid challenges and invest as little effort as possible in completing academic tasks (Nicholls et al., 1985).

Niemivirta (2002, Niemivirta et al., 2019) has differentiated between five goal orientations. In addition to performance-approach, performance-avoidance, and work-avoidance orientations, the model distinguishes between mastery intrinsic and extrinsic goal orientations. Mastery intrinsic goals correspond to mastery approach goals, while mastery extrinsic goals reflect the desire for achieving good grades and obtaining absolute success. Mastery-extrinsic oriented students evaluate their achievement using external criteria (like grades) to evaluate the attainment but without comparing themselves to others.

In the first few decades of research on goal orientations, the relationships between specific goal orientations and various educational outcomes were widely explored (Senko et al., 2011). However, as it became evident that individuals can pursue different goals at the same time (Pintrich, 2000), attention shifted to examining multiple goal orientations simultaneously (Niemivirta et al., 2019; Senko et al., 2011). This person-centred approach groups students into distinct, homogeneous profiles based on similar patterns of goal orientations and offers a deeper understanding of students' motivational tendencies (Tuominen-Soini et al., 2011, 2012). Although various achievement goal profiles were identified in numerous studies (Wormington & Linnenbrink-Garcia, 2017), several studies using Niemivirta's (Helsinki 5) model have consistently resulted in four-profile solutions (Niemivirta et al., 2019). The following groups are typically identified: a group with a dominant tendency towards mastery (mastery-oriented students), a group with a tendency towards performance or success (students oriented mainly on performance or both performance and mastery goals), a group with a tendency towards avoidance (avoidance-oriented students), and a group of students without a dominant tendency towards any specific achievement goal orientation (indifferent students). Earlier studies on Croatian university and high school students yielded similar four profile solutions (Pahlji-

na-Reinić, 2022; Pahljina-Reinić et al., 2024). Both mastery-oriented and success-oriented students concentrate on understanding and mastery. However, success-oriented students also tend to focus on comparison with other students. Indifferent students, on the other hand, are those who aim to meet basic expectations without investing a significant amount of effort. Compared to other groups, avoidance-oriented students set lower mastery goals and strive to put in the least possible effort in studying (Niemivirta et al., 2019).

Building on these findings, it is plausible to expect that students' achievement goals are also related to their grit. Grit is defined as perseverance and passion for long-term goals, and it comprises two dimensions: perseverance of effort, which refers to the ability to sustain effort in the face of adversity, and consistency of interests, which refers to the stability of interests over time (Duckworth et al., 2007). Gritty individuals pursue their goals with great effort and determination, overcoming challenges and progressing despite obstacles and failures. They also tend to attain higher levels of education (Duckworth et al., 2007).

Muenks et al. (2018) suggested that students with *approach* goal orientations, whether focused on mastery and skill development or on superior performance, are likely to show more grit when faced with challenges compared to those with *avoidance* goal orientations. In line with this, they found that both mastery and performance-approach orientations were positively related, while performance-avoidance was negatively related to perseverance of effort. However, consistency of interest was positively linked only to mastery goal orientation. Alhadabi and Karpinski (2020), as well as Sadoughi and Eskandari (2024) reported comparable findings, adding that performance-avoidance was also (weakly) negatively associated with consistency of interest. Han et al. (2023) confirmed that mastery orientation was positively related to perseverance of effort, while performance-avoidance had a negative effect, though they found no significant effect of performance-approach goal orientation. Zhao et al. (2024) found a positive correlation between mastery goal orientation and overall grit, though they did not examine grit dimensions separately.

To our knowledge, differences in grit across goal orientation profiles have not yet been explored. However, based on previous findings, we can hypothesise that mastery-oriented and success-oriented students would exhibit higher levels of grit compared to indifferent or work-avoidant students. While performance orientation has not been consistently linked to grit, we propose that students who combine a performance-approach orientation with mastery goal orientation are likely to demonstrate high levels of grit.

Whereas grit is related to long-time perseverance and effort expenditure, goal orientations can also affect perceptions of specific academic tasks and challenges. It is already acknowledged that both mastery- and success-oriented students invest considerable effort in academic tasks (Pintrich, 2000; Tuominen-Soini et al., 2011, 2012). However, since success-oriented students are more preoccupied with possible failures in school, they are at risk for certain adverse outcomes such as emotional exhaustion and higher sense of inadequacy as a student (Tuominen et al., 2020; Tuominen-Soini et al., 2012). Therefore, they might perceive academic assignments, especially the ones that are graded, as more threatening and difficult. Task difficulty and effort at the task specific level essentially overlap with cognitive load constructs (Plass & Kalyuga, 2019).

Cognitive load refers to the degree of strain on the cognitive system, specifically on an individual's working memory capacity, caused by information processing during learning or task-solving. According to widely recognised classifications (Klepsch & Seufert, 2021; Sweller et al., 1998), there are three types of cognitive load: intrinsic cognitive load (ICL), which arises from the complexity of the presented material and is related to the individual's prior knowledge; extraneous cognitive load (ECL), which is triggered by ambiguous task formulation or inadequate design of the material (such as irrelevant information or unclear instruction); and germane cognitive load (GCL), which reflects deliberate investment of additional internal resources and an individual's willingness to engage actively in task-solving and persevere. Scheiter et al. (2020) distinguish between mental load, which refers to the resources required to perform a task, and mental effort, which refers to the resources invested in performing the task. Feldon et al. (2019) argue that mental effort reflects a willingness to fully engage under the demands of the cognitive load imposed by a learn-

ing context. Because GCL entails the intentional investment of internal resources, it is often equated with mental effort. Seufert (2020) argues that if learners still have working memory resources available, they can allocate GCL to learning and self-regulation while engaging with the task, despite the task's intrinsic and extraneous demands. However, GCL is influenced not only by the available capacity of working memory and characteristics of the learning task, but also by learners' willingness to allocate their resources to specific learning activities and engage in them for extended period. Learners' willingness to actively engage in a specific learning activity involves investing additional working memory resources to process information related to the learning situation, as well as effectively regulating emotions that may arise during the learning or problem-solving process. This is influenced by the learner's motivational tendencies, which contribute significantly to persistence and success in the task (Feldon et al., 2019; Schnotz et al., 2009).

Findings from sparse previous research exploring relations between goal orientations and GCL mostly indicate positive relations between mastery orientation and GCL (Cook et al., 2017; Sunawan et al., 2021) with some exceptions (Xu et al., 2021). Performance orientation was rarely examined, indicating positive relation of GLC with its approach dimension (Cook et al., 2017) and no significant correlation with its avoidance dimension (Cook et al., 2017; Sunawan et al., 2021). Therefore, it can be expected that students with distinct goal orientation profiles would differ in reported GCL in specific knowledge assessment situation. We propose that mastery-oriented students will report highest effort investment (GCL) compared to other achievement goal profiles, while work-avoidant students will report minimal GCL, since they are inclined to avoid engagement and effort investment (King & McInerney, 2014; Niemivirta et al., 2019; Tuominen et al., 2020). Success-oriented students are expected to invest substantial effort, similar to mastery-oriented students. Previous findings show that in students with performance goal orientation, other beliefs such as their implicit theories of intelligence may influence their effort investment. Yu and McLellan (2020) found that performance-oriented students with a fixed mindset (i.e., the belief that abilities are unchangeable) reported low perseverance and high self-handicapping. This suggests that such students are less inclined to exert effort, likely to avoid implications of low ability. Conversely, when students view their abilities as malleable, performance goals shift towards demonstrating their developed skills. Recognising that effort supports their growth, these students sustain effort and perseverance. It should be noted that for this group of students, performance goals coexisted with mastery goals, aligning closely with success-oriented profiles obtained in other studies.

Since ICL and ECL depend on prior knowledge and task clarity, predicting their relationship with goal orientations is more complex. However, as mastery-oriented students tend to gain knowledge and understanding, they are likely to be more familiar with exam material, and therefore, perceive lower ICL. In contrast, indifferent, and especially work-avoidant students may perceive higher ICL, as well as elevated ECL since they are more prone to avoid effort and have higher cynicism towards the meaning of school (Tuominen-Soini et al., 2012). Success-oriented students could perceive tasks as more threatening and difficult as they are concerned with possible failures (Tuominen-Soini et al., 2011). Previous studies are not completely consistent in findings, mainly indicating no or weak correlations of goal orientations with ICL and ECL (Cook et al., 2017; Sunawan et al., 2021; Xu et al., 2021). In a study investigating relation of goal orientations to tenseness in achievement situation, no relation between goal orientations and perceived difficulty of the task was found, regardless of differences in tenseness (Wimmer et al., 2018).

Despite these initial findings, further research is needed to relate motivational concepts, such as goal orientation profiles and sustained perseverance in challenging contexts to the cognitive load, and more precisely its specific types. Although the need to integrate motivational constructs with cognitive load has been recognised for some time (e.g., Feldon et al., 2019; Schnotz et al., 2009), existing findings remain limited. This study represents a step in that direction, offering integrative examination of these constructs. More specifically, the study aimed to compare students' achievement goal orientation profiles in terms of grit, as a trait variable, and more situation-specific measures of cognitive load and performance on a midterm exam.

Methods

Participants

A total of 418 participants (63.4% female) were recruited for the broader study at various faculties of the University of Rijeka; 309 students participated in the first and 377 in the second assessment point. In the present study, we analysed the results of 309 participants that took part in the first assessment point (69.6% female). Forty-one out of them did not take part in the second time point. The participating students were mostly undergraduate students (4.9% first-year, 58.6% second-year, 23.9% third-year) and 12.6% were first-year graduate students. The sample was convenient as the selection was based on the willingness of the instructors to allocate a portion of their class time for the implementation of the study. The students were recruited from the Faculty of Economics and Business (n = 126; 41.9%), Faculty of Engineering (n = 44; 14.2%), Faculty of Law (n = 58; 18.8%), Faculty of Humanities and Social Sciences-Psychology (n = 32; 10.4%), and from different teacher education programmes studying the same course (n = 49; 15.9%).

Instruments

Achievement Goal Orientations were assessed by an instrument designed to assess five goal orientations with three items per scale (Niemivirta, 2002; Croatian adaptation Pahljina-Reinić, 2022). The scales are as follows: 1) Mastery-Intrinsic Orientation—assesses students' focus on learning, understanding content, and gaining competencies (e.g., *"To acquire new knowledge is an important goal for me"*); 2) Mastery-Extrinsic Orientation—assesses the students' aspirations to achieve high grades and success in courses (e.g., *"My goal is to succeed at the university"*); 3) Performance-Approach Orientation—assesses students' focus on relative abilities and judgments of competence (e.g., *"An important goal for me is to do better than other students"*); 4) Performance-Avoidance Orientation—assesses students' tendency to avoid situations that could demonstrate relative incompetence (e.g., *"I try to avoid situations in which I might fail or make a mistake"*); 5) Work-Avoidance Orientation—assesses students' tendency to avoid challenges and minimise effort in learning (e.g., *"I try to get away with as little effort as possible in my academic work"*). The participants were asked to rate the extent to which each statement applies to them using a 7-point Likert-type scale ranging from 1 (*not true at all for me*) to 7 (*very true to me*), where a higher score indicates a greater expression of each of the five goal orientations. The internal consistencies of the scales are shown in Table 1.

Grit was assessed with the Short Grit Scale (Duckworth & Quinn, 2009; Croatian adaptation Zrilić, 2018). The scale consists of two four-item subscales: Consistency of Interest (e.g., *"I often set a goal but later choose to pursue a different one"*) and Perseverance of Effort (e.g., *"Setbacks don't discourage me"*). The participants rated the extent to which each statement applies to them using a 5-point Likert-type scale ranging from 1 (*not true at all for me*) to 5 (*very true to me*), with a higher score indicating greater grit. The internal consistencies of the scales are shown in Table 1.

Perceived cognitive load was assessed with the Cognitive Load Questionnaire (Zu et al., 2021; Croatian adaptation Korać & Rončević Zubković, 2023). The scale comprises eight items measuring three types of cognitive load perceived by the participants in a test situation: the Intrinsic Cognitive Load (three items, e.g., *"The material covered by the exam was very complex"*); the Extraneous Cognitive Load (three items, e.g., *"The exam had confusing language that was not clear to me"*); the Germane Cognitive Load (two items, e.g., *"I devoted a lot of mental effort in finding and applying the relevant concepts needed to answer the exam questions"*). Each item was rated on a Likert scale from 1 (*not at all the case*) to 9 (*completely the case*), with

a higher score reflecting a greater tendency to assess exam as more difficult (ICL) and ambiguous (ECL), as well as a greater level of effort devoted to the exam (GCL).

The internal consistencies of the ICL and ECL scales are shown in Table 1.

Procedure

The study was carried out during regular class sessions at various faculties at the University of Rijeka. Each student group participated in two phases of the research. The first phase occurred approximately one week before a regularly scheduled midterm exam, in agreement with the course instructor. During this phase, the students completed scales assessing goal orientations and grit (among other scales not presented in this paper). The second phase was conducted immediately after the midterm exam when the participants filled out the cognitive load questionnaire. The participants were subsequently provided with a link to a digital table, where they were required to record the number of points they had achieved on the midterm exam and maximal possible score. A unique participant-generated code was used by the participants throughout all stages of the study, including during performance data entry. However, only a small percentage of students (n = 81) provided data about their performance, so we decided not to further analyse these results.

At the start of each phase of the study, the participants were informed, both in writing and orally, about the purpose and conditions of the research. These included voluntary participation, the option to withdraw at any time, guaranteed anonymity, and the possibility of contacting the researchers via email for further inquiries.

Data Analyses

Since the factor structure of the goal orientation scale had been validated in a previous study on a university student sample (Pahljina-Reinić, 2022)—and given that this variable assesses students' general tendencies regardless of a specific educational context—Confirmatory Factor Analysis (CFA) was not conducted in the present study. However, as cognitive load is context-specific variable, CFA and multigroup CFAs using maximum likelihood (ML) estimation were employed to assess the structural validity of the questionnaire, considering that the students assessed cognitive load for different midterm exams depending on their study programme. Adequacy of model fit was assessed by comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardised root mean square residual (SRMR) using the following cut-off values: CFI > .90, RMSEA < .06 and SRMR <.08 (Browne & Cudeck, 1992; Hu & Bentler, 1999).

To identify the students with similar patterns of achievement goal orientation, Latent Profile Analysis (LPA) was performed, using the composite scores of achievement goal orientation scales. Five groups were added stepwise to explore the most optimal data fit in terms of number of profiles. In line with the existing recommendations (Masyn, 2013), the following statistical criteria were used to select the optimal time-specific solution: Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Vuong-Lo-Mendell-Rubin (VLMR) likelihood ratio test, and Lo-Mendell-Rubin (LMR) adjusted likelihood ratio test. A better fit to the data is indicated by a model with lower AIC and BIC values, while p-values of the VLMR and LMR tests less than .05 indicate that the estimated model is preferable over the reduced model. The classification quality (entropy value > .70), meaningfulness and interpretability of the latent profiles were also considered for choosing the best-fitting model. In the last step of LPA, Bolck-Croon-Hagenaars (BCH) approach was applied to identify statistically significant differences between the mean scores of grit and cognitive load across profile groups. The models were estimated using the full-information maximum likelihood estimation with robust standard errors, as implemented in Mplus Statistics Software Version 8.10 (Muthén & Muthén, 1998–2023).

Results

CFA failed to identify the three-factor cognitive load model given convergence problems involving GCL items. Therefore, both GCL items were excluded from the model. The two-factor CFA on the remaining six items, hypothetically representing ICL and ECL, suggested a good fit to the data: χ^2 (8) = 9.53, p > .05, CFI = .99, RMSEA = .023, SRMR = .022. We used this solution in further analyses, while GCL was analysed using a single-item measure. Out of the two items applied, the item *"I devoted a lot of mental effort in finding and applying the relevant concepts needed to answer the exam questions"* was chosen. Its content aligns better with the concept of GCL that refers to the active investment of germane resources by the learner (Seufert, 2018) and "reflects the effort that contributes to the construction of schemas" (Sweller et al., 1998, p. 259).

The metric measurement invariance of ICL and ECL cognitive load measures across five study programmes was confirmed through multigroup CFAs. The configural invariance model suggested an acceptable fit to the data, χ^2 (40) = 65.50, p < .001, CFI = .98, RMSEA = .092, SRMR = .045, as did the metric invariance model, χ^2 (56) = 86.50, p < .001, CFI = .98, RMSEA = .085, SRMR = .086. The comparisons between these models yielded a nonsignificant χ^2-difference test, $\Delta\chi^2$ = 20.99, Δdf = 16, p = .18, and the change in CFI (ΔCFI = .004) was below the recommended threshold of ΔCFI < .01 (Chen, 2007), thus indicating that the metric invariance was met.

Descriptive statistics, internal consistencies, and correlations between goal orientations, grit, and cognitive load are presented in Table 1.

GCL showed a positive correlation with both ICL and ECL. However, GCL and grit dimensions were not significantly correlated. Both dimensions of grit correlated positively with mastery-intrinsic and mastery-extrinsic goal orientations, while GCL correlated positively with mastery-extrinsic goal orientation. Performance-avoidance goal orientation was negatively correlated with consistency of interest. As expected, work-avoidance orientation negatively correlated with grit but positively correlated with ECL.

Table 1

Descriptive Statistics, Internal Consistencies, and Bivariate Pearson Correlations for Goal Orientation, Grit, and Cognitive Load Scales

Variable	1	2	3	4	5	6	7	8	9	10
1. Mastery-intrinsic	-									
2. Mastery-extrinsic	.43**	-								
3. Performance-approach	.26**	.63**	-							
4. Performance-avoidance	.00	.31**	.41**	-						
5. Work-avoidance	-.42**	-.35**	-.12*	.19**	-					
6. Consistency of interest	.21**	.12*	-.06	-.17**	-.26**	-				
7. Perseverance of effort	.20**	.14*	-.03	-.06	-.30**	.42**	-			
8. Intrinsic CL	.03	.03	-.02	.04	.04	-.04	.00	-		
9. Extraneous CL	-.09	-.08	-.03	-.01	.18**	-.09	-.12	.48**	-	
10. Germane CL	.12	.23**	.10	.06	-.10	.04	.11	.36**	.22**	-
M	5.51	4.34	3.87	4.46	3.97	3.09	3.41	4.96	2.70	6.07
SD	1.19	1.45	1.38	1.46	1.48	0.77	0.86	1.96	1.57	2.15
Range	1 - 7	1 - 7	1 - 7	1 - 7	1 - 7	1 - 5	1 - 5	1 - 9	1 - 9	1 - 9
α	.84	.83	.72	.77	.74	.71	.77	.92	.81	-

Note. CL = cognitive load.

*p** < .05. *p*** < .01.

Achievement Goal Orientation Profiles

The results of the LPA are reported in Table 2. The results provided support for the three-profile solution. Although AIC and BIC value suggested better fit for four-profile solution, *p*VLMR and *p*LMR were not significant, indicating that adding a fourth group did not result in a meaningful improvement in model fit compared to the three-profile model. Also, entropy value was satisfactory for both models but higher for three-profile solution (.82). The three identified profiles were qualitatively informative and consistent with previous research and theory. Mean differences in achievement goal orientations between the latent goal orientation profile groups based on the Wald test are shown in Table 3.

Table 2

Information Criteria Values for Different Profile Solutions

k	AIC	BIC	p_{VLMR}	p_{LMR}	Entropy	Group sizes
1	4404.520	4441.853	-	-	-	309
2	4184.036	4262.436	.0000	.0000	.73	173, 136
3	4097.389	4216.856	.0066	.0071	.82	167, 57, 85
4	4037.851	4198.385	.0763	.0796	.77	72, 44, 88, 105
5	3995.653	4197.253	.3466	.3508	.78	54, 38, 99, 41, 77

Note. k = number of latent profiles in the model; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion, pVLMR = Vuong-Lo-Mendell-Rubin test likelihood ratio test, pLMR = Lo-Mendell -Rubin test adjusted likelihood ratio test.

The profiles were labelled as *success-oriented* (n = 85, 27.5%), *indifferent* (n = 167, 54.0%), and *work-avoidant* (n = 57, 18.5%) (Figure 1). The success-oriented students showed high emphasis on both mastery- and performance-related orientations, along with relatively low work-avoidance orientation in comparison with other goal orientation profiles. The indifferent students were characterised by goal orientations that were average relative to the other groups. Work-avoidant profile displayed a stronger emphasis on work-avoidance orientation compared to the remaining goal orientation profiles, along with relatively lower performance-approach, performance-avoidance, mastery-intrinsic, and particularly mastery-extrinsic orientation.

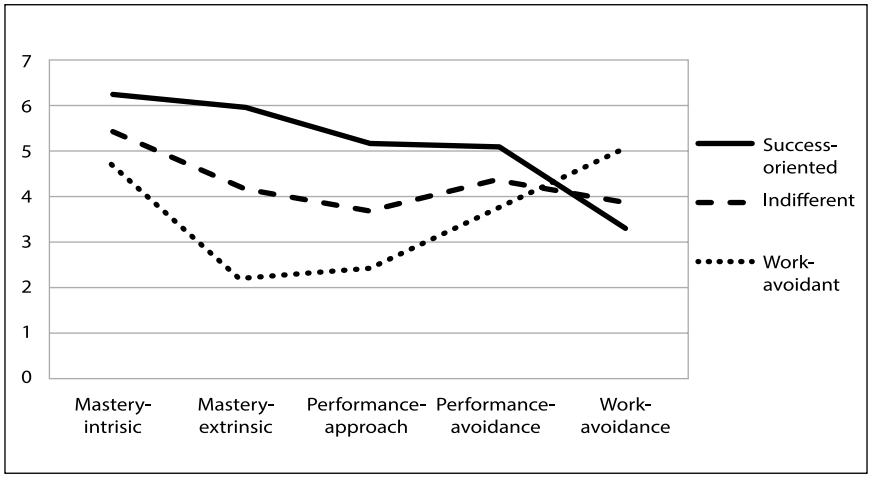
Table 3

Mean Differences in Achievement Goal Orientations Between the Goal Orientation Profiles

Measure	1. Success-oriented		2. Indifferent		3. Work-avoidant		χ^2	*p*	Significant differences[a]
	M	*SE*	*M*	*SE*	*M*	*SE*			
Mastery-intrinsic	6.30	0.07	5.42	0.07	4.60	0.21	107.27	.00	1 > 2 > 3
Mastery-extrinsic	6.05	0.07	4.21	0.05	2.17	0.09	1246.35	.00	1 > 2 > 3
Performance-approach	5.18	0.12	3.67	0.08	2.54	0.16	243.21	.00	1 > 2 > 3
Performance-avoidance	5.11	0.16	4.36	0.09	3.78	0.22	25.79	.00	1 > 2 > 3
Work-avoidance	3.38	0.15	3.89	0.10	5.10	0.20	47.83	.00	3 > 2 > 1

Note. [a] differences between achievement goal orientation profile groups based on the Wald test.

Figure 1
Achievement Goal Orientation Profiles



Comparison of achievement goal orientation profiles with BCH method revealed that the success-oriented students reported higher grit (both consistency of interest and perseverance of effort), as well as greater germane cognitive load compared to the indifferent and work-avoidant profiles. The indifferent and work-avoidant students showed no significant differences in grit, nor in perceived cognitive load. No significant differences were found among the goal orientation profiles in perceptions of intrinsic and extraneous cognitive load (Table 4).

Table 4
Mean Differences in Grit and Cognitive Load Between the Achievement Goal Orientation Profiles

Measure	1. Success-oriented		2. Indifferent		3.Work-avoidant		χ^2	*p*	Significant differences[a]
	M	*SE*	*M*	*SE*	*M*	*SE*			
CI	3.28	0.09	3.04	0.06	2.93	0.12	6.35	.04	1 > 2, 3
PE	3.67	0.11	3.32	0.07	3.27	0.13	8.11	.02	1 > 2, 3
ICL	4.98	0.28	5.09	0.16	4.53	0.35	1.95	.38	-
ECL	2.69	0.20	2.66	0.13	2.83	0.32	0.25	.88	-
GCL	6.72	0.24	5.94	0.18	5.36	0.43	9.89	.01	1 > 2, 3

Note. CI = consistency of interest; PE = perseverance of effort; ICL = intrinsic cognitive load; ECL = extraneous cognitive load; GCL = germane cognitive load.
[a] differences between achievement goal orientation profile groups based on the BCH method

Discussion

The aim of the present study was to examine the relationship between motivational concepts, more specifically, achievement goal orientation profiles and grit, and specific types of cognitive load. In doing so, we employed a person-centred approach to identify achievement goal orientation profiles among students and compare these profiles across grit and cognitive load.

Firstly, we hypothesised that a four-profile solution would best fit the data, as most earlier studies employing Helsinki 5 conceptualisation of achievement goal orientations have obtained four-profile solutions (for overview see Niemivirta at al., 2019). However, LPA indicated that three-profile solution was the most suitable. The largest group, comprising approximately half of the student sample, was identified as *in-*

different students (54%). Consistent with previous findings, these students represent a typical profile with goal orientations that are generally average compared to the other groups. However, their mastery intrinsic and extrinsic orientations, as well as performance-avoidance orientation were above the scale midpoint, while performance-approach and work-avoidance orientations were closer to midpoint. The *success-oriented* profile accounted for about 28% of the sample, making it about half the size of the indifferent group. The students in this profile displayed a strong emphasis on both mastery and performance orientations compared to other profiles, with absolute values on these scales exceeding the midpoints. Their work-avoidance orientation was around the scale midpoint and the lowest among the profiles. Notably, their emphasis on mastery-extrinsic goals was the most pronounced compared to the other groups. The smallest group, representing *work-avoidant* students, comprised about 18% of the sample. These students placed a stronger emphasis on work-avoidance goals than other profiles and reported the highest scores on this scale. In contrast, they demonstrated relatively low performance-approach, mastery-intrinsic, and particularly mastery-extrinsic orientations compared to the other groups. Their performance-approach scores were below the scale midpoint, performance-avoidance scores were around the midpoint, while their mastery-extrinsic orientation was very low. Interestingly, their mastery-intrinsic orientation was above the scale midpoint.

Obtained profiles align with previously identified profiles using LPA (Niemivirta et al., 2019; Pahljina-Reinić et al., 2024) but unexpectedly, mastery-oriented profile was not differentiated. Most of the earlier studies that identified mastery-oriented groups were conducted on younger (secondary schools) students (e.g., Mädamürk et al., 2020; Tuominen et al. 2020; Tuominen-Soini et al., 2012). Some findings suggest that mastery goals may be more beneficial, while performance-approach goals may be more detrimental, during elementary school. At the secondary level, there is evidence supporting the benefits of both mastery and performance-approach goals, while at the undergraduate level, some findings indicate that performance-approach goals may be more advantageous due to higher academic demands and a more competitive context (Linnenbrink-Garcia et al., 2008). However, benefits of mastery orientations have still been acknowledged, and studies show that mastery-oriented profile was also identified in university students, showing adaptive motivational patterns (Pahljina-Reinić, 2022; Pulkka & Niemivirta, 2013, 2015). In a study by Lee et al. (2017), mastery-oriented group was not identified as all groups of university students showed high levels of mastery orientation. In our study, the groups differed slightly in their levels of mastery-intrinsic orientation (which were above scales' midpoints), but the differences were not as pronounced as those in mastery-extrinsic orientation. Mastery-extrinsic orientation reflects orientation on absolute success and can be crucial for success at the university. Niemivirta et al. (2019) argued that such goals are related to adaptive coping strategies and behaviours, such as investment of effort, persistence, and academic success.

To explore whether the profiles identified in the present study will differ in their persistence and effort, more specifically, in their grit and in more situation specific appraisals of cognitive load on midterm exam, BCH approach was used in the last step of LPA. The results showed that, in line with our hypothesis, the success-oriented students were indeed grittier, reporting more consistent interests and higher perseverance of effort. In the present study, no differences were found between indifferent and work-avoidant profiles in terms of grit. Pulkka and Niemivirta (2013) found a similar dominance of success-oriented university students over work-avoidant students (but not over indifferent or mastery-oriented students) in terms of perceived effort and attainment during the course. However, no differences were found between the profiles in reported participation. The same authors partially replicated these findings in the subsequent study (Pulkka & Niemivirta, 2015), showing that the success-oriented group performed significantly better than the avoidance-oriented group in terms of reported effort and attainment. In addition, they found that the success-oriented students reported higher levels of participation in the course. To conclude, the findings indicate that the success-oriented students who strive to achieve both mastery but also academic success, especially in terms of absolute standards, demonstrate greater perseverance and more consistent interests,

which may facilitate the accomplishment of their goals. In contrast, the indifferent and work-avoidant students invest less effort when facing obstacles and exhibit less stable interests.

In the present study, we aimed to explore how these general motivational patterns are manifested in more situation-specific appraisals of students' perceived cognitive load during an exam. As elaborated earlier, GCL seems to be constrained not only by working memory capacity and the nature of the task, but also by the learner's motivation (Schnotz et al., 2009). Indeed, our findings indicate that the success-oriented students not only showed higher levels of grit in general, but they were more prone to invest effort during knowledge assessment situation. Although we expected the (mastery and) success-oriented students would also differ from indifferent and work-avoidant profiles in terms of intrinsic and extrinsic cognitive load, given their tendency to master the material more thoroughly and therefore perceive exam as less complex and more comprehensible, that result was not observed.

All three achievement goal profiles perceived moderate levels of ICL and low levels of ECL, suggesting they perceived exams as moderately complex and appropriately designed, mostly without irrelevant information. Since the students across different goal orientation groups reported similar levels of ICL and ECL, it can be concluded that differences in germane load do not stem primarily from task characteristics (i.e., ICL and ECL) but rather are driven by the students' willingness to utilise their available mental resources. That aligns with assumptions of Schnotz at al. (2009), which suggest that GCL depends on general learning orientations, as well as affective and motivational aspects, since learners determine how much effort they invest in learning or solving a task. Low levels of perceived ECL suggest that sufficient working memory capacity was available to invest into germane processing, yet students were differently inclined to do so.

While reducing ECL to a minimum is proposed as the most effective way to maximise students' germane effort (e.g., Wang & Lajoie, 2023), our findings indicate that motivational tendencies also play a significant role, as students' achievement goal orientations shape their decision to invest effort. A recent study (Wang et al., 2023) identified distinct cognitive load patterns based on the students' perceived intrinsic, extraneous, and germane load, using person-centred approach. Their findings indicate that different combinations of cognitive load types can be recognised, and that those patterns are linked to temporal dynamics of self-regulated learning. Future research should further investigate possible combinations of cognitive load types and their relationships with motivation and self-regulated learning, contributing to the ongoing research trend of integrating cognitive load theory with self-regulated learning (e.g., Seufert, 2020).

Limitations of the Study

Several limitations should be acknowledged that might affect the findings obtained in the present study. The most significant issue concerns the fact that the students were recruited from different study programmes and years of study, leading to variability in midterm exam content and difficulty. Although measures of ICL and ECL demonstrated metric invariance across the student groups, future studies should employ larger and more homogeneous samples. This would allow for a more rigorous assessment of the relations between cognitive load types and motivation. The second issue is related to participant attrition. Almost a quarter of the sample was not present at both measurement points, which impacts the robustness of the findings. Also, the present study brings attention to the need for more precise conceptualisation of cognitive load, as the construct is interpreted in various ways in the literature (see Orru & Longo, 2019; Seufert, 2020; Sweller et al., 2019). Our data could not replicate the original three-factor structure, and thus our findings concerning GCL rely on a single-item measure. Although it is not uncommon to use single-item measures in cognitive load assessment (Schuessler et al., 2025), conclusions drawn from them should be interpreted with caution. Additionally, it would be beneficial to include not only self-reported measures of cognitive load but more objective measures such physiological or eye-tracking techniques. However, such

measures are difficult to implement in natural educational settings, and additional research is needed to evaluate these techniques as valid measures of cognitive load (Sweller et al., 2019).

Despite the limitations, the present study underscores the importance of further investigating the relationships between motivational aspects, such as achievement goal orientations and persistence, and cognitive load, thereby integrating different research traditions.

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