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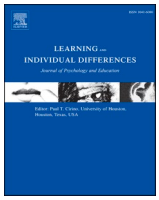

Self-regulated learning at the workplace: State, trait, or development?

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ABSTRACT

Background: Health sciences students often encounter challenges when they begin learning and practicing in the workplace. Various research approaches and interventions have been developed to facilitate self-regulated learning in this context. To determine the most effective approach, a thorough understanding of the stability and variability of self-regulated learning in the workplace is necessary.
Aim: This study analyzed the stable trait, autoregressive trait, and time-varying state components of self-regulated learning in the workplace.
Sample: The sample comprised 188 undergraduates who were learning at a medical workplace for the first time and rotating weekly between various settings.
Methods: Undergraduates completed a diary on 37 aspects of self-regulated learning for a duration of 10 weeks. Data were analyzed using STARTS models.
Results: The aggregate results showed that 28 % of the total variance in self-regulated learning in the workplace was accounted for by the stable trait component, 22 % by the autoregressive trait component, and 50 % by the time-varying state component. These component ratios vary across different areas (cognition, motivation, emotion, and context) and levels (learning process level and metalevel) of self-regulated learning.
Conclusions: To enhance health sciences students' self-regulated learning in the workplace, it is recommended to focus on research and interventions to provide situation-specific supportive framework conditions while acknowledging individual differences and considering phase-specific interventions. Further research is required to determine whether these findings can be applied to other rotational intervals and subject areas.

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.

1. Introduction[1]

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

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[1] **Abbreviations:** autoregressive trait (AR); Markov Chain Monte Carlo (MCMC); stable trait (ST); time-varying state (TS); self regulated learning (SRL).

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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. Nevertheless, no studies have yet been conducted to ascertain to which extend SRL and SRL aspects are stable over time (trait component), vary between situations (state component) or are characterized by development over time and previous experience (developmental component). If SRL is stable over time, theoretical models need to emphasize interindividual differences and struggling learners require intensive training. If SRL varies between situations theoretical models need to emphasize the situation dependency and interventions need to focus on creating supportive learning environments and training students to adapt to their learning. If SRL is characterized by development over time and previous experience theoretical models need to emphasize the cyclical nature and interventions need to provide training elements specific to the respective stages. If SRL comprises all three components (trait, state, and development) the theoretical model needs to integrate all three components and interventions require a combination of training elements. This study is the first to investigate 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). Additionally to the differences in learning, students entering workplace settings often do not know how to become part of the team, are uncertain of their roles and are concerned about their workload (Atherley et al., 2016; Berkhout et al., 2017).

The health sciences curricula usually facilitate a gradual introduction to learning and working in a workplace setting. At the outset of the transition from the academic to the workplace environment, the focus is on clearly defined learning objectives pertaining to the acquisition of clinical-practical skills and their guided teaching. The majority of learning occurs on-site in formal settings, with informal learning playing a less prominent role (how to become part of a team). However, interviews indicate that students engage in preparatory and planning activities for on-site learning and reflect on their experiences afterwards, often in informal contexts (Steinberg et al., 2024a).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. On the learning process level cognition refers to learning strategies focused on workplace learning (Weinstein et al., 2011). Motivation means instigating and sustaining goal-directed activity (Koenka, 2020). Emotions are defined within the broader concept of affect but are distinguished from other affective phenomena, such as moods, in that emotions are more intense, have a clearer object focus and a more salient cause, and are typically experienced for a shorter duration (Scherer, 2005). Context means undergraduate medical students' perceptions of multiple dimensions of the educational environment in the clinical practice setting (Strand et al., 2013). The metalevel of cognition, motivation, emotion, and context means regulating those respective aspects of the learning process (Ben-Eliyahu & Bernacki, 2015; Panadero, 2017; Pintrich, 2004; Wolters, 2003). This model is proposed as a conceptual framework for undergraduate SRL in the workplace (Steinberg et al., 2024a). 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 Fig. 1 for an overview).

The newly developed workplace SRL model was therefore developed on the basis of both a review of the existing literature on SRL and the results of empirical studies. It differs from models that have been developed for use in the academic setting. At the level of the learning process and in the area of cognition, the model incorporates proximal metacognitive learning strategies in conjunction with cognitive learning strategies. Proximal metacognitive learning strategies entail planning, reviewing and reflecting one's own practical medical activities. It is important to note that this definition of proximal metacognitive learning strategies differs from the conventional definition of (distal) metacognitive learning strategies, which focuses on the regulation of the cognitive aspects of the learning process, such as setting learning goals or selecting and evaluating learning strategies. In the area of motivation, the aspect 'proactive attitude' has been added which means seeking and taking opportunities to practice and learn. In the area of emotions and the learning environment, those aspects were included that were identified as relevant in the field of health sciences education research (Duffy et al., 2018; Dyrbye et al., 2020).

Moreover, the model diverges from the majority of its predecessors in that the metalevel addresses not only cognitive aspects (metacognition), but also motivational, emotional, and contextual aspects. It is important that students monitor and regulate motivation and emotions in the workplace to avoid negative consequences for patients and ensure patient safety (Doulougeri et al., 2016). Furthermore, the metalevel is relevant in relation to the perception of the context. The workplace learning environment can only be shaped to a limited extent and is characterized by predefined teams and standardised processes. It is important that students learn to deal with this consciously. For example,

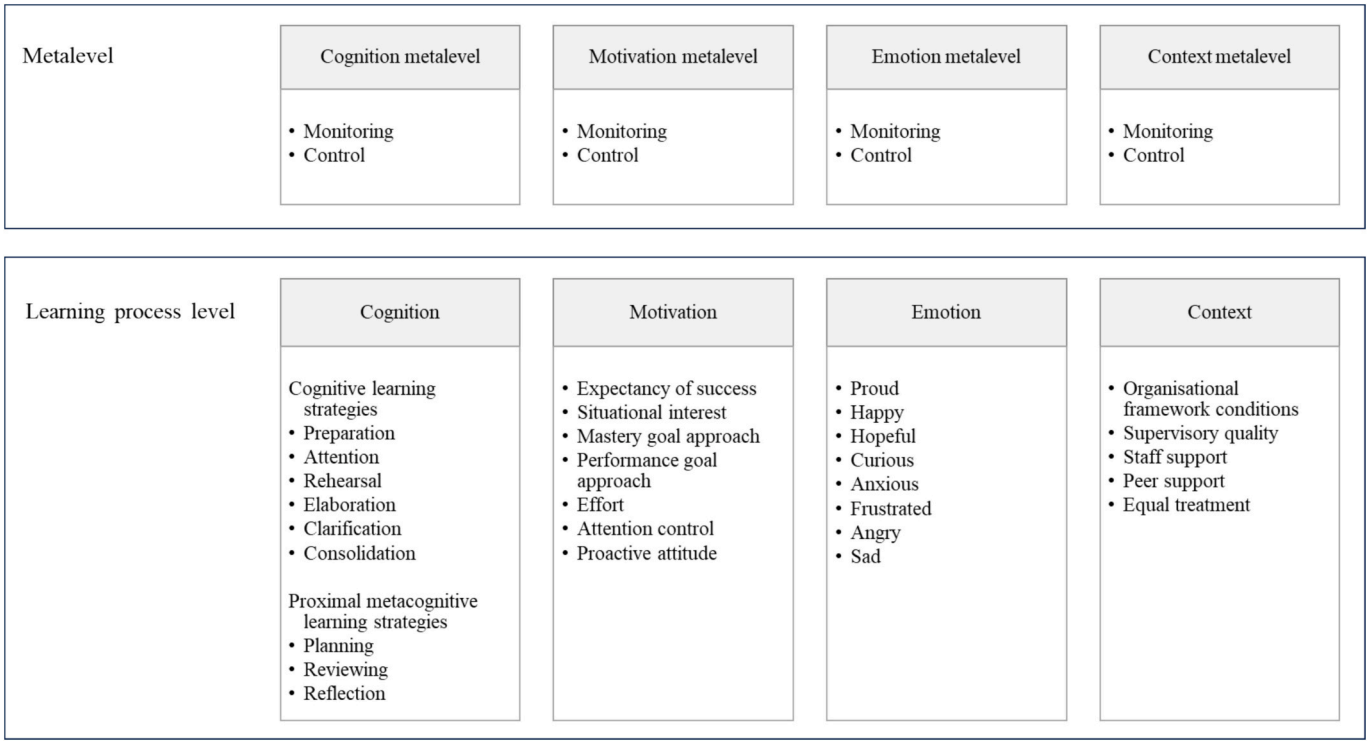

Fig. 1. Figure 1 shows different parts and aspects of self-regulated learning at the workplace per level and area.

students need be able to deal with a lack of support from the clinical team in stressful phases.

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 (Steinberg et al., 2024a).

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 several theories referring to the cyclical nature of learning and hence the developmental component of SRL. These include SRL theories concerning the cyclical nature of SRL (e.g., Zimmerman, 2008), the theory of transition stages (Nicholson, 1990), or theories of expertise, such as the model of domain learning (Alexander, 2004). The latter proposes three dimensions (knowledge, interest, strategic processing) and describes how they change during three stages, i.e., acclimation, competence, proficiency/expertise. During the acclimation stage students begin to build a foundation of subject-matter knowledge (and skills, we assume for a workplace learning environment) and rely on situational interest as well as on surface-level strategies. By meaningful formal instruction students should be able to transfer to the competence stage, where – dependent on the phase (early, middle, late competence) – the aspects of the dimensions change. For example, strategic processing changes towards the use of more deep-processing strategies. Finally, there are also 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, such as questionnaires, interviews, think-aloud techniques, learning diaries, and observations (Roth et al., 2016; Schunk & Greene, 2018). Self-report questionnaires are commonly used to assess SRL in higher education, as they evaluate core learning aspects that are hard to observe and are easier to administer than interviews or diaries (Roth et al., 2016). However, the validity of self-report data has been questioned (Wolters & Won, 2018), and careful questionnaire development is recommended (Gehlbach & Brinkworth, 2011). Steinberg and colleagues (2024a) have developed scales for workplace learning, based on Gehlbach and Brinkworth's procedure for questionnaire development and single-items

Table 1
STARTS model: results for SRL parts and SRL aspects.

SRL part	SRL aspect	Variance components									AR coefficient		
		Trait			AR			State					
		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.

based on Gogol and colleagues procedure for analyzing the psychometric properties of single-items measures (Gogol et al., 2014). 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 heterogeneous levels of cognition, motivation, and emotions who learned in various workplace settings. We therefore decided to make an effort to reach the vast majority of a relevant cohort of students at one institution and thus obtain data from a heterogeneous group, rather than send a questionnaire to different institutions and risk a biased sample by obtaining data from mostly motivated high achievers. Hence, our study covered a wide range of students, from highly motivated and high-achieving students to struggling students who encountered learning challenges and exhibited a problematic attitude towards learning. 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, called Clinical Rotation, is conducted in the ninth out of 12 semesters. The course has clearly defined learning objectives, with a focus on clinical and practical skills. Students receive guidance from lecturers in order to facilitate the acquisition of these skills. While informal learning is also a factor, formal learning is the primary mode of instruction. 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). On average, participants provided data on daily measurements on 43.20 ($SD = 5.74$) days and data on weekly measurements on 9.17 ($SD = 1.23$) weeks.

2.2. Measures

We incorporated all pertinent constructs for workplace learning from the Workplace Learning Inventory in Health Sciences Education (Steinberg et al., 2024a) and used single items derived from this instrument (29 items) and the Medical Emotion Scale (8 items) (Duffy et al., 2018; Steinberg et al., 2024b). The full scales from the Workplace Learning Inventory had been developed and thoroughly validated by following a seven-step process: deriving indicators from the literature, deriving indicators from interviews with students, teachers and researchers, synthesizing indicators, developing items, expert review, cognitive pretesting, pilot testing including analyzing the relation within nomological network using established scales (following Gehlbach & Brinkworth, 2011). The single items had been validated by analyzing information reproduction and whether the single-items show similar relationships within the nomological network as the Workplace Learning Inventory's full scales. While the relationship within the nomological network was similar, information reproduction was insufficient for most single items, indicating that the single-item does not represent all aspects of the construct. Therefore, in interpreting the results it is recommended rather to refer to the item wording than to the definition of the construct (Steinberg et al., 2024b). 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). An item example for cognition is "At the workplace, I tried to connect the practical medical tasks to what I had previously learned." (Elaboration). 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).[2] An item example for motivation is "This week it was important to me to expand my knowledge" (Mastery goal - approach). All items were administered using a five-point Likert scale with 1 = does not apply at all, 2 = does not apply, 3 = partly applies, 4 = applies, and 5 = fully applies; for the "control" scales at the metalevel, 6 = this case did not occur was also included; except for the area emotion with 1 = not at all; 2 = a little; 3 = moderately; 4 = fairly; and 5 = very much. Please find a list of aspects, definitions, single-items and response formats in the Supplementary Material (Table 1).

2.3. Procedure

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, Vienna. The decision was that no ethical approval was required according to the Declaration of Helsinki. The following ethical standards were met. Providing data to the study was completely voluntary. The students were also informed that they would not suffer any disadvantages should they opt out. 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.

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

[2] 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.

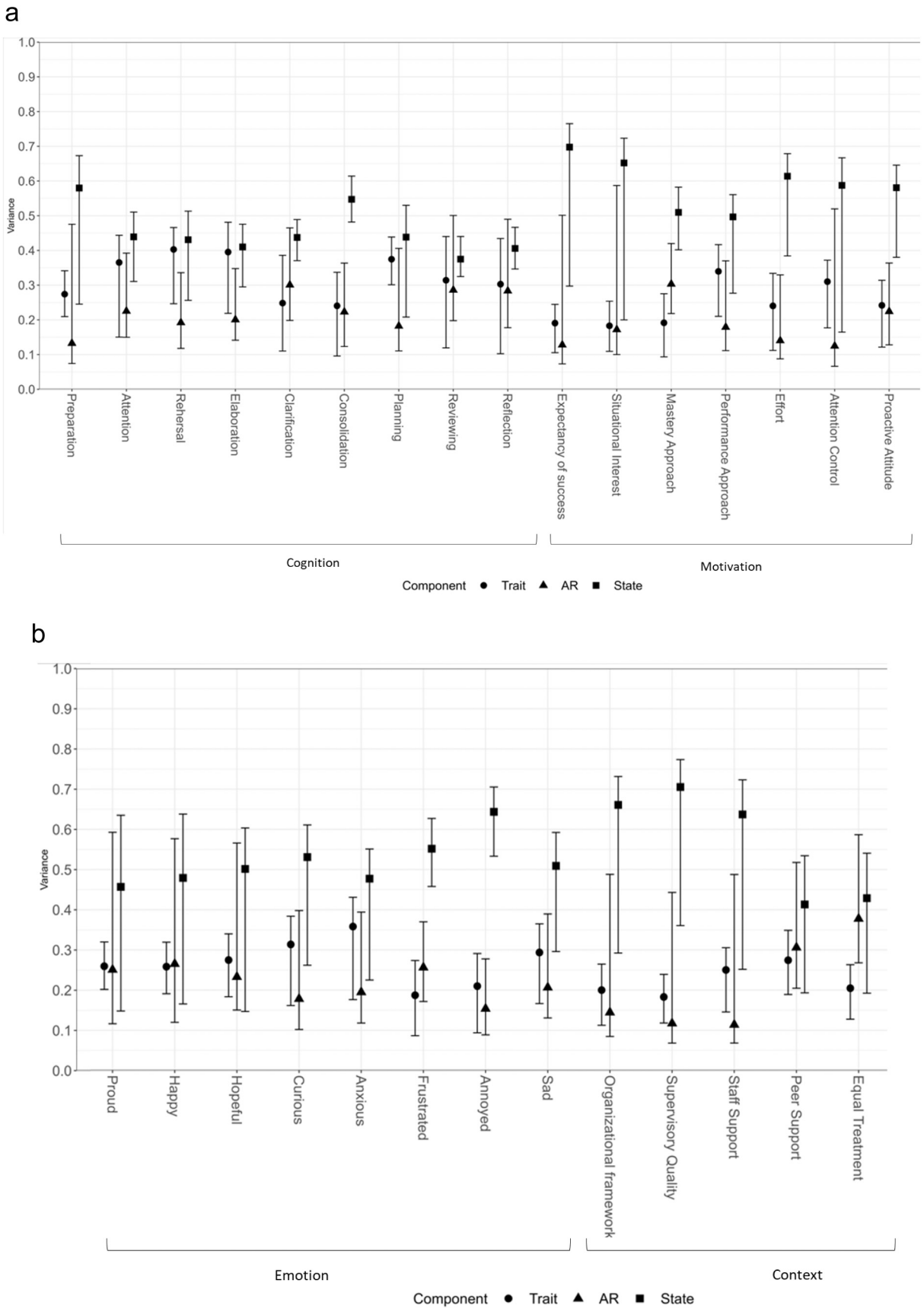

Fig. 2. a. Stable trait, autoregressive trait (AR), and state components of cognitive and motivational SRL aspects (learning process level).
b. Stable trait, autoregressive trait (AR), and state components of emotional and contextual SRL aspects (learning process level).
c. Stable trait, autoregressive trait (AR), and state components of cognitive, motivational, emotional and contextual SRL aspects (metalevel).

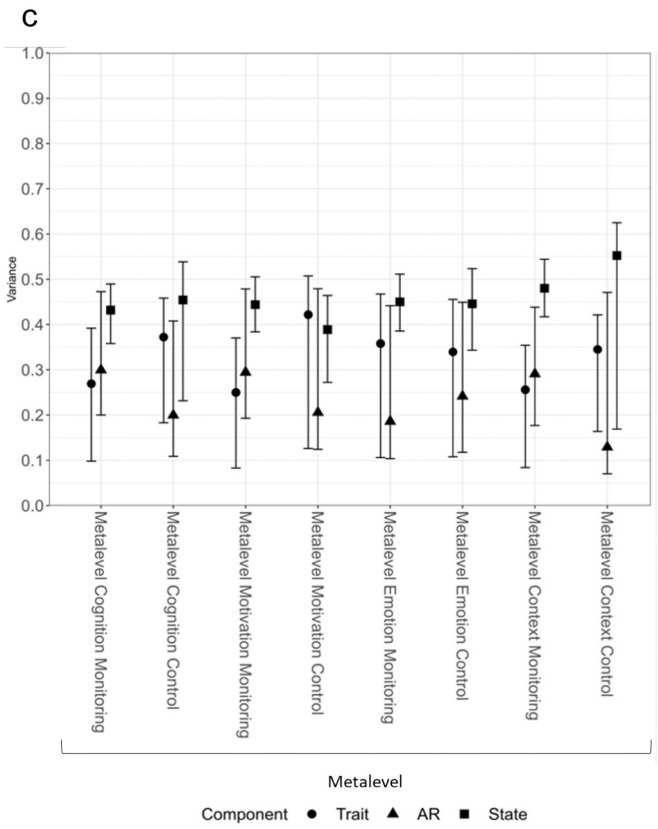

Fig. 2. (*continued*).

and lifelong learning, weekly contact with student representatives, individualized reports for students, social gatherings, and vouchers).

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 $\widehat{R}$ was inspected for each parameter to ensure convergence of the MCMC algorithm, where a $\widehat{R} < 1.05$ 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 Fig. 2.

3.2. Aggregated results for SRL and SRL parts

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

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

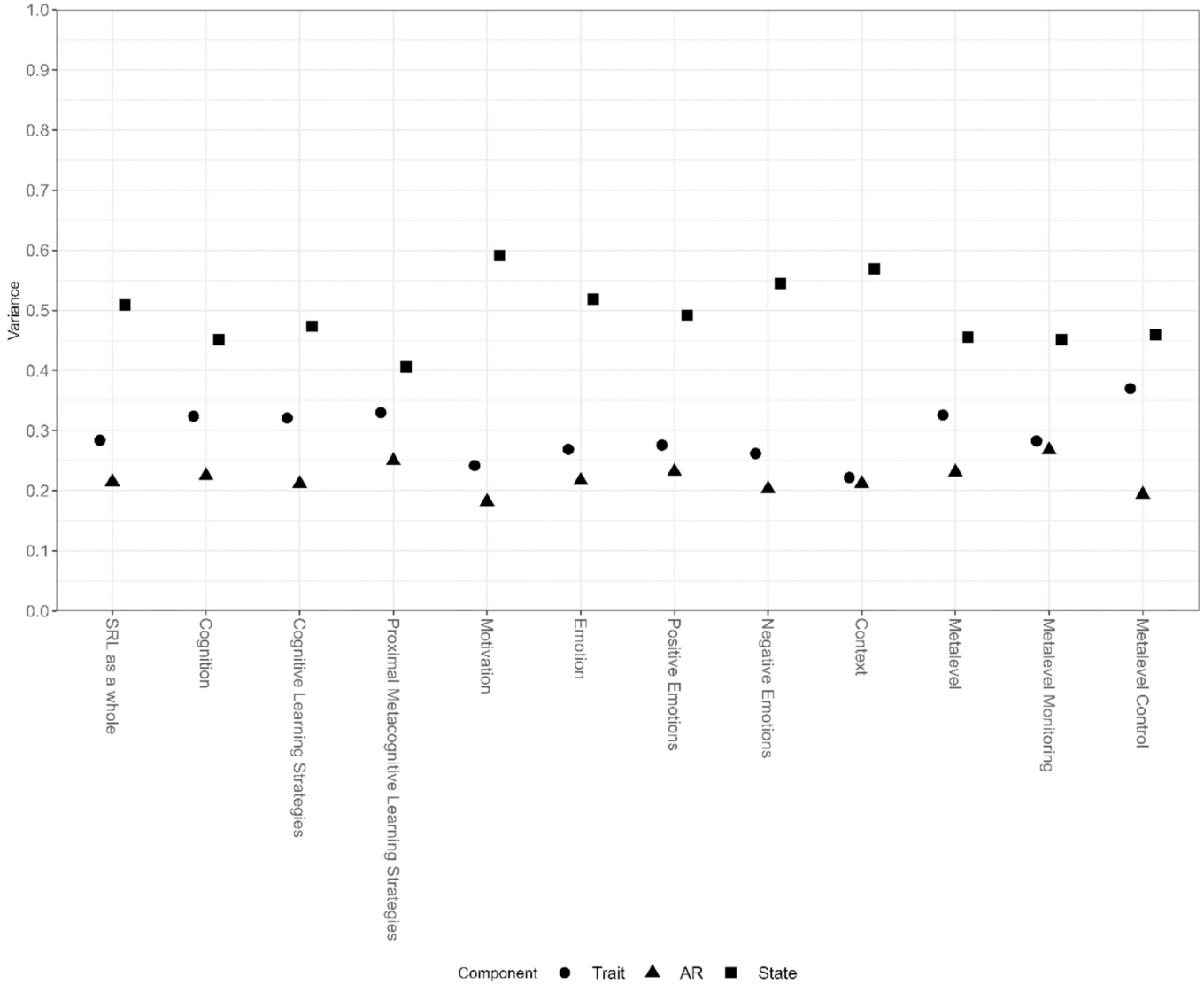

Fig. 3. Stable strait, autoregressive trait (AR), and state components of SRL as a whole, SRL parts and SRL sub-parts.

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.

4.1.1. 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), transition theory (Nicholson, 1990) as well as the model of domain learning (Alexander, 2004) 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.

4.1.2. 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 (Steinberg et al., 2024a).

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. However, descriptive statistics showed high mean values for a few aspects like effort or peer support, indicating a ceiling effect and less heterogeneity within these aspects. Furthermore, 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, which is a limitation. 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.

This study did not focus on initial SRL levels and how these levels have changed after the course. However, future studies could be

grounded in the model of domain learning (Alexander, 2004) to describe and explain changes in cognitive and motivational aspects over time

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 (Brydges & Butler, 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. (2024) 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 eitheer the four transition stages from preparation through encounter and adjustment to stabilization (Nicholson, 1990) or according to the model of domain learning from acclimation to competency (Alexander, 2004) can be found.

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.

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.

CRediT authorship contribution statement

Evelyn Steinberg: Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Stephan Marsch:** Writing – review & editing, Software, Resources, Project administration, Investigation, Data curation. **Takuya Yanagida:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Laura Dörrenbächer-Ulrich:** Writing – review & editing, Supervision. **Arowotosuna E. Smith:** Investigation. **Christopher Pfeiffer:** Writing – review & editing, Software, Investigation. **Petra Bührle:** Writing – review & editing, Investigation. **Lukas Schwarz:** Writing – review & editing, Resources, Investigation. **Ulrike Auer:** Writing – review & editing, Resources, Investigation. **Franziska Perels:** Writing – review & editing, Supervision, Conceptualization.

Note on data used

The study is part of a larger project funded by a National Science Fund. The data, on which this study is based, is used to answer three research questions, as stated in the funding proposal, one of which is addressed in this manuscript.

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Declaration of competing interest

None.

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References

Alexander, P. A. (2004). A model of domain learning: Reinterpreting expertise as a multidimensional, multistage process. In D. Y. Dai, & R. J. Sternberg (Eds.), *The educational psychology series. Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development* (pp. 287–312). Lawrence Erlbaum Associates.

Association of American Veterinary Medical Colleges. (2020). Annual Data Report 2019-2020. https://www.aavmc.org/wp-content/uploads/2020/10/2020-aavmc-annual-data-report.pdf.

Atherley, A. E., Dolmans, D., Hu, W., Hegazi, I., Alexander, S., & Teunissen, P. W. (2019). Beyond the struggles: A scoping review on the transition to undergraduate clinical training. *Medical Education, 53*(6), 559–570. https://doi.org/10.1111/medu.13883

Atherley, A. E., Hambleton, I. R., Unwin, N., George, C., Lashley, P. M., & Taylor, C. G. (2016). Exploring the transition of undergraduate medical students into a clinical clerkship using organizational socialization theory. *Perspectives on Medical Education, 5*(2), 78–87. https://doi.org/10.1007/s40037-015-0241-5

Ben-Eliyahu, A. (2019). Academic emotional learning: A critical component of self-regulated learning in the emotional learning cycle. *Educational Psychologist, 54*(2), 84–105. https://doi.org/10.1080/00461520.2019.1582345

Ben-Eliyahu, A., & Bernacki, M. L. (2015). Addressing complexities in self-regulated learning: A focus on contextual factors, contingencies, and dynamic relations. *Metacognition and Learning, 10*(1), 1–13. https://doi.org/10.1007/s11409-015-9134-6

Bergsmann, E., Schultes, M.-T., Winter, P., Schober, B., & Spiel, C. (2015). Evaluation of competence-based teaching in higher education: From theory to practice. *Evaluation and Program Planning, 52*, 1–9. https://doi.org/10.1016/j.evalprogplan.2015.03.001

Berkhout, J. J., Helmich, E., Teunissen, P. W., van der Vleuten, C. P. M., & Jaarsma, A. D. C. (2018). Context matters when striving to promote active and lifelong learning in medical education. *Medical Education, 52*(1), 34–44. https://doi.org/10.1111/medu.13463

Berkhout, J. J., Teunissen, P. W., Helmich, E., van Exel, J., van der Vleuten, C. P. M., & Jaarsma, D. A. D. C. (2017). Patterns in clinical students' self-regulated learning behavior: A Q-methodology study. *Advances in Health Sciences Education: Theory and Practice, 22*(1), 105–121. https://doi.org/10.1007/s10459-016-9687-4

Bidjerano, T., & Dai, D. Y. (2007). The relationship between the big-five model of personality and self-regulated learning strategies. *Learning and Individual Differences, 17*(1), 69–81. https://doi.org/10.1016/j.lindif.2007.02.001

Boekaerts, M. (1996). Self-regulated learning at the junction of cognition and motivation. *European Psychologist, 1*(2), 100–112. https://doi.org/10.1027/1016-9040.1.2.100

Breil, S. M., Schweppe, P. C., Geukes, K., Biesanz, J. C., Quintus, M., Wagner, J., … Back, M. D. (2022). The incremental validity of average states: A replication and extension of Finnigan and Vazire (2018). *Journal of Personality and Social Psychology, 123*(3), e23–e37. https://doi.org/10.1037/pspp0000408

Brydges, R., & Butler, D. (2012). A reflective analysis of medical education research on self-regulation in learning and practice. *Medical Education, 46*(1), 71–79. https://doi.org/10.1111/j.1365-2923.2011.04100.x

Bürger, K., & Schmitt, M. (2017). Students' multiple state goals as a function of appraisals, trait goals, and their interactions. *Contemporary Educational Psychology, 51*, 464–481. https://doi.org/10.1016/j.cedpsych.2017.09.006

Cho, K. K., Marjadi, B., Langendyk, V., & Hu, W. (2017a). Medical student changes in self-regulated learning during the transition to the clinical environment. *BMC Medical Education, 17*(1), 59. https://doi.org/10.1186/s12909-017-0902-7

Cho, K. K., Marjadi, B., Langendyk, V., & Hu, W. (2017b). The self-regulated learning of medical students in the clinical environment - A scoping review. *BMC Medical Education, 17*(1), 112. https://doi.org/10.1186/s12909-017-0956-6

Cleary, T. J., Durning, S. J., Gruppen, L. D., Hemmer, P. A., & Artino, A. R. (2013). Self-regulated learning in medical education. In K. Walsh (Ed.), *Oxford textbook of medical education (1. ed., pp. 465–477)*. Oxford Univ. Press. https://doi.org/10.1093/med/9780199652679.003.0040.

Cleary, T. J., & Callan, G. L. (2018). Assessing self-regualted learning using microanalytic methods. In D. H. Schunk, & J. A. Greene (Eds.), *Educational psychology handbook series. Handbook of self-regulation of learning and performance* (2nd ed., pp. 338–350). Routledge/Taylor & Francis Group.

Cleary, T. J., Callan, G. L., & Zimmerman, B. J. (2012). Assessing self-regulation as a cyclical, context-specific phenomenon: Overview and analysis of SRL microanalytic protocols. *Education Research International, 2012*, 1–19. https://doi.org/10.1155/2012/428639

Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning, 3*(3), 231–264. https://doi.org/10.1007/s11409-008-9029-x

Dörrenbacher, L., & Perels, F. (2015). Volition completes the puzzle: Development and evaluation of an integrative trait model of self-regulated learning. *Frontline Learning Research, 3*(4), 14–36. https://doi.org/10.14786/flr.v3i4.179

Dörrenbächer, L., & Perels, F. (2016a). More is more? Evaluation of interventions to foster self-regulated learning in college. *International Journal of Educational Research, 78*, 50–65. https://doi.org/10.1016/j.ijer.2016.05.010

Dörrenbächer, L., & Perels, F. (2016b). Self-regulated learning profiles in college students: Their relationship to achievement, personality, and the effectiveness of an intervention to foster self-regulated learning. *Learning and Individual Differences, 51*, 229–241. https://doi.org/10.1016/j.lindif.2016.09.015

Dörrenbächer-Ulrich, L., Weißenfels, M., Russer, L., & Perels, F. (2021). Multimethod assessment of self-regulated learning in college students: Different methods for different components? *Instructional Science, 49*(1), 137–163. https://doi.org/10.1007/s11251-020-09533-2

Doulougeri, K., Panagopoulou, E., & Montgomery, A. (2016). (How) do medical students regulate their emotions? *BMC Medical Education, 16*(1), 312. https://doi.org/10.1186/s12909-016-0832-9

Duffy, M. C., Lajoie, S. P., Pekrun, R., & Lachapelle, K. (2018). Emotions in medical education: Examining the validity of the Medical Emotion Scale (MES) across authentic medical learning environments. *Learning and Instruction*. https://doi.org/10.1016/j.learninstruc.2018.07.001. Advance online publication.

Dyrbye, L. N., Lipscomb, W., & Thibault, G. (2020). Redesigning the learning environment to promote learner well-being and professional development. *Academic Medicine, 95*(5), 674–678. https://doi.org/10.1097/ACM.0000000000003094

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology, 61*, Article 101859. https://doi.org/10.1016/j.cedpsych.2020.101859

Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: The MASRL model. *Educational Psychologist, 46*(1), 6–25. https://doi.org/10.1080/00461520.2011.538645

EFS Survey. (2022). *Unipark* [computer software]. In *Globalpark*. https://www.unipark.com/.

Fixsen, D. L., Blase, K. A., Naoom, S. F., & Wallace, F. (2009). Core implementation components. *Research on Social Work Practice, 19*(5), 531–540. https://doi.org/10.1177/1049731509335549

Gehlbach, H., & Brinkworth, M. E. (2011). Measure twice, cut down error: A process for enhancing the validity of survey scales. *Review of General Psychology, 15*(4), 380–387. https://doi.org/10.1037/a0025704

Geiser, C., Götz, T., Preckel, F., & Freund, P. A. (2017). States and traits. *European Journal of Psychological Assessment, 33*(4), 219–223. https://doi.org/10.1027/1015-5759/a000413

Godefrooij, M. B., Diemers, A. D., & Scherpbier, A. J. J. A. (2010). Students' perceptions about the transition to the clinical phase of a medical curriculum with preclinical patient contacts; a focus group study. *BMC Medical Education, 10*, 28. https://doi.org/10.1186/1472-6920-10-28

Gogol, K., Brunner, M., Goetz, T., Martin, R., Ugen, S., Keller, U., … Preckel, F. (2014). "My questionnaire is too long!" The assessments of motivational-affective constructs with three-item and single-item measures. *Contemporary Educational Psychology, 39*(3), 188–205. https://doi.org/10.1016/j.cedpsych.2014.04.002

Greene, J. A., Deekens, V. M., Copeland, D. Z., & Yu, S. (2018). Capturing and modeling self-regulated learning using think-aloud protocols. In D. H. Schunk, & J. A. Greene (Eds.), *Educational psychology handbook series. Handbook of self-regulation of learning and performance* (2nd ed., pp. 323–336). Routledge/Taylor & Francis Group.

Hong, E. (1998). Differential stability of state and trait self-regulation in academic performance. *The Journal of Educational Research, 91*(3), 148–159. https://doi.org/10.1080/00220679809597536

Jansen, M., Lüdtke, O., & Robitzsch, A. (2020). Disentangling different sources of stability and change in students' academic self-concepts: An integrative data analysis using the STARTS model. *Journal of Educational Psychology, 112*(8), 1614–1631. https://doi.org/10.1037/edu0000448

Jouhari, Z., Haghani, F., & Changiz, T. (2015). Factors affecting self-regulated learning in medical students: A qualitative study. *Medical Education Online, 20*, Article 28694. https://doi.org/10.3402/meo.v20.28694

Kenny, D. A., & Zautra, A. (1995). The trait-state-error model for multiwave data. *Journal of Consulting and Clinical Psychology, 63*(1), 52–59. https://doi.org/10.1037//0022-006x.63.1.52

Kenny, D. A., & Zautra, A. (2001). The trait-state models for longitudinal data. In L. M. Collins, & A. G. Sayer (Eds.), *New methods for the analysis of change* (pp. 243–263). American Psychological Association.

Koenka, A. C. (2020). Academic motivation theories revisited: An interactive dialog between motivation scholars on recent contributions, underexplored issues, and future directions. *Contemporary Educational Psychology, 61*, Article 101831. https://doi.org/10.1016/j.cedpsych.2019.101831

Lüdtke, O., Robitzsch, A., & Wagner, J. (2018). More stable estimation of the STARTS model: A Bayesian approach using Markov chain Monte Carlo techniques. *Psychological Methods, 23*(3), 570–593. https://doi.org/10.1037/met0000155

Marsch, S., Yanagida, T., & Steinberg, E. (2024). Stressors and stress of veterinary students during their introduction to the clinical workplace. *Journal of Veterinary Medical Education, 52*(1), 139–151. https://doi.org/10.3138/jvme-2023-0127

Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and new findings. In *, Vol. 26. Psychology of learning and motivation* (pp. 125–173). Elsevier. https://doi.org/10.1016/S0079-7421(08)60053-5.

Nicholson, N. (1990). The transition cycle: Causes, outcomes, processes and forms. In S. Fisher, & C. L. Cooper (Eds.), *On the move: The psychology of change and transition* (pp. 83–108). Wiley.

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology, 8*, 422. https://doi.org/10.3389/fpsyg.2017.00422

Panadero, E., Klug, J., & Järvelä, S. (2016). Third wave of measurement in the self-regulated learning field: When measurement and intervention come hand in hand. *Scandinavian Journal of Educational Research, 60*(6), 723–735. https://doi.org/10.1080/00313831.2015.1066436

Perels, F., Otto, B., Landmann, M., Hertel, S., & Schmitz, B. (2007). Self-regulation from a process perspective. *Zeitschrift Für Psychologie/Journal of Psychology, 215*(3), 194–204. https://doi.org/10.1027/0044-3409.215.3.194

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 451–502). Academic Press. https://doi.org/10.1016/B978-012109890-2/50043-3.

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review, 16*(4), 385–407. https://doi.org/10.1007/s10648-004-0006-x

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63*(2), 167–199. https://doi.org/10.3102/00346543063002167

Poncelet, A., & O'Brien, B. (2008). Preparing medical students for clerkships: A descriptive analysis of transition courses. *Academic Medicine : Journal of the Association of American Medical Colleges, 83*(5), 444–451. https://doi.org/10.1097/ACM.0b013e31816be675

R Core Team. (2023). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Robitzsch, A., & Lüdtke, O. (2022). STARTS: Functions for the STARTS model. R package version 1.3-8. https://CRAN.R-project.org/package=STARTS.

Roth, A., Ogrin, S., & Schmitz, B. (2016). Assessing self-regulated learning in higher education: A systematic literature review of self-report instruments. *Educational Assessment, Evaluation and Accountability, 28*(3), 225–250. https://doi.org/10.1007/s11092-015-9229-2

Sawatsky, A. P., Ratelle, J. T., Bonnes, S. L., Egginton, J. S., & Beckman, T. J. (2018). Faculty support for self-directed learning in internal medicine residency: A qualitative study using grounded theory. *Academic Medicine : Journal of the Association of American Medical Colleges, 93*(6), 943–951. https://doi.org/10.1097/ACM.0000000000002077

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information, 44*(4), 695–729. https://doi.org/10.1177/0539018405058216

Schmitz, B., Klug, J., & Schmitz, M. (2011). Assessing self-regualted learning suint diary measures with university students. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Educational psychology handbook series. Handbook of self-regulation of learning and performance* (p. 1). Routledge.

Schunk, D. H., & Greene, J. A. (Eds.). (2018) (2nd ed.)*Handbook of self-regulation of learning and performanceEducational psychology handbook series*. Routledge/Taylor & Francis Group.

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*(3), 407. https://doi.org/10.2307/1170010

Steinberg, E., Marsch, S., Yanagida, T., Dörrenbächer-Ulrich, L., Pfeiffer, C., Bührle, P., Schwarz, L., Auer, U., Kleinsorgen, C., & Perels, F. (2024a). Development and validation of the Workplace Learning Inventory in Health Sciences Education: a multimethod study. *Advances in Health Sciences Education, 29*(4), 1075–1129. https://doi.org/10.1007/s10459-023-10295-y

Steinberg, E., Yanagida, T., Marsch, S., Dörrenbächer-Ulrich, L., Schwarz, L., Auer, U., Kleinsorgen, C., Pfeiffer, C., Bührle, P., & Perels, F. (2024b). Undergraduates' workplace learning in health sciences education: psychometric properties of single-item measures. *BMC Medical Education, 24*(1), 861. https://doi.org/10.1186/s12909-024-05848-7

Strand, P., Sjöborg, K., Stalmeijer, R., Wichmann-Hansen, G., Jakobsson, U., & Edgren, G. (2013). Development and psychometric evaluation of the undergraduate clinical education environment measure (UCEEM). *Medical Teacher, 35*(12), 1014–1026. https://doi.org/10.3109/0142159X.2013.835389

Theobald, M. (2021). Self-regulated learning training programs enhance university students' academic performance, self-regulated learning strategies, and motivation: A meta-analysis. *Contemporary Educational Psychology, 66*, Article 101976. https://doi.org/10.1016/j.cedpsych.2021.101976

van Houten-Schat, M. A., Berkhout, J. J., van Dijk, N., Endedijk, M. D., Jaarsma, A. D. C., & Diemers, A. D. (2018). Self-regulated learning in the clinical context: A systematic review. *Medical Education, 52*(10), 1008–1015. https://doi.org/10.1111/medu.13615

Wagner, J., Lüdtke, O., & Trautwein, U. (2016). Self-esteem is mostly stable across young adulthood: Evidence from latent STARTS models. *Journal of Personality, 84*(4), 523–535. https://doi.org/10.1111/jopy.12178

Weinstein, C. E., Acee, T. W., & Jung, J. (2011). Self-regulation and learning strategies. *New Directions for Teaching and Learning, 2011*(126), 45–53. https://doi.org/10.1002/tl.443

Westerman, M., & Teunissen, P. W. (2013). Transitions in medical education. In K. Walsh (Ed.), *Oxford textbook of medical education* (1. ed., pp. 372–382). Oxford Univ. Press. https://doi.org/10.1093/med/9780199652679.003.0032.

Winne, P. H. (1997). Experimenting to bootstrap self-regulated learning. *Journal of Educational Psychology, 89*(3), 397–410. https://doi.org/10.1037/0022-0663.89.3.397

Wirth, J., Stebner, F., Trypke, M., Schuster, C., & Leutner, D. (2020). An interactive layers model of self-regulated learning and cognitive load. *Educational Psychology Review, 32*(4), 1127–1149. https://doi.org/10.1007/s10648-020-09568-4

Wolters, C. A. (2003). Regulation of motivation: Evaluating an underemphasized aspect of self-regulated learning. *Educational Psychologist, 38*(4), 189–205. https://doi.org/10.1207/S15326985EP3804_1

Wolters, C. A., & Won, S. (2018). Validity and the use of self-report questionnaires to asess self-regulated learning. In D. H. Schunk, & J. A. Greene (Eds.) (2nd ed.) *Handbook of self-regulation of learning and performanceEducational psychology handbook series*. Routledge/Taylor & Francis Group.

Woods, N. N., Mylopoulos, M., & Brydges, R. (2011). Informal self-regulated learning on a surgical rotation: Uncovering student experiences in context. *Advances in Health Sciences Education: Theory and Practice, 16*(5), 643–653. https://doi.org/10.1007/s10459-011-9285-4

Zheng, J., Lajoie, S., & Li, S. (2023). Emotions in self-regulated learning: A critical literature review and meta-analysis. *Frontiers in Psychology, 14*, Article 1137010. https://doi.org/10.3389/fpsyg.2023.1137010

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology, 11*(4), 307–313. https://doi.org/10.1016/0361-476X(86)90027-5

Zimmerman, B. J. (2008). Attaining self-regulation. In M. Boekaerts (Ed.), *Handbook of self-regulation [Nachdr.]* (pp. 13–39). Academic Press. https://doi.org/10.1016/B978-012109890-2/50031-7.