

Undergraduates' Self-regulated Learning at the Workplace: State, Trait, or Development?

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Author contributions⁴

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Ethics

Disclaimer: Views are our own and not an official position of institution.

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Ethical aspects: The study was submitted to the Ethics Committee of the Medical University of Vienna. This committee makes decisions on studies involving human subjects at the University of Veterinary Medicine in Vienna. The decision was that no ethical approval was required according to the Declaration of Helsinki. The following ethical standards were met. Participation in the study was completely voluntary. Written consent was obtained for participation in the study and for the use of the data. Participants were assured that their responses would remain confidential and would only be used for scientific purposes. Complete anonymity was ensured by not publishing any data that would allow conclusions to be drawn about the identity of the respondents. Moreover, the study was approved and supported by the project steering committee, including the Vice-Rector for Study Affairs and Clinical Veterinary Medicine.

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⁵ *Abbreviations:*

autoregressive trait (AR); Markov Chain Monte Carlo (MCMC); stable trait (ST); time-varying state (TS); self-regulated learning (SRL).

Abstract

Health sciences students often encounter challenges when they begin learning in the workplace. To determine the most effective intervention, a thorough understanding of the stability and variability of self-regulated learning (SRL) is necessary. This study analyzed the stable trait, autoregressive trait, and time-varying state components of SRL in the workplace.

The sample comprised 188 undergraduates rotating weekly between various workplaces. They completed a diary on 37 aspects of SRL for ten weeks. Data were analyzed using STARTS models.

The aggregate results showed that 28% of the total variance in SRL was accounted for by the stable trait, 22% by the autoregressive trait, and 50% by the time-varying state component. These component ratios vary across SRL areas and levels.

To enhance students' SRL, focusing on situation-specific supportive framework conditions while acknowledging individual differences and considering phase-specific interventions is recommended. Further research needs to investigate other rotational intervals and subject areas.

Keywords: self-regulated learning; diary; trait; state; STARTS model.

Educational Relevance and Implications Statement

Students' self-regulated learning in the workplace is primarily dependent on the situation, but also on previous experience and stable traits. This study contributes to the debate on stability and variability of self-regulated learning. Higher education institutions should support students self-regulated learning in the workplace by providing the right conditions and support at the right time, but also by considering individual differences.

Introduction

Self-regulated learning refers to a learner's ability to establish goals and regulate their cognition, motivation/affect, behavior, and context to achieve those goals (Pintrich, 2004). Students must be self-regulated learners not only in academic and classroom-based settings but also in the workplace when facing real-life situations. This is particularly true for health sciences students, who usually complete a practical year or semester during their studies (van Houten-Schat et al., 2018). The transition from academic to workplace learning is a crucial phase that students often perceive as challenging and stressful (Atherley et al., 2019; Godefrooij et al., 2010; Westerman & Teunissen, 2013). Therefore, students need support in self-regulated learning (SRL) to successfully transition from academic to workplace settings (Westerman & Teunissen, 2013).

To further develop theoretical models for SRL in the workplace and to design efficient and effective support for first-time workplace learners, it is essential to gain a deeper understanding of SRL dynamics. If SRL is stable over time (a trait), struggling learners require intensive training. If SRL varies between situations (states), the focus should be on creating supportive learning environments and training students to adapt to their learning. If SRL is characterized by development over time and previous experience (developmental component), training elements specific to the respective transition stages should be provided. If SRL comprises all three components (trait, state, and development) a combination of training elements is required. This study investigated the dynamics of SRL aspects by analyzing the corresponding ratios of trait, state, and developmental components in the context of health sciences students' workplace learning.

1.1. Self-regulated learning in the workplace

SRL has been included in the research on undergraduate medical students' workplace learning. In a systematic review of studies on SRL in the clinical context, van Houten-Schat

et al. (2018) concluded that SRL theory could add to our understanding of medical students' learning in the workplace, but previous studies were not sufficiently grounded in theory. Notably, theories from the academic context cannot simply be transferred to the work environment because learning in the workplace differs in many aspects from learning in an academic context. We focused on the most significant aspects:

Workplace learning extends from knowledge to competency acquisition (Cleary et al., 2013). Competencies include not only a cognitive aspect (knowledge) but also a practical aspect (skills, doing, and applying; Bergsmann et al., 2015). Further, students must not only focus on their learning goals but also provide healthcare to patients. This creates greater complexity in practical clinical settings than in academic settings (Berkhout et al., 2017; van Houten-Schat et al., 2018). Additionally, students often have a higher degree of autonomy in academic settings such as choosing learning strategies, than in practical clinical settings where adherence to standard clinical procedures is required (Westerman & Teunissen, 2013). Therefore, success in SRL in academic settings does not guarantee success in clinical practice, and students are usually unprepared to become self-regulated learners in practical clinical settings (Poncelet & O'Brien, 2008; Westerman & Teunissen, 2013).

SRL theory has continuously evolved (Panadero, 2017) since researchers began to distinguish between SRL and metacognition (e.g., Pintrich et al., 1993; Zimmerman, 1986). In addition to cognition/metacognition different areas were integrated, such as motivation (Pintrich, 2000, 2004), emotion (e.g., Ben-Eliyahu, 2019; Boekaerts, 1996; Efklides, 2011), and context (e.g., Pintrich, 2004). Ideal learners implement a suitable learning process; they implement appropriate learning strategies to achieve learning goals (cognition), are motivated (motivation), feel positive about their learning (emotion), and perceive the learning environment as supportive (context). However, ideal learners also step out of the learning process and—from a metalevel—monitor cognition, motivation, emotion, and context at the

learning process level and compare their progress with the goal to be achieved. When encountering obstacles, students control and regulate the respective aspects of the learning process (Ben-Eliyahu, 2019; Pintrich, 2004; Wolters, 2003). Hence, based on previous work on the different levels of SRL (Boekaerts, 1996; Nelson & Narens, 1990; Wirth et al., 2020), the four areas (cognition, motivation, emotion, and context) were identified at two levels—the learning process level and the metalevel—resulting in eight parts. This model is proposed as a conceptual framework for undergraduate SRL in the workplace [blinded for review, 2023]. In a six-step process, including methods such as literature review, interviews, and expert review (Gehlbach & Brinkworth, 2011), they separately identified the most relevant aspects for health sciences undergraduates learning at the workplace for each of the eight parts (see Figure 1 for an overview). Definitions of the different parts and aspects are included in the Supplementary Material (Table 1). For details on the conceptual model, its areas and levels, and the process of defining relevant aspects of undergraduate SRL in the workplace, we refer the interested reader to [blinded for review, 2023].

Figure 1

Figure 1 shows different parts and aspects of self-regulated learning at the workplace per level and area.

Metalevel	Cognition metalevel	Motivation metalevel	Emotion metalevel	Context metalevel
	<ul style="list-style-type: none"> • Monitoring • Control 	<ul style="list-style-type: none"> • Monitoring • Control 	<ul style="list-style-type: none"> • Monitoring • Control 	<ul style="list-style-type: none"> • Monitoring • Control

Learning process level	Cognition	Motivation	Emotion	Context
	Cognitive learning strategies <ul style="list-style-type: none"> • Preparation • Attention • Rehearsal • Elaboration • Clarification • Consolidation Proximal metacognitive learning strategies <ul style="list-style-type: none"> • Planning • Reviewing • Reflection 	<ul style="list-style-type: none"> • Expectancy of success • Situational interest • Mastery goal approach • Performance goal approach • Effort • Attention control • Proactive attitude 	<ul style="list-style-type: none"> • Proud • Happy • Hopeful • Curious • Anxious • Frustrated • Angry • Sad 	<ul style="list-style-type: none"> • Organisational framework conditions • Supervisory quality • Staff support • Peer support • Equal treatment

1.2. Trait, state and the developmental component

Analyzing SRL dynamics relates to the discourse on the stability of psychological constructs (Geiser et al., 2017; Hong, 1998). The stability perspective is referred to as the trait, and the variability perspective as the state. A trait is viewed as an individual characteristic that is less prone to change, whereas a state fluctuates based on physical or social context. There are many trait and state measures of various psychological constructs (e.g., individual and situational interests). Sometimes, the scales for the trait and state of one psychological construct share identical items, differing only in their time-related references; for instance, “generally” for a trait scale and “today” for a state scale (e.g., Bürger & Schmitt, 2017).

In SRL research, the trait component is referred to as an aptitude-like SRL and the state component is referred to as an event-like SRL (Winne, 1997; Zheng et al., 2023). Beyond the trait and state components, the concept of SRL as a cyclical process suggests a developmental component in which one SRL cycle may influence the next (Perels et al., 2007). For example, this occurs when learners’ motivational experiences during Cycle A impact their motivation and strategy selection in Cycle B. Hence, this component informs us about changes in individual aspects that can be explained by previous experiences. Statistically, the developmental component is known as an autoregressive component or autoregressive trait, unlike stable traits (Kenny & Zautra, 2001).

Existing literature indicates that SRL comprises three components: trait, state and development. Studies have been conducted on SRL types related to stable trait components (Dörrenbacher & Perels, 2015; Woods et al., 2011). Second, studies exist on the external factors that influence students’ SRL, which are related to state components (Berkhout et al., 2018; Cho et al., 2017b; Jouhari et al., 2015; Sawatsky et al., 2018; van Houten-Schat et al., 2018). Third, there are SRL theories concerning the cyclical nature of SRL (e.g., Zimmerman, 2008) and the theory of transition stages (Nicholson, 1990), as well as intervention studies

that aim to foster SRL (Dignath & Büttner, 2008; Dörrenbächer & Perels, 2016a, 2016b; Theobald, 2021), which are related to the developmental component. To date, no study has investigated the proportions of state, trait, and developmental components of SRL. However, there are theoretical considerations and empirical evidence related to the variability and stability of different aspects of SRL in the workplace. These results are summarized in the Supplementary Material.

There are various methods for measuring SRL (Roth et al., 2016). Diaries are suitable for assessing the dynamics of psychological constructs, capturing not only states but also stable traits and developmental components (autoregressive traits; Perels et al., 2007; Schmitz et al., 2011). Further information on the diary method is provided in the Supplementary Material.

1.3. Aims and expectations

Our goal was to analyze the proportion of trait, state, and developmental components of SRL in the workplace. Based on the conceptual framework for undergraduates' SRL at the workplace, which distinguishes between several parts of SRL (cognition, motivation, emotion, context at the learning process level, and the metalevel) and, more specifically, between aspects of SRL (e.g., the motivational aspect 'expectancy of success'), we considered three different levels of abstraction: (1) SRL as a whole (high level of abstraction); (2) different parts of SRL (medium level of abstraction); and (3) individual SRL aspects (low level of abstraction).

We expect all three components—state, trait, and development—to be relevant to SRL because, as outlined above, theoretical considerations and previous studies have indicated that SRL comprises all three components. Previous studies on the dynamics of SRL parts or aspects used different analytical approaches and did not show a clear picture of the size of the three components (Supplementary Material). However, we expected the state component

ratio to be large ($> 40\%$) because undergraduate medical students rotate between workplaces and are exposed to various learning environments, situations, and tasks (Berkhout et al., 2018; Cho et al., 2017b; Jouhari et al., 2015; Sawatsky et al., 2018; van Houten-Schat et al., 2018). Further, we expected the trait component ratio to be substantial ($> 10\%$) because previous studies have shown a substantial stability coefficient for SRL aspects and a relationship between SRL aspects and personality (Dörrenbacher & Perels, 2015; Woods et al., 2011). Finally, we also expected the developmental component to be substantial ($> 10\%$) because of the cyclical nature of SRL (Perels et al., 2007) and the transitional stage of undergraduates (Nicholson, 1990) who gained considerable experience during this time.

To address our research questions, we conducted a 10-week diary study comprising daily and weekly items. Questionnaires were administered daily to undergraduate students in their workplaces.

2. Methods

2.1. Participants

We aimed to include a diverse range of students with varying levels of cognition, motivation, and emotions who learned in heterogeneous workplace settings. The diary was distributed to all veterinary medicine students enrolled in a course at a single higher education institution, where they had learned for the first time in a practical clinical setting over an extended period. Typically, this course is conducted in the ninth out of 12 semesters. Participants were divided into groups of eight. Each week, each group was rotated to a different work placement with diverse personnel, subject areas, and learning objectives. Workplace placements covered companion animals and equine medicine, including topics such as anesthesia, imaging diagnostics, surgery, reproduction, internal medicine, and emergency medicine: livestock, including topics similar to ruminants, pigs, poultry, fish and pathology.

In the oversight of clinical professionals, students are entrusted with the compilation of patient histories, execution of partial or complete clinical examinations, and laboratory analyses. They engage in an array of therapeutic interventions encompassing basic surgical procedures and subsequent postoperative management. Within the domain of herd health, students contribute to the veterinary care of herd animals in addition to delivering veterinary services to agricultural enterprises. Data were collected from 15 workplaces. Some groups had a break of five weeks between weeks five and six. Three students did not provide consent for the use of their data for research purposes. One participant was excluded from further analysis because of a high proportion of missing values (>50%), resulting in a sample size of 188 (80.32% female, 15.43% male, 0% diverse; 4.25% no response; age: 21 – 39 years; $M = 24.60$, $SD = 2.92$). The gender representation was typical of veterinary medicine students (Association of American Veterinary Medical Colleges, 2020).

2.2. Measures

We incorporated all pertinent constructs for workplace learning from the [name of the instrument deleted to maintain the integrity of the review process, 2023] and used single items derived from this instrument (29 items) and the Medical Emotion Scale (8 items) (Duffy et al., 2018; [blinded for review, 2023]). Details of the analysis of the psychometric properties of the single items are included in the Supplementary Material.

Single items representing cognitive aspects were administered daily (daily items). The other single items, representing aspects of motivation, emotion, context at the learning process level, and monitoring and control at the metalevel, were administered weekly at the end of the week, except for expectancy of success, which was administered at the beginning of the

week (weekly items).⁶ Please find a list of aspects, definitions, single-items and response formats in the Supplementary Material (Table 1).

2.3. Procedure

To prevent student dropouts and overburdening, we addressed three implementation drivers (Fixsen et al., 2009). First, we secured support from decision-makers at each organizational level and from student representatives (leadership drivers). Second, a diary was implemented as an integral part of the course to achieve the course-learning goal of reflecting on one's own learning and practices. The diary was included as part of the daily tasks, and teachers allocated time in the workplace for students to complete the diary (organizational driver). Third, we selected and trained students and teachers to serve as contacts and ensure effective communication between students, teachers, and the project team (competency driver). Finally, before collecting the data, all affected students and teachers were notified through informational events and written materials about the learning objectives of the course, questionnaires, the study, and the utilization of the data.

Participants completed the diary over 10 weeks (50 days) at a workplace in the winter semester of 2021/22 via the online survey tool unipark© (EFS Survey, 2022). To improve response rates, participants who did not complete their diaries were sent reminders on the same day. Moreover, the project team reached out to student representatives to identify the reasons for missing data and to help solve the problems. To enhance students' motivation and ensure high-quality data, we implemented several measures (e.g., communicating the significance of reflecting on one's own learning and practice for educational success and lifelong learning, weekly contact with student representatives, individualized reports for students, social gatherings, and vouchers).

⁶ This study was part of a larger project and included additional measures such as one daily item on stress and one weekly item on stress and additional questions at the end of weeks 1, 5, and 10.

2.4. Data Analysis

The data comprise daily and weekly measurements. Daily measures were aggregated into weekly measures by calculating their weekly mean. The STARTS model (Kenny & Zautra, 1995, 2001) was estimated for each aspect of self-regulated workplace learning to determine the proportion of stable trait (ST), autoregressive trait (AR), and time-varying state (TS).

More specifically, the model decomposes the variance of an aspect of self-regulated workplace learning into three components: (1) stable trait variance, which is the amount of variance in repeated measurements that is completely stable; (2) autoregressive trait variance, which is the amount of variance that is enduring and changes over time; and (3) state variance, which is the amount of variance that is unique to each measurement occasion. Note that this unique variance is confounded by measurement errors, which can lead to an overestimated state variance. In addition, the autoregressive coefficient indicates the rank-order stability of autoregressive trait variance across time.

A Bayesian approach based on the Markov Chain Monte Carlo (MCMC) algorithm was used to estimate all model parameters (R version 4.3.1; R Core Team, 2023) using the STARTS package version 1.3-8 (Robitzsch & Lüdtke, 2022). Weakly informative prior distributions for all the model parameters were specified according to the default settings of the STARTS package (Lüdtke et al., 2018). A total of 30,000 iterations with a burn-in phase of 10,000 iterations were requested. The potential scale reduction factor \hat{R} was inspected for each parameter to ensure convergence of the MCMC algorithm, where a $\hat{R} < 1.05$ indicates convergence. To obtain an overview of the different ratios for SRL as a whole and for the different SRL parts, we pooled the results of the respective aspects (based on Jansen et al., 2020).

Further, we conducted a preliminary analysis to investigate whether differences existed in the proportions of stable trait, autoregressive trait, and time-varying states between daily

measures aggregated into one manifest weekly measure and a single weekly measure (see Breil et al., 2022 for a discussion on aggregated state measures vs. global measures). We refer the interested reader to the Supplementary Material.

3. Results

For better comprehensibility, the results for each SRL aspect (low level of abstraction; Aim 3) are first presented. Thereafter, the results of SRL were aggregated as a whole and per SRL part (high and medium levels of abstraction; Aims 1 and 2). Descriptive statistics are included in the Supplementary Material (Table 3).

3.1. Trait, state and autoregressive component of SRL aspects.

We estimated the STARTS model separately for each SRL aspect. For almost all aspects of SRL, all three variance components (stable trait, autoregressive trait, and state variance) were substantial. State variance accounted for 38% to 71% of the total variance, stable trait variance accounted for 18% to 42% of the total variance and autoregressive trait ratio accounted for 13% to 38% of the total variance. Table 1 summarizes results shown in Figure 2.

Table 1**STARTS Model: Results for SRL Parts and SRL Aspects**

		Variance components									AR coefficient		
		Trait			AR			State					
SRL Part	SRL Aspect	Est.	95% CI		Est.	95% CI		Est.	95% CI		Est.	95% CI	
			Low	Upp		Low	Upp		Low	Upp		Low	Upp
Cognition													
Cognitive learning strategies	Preparation	0.274	0.209	0.341	0.133	0.074	0.475	0.580	0.245	0.673	0.151	0.046	0.827
	Attention	0.365	0.150	0.444	0.225	0.150	0.392	0.439	0.311	0.510	0.863	0.364	0.929
	Rehearsal	0.403	0.246	0.466	0.192	0.118	0.336	0.431	0.256	0.513	0.463	0.219	0.906
	Elaboration	0.395	0.219	0.481	0.200	0.141	0.348	0.410	0.295	0.476	0.750	0.378	0.909
	Clarification	0.248	0.110	0.386	0.301	0.198	0.465	0.437	0.371	0.489	0.892	0.707	0.933
	Consolidation	0.240	0.096	0.337	0.223	0.123	0.364	0.547	0.482	0.614	0.888	0.555	0.936
Proximal metacognitive learning strategies	Planning	0.375	0.301	0.439	0.182	0.111	0.406	0.438	0.208	0.530	0.369	0.174	0.757
	Reviewing	0.314	0.119	0.440	0.286	0.198	0.501	0.375	0.325	0.440	0.887	0.681	0.935
	Reflection	0.303	0.103	0.434	0.283	0.177	0.490	0.406	0.347	0.467	0.905	0.656	0.942
Motivation													
	Expectancy of success	0.191	0.105	0.245	0.128	0.073	0.501	0.698	0.297	0.765	0.119	0.037	0.905
	Situational interest	0.183	0.109	0.254	0.172	0.100	0.587	0.652	0.200	0.723	0.633	0.099	0.848
	Mastery approach	0.191	0.093	0.275	0.303	0.218	0.420	0.510	0.402	0.582	0.749	0.495	0.847
	Performance approach	0.340	0.210	0.417	0.179	0.111	0.370	0.497	0.277	0.561	0.655	0.206	0.891
	Effort	0.240	0.112	0.334	0.140	0.088	0.329	0.614	0.384	0.679	0.888	0.106	0.946
	Attention control	0.310	0.177	0.372	0.125	0.066	0.520	0.587	0.165	0.667	0.117	0.034	0.950
	Proactive attitude	0.242	0.121	0.314	0.224	0.128	0.364	0.581	0.380	0.646	0.686	0.248	0.887
Emotion													

Positive emotion	Proud	0.259	0.202	0.320	0.251	0.116	0.593	0.457	0.148	0.635	0.153	0.066	0.493
	Happy	0.258	0.191	0.319	0.265	0.120	0.577	0.479	0.166	0.638	0.216	0.105	0.702
	Hopeful	0.275	0.183	0.340	0.233	0.150	0.566	0.501	0.147	0.603	0.275	0.158	0.823
	Curious	0.314	0.162	0.384	0.178	0.102	0.398	0.531	0.262	0.611	0.632	0.146	0.919
Negative emotion	Anxious	0.358	0.176	0.431	0.195	0.118	0.394	0.477	0.225	0.551	0.693	0.205	0.914
	Frustrated	0.187	0.086	0.274	0.256	0.172	0.370	0.552	0.458	0.627	0.795	0.506	0.880
	Annoyed	0.210	0.094	0.291	0.154	0.089	0.278	0.644	0.533	0.705	0.862	0.243	0.930
	Sad	0.294	0.166	0.365	0.206	0.131	0.389	0.509	0.296	0.592	0.595	0.215	0.855
Context	Organizational framework conditions	0.200	0.112	0.265	0.144	0.085	0.488	0.661	0.292	0.731	0.415	0.109	0.887
	Supervisory quality	0.183	0.118	0.239	0.117	0.068	0.443	0.705	0.360	0.774	0.136	0.031	0.874
	Staff support	0.250	0.146	0.305	0.114	0.068	0.488	0.637	0.252	0.723	0.095	0.021	0.941
	Peer support	0.274	0.189	0.349	0.306	0.204	0.518	0.413	0.193	0.534	0.480	0.250	0.762
	Equal treatment	0.205	0.128	0.263	0.378	0.268	0.587	0.429	0.192	0.541	0.504	0.281	0.705
Metalevel cognition	Cognition monitoring	0.269	0.098	0.392	0.299	0.200	0.473	0.432	0.358	0.490	0.871	0.641	0.921
	Cognition control	0.372	0.183	0.458	0.200	0.109	0.408	0.454	0.231	0.538	0.806	0.211	0.914
Metalevel motivation	Motivation monitoring	0.250	0.083	0.370	0.294	0.193	0.479	0.444	0.384	0.505	0.885	0.721	0.933
	Motivation control	0.422	0.126	0.507	0.206	0.124	0.479	0.389	0.272	0.464	0.890	0.365	0.947
Metalevel emotion	Emotion monitoring	0.358	0.106	0.467	0.186	0.104	0.441	0.450	0.386	0.511	0.933	0.646	0.962
	Emotion control	0.339	0.108	0.456	0.242	0.118	0.449	0.446	0.343	0.523	0.890	0.440	0.945
Metalevel context	Context monitoring	0.256	0.084	0.354	0.291	0.177	0.438	0.480	0.417	0.544	0.881	0.666	0.926
	Context control	0.345	0.164	0.421	0.129	0.070	0.471	0.552	0.169	0.625	0.839	0.053	0.946

Note. 95% CI = 95% Bayesian credible interval.

Figure 2a

Stable trait, autoregressive trait (AR), and state components of SRL aspects.

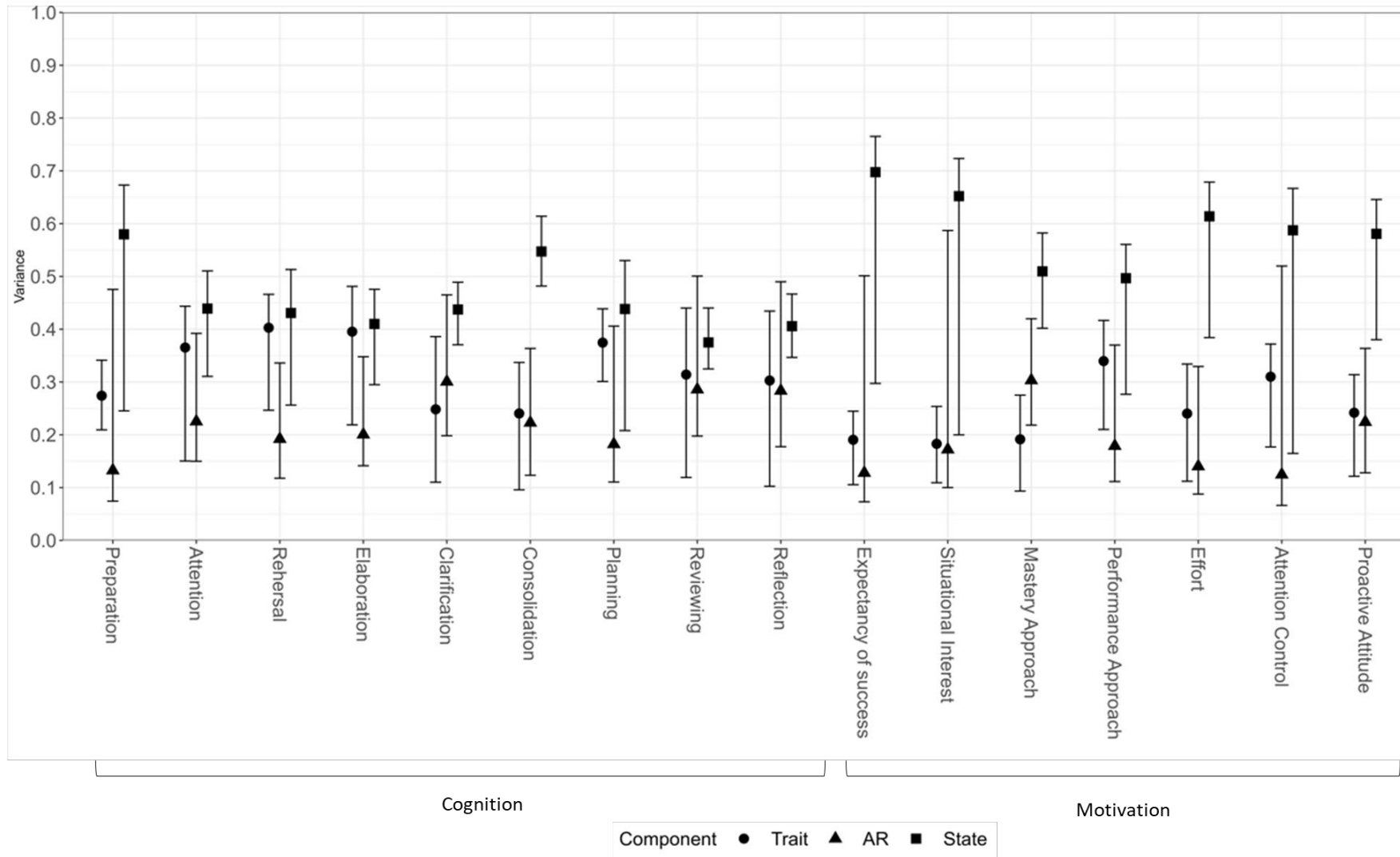


Figure 2b

Stable trait, autoregressive trait (AR), and state components of SRL aspects.

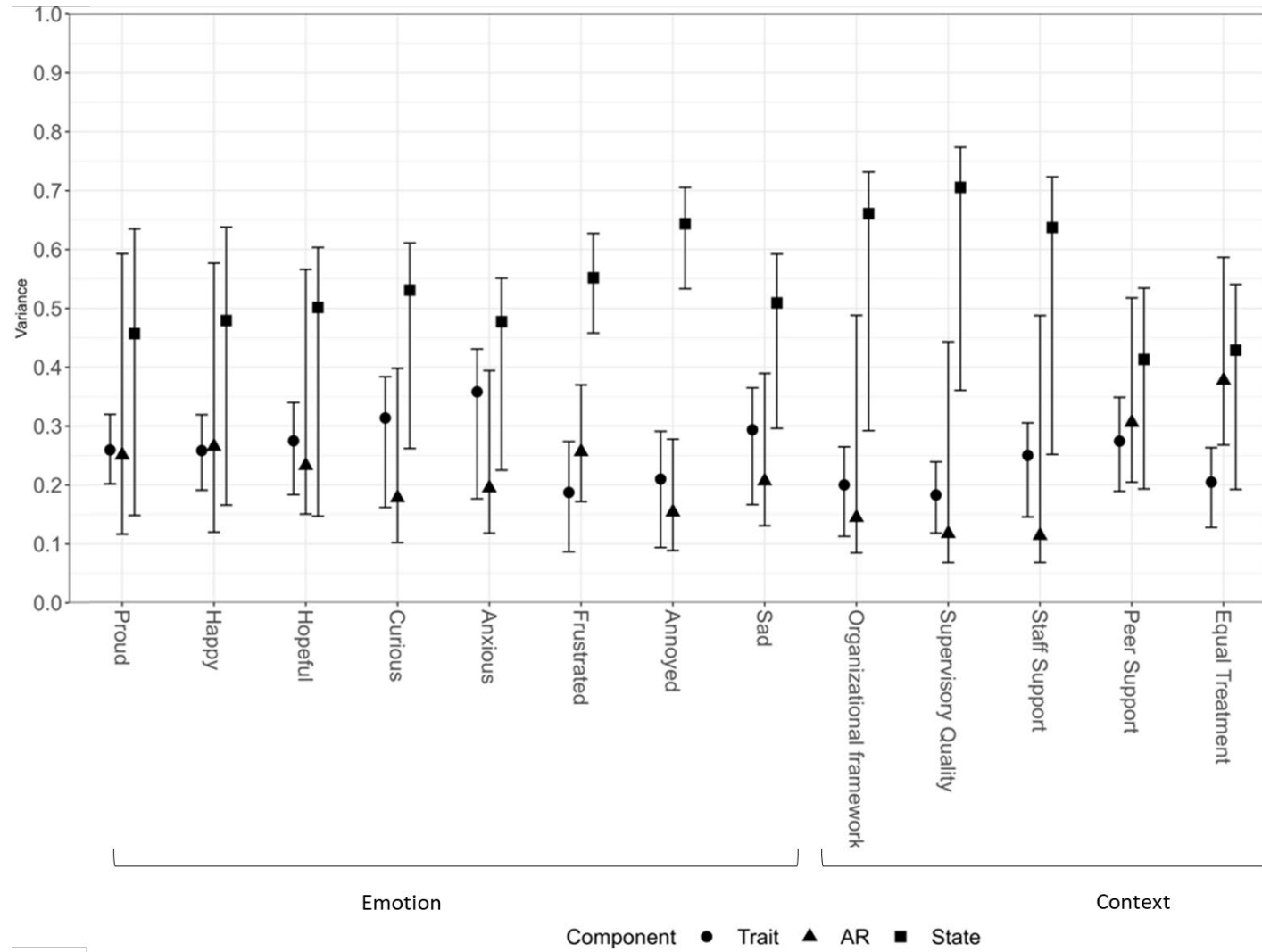
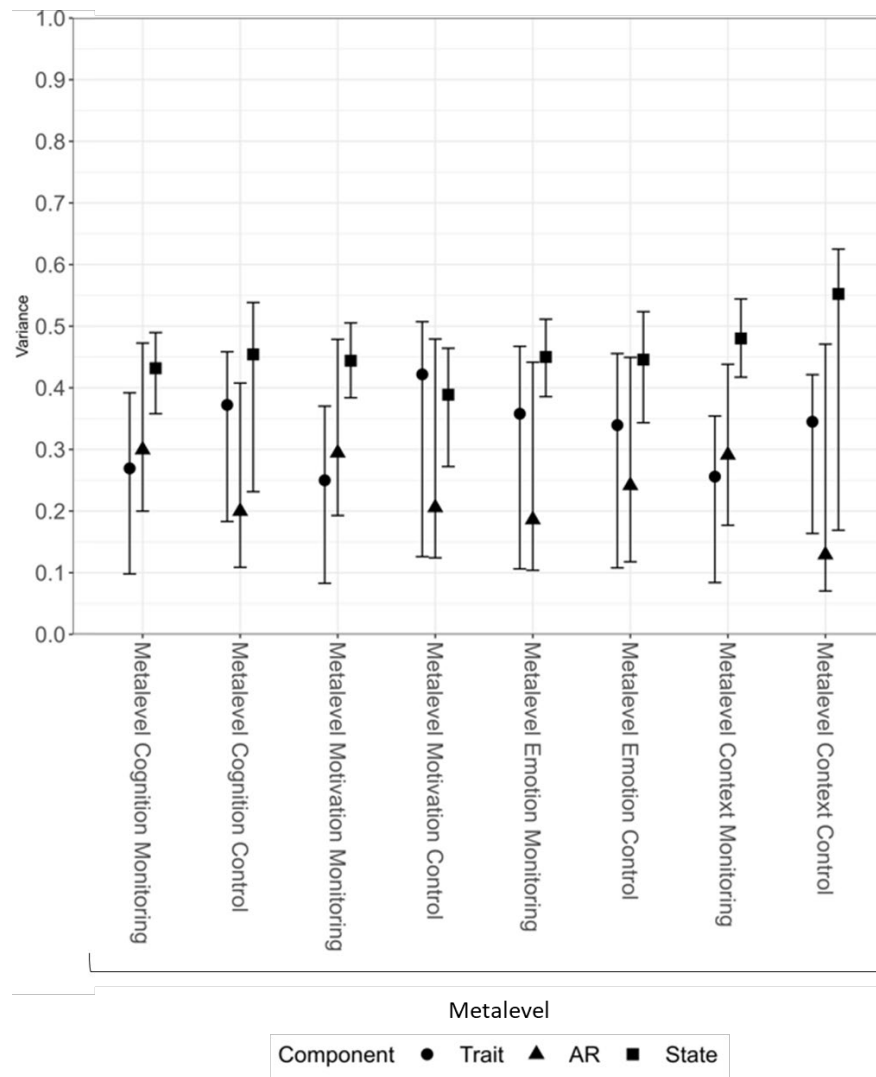


Figure 2c

Stable trait, autoregressive trait (AR), and state components of SRL aspects.



3.2. Aggregated results for SRL and SRL parts

The aggregated results for SRL and different SRL parts are presented in Table 2 and Figure 3.

The results for SRL as a whole showed that the state variance component accounted for 50% of the total variance, a stable trait variance of 28% and an autoregressive trait of 22%.

Table 2

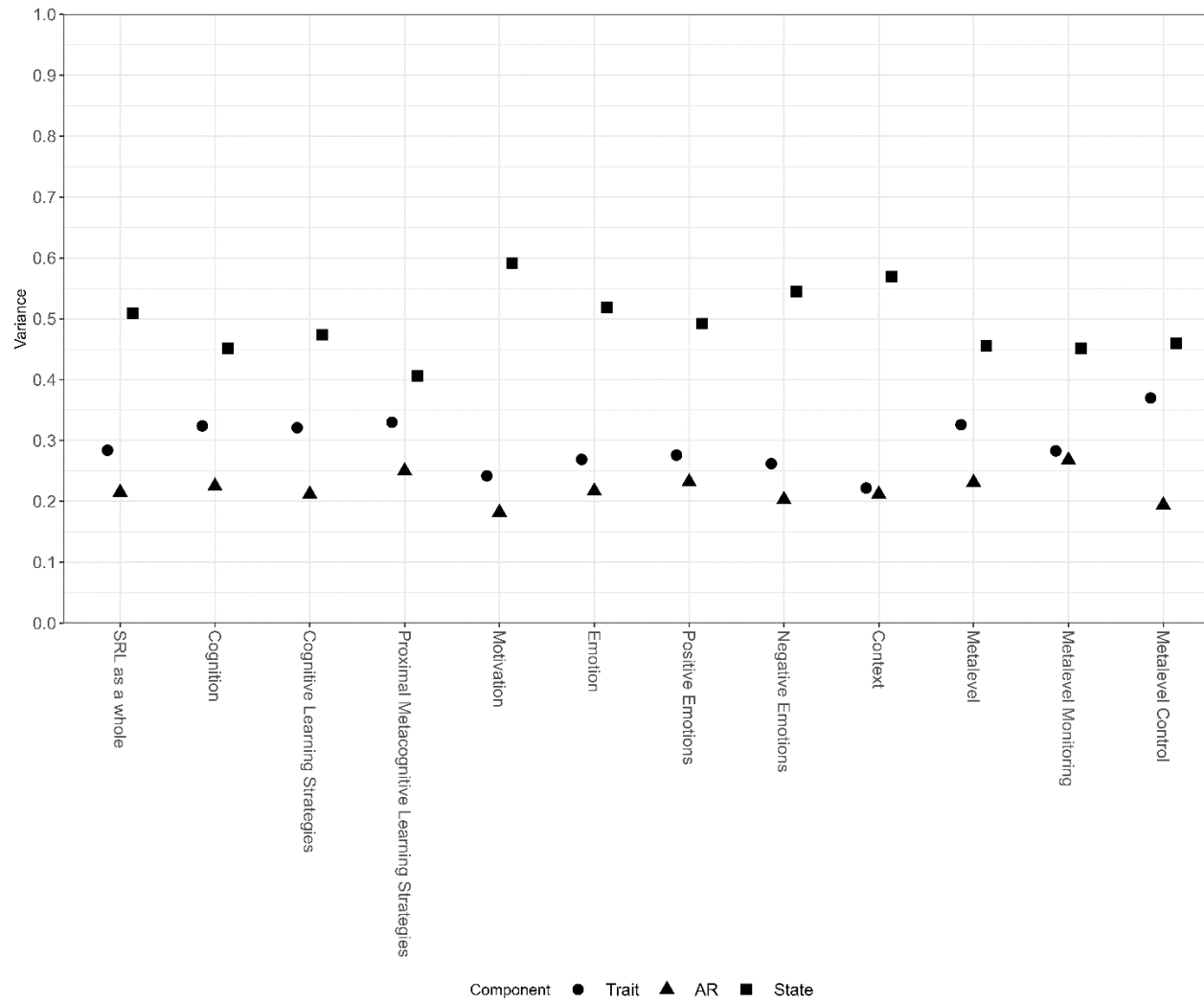
STARTS Model: Aggregated Results for SRL as a Whole and SRL Parts

SRL / SRL Parts	Variance components			AR coefficient
	Trait	AR	State	
SRL as a whole	0.284	0.215	0.509	0.618
Cognition	0.324	0.225	0.451	0.685
Cognitive learning strategies	0.321	0.212	0.474	0.668
Proximal metacognitive learning strategies	0.330	0.250	0.406	0.720
Motivation	0.242	0.182	0.591	0.550
Emotion	0.269	0.217	0.519	0.528
Positive emotion	0.276	0.232	0.492	0.319
Negative emotion	0.262	0.203	0.545	0.736
Context	0.222	0.212	0.569	0.326
Metalevel	0.326	0.231	0.456	0.874
Metalevel monitoring	0.283	0.268	0.451	0.893
Metalevel control	0.370	0.194	0.460	0.856

Note. The estimates were combined across SRL aspects by computing the average across individual estimates.

Figure 3

Stable trait, autoregressive trait (AR), and state components of SRL as a whole, SRL parts and SRL sub-parts.



4. Discussion

Health sciences students must exhibit SRL in both academic and workplace settings.

However, they face difficulties during this transition and require support. This study analyzed SRL dynamics to provide a solid foundation for further research and the development of effective interventions. STARTS models were used to distinguish between stable traits, autoregressive traits, and time-varying states, based on an analysis of 37 SRL aspects. The findings suggest that the state variance component is generally large ($> 38\%$), and the stable trait and developmental (autoregressive trait) variance components are substantial ($> 18\%$ and $> 13\%$, respectively). Consequently, future research and interventions should address the state component and prioritize supportive framework conditions to promote SRL in the workplace. In addition, it is crucial to identify and assist struggling students, addressing the stable trait component. Further, incorporating course elements to prepare and supervise students for SRL in the workplace is recommended, addressing the developmental component.

4.1. Trait, state, and developmental components

The results indicated that the SRL of first-time workplace learners includes three components: trait, state, and development. We discuss the component ratios (1) aggregated for SRL as a whole and (2) aggregated for various SRL parts, including cognition, motivation, emotion, and context, in the learning process level and metalevel. A discussion of the (3) sub-parts and individual aspects of SRL can be found in the Supplementary Material.

The components of SRL as a whole. The state component explained 50% of SRL variance based on the aggregated results of the individual aspects. Consequently, SRL in the workplace appears to be highly dependent on situation and framework conditions. This finding aligns with existing literature concerning external factors affecting students' SRL in the workplace (Berkhout et al., 2018; Cho et al., 2017a; Jouhari et al., 2015; Sawatsky et al., 2018; van Houten-Schat et al., 2018). These results are consistent with the literature on event-

like SRL (Cleary & Callan, 2018; Greene et al., 2018; Schmitz et al., 2011) and support the notion that specific self-aspects are more likely to change (Jansen et al., 2020; Shavelson et al., 1976). It should be considered that this study may have overemphasized the state component of motivational, emotional, contextual, and metalevel aspects owing to the weekly single items (and as indicated by the preliminary analysis) and confusion between the state component and measurement error in STARTS models with manifest variables (Wagner et al., 2016). Future research should apply a multiple-item approach instead of a single-item approach to estimate trait–state–occasion models instead of the STARTS model to separate measurement errors from occasion-specific variance.

The trait component accounted for 28% of the variance, suggesting a stable and unchanging SRL component among first-time workplace learners. This can be attributed to two factors. Personality characteristics may be related to genetic factors, causing individual differences (Jansen et al., 2020). Hence, various types of students may exhibit distinct SRL patterns in the workplace. Second, the findings can be attributed to consistent workplace demands, even though the students rotated their workplaces weekly. The trait component results align with the existing literature on SRL profiles and the stability of SRL aspects (Berkhout et al., 2017; Bidjerano & Dai, 2007; Dörrenbächer & Perels, 2016b; Woods et al., 2011) and add to the debate on trait-like SRL assessments (Wolters & Won, 2018). This finding is consistent with previous research on academic self-concept, in which 26% of the total variance was attributed to a stable trait component (Jansen et al., 2020).

The developmental component accounted for 22% of the total variance, suggesting that a significant proportion of SRL among first-time workplace learners could be ascribed to prior SRL experience in the course. This aligns with the literature on SRL's cyclical nature (e.g., Cleary et al., 2012; Zimmerman, 2008) and transition theory (Nicholson, 1990). From a theoretical perspective, it can be assumed that students gain valuable experience, adapt to the

workplace context, and refine their SRL while learning for the first time in a workplace setting. Notably, participants switched between various workplaces weekly. Further research is required to investigate whether developmental components are higher in more stable workplace environments.

Components of SRL parts. A more refined examination of the various parts of SRL presents a more nuanced perspective. While the stable trait proportion was over 30% for cognition at the learning process level and for the metalevel, it was below 30% for motivation, emotion, and context at the learning process level. In contrast, while the state proportion was below 50% for cognition at the learning process level and for the metalevel, it was over 50% for motivation, emotion and context at the learning process level. Two possible explanations for this finding emerge. First, the stable trait component of cognition and the metalevel may arise from related strategies that could be equally important in different workplace settings. This is accurate for cognitive learning strategies such as attention, rehearsal, and elaboration; proximal metacognitive learning strategies involving planning, reviewing, and reflecting on medical procedures; and metalevel strategies for monitoring and controlling the learning process. Second, there may be individual differences in the use of these strategies, influenced by genetic factors and/or prior SRL habits adopted in previous academic contexts (Bidjerano & Dai, 2007; Dörrenbächer & Perels, 2016b). In contrast, motivation, emotion, and context at the learning process level seem to be strongly dependent on the situation, and thus on different workplaces, specialist areas, and tasks.

Finally, at a low level of abstraction, the individual aspects revealed a highly differentiated perspective (Supplementary Material). Because these results rely on single items, they can be viewed as a starting point for further research on individual constructs.

4.2. Strengths and limitations

This study presents novel evidence on the ratios of trait, state, and developmental components in SRL at different levels of abstraction (SRL as a whole, parts, and aspects). It adopts a comprehensive and nuanced perspective on SRL in the workplace by analyzing 37 crucial SRL aspects for first-time workplace learners [blinded for review, 2023].

Another strength lies in the use of intensive longitudinal data to capture the variable components of psychological constructs and the rigorous implementation management that contributed to high-quality data by minimizing missing data and dropouts, potentially improving validity. However, this cannot be tested. One limitation is the use of self-report data (future studies should combine methods; Dörrenbächer-Ulrich et al., 2021), and diaries may be regarded as an intervention although using a diary alone does not lead to changes in learning behaviors (Dörrenbächer & Perels, 2016a; Panadero et al., 2016).

To avoid overburdening participants, we used single items that have been extensively investigated in a previous study. Although most items demonstrated sufficient reliability (two items with low reliability should be replaced in future studies) and comparable relationships within the full-scale nomological network, they only captured facets of individual constructs, which must be considered when interpreting the results.

Another limitation of a single item is that measurement error cannot be estimated. The findings show that the state ratios were higher for weekly measures than for daily measures aggregated into weekly measures. In addition to the theoretical explanations, this could be attributed to a higher margin of measurement error in the weekly measures than in the accumulated daily measures. These findings can also be attributed to memory effects. The study was conducted in a real-life setting and a limitation is that some students had a five-week break between weeks five and six for organizational reasons. We treated the measures

equally to ensure sufficient power for the analysis. Future studies should replicate the results of this study without such breaks.

A strength of this study is the heterogeneity of students, capturing variations in their cognition, motivation, and emotions. This could also be considered a limitation, as considerable effort was required to prevent struggling or unmotivated students from dropping out; thus, we conducted the study in just one institution and in just one discipline of health sciences. Further research is necessary to determine the generalizability of our findings to other health disciplines and rotation intervals.

Students learned in heterogeneous environments as they rotated weekly between workplaces. This is an advantage of interpreting stable trait components because they are robust even in weekly changing settings. This is also a limitation, as the ratio of state components may be higher and the ratio of developmental components may be lower in weekly changing settings than in more stable environments. However, further research is required to confirm these hypotheses.

4.3. Scientific implications

Our study shows that theoretical models of SRL in the workplace, such as Brydges and Butler, need to consider situational dependency and stable trait components (2012). The finding of situations-specificity also aligns with recent models in educational psychology, such as the situated expectancy-value theory (Eccles & Wigfield, 2020). Although evidence exists regarding the situational factors that can facilitate or obstruct undergraduates' SRL in the workplace (Berkhout et al., 2018; Cho et al., 2017b; Jouhari et al., 2015; Sawatsky et al., 2018; van Houten-Schat et al., 2018), future studies could investigate whether the same or different external factors impact different parts of SRL (cognition, motivation, emotion, and metalevel). For example, a common factor could be the cognitive load (Wirth et al., 2020). In contrast, patient-related factors can impact motivation and emotion more than cognition. For

example, encountering patients could be motivating and emotionally challenging cases could affect academic emotions.

Our study revealed that the stable trait was a substantial component of SRL at the workplace, possibly owing to comparable framework conditions across different workplace environments as well as individual differences. While the existing literature on SRL in practical clinical settings provides insights into SRL types (Berkhout et al., 2017; Woods et al., 2011), future research could adopt person-centered approaches to identify different types of learners in the workplace (Dörrenbächer & Perels, 2016b). For example, Marsch et al. (2023) found individual differences in stress among first-time workplace learners. Further investigation of the relationship between personality characteristics/potential genetic factors and SRL in the workplace could help us understand student learning. Based on this basic research, future studies should address the appropriate interventions for various types of learners.

The developmental component of SRL was also relevant but less significant than the state and trait components, particularly in dynamic workplace environments. Whether this finding holds in more stable learning environments or over extended periods remains unclear. Additional information is needed on SRL progression over time and students' needs at different stages. For example, diary studies analyzing changes over time could investigate whether there are different stages of SRL from novice to expert or whether the four transition stages from preparation through encounter and adjustment to stabilization can be found (Nicholson, 1990).

4.4. Practical implications

Resources for workplace learning interventions are limited; therefore, interventions should be highly accurate and effective. The findings suggest that a combination of intervention elements is the most successful in supporting students' SRL in the workplace. SRL in the workplace is situation-specific (state) and influenced by individual differences (stable traits).

Emphasis should be placed on creating suitable framework conditions and addressing individual differences.

This study considers the individual differences in SRL among first-time workplace learners. Individual support and supervision should be provided, particularly for struggling students. This support should focus not only on medical knowledge and skills but also on monitoring and controlling learning processes. Regular sessions at the beginning of shifts, questions in between, and debriefing sessions can aid in planning, reviewing, clarifying, and reflecting on the learning process and in coping with challenging situations. Additionally, the developmental component of workplace SRL was substantial. Interventions could incorporate “stage-specific” elements, in which students receive SRL training at the beginning of clinical training and throughout the process.

4.5. Conclusion

By actively managing their learning processes, individuals can identify and address knowledge gaps, acquire new skills, and enhance their overall competency. The SRL of first-time workplace learners is highly situation-specific. Therefore, health sciences educational institutions can best support their students by providing them with supportive learning environments. Stable trait and developmental components also contribute to SRL in the workplace. Hence, health sciences education institutions can support their students by acknowledging and addressing individual differences in their SRL in the workplace. Additionally, integrating course elements at the beginning and during practical training to reflect on workplace SRL can be beneficial. Fostering students’ workplace SRL is essential not only for academic excellence but also for lifelong learning, especially in today's fast-paced and ever-changing work environment.

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[2 publications deleted to maintain the integrity of the review process, 2023]

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