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LEADERSHIP EDUCATION IN A TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT: THE RELATION BETWEEN SELF-REGULATED LEARNING AND SELF-LEADERSHIP

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LEADERSHIP EDUCATION IN A TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT: THE RELATION BETWEEN SELF-REGULATED LEARNING AND SELF-LEADERSHIP

Research Paper

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Abstract

Our increasingly complex and dynamic environment demands comprehensive self-regulatory skills from university graduates. Self-regulation summarizes the ability to set goals, monitor progress, and adopt behavior purposefully. In an increasingly technology-enhanced learning environment, information systems (IS) research explores approaches to promote self-regulation in students' learning activities. However, it is unclear whether this self-regulated learning (SRL) prepares students for leadership roles. To address this research gap, we gather survey data and apply multiple regression analysis to examine how SRL strategy usage is linked to self-leadership (SL) strategy usage. Our results suggest that behavioral SL strategies are related to the usage of SRL strategies, e.g., the SL strategy "self-rewarding" to the SRL strategy "repeating". In contrast, SL strategies such as "mental imagery" are unrelated to SRL. Based on these findings, we suggest a target-oriented use of digital technologies to foster SL and reveal the need to promote SL strategies like "mental imagery" separately.

Keywords: Self-regulated learning, self-leadership, technology-enhanced learning, higher education.

1 Introduction

Higher education needs more knowledge on training students' self-regulation skills (Boor & Cornelisse, 2021; Hamdan et al., 2021) in order to develop future executives who are well-prepared for an increasingly dynamic and complex environment (Kontostavlou & Drigas, 2021). Self-regulation summarizes the ability to set personal goals, compare progress to goals, and change behavior or perception when there is a discrepancy between the defined goals and the current state (Karoly, 1993; Lord et al., 2010). Especially when changing situational and environmental characteristics appear, a high degree of self-regulation is required (Lord et al., 2010). This is the case in the flexible and dynamic work structures of our time, where the autonomous takeover of responsibility and independent action is needed (Andreßen & Konradt, 2007; Moldoveanu & Narayandas, 2019). Particularly, executives need a high degree of self-regulation to handle complex situations (Watkin et al., 2017). Therefore, the need for adequate leadership development has never been more critical (Moldoveanu & Narayandas, 2019) and universities need to consider self-regulatory training of their students as an important means to prepare their graduates for future leadership roles (Watkin et al., 2017). Many universities have recognized the potential of their students to become executives and offer leadership development programs, although the impact of these programs is often unknown (Reyes et al., 2019). However, due to the focus of universities on students' academic education, the focus in terms of self-regulation is mostly limited to self-regulated learning (SRL) (e.g., Pérez-Álvarez et al. (2018), Eggers et al. (2021)). SRL summarizes the ability to plan, motivate, and, if necessary, adjust learning processes in a self-directed way (Boekaerts,

1999; Zimmerman & Schunk, 2011). The increasing digitization of teaching in higher education and the proliferation of digital learning environments (Bygstad et al., 2022) provide multifold opportunities for information systems (IS) research regarding SRL: Currently, IS research addresses SRL in higher education through technical implementations, for example, mobile applications to foster students' SRL (Broadbent et al., 2020; Steinherr, 2021), or digital assistants that advise students towards SRL (Scheu & Benke, 2022). Besides, SRL in higher education is often targeted through learning analytics (Bentivoglio et al., 2010), or specific features in learning management systems that promote students' SRL strategies (Yot-Domínguez & Marcelo, 2017). Furthermore, systematic reviews examine the state-of-the-art in supporting SRL in online or digital learning environments (Eggers et al., 2021; Wang et al., 2021).

Reviews of SRL in technology-enhanced learning environments show that these targeted approaches towards SRL training in higher education are beneficial for students' academic education (Mooij et al., 2014; Steffens, 2006). However, it is not clear if self-regulation with a focus on learning prepares students purposefully for the current world of work and their role as future leaders in an environment that requires high levels of self-regulation. Accordingly, well-trained graduates should not only know how to learn self-regulated but also receive a more holistic training on self-regulation to be prepared for future leadership roles. In this regard, self-leadership (SL) is an approach that can be used for self-regulation training in leadership development (Megheirkouni & Mejheirkouni, 2020). Especially in a dynamic and flexible work environment, SL is an important prerequisite for good job performance and a successful career (Andreßen & Konradt, 2007), as it enables the creation of self-direction and self-motivation for successful task completion (Neck & Houghton, 2006). Several studies demonstrated the positive effects of SL on work performance and work engagement (e.g., Inam et al. (2021) or Schultz (2021)). Therefore, SL seems to be a suitable theoretical basis for more job-oriented self-regulation training among higher education students.

Correspondingly, our overarching research aim is to investigate how current self-regulation training in technology-enhanced learning environments at universities should be expanded to enable the development of well-rounded graduates who meet the necessary self-regulation requirements of the current working environment. This aim can be reached by identifying the effects of higher education learning-focused SRL strategy usage (e.g., Eggers et al. (2021)) on the more job-oriented SL strategy usage (e.g., Inam et al. (2021)). Therefore, and especially to draw conclusions about self-regulation training in technology-enhanced environments, we investigate the following research question: *How is the SRL of higher education students related to their use of SL strategies?*

To answer this research question, we analyze the relationships between SRL and SL strategy usage among 68 IS students in higher education based on two questionnaires: "Learning Strategies in Studies - Short Version" (LIST-K) and the "Revised Self-Leadership Questionnaire – German Version" (RSLQ-D). In the second step, we enrich the findings of this analysis with knowledge from the literature describing the effects of digital technology or content on SRL strategy usage. Combining these findings, we draw implications on how to apply digital technologies or content towards more job-oriented self-regulation training in higher education. By answering the research question, our study makes a descriptive contribution by providing researchers in the field of technology-enhanced learning environments insights into the relationship between SRL and SL. In addition, this study makes a pragmatic contribution by providing conclusions and guidance on how existing self-regulation training in technology-enhanced learning environments can be further developed towards leadership-oriented self-regulation training. Thus, our research does not aim to replace existing self-regulation training in higher education but to extend it appropriately.

2   Theoretical background

2.1   Self-regulated learning

SRL describes a form of learning that is not externally controlled. Accordingly, this form of learning requires that self-regulated learners have control over their learning and that they can regulate cognition

and motivation to meet self-defined learning goals (Loyens et al., 2008). Research shows that learners who can engage in SRL benefit from a variety of positive effects on their learning outcomes, including increased construction of declarative knowledge, enhanced skill development, and positive affective effects such as high learner satisfaction (Wan et al., 2012). In current research, SRL is understood as an overarching term under which a wide variety of constructs can be found that affect learning processes (Panadero, 2017). SRL is presented in different theoretical backgrounds with different perspectives and with different emphases (Landmann et al., 2015; Loyens et al., 2008). Models that schematically illustrate SRL can be subdivided into structural models (Boekaerts, 1999) and process models (Zimmerman, 1990; Zimmerman & Schunk, 2011). Despite the different histories of development and perspectives of SRL models, there are overarching similarities in the most widely used concepts of SRL: All concepts share the understanding that goal setting and planning, knowledge acquisition and learning, as well as regulation, including monitoring, control, and adjustment of the learning process, are essential components of SRL. Learners refer to the individual components of SRL by applying specific learning strategies (Landmann et al., 2015; Zimmerman & Schunk, 2011). Consequently, these strategies summarize different facets of the SRL process (Pintrich & Groot, 1990). The SRL strategies are classified into superordinate learning strategies and underlying learning strategies. Table 1 presents an overview of SRL strategies: 1) cognitive learning strategies comprise gaining new knowledge and its storage in memory; 2) metacognitive learning strategies allow learners to reflect on self-set goals; if necessary self-regulated learners adjust their learning behavior goal-oriented; 3) resource management comprises how learners handle available internal and external resources. Internal resources are within the learners, for example, stimulation and attention. In contrast, external resources conclude additional support, for example, literature or the possibility to contact other learners (K.-P. Wild, 1994).

SRL strategy	Underlying SRL Strategy
Cognitive	Elaborating: linking relationships between new learning content and existing knowledge
	Repeating: repeating learning content systematically
	Organizing: structuring of learning content
	Critical thinking: examine learning content critically
Meta-cognitive	Goal setting and planning: defining goals and target-oriented planning
	Regulation: adapting learning strategies if current strategies do not work sufficiently
	Controlling: checking whether what has been learned hasreally been understood
Resource Management	Effort: having the awareness for and willingness to work hard
	Concentration: avoiding distractions and focusing on learning tasks
	Time management: using a timetable for documenting the learning time
	Literature: using literature to deepen learning content and eliminate uncertainties
	Learning with other students: forming learning groups for joint learning
	Learning environment: create and adjust a suitable learning environment

Table 1.   Self-regulated learning strategies (Klingsieck, 2013; K.-P. Wild, 1994).

In general, students benefit from the use of the SRL strategies. Consequently, high and regular use of individual SRL strategies indicates good self-regulation in technology-enhanced learning environments. However, it is also crucial for students to develop a wide set of strategies that covers all three categories of learning strategies (Weinstein et al., 2011).

Validated and widely used questionnaires to measure the level of SRL are the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993) and the Learning and Study Strategies Inventory (LASSI). As this study collects data at a German university, scales measuring SRL in German are considered. Consequently, the LIST (K.-P. Wild, 1994) and the LIST-K (Klingsieck, 2018) are identified as appropriate. Both German questionnaires are based on the items of the MSLQ (K.-P. Wild, 1994).

While the LIST is the originally developed survey with 77 items, the LIST-K provides a shorter scale based on 39 items (Klingsieck, 2018).

Besides SRL, research has also established the closely related term self-directed learning as an umbrella term that includes goal setting, metacognition, and self-assessment within learning contexts (Loyens et al., 2008). As both concepts show major similarities, only a few research papers address self-directed learning and SRL as distinct concepts. However, they differ in terms of their backgrounds: While self-directed learning has its roots in adult education, SRL is dominantly used in the school context (Loyens et al., 2008). According to previous research, we use the term self-regulated learning to address the students' independence and responsibility for learning processes during higher education.

With progressively more technology-enhanced learning environments in higher education, students will need a certain level of SRL strategies to successfully manage learning that is increasingly independent of time and place (Anthonysamy et al., 2020). In addition, technology-enhanced learning environments provide higher education institutions with manifold opportunities to foster SRL (Johnson & Davies, 2014). In the "Survey of Self-regulated Learning with Technology at the University" Yot-Domínguez and Marcelo (2017) map SRL strategies to corresponding technologies. Table 2 summarizes the results and maps the technologies according to SRL strategies.

Strategy	Application	Technology or digital content
Cognitive	Comment information	Social networks, cloud-based production and storage tools
	Self-listening	Multimedia resources
	Translate information	Internet resources
	Create concept maps, draft texts and manage bibliography, verify plagiarism	Management tools (e.g., mind map software)
Meta-cognitive	Review of study material	Repositories (e.g., video platforms)
	Be informed	Repositories, social networks, or cloud-based production and storage tools
	Record and receive information	Social markers and RSS
	Watch recorded lectures	Multimedia resources (e.g. videos)
	Self-observation	
	Verify learning	Internet resources
	Locate information	
Resource Management	Exchange information, solve doubts, discussion	Communications tools (e.g., messenger)
	Share one's own productions and material	Repositories (e.g., video platform)
	Information exchange	Social networks
	Teamwork	Cloud-based production and storage tools
	Manage academic activities	Specific apps and calendars

Table 2.   Technology supporting self-regulated learning (Yot-Domínguez & Marcelo, 2017).

2.2 Self-leadership

SL describes a self-influencing process, to gain the necessary self-direction and self-motivation to perform tasks (Neck & Houghton, 2006), regardless if the tasks are inherently motivating or not (Manz, 1986). SL is considered as an essential leadership skill for executives (Goldsby et al., 2021; Watkin et al., 2017) and includes three different categories (Table 3) of behavioral and cognitive strategies which aim to identify and accomplish goals by determining and utilizing related strategies and awards (Stewart et al., 2011). SL strategies are grouped into three superordinate strategies (Neck & Houghton, 2006): 1) Behavior-focused targeting on increasing self-awareness to allow behavioral management. 2) Natural reward strategies aim to create a task design in which a person is inherently motivated by the task or task aspects. 3) Strategies for constructive thought patterns include the generation of thought patterns that impact performance in a positive way or the identification and replacement of dysfunctional

thoughts (Goldsby et al., 2021; Neck & Houghton, 2006). Therefore, SL strategies should be promoted already among students, as their use is positively associated with their own self-efficacy expectations and a reduction of stress, as well as helping them to cope with various difficulties in their future working lives (lknur & Ersin, 2019).

SL strategy	Underlying SL Strategy
Behaviour-focused strategies	Self-observation: raising awareness of when and why a particular behavior is taking place
	Self-goal setting: setting personal goals for life and career in the short and long term.
	Self-rewarding: using physical and non-material rewards upon completion of desired activities or behaviors
	Self-punishment: using self-criticism, guilt, and withdrawal of rewards.
	Self-cueing: using reminders, attention enhancers, and other cues to remember essentials
Natural reward strategies	Including more pleasant / aspects in a required activity
	Focusing on inherently rewarding aspects of an activity
Constructive thought patterns	Identify and replace dysfunctional beliefs
	Mental imagery: creating optimistic or opportunity-oriented thinking patterns
	Self-talk: using constructive, self-instructive, self-motivating inner speech.

Table 3.   Self-Leadership strategies (Manz, 1992; Neck & Houghton, 2006).

In general, students can benefit from applying the SL strategies. Consequently, high and regular usage of the individual SL strategies is desirable, but the promotion of self-punishment strategies needs to be seen in an ambivalent way: Self-punishment can have the potential to enhance self-regulation (Neck & Houghton, 2006), but when used excessively it is not seen as effective (Houghton & Neck, 2002). Self-punishment could even be a trigger for psychosomatic disorders (Basyouni, 2019) or the Dobby Effect, which is associated with negative behavior (Nelissen & Zeelenberg, 2009). As a result, when promoting SL in a technology-enhanced learning environment, it is important to consider the strategy of self-punishment as potentially beneficial but harmful if used too heavily.

Theoretically, SL is based on the framework of self-regulation theory, social cognitive theory, self-management and self-control, and intrinsic motivation (Neck & Houghton, 2006). In contrast to self-management SL does not focus on how to work, but also addresses the question of what to do and how to do it. Therefore SL integrates more intrinsic motivation and cognitive process aspects (Stewart et al., 2011). Besides a conceptual distinction from self-regulation by Neck and Houghton (2006), Bailey et al. (2018) empirically proved, that SL appears to asses particular self-regulatory characteristics that help to predict job performance. This illustrates the independence of SL from the general self-regulation theory. Compared to SRL, SL strategies sometimes have obvious overlaps with SRL (e.g., self-goal setting), whereas SRL strategies are often very specific to the learning context (e.g., learning with other students). Furthermore, SRL strategies have a more descriptive character, whereas SL strategies are seen as more normative (James, 2009). With the Revised Self-Leadership Questionnaire (RSLQ), Houghton and Neck (2002) developed a validated and reliable measurement scale for SL containing 35 items. Andreßen and Konradt (2007) developed on the basis of the RSLQ the RSLQ-D, which is a validated German version of the RSLQ with 27 items.

2.3   Related work

Recent literature reviews provide overviews of current support systems promoting SRL in technology-enhanced learning environments (Heikkinen et al., 2023; Wong et al., 2019) in higher education (Jansen et al., 2019) often with a focus on academic success (Edisherashvili et al., 2021). Furthermore, existing studies examine techniques to foster SRL in commonly used IS in the educational domain (e.g., Shine

and Heath (2020)) or combine digital technologies with certain SRL strategies (Yot-Domínguez & Marcelo, 2017). At the other end of the spectrum, there are literature reviews summarizing existing studies that demonstrate the positive effects of SL as a useful skill set to prepare students for their future careers (Goldsby et al., 2021; Harari et al., 2021). In addition, further studies underline the positive effects of SL on work performance and work engagement (e.g., Inam et al. (2021) or Schultz (2021)). This state of current research raises the tension for our study of the extent to which the effort invested in SRL technology pays off in the later professional lives of graduates. Figure 1 depicts the current state of research as well as the addressed research gap.
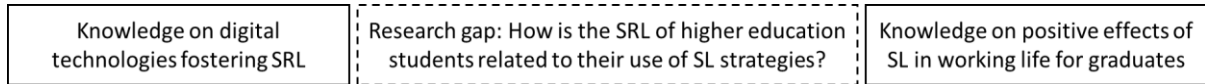
Knowledge on digital technologies fostering SRL	Research gap: How is the SRL of higher education students related to their use of SL strategies?	Knowledge on positive effects of SL in working life for graduates

Figure 1.   *Research gap in the current state of research and related work.*

We aim to build on this existing knowledge base (technologies fostering SRL and effects of SL in working life) and investigate the research gap that bridges the insight by linking SRL to SL. In the existing literature, this investigation of the relationship between SRL and SL has been considered limited. We could only identify one similar approach by James (2009), who also examines the relationship between SL and SRL in terms of their behavioural, motivational, and cognitive dimension. The study indicates that SL and SRL address the same self-regulation processes by identifying some weak to moderate correlations between several SL and SRL strategy dimensions. However, James (2009) states, that there should be further investigations on the cross-application of these theories: SL as a method for teaching SRL and SRL as an approach for promoting professional and organizational learning. Furthermore, Durnali (2020) found indications for a moderate positive correlation between SL and self-directed learning among university students in Turkey. However, implications for SRL training to promote SL are missing.

3   Research Methodology

3.1   Design Science Research

The research context of this study is a larger Design Science Research (DSR) project that follows the DSR cycles of Hevner (2007). The focus of this project is an artifact that is iteratively improved. In this research project, the artifact is a web application with the aim to support students' soft skills development to prepare them for their future careers. So far, the web application is limited to the training of SRL strategies. To build this artifact, our research project has already gone through relevance cycles (examination of the environmental requirements for SRL training in higher education, first field testing of the web application in several basic IS lectures), rigor cycles (implementing basic SRL theories in an IS context, theoretical findings in the field of digital intervention towards an SRL behavior), and design cycles (building and evaluating the web application). The evaluation shows a high acceptance and a good appreciation among the students. The students highlight the relevance of SRL. In addition, the students made suggestions for improvement, which we implemented iteratively (Steinherr, 2021, 2023). The ongoing shift in the environment towards a digitized, fast-changing, and crisis-ridden working (Vay & Steinherr, 2023) and learning environment (e.g., broad usage of online learning platforms due to the Covid-19 pandemic), where leadership competencies are in demand as never before (Moldoveanu & Narayandas, 2019), initiated another relevance cycle in our DSR project (Vay & Steinherr, 2023). This recent relevance cycle revealed the need to expand the application domain of the web application from a learning context towards leadership training on self-regulation in higher education and entails the implementation of the SL theory. Against this background, the results of this study can be classified as a *guideline* according to Offermann et al. (2010) as the study investigates how the web application on SRL should be expanded to enable the development of well-rounded graduates who also meet the necessary self-regulation requirements of current working environments through SL.

3.2 Data Collection

The target population of our research is IS students in higher education. Therefore, we collected data from different IS courses at a German university. For a broad range of IS students, we surveyed IS courses at bachelor's and master's level. Table 4 summarizes the descriptive data of the participating students.

Course	N	Gender		Age				
		m	f	18-20	21-23	24-26	27-29	>29
Bachelor	39	29	10	7	19	10	2	1
Master	29	22	7	0	15	13	1	0
Total	68	51	17	7	34	23	3	1

Table 4.   Demographics of participants.

Data collection took place during the first session of each course. The survey consisted of three different parts. Figure 2 depicts the structure of the used questionnaire.

Demographics	LIST-K	RSLQ-D
Gender Age Course	Cognitive strategies (4 subscales) Metacognitive strategies (3 subscales) Management internal resources (3 subscales) Management external resources (3 subscales)	Behavior-focused strategies (5 subscales) Natural reward strategies (1 subscale) Constructive thought pattern strategies (3 subscales)

Figure 2.   Structure of the questionnaire used in this study.

The first part contained demographic information. To minimize cognitive effort and to increase the likelihood that students would complete the survey thoughtfully, we decided to use the validated short version of an SRL questionnaire to measure SRL: The LIST-K questionnaire with a total of 39 items measures 13 subscales (Klingsieck, 2018). These subscales are mapped to the four subordinate SRL strategies: cognitive and metacognitive strategies as well as strategies for the management of internal and external resources in a differentiated way. The third part of the questionnaire is a German SL questionnaire (RSLQ-D), based on the RSLQ designed by Houghton and Neck (2002). With a total of 27 items, the RSLQ-D measures 9 subscales. These subscales can be categorized into the three SL strategies: behavior-focused strategies, natural reward strategies, and constructive thought pattern strategies. Previous research has examined both scales, the LIST-K as well as the RSLQ-D, multiple times with regard to scale properties, reliability (internal consistency), and validity (construct and criterion-related validity) and stated them to be reliable, construct-valid scales (Andreßen & Konradt, 2007; Houghton & Neck, 2002; Klingsieck, 2018).

In our survey, we measured students' agreement with the items of the LIST-K and the RSLQ-D using a 5 Point Likert Scale. With 1 "strongly disagree" and 5 "strongly agree".

4   Results

4.1 Internal consistency and descriptive data

To determine the internal consistency of the measured items, we analyzed Cronbach's alphas (α) for the constructs of the LIST-K (Table 5) and the RSLQ-D (Table 6). In addition, we report the descriptive data for all constructs.

	SRL strategy	α	Min	Max	Mean
cognitive	Elaboration	0.68	2.33	5.00	3.6667
	Repeating	0.72	1.33	5.00	3.4510
	Organizing	0.85	1.00	5.00	3.5147
	Critical thinking	0.76	2.00	5.00	3.3235
meta-cogni-tive	Monitoring	0.70	1.00	5.00	3.2647
	Regulation	0.64	1.67	5.00	3.8039
	Goal setting and planning	0.73	1.00	5.00	3.3529
Resource man-agement	Time management	0.70	1.00	5.00	2.8578
	Attention	0.87	1.00	5.00	3.2353
	Effort	0.50	2.33	5.00	4.2206
	Literature	0.88	1.00	5.00	3.1863
	Environment	0.32	1.67	4.67	3.4167
	Learning with other students	0.83	1.00	5.00	2.8627

Table 5.   Descriptive data of the LIST-K.

The descriptive data show that students use the learning strategies at different levels. While *effort* has the highest mean value, with 4.2206, the learning strategy that addresses *time management* shows the lowest value with 2.8578. The reliability analysis of the constructs of the LIST-K shows that not all constructs have the minimum internal consistency of Cronbach's alpha ≥ 0.70. Consequently, we exclude the LIST-K constructs *elaboration*, *regulation*, *effort,* and *learning environment* from further analysis. Table 6 summarizes Cronbach's alphas (α) as well as the descriptive data of the RSLQ-D.

SL strategy	α	Min	Max	Mean
Self-observation	0.45	2.33	5.00	4.1863
Self-goal setting	0.70	2.00	5.00	3.8922
Self-rewarding	0.92	1.00	5.00	3.2696
Self-punishment	0.78	2.33	5.00	4.1863
Self-cueing	0.83	1.33	5.00	3.7402
Natural rewards	0.36	2.33	5.00	3.8431
Self-talk	0.73	1.33	5.00	3.8627
Mental imagery	0.85	1.00	5.00	3.3971
Identification and replacement of dysfunctional beliefs	0.70	2.33	5.00	3.9363

Table 6.   Descriptive data of the RSLQ-D.

The descriptive data of the RSLQ-D show that students apply all SL strategies on a high level. No mean value is below 3.2 ("neutral") but there are several mean values around 4 ("agree"). The reliability analysis of the constructs of the RSLQ-D shows that not all constructs have the minimum internal consistency of Cronbach's alpha ≥ 0.70. Consequently, *self-observation* and *natural rewards* cannot be included in further analysis.

4.2   Relation of self-regulated learning strategies and self-leadership

To identify relations between SRL strategies and SL strategies, we performed seven individual multiple regression analyses using IBM's Statistical Package for Social Sciences (SPSS) software. Our goal was to identify the significant relations of SRL strategies on each of the seven SL. With regard to our research question on the relation of SRL and SL, we regressed 7 SL strategies on 9 SRL strategies. We first analyzed the collected data and identified the prerequisites as given (linear relationship, no outliers, independence of the residuals, no multicollinearity, homoskedasticity, and normal distribution). Table 7 presents the results of the seven applied multiple linear regression analyses.

Depending variable	Durbin-Watson statistic	R	R²	Adjusted R	goodness-of-fit	F(9, 58)	p < .05
Self-goal setting	2.293	.628	.394	.300	high	4.198	Significant
Self-rewarding	2.210	.618	.382	.286	high	3.361	Significant
Self-punishment	2.450	.575	.331	.227	high	3.190	Significant
Self-cueing	2.172	.582	.339	.236	high	3.300	Significant
Self-talk	2.156	.531	.282	.171	high	2.530	Significant
Mental imagery	2.023	.404	.163	.033	low	1.256	Not significant
Identification and replacement of dysfunctional beliefs	2.062	.429	.184	.057	low	1.452	Not significant

Table 7.   Summary of seven multiple linear regression analyses.

The Durbin-Watson statistics of the seven multiple linear regression analyses show that the seven underlying models have no autocorrelation, as all values are around 2. Regarding the R², Cohen (2013) defines their goodness of fit as follows: low goodness of fit $|R^2|$ = .02; moderate goodness of fit $|R^2|$ = .13; high goodness of fit $|R^2|$ = .26. The criterion for significance is a significance level of $p < .05$. As Table 7 depicts, five of the seven multiple linear regression analyses identified the underlying model as significant. Consequently, in these models, the use of SRL strategies is able to significantly predict *self-goal setting*, *self-rewarding*, *self-punishment*, *self-cueing*, and *self-talk*. However, the SL strategies *mental imagery* and *identification and replacement of dysfunctional beliefs* are not significantly related to SRL strategies. Figure 3 shows the identified significant relations and the corresponding regression coefficients based on the results of the seven multiple linear regression analyses.
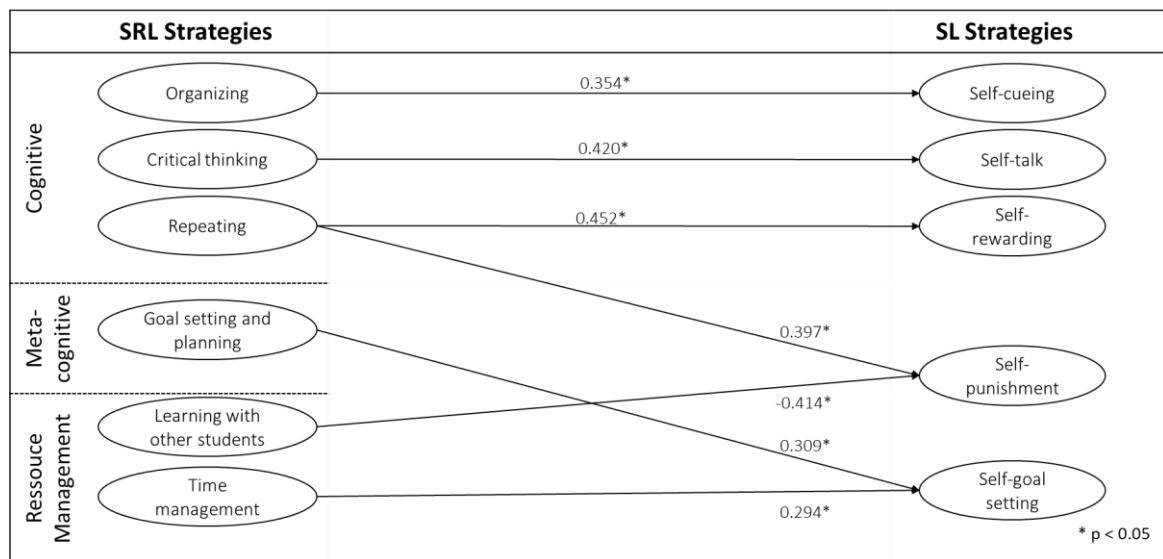

Figure 3.   Identified significant relations between SRL and SL constructs.

The seven multiple linear regression analyses identified several significant relations between SRL and SL. In the analysis, we investigated the relation between nine SRL and seven SL strategies. Of the six SRL strategies that showed a significant relation to SL, three were identified without a significant relation. While three SRL strategies (*attention*, *literature*, *monitoring*) do not have a significant relation to SL strategies, most SRL strategies show a positive and significant relation to SL strategies. The multiple linear regression analysis identified *repeating* with two significant relations (*self-rewarding* and *self-punishment*). Five SRL strategies (*learning with other students*, *organizing*, *goal setting and planning*, *time management*, and *critical thinking*) are identified with a significant relation to one SL strategy. Out

of the seven identified relations between SRL and SL, one relation shows a negative relation (*learning with other students* and *self-punishment)*.

The seven multiple linear regression analyses also identified that most SL strategies have a significant relation to SRL. While five SL strategies (*self-rewarding*, *self-cueing*, *self-goal setting self-talk*) are significantly related to SRL, two SL strategies (*mental imagery* and *identification and replacement of beliefs*) do not show a significant relation. Out of the SL strategies that are related to SRL, three (*self-rewarding, self-punishment, self-cueing, self-talk*) have a relation to a single SRL strategy and two (*self-punishment* and *self-goal setting*) have a significant relation to two SRL strategies.

5 Discussion

The goal of this study was to identify relations between students' SRL and SL usage and to relate these findings to digital technologies or content. Based on these findings, we derive practical implications and improvement opportunities for SRL training towards a more job-oriented self-regulation training by also considering SL in a technology-enhanced learning environment.

5.1 Identified relations between SRL and SL

This study reveals several statistically significant relations between students' usage of SRL and SL strategies. Three cognitive SRL strategies show a positive significant relation to SL strategies: First, the cognitive SRL strategy *organizing* is positively related to the SL strategy *self-cueing* (0.354*). This implies that students who organize their learning activities, use *self-cueing* as a strategy to remind themselves, e.g., of their own goals, and to regulate themselves. Second, the cognitive SRL strategy *critical thinking* is positively related to the SL strategy *self-talk* (0.420*). This implies that students who use *critical thinking* tend to use the constructive-thought pattern strategy *self-talk* from an SL perspective to regulate themselves. Third, the cognitive SRL strategy *repeating* is positively related to the SL strategies *self-rewarding* (0.452*) and *self-punishment* (0.397*). This indicates that students applying the SRL strategy *repeating* tend to use *self-rewarding* but also *self-punishment* strategies to regulate themselves in an SL context. Due to the identified significant and positive relationship of these three cognitive learning strategies and SL, the training of these SRL strategies might also bring benefits to students' SL skills.

Furthermore, the metacognitive SRL strategy *goal setting and planning* is positively related to the SL strategy *self-goal setting* (0.309*). This implies that students who use SRL *goal setting and planning* strategies within their learning activities tend to use also *self-goal setting* strategies from an SL perspective to regulate themselves. This also indicates a possible overlapping of both theories.

In addition, SRL strategies dealing with resource management show significant relations to SL strategies. Here, the SRL strategy *learning with fellow students* is negatively related to the SL strategy *self-punishment* (-0.414*). This indicates that students who learn in groups with their fellow students use less *self-punishment* to regulate themselves. The resource management related SRL strategy *time management* is positively related to the SL strategy *self-goal setting* (0.294*). This implies that students who manage their time tend to have self-set goals they follow to regulate themselves.

Moreover, for the statistically significant relations between SRL and SL, we identified three SRL strategies that have no relation with SL strategies: *attention*, *literature*, and *regulation*. Furthermore, the SL strategies *identification and replacement of dysfunctional beliefs* and *mental imagery* do not have relations with SRL strategies. Based on these findings, the following conclusions can be drawn. First, the promotion of the strategies *attention*, *literature*, and *regulation* does not influence the usage of any SL strategy. Consequently, these strategies can be considered as rather specific strategies for a learning context. Second, skills related to the *identification and replacement of dysfunctional beliefs* and *mental imagery* need to be trained to gain, from an SL perspective, holistically trained graduates.

5.2   Practical implications

In terms of practical implications, our results allow us to suggest how SRL and SL skills can be simultaneously promoted in technology-enhanced learning environments. Combining the results of the seven multiple linear regression analyses with the results of the "Survey of Self-Regulated Learning with Technology in Higher Education" (Yot-Domínguez & Marcelo, 2017) and related work provides concrete recommendations for more holistic and job-oriented self-regulation training in higher education. In the following, we discuss opportunities to foster both SRL as well as SL in technology-enhanced learning environments, with a focus on higher education.

The SRL strategy *repeating* can be promoted by providing multimedia resources. This includes, for example, the repetition of definitions or formulas over and over, using digital flashcards, listening to video recordings or podcasts of lectures over and over, and highlighting material in scripts (Weinstein et al., 2011; Yot-Domínguez & Marcelo, 2017). Combining *repeating* with *self-rewarding* can be done through prompts for self-rewarding at the end of lecture recordings that suggest students to reward themselves for completing the repetition task. Such rewards for students can include reminders of future benefits of learning behavior, as well as physical objects, or self-praising thoughts (Manz, 1992). The relation to *self-punishment* can be made by eliminating rewards that foster negative behavior, such as unsustainable or incomplete repetition phases. By establishing rewards for behaviors that are more desirable than unwanted behaviors, students can systematically guide themselves towards desired behaviors (Manz, 1986).

The SRL strategy *organizing* can be applied using specific apps, for example, graphic organizers, to create outlines, cause-and-effect charts, mind maps, and relationship diagrams (Weinstein et al., 2011; Yot-Domínguez & Marcelo, 2017). By identifying and highlighting priorities and cues regarding important learning tasks, *organizing* can also address *self-cueing* (Manz, 1992). Lecturers can enrich organizing tasks, for example, to create mind-maps summarizing the content of a lecture unit with prompts for *self-cueing*. In doing so, students train to identify cues and guide their focus (Manz, 1992).

The SRL strategy *critical thinking* can be applied by questioning one's understanding while reading digital scripts or consuming lecture videos and further internet resources (Bjork et al., 2013; Yot-Domínguez & Marcelo, 2017). When guiding students in their critical thinking, for example through reflective questions in provided digital resources, lecturers can add prompts such as "explain yourself why/how [...]" to nudge students towards *self-talk.* In this way, constructive *self-talk*, including self-instructional thoughts, can be fostered (Manz, 1992). This helps students prepare for potential comprehension difficulties and upcoming challenges (Manz, 1992).

The SRL strategy *learning with fellow students* can be supported by instructing students to use communication tools (e.g., messenger), cloud-based production and storage tools that might already be included in a university's learning management system as well as further social networks (Yot-Domínguez & Marcelo, 2017). Studies show that students who learn in groups foster their self-esteem, sense of worth, and motivation (Rienovita et al., 2018). Consequently, *learning with fellow students* could prevent students from relying too heavily on self-punishment and lead students towards applying this learning strategy in a healthy level (Manz, 1992).

The SRL strategy g*oal setting and planning* can be carried out using open-source products, web 2.0 tools, social networking sites, as well as blogging tools, for example, through e-portfolios, including the ability to share the goals with peers or teachers (Alexiou & Paraskeva, 2010; Yot-Domínguez & Marcelo, 2017). Besides, the possibility to work out learning material by themselves with the help of multimedia content and sharing ideas with others, e.g., via social networks, could foster *self-goal setting* among students (Yot-Domínguez & Marcelo, 2017). The SRL strategy *time management* can be supported by providing specific apps and calendars (Yot-Domínguez & Marcelo, 2017). Calendars that are compatible with personal digital calendars to keep track of deadlines as well as exam dates, remind students of important dates, and study before deadlines are beneficial (Mei, 2016). *Goal setting and planning,* as well as *time management,* can foster *self-goal setting,* for example, through prompts for specific goal setting and the consideration of long- and short-term goals when students plan their weekly schedules and share goals (Manz, 1992).

SRL strategy	Relation	SL strategy	Suggested technology or digital content	Exemplary implementation
repeating	positive	self-rewarding	Multimedia resources	Implementation of self-rewarding prompts in learning videos
	positive	self-punishment		
organizing	positive	self-cueing	Specific apps and calendars	Implementation of calendars into the learning management systems which are compatible with personal digital calendars
critical thinking	positive	self-talk	digital scripts, videos, Internet resources	Implementation of reflective questions after a digital learning unit
learning with fellow students	negative	self-punishment	Communication tools, cloud-based production/storage tools, social networks	Implementation of messenger applications, social networks, and share digital files folders into the learning management system
Goal setting and planning	positive	Self-goal setting	Multimedia content, social networks	Implementation of self-goal setting and sharing functions directly after videos and, in general, into the learning management system
Time management			Specific apps and calendars	Implementation of calendars into learning management systems which are compatible with personal digital calendars

Table 8.   Relations between SRL strategies, SL strategies, and technology or digital content.

Regarding the three SRL strategies without statistically significant relation with SL strategies, the question arises of how these SL strategies can be fostered through the usage of digital tools in a technology-enhanced learning environment. One possible way to answer this question could be the use of psychological methods, e.g., Kocur et al. (2021), which aim to reduce dysfunctional beliefs with a computer-assisted avatar-based adjunct. To train *mental imagery*, digital experiences could be used to stimulate and foster its usage (Stergiou et al., 2019). While this chapter provides an overview and inspiration for lecturers to implement a more holistic self-regulation training that addresses both SRL and SL, studies highlight the importance of explicitly addressing these strategies as learning goals (Majid et al., 2019; Steinherr & Vay, 2022). Thus, only providing technologies or content to promote self-regulation without embedding them in a way that requires students to actively interact with them is not sufficient for successful education. Furthermore, lecturers should give students concrete tasks and prompts and thus provide guidance on the usage of the addressed SRL and SL strategies.

5.3 Theoretical contribution

From a theoretical perspective, we contribute to filling an existing research gap by examining the relationship between different theories of self-regulation (Houghton & Neck, 2002; James, 2009). The relationships identified in this study extend the understanding of the SL and SRL constructs.

With a focus on superordinate strategies, analyzing the interrelationships of SRL and SL reveals a clear pattern. From an SRL perspective, all superordinate strategies (cognitive, metacognitive, and resource management) show a significant relation to SL. However, from an SL perspective, mainly behavior-focused strategies have a significant relation to SRL. This reveals that the superordinate strategy *constructive thought patterns* (including the *identification and replacement of dysfunctional beliefs* and *mental imagery)* is a valuable addition to SRL towards a more holistic self-regulation training.

Analysis at the level of individual SRL strategy reveals multiple significant correlations between both theories. These significant positive relations, along with the constructs themselves, indicate an

overlapping of both theories. For example, the data suggest that the SRL strategies *goal setting and planning,* and *time management* may overlap with the SL strategy *self-goal setting*. However, the data also suggest differences between both theories. The SRL strategies *monitoring*, *literature,* and *attention* do not show significant relations to SL. The items of *literature* and *attention* indicate a clear focus on learning tasks (e.g., "I consult additional literature when my notes are incomplete.", "If there are questions or tests included in the learning material, I use them to check myself."). This can explain the absence of the more job-oriented self-regulation theory of SL. However, the construct *attention*, which includes items such as "It's hard for me to stay on task ", and "I am easily distracted" (both items are coded reversed) might provide a valuable addition and further development of the SL theory. Moreover, the SL theory also provides self-regulatory aspects that could enrich SRL. In our study, *identification and replacement of dysfunctional beliefs*, as well as *mental imagery* are identified without a significant relation to measured SRL strategies. Regarding *mental imagery* there is already existing research in the field of pedagogical psychology, that is revealing its relation to SRL (Efklides, 2011). Combining the findings of previous research and the findings of our study suggests a consideration of *mental imagery* within the SRL theory to broaden higher education students' self-regulation training. This enrichment could be beneficial for both, students' current academic careers and also future workplaces.

6 Outlook to future research

By investigating the relationship between SRL and SL, we were able to provide theoretical and practical implications for leadership education in a technology-enhanced learning environment. Our study reveals multiple significant relations between students' SRL and SL strategy usage. These findings suggest several insights for self-regulation training in the context of leadership education in higher education: First, the application of SRL strategies is partially related to SL skills that are important for future executives in our complex and dynamic working environment (Watkin et al., 2017). Second, some SL skills are not related to the application of SRL strategies. More specifically, these SL strategies are the *identification and replacement of dysfunctional beliefs* and *mental imagery*. Consequently, these strategies need to be trained separately from the SRL training. Therefore, the necessity for researchers and practitioners to deal with the promotion of these strategies in a technology-enhanced learning environment arises. In this regard, they need to find out how to use, develop, and apply digital content or technologies to gain, from an SL perspective, well-trained and well-rounded graduates who are ready for the challenges in our complex and dynamic working environment. Our study is limited by several constructs that were not able to meet the criterium for internal consistency (Cronbach's alpha $\geq$ 0.70). Due to this requirement for meaningful analysis, a total of six constructs were excluded from the further investigation (*self-observation*, *natural rewards*, *elaboration*, *regulation*, *effort,* and *learning environment*). Furthermore, our study has a certain risk of being influenced by an endogeneity problem. Therefore, we recommend confirming our results, e.g. by collecting and analyzing time series or panel data (Sande & Ghosh, 2018). Besides, our findings are based on two German questionnaires that address SRL or SL. While the questionnaires selected for the study are the most fitting questionnaires for the participants (German IS students), other questionnaires in English capture different facets of SRL. Therefore, to gain a deeper understanding, we suggest further investigation of the relations between different SRL concepts and SL. Based on our findings, we encourage further research towards a more holistic self-regulatory training for higher education that addresses both competencies that students need during their academic education but also includes competencies students require as future leaders. In addition, we promote research on technology to foster self-regulatory competencies from a practical as well as a theoretical perspective. In general, a more detailed framework that refines our findings by describing the impact of a particular technology or content on self-regulatory capabilities could be an interesting area of research. Especially for the SL strategies not being fostered by SRL training (*identification and replacement of dysfunctional beliefs* and *mental imagery*) further research is needed to reveal which digital technologies, tools, or methods help to implement the promotion of these strategies in higher education.

References

Alexiou, A., & Paraskeva, F. (2010), "Enhancing self-regulated learning skills through the implementation of an e-portfolio tool," *Procedia - Social and Behavioral Sciences* 2 (2), 3048–3054, https://doi.org/10.1016/j.sbspro.2010.03.463.

Andreßen, P., & Konradt, U. (2007), "Messung von Selbstführung: Psychometrische Überprüfung der deutschsprachigen Version des Revised Self-Leadership Questionnaire," *Zeitschrift Für Personalpsychologie* 6 (3), 117–128, https://doi.org/10.1026/1617-6391.6.3.117.

Anthonysamy, L., Koo, A. C., & Hew, S. H. (2020), "Self-regulated learning strategies in higher education: Fostering digital literacy for sustainable lifelong learning," *Education and Information Technologies* 25 (4), 2393–2414, https://doi.org/10.1007/s10639-020-10201-8.

Bailey, S. F., Barber, L. K., & Justice, L. M. (2018), "Is Self-Leadership Just Self-Regulation? Exploring Construct Validity with HEXACO and Self-Regulatory Traits," *Current Psychology* 37 (1), 149–161, https://doi.org/10.1007/s12144-016-9498-z.

Bentivoglio, C. A., Bonura, D., Cannella, V., Carletti, S., Pipitone, A., Pirrone, R., Rossi, P. G., & Russo, G. (2010), "Intelligent Agents supporting user interactions within self regulated learning processes," *Journal of E-Learning and Knowledge Society* 6 (2), 27–36.

Bjork, R. A., Dunlosky, J., & Kornell, N. (2013), "Self-regulated learning: Beliefs, techniques, and illusions," *Annual Review of Psychology* 64, 417–444, https://doi.org/10.1146/annurev-psych-113011-143823.

Boekaerts, M. (1999), "Self-regulated Learning: Where We are Today," *International Journal of Educational Research* 31 (6), 445-457, https://doi.org/10.1016/S0883-0355(99)00014-2.

Boor, I., & Cornelisse, S. (2021), "How to Encourage Online Self-regulation of Students," *Communications of the Association for Information Systems* 48 (1), 211–217, https://doi.org/10.17705/1CAIS.04827.

Broadbent, J., Panadero, E., & Fuller-Tyszkiewicz, M. (2020), "Effects of mobile-app learning diaries vs online training on specific self-regulated learning components," *Educational Technology Research and Development* 68 (5), 2351–2372, https://doi.org/10.1007/s11423-020-09781-6.

Bygstad, B., Øvrelid, E., Ludvigsen, S., & Dæhlen, M. (2022), "From dual digitalization to digital learning space: Exploring the digital transformation of higher education," *Computers & Education* 182, 1–11, https://doi.org/10.1016/j.compedu.2022.104463.

Cohen, J. (2013). *Statistical Power Analysis for the Behavioral Sciences*, 2nd Edition. New York: Routledge.

Durnali, M. (2020), "The effect of Self-Directed Learning on the relationship between Self-Leadership and Online Learning among university students in Turkey," *Tuning Journal for Higher Education* 8 (1), 129–165, https://doi.org/10.18543/tjhe-8(1)-2020pp129-165.

Edisherashvili, N., Saks, K., Pedaste, M., & Leijen, Ä. (2021), "Supporting Self-Regulated Learning in Distance Learning Contexts at Higher Education Level: Systematic Literature Review," *Frontiers in Psychology* 12, 792422, https://doi.org/10.3389/fpsyg.2021.792422.

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.

Eggers, J. H., Oostdam, R., & Voogt, J. (2021), "Self-regulation strategies in blended learning environments in higher education: A systematic review," *Australasian Journal of Educational Technology* 37 (6), 175–195, https://doi.org/10.14742/ajet.6453.

Goldsby, M. G., Goldsby, E. A., Neck, C. B., Neck, C. P., & Mathews, R. (2021), "Self-Leadership: A Four Decade Review of the Literature and Trainings," *Administrative Sciences* 11 (1), 1–21, https://doi.org/10.3390/admsci11010025.

Hamdan, K. M., Al-Bashaireh, A. M., Zahran, Z., Al-Daghestani, A., AL-Habashneh, S., & Shaheen, A. M. (2021), "University students' interaction, Internet self-efficacy, self-regulation and satisfaction with online education during pandemic crises of COVID-19 (SARS-CoV-2)," *International Journal of Educational Management* 35 (3), 713–725, https://doi.org/10.1108/IJEM-11-2020-0513.

Harari, M. B., Williams, E. A., Castro, S. L., & Brant, K. K. (2021), "Self-leadership: A meta-analysis of over two decades of research," *Journal of Occupational and Organizational Psychology* 94 (4), 890–923, https://doi.org/10.1111/joop.12365.

Heikkinen, S., Saqr, M., Malmberg, J., & Tedre, M. (2023), "Supporting self-regulated learning with learning analytics interventions," *Education and Information Technologies* 28 (3), 3059–3088, https://doi.org/10.1007/s10639-022-11281-4.

Hevner, A. R. (2007), "A Three Cycle View of Design Science Research," *Scandinavian Journal of Information Systems* 19 (2), 87–92.

Houghton, J. D., & Neck, C. P. (2002), "The Revised Self-leadership Questionnaire: Testing a hierarchical factor structure for self-leadership," *Journal of Managerial Psychology* 17 (8), 672–691, https://doi.org/10.1108/02683940210450484.

Inam, A., Ho, J. A., Sheikh, A. A., Shafqat, M., & Najam, U. (2021), "How self leadership enhances normative commitment and work performance by engaging people at work?," *Current Psychology*, 1–14, https://doi.org/10.1007/s12144-021-01697-5.

James, A. M. (2009), "Self-Leadership and Self-Regulated Learning: An Investigation of Theoretical Relationships," *Journal of Business & Leadership: Research, Practice, and Teaching* 5 (1), 59–67.

Jansen, R. S., van Leeuwen, A., Janssen, J., Jak, S., & Kester, L. (2019), "Self-regulated learning partially mediates the effect of self-regulated learning interventions on achievement in higher education: A meta-analysis," *Educational Research Review* 28, 100292, https://doi.org/10.1016/j.edurev.2019.100292.

Johnson, G. M., & Davies, S. M. (2014), "Self-Regulated Learning in Digital Environments: Theory, Research, Praxis," *British Journal of Research* 1 (2), 1–14.

Karoly, P. (1993), "Mechanisms of self-regulation: a view," *Annual Review of Psychology* 44.

Klingsieck, K. B. (2013), "Procrastination: When Good Things Don't Come to Those Who Wait," *European Psychologist* 18 (1), 24–34, https://doi.org/10.1027/1016-9040/a000138.

Klingsieck, K. B. (2018), "Kurz und knapp: Die Kurzskala des Fragebogens „Lernstrategien im Studium" (LIST)," *Zeitschrift Für Pädagogische Psychologie* 32 (4), 249–259, https://doi.org/10.1024/1010-0652/a000230.

Kocur, M., Dechant, M., Wolff, C., Nothdurfter, C., Wetter, T. C., Rupprecht, R., & Shiban, Y. (2021), "Computer-Assisted Avatar-Based Treatment for Dysfunctional Beliefs in Depressive Inpatients: A Pilot Study," *Frontiers in Psychiatry* 12, 1–13, https://doi.org/10.3389/fpsyt.2021.608997.

Kontostavlou, E. Z., & Drigas, A. (2021), "How Metacognition Supports Giftedness in Leadership," *International Journal of Advanced Corporate Learning (IJAC)* 14 (2), 4–16, https://doi.org/10.3991/ijac.v14i2.23237.

Landmann, M., Perels, F., Otto, B., Schnick-Vollmer, K., & Schmitz, B. (2015), "Selbstregulation und selbstreguliertes Lernen," in: E. Wild & J. Möller (eds.), *Springer-Lehrbuch. Pädagogische Psychologie*, pp. 45–65, Springer.

lknur, M., & Ersin, U. (2019), "The predictive power of university student' self-leadership strategies on their self-efficacy," *Educational Research and Reviews* 14 (11), 372–379, https://doi.org/10.5897/ERR2019.3747.

Lord, R. G., Diefendorff, J. M., Schmidt, A. M., & Hall, R. J. (2010), "Self-Regulation at Work," *Annual Review of Psychology* 61 (1), 543–568, https://doi.org/10.1146/annurev.psych.093008.100314.

Loyens, S. M. M., Magda, J., & Rikers, R. M. J. P. (2008), "Self-Directed Learning in Problem-Based Learning and its Relationships with Self-Regulated Learning," *Educational Psychology Review* 20 (4), 411–427, https://doi.org/10.1007/s10648-008-9082-7.

Majid, S., Eapen, C. M., Aung, E. M., & Oo, K. T. (2019), "The Importance of Soft Skills for Employability and Career Development: Students and Employers' Perspectives," *Journal of Soft Skills* 13 (4), 7–39.

Manz, C. C. (1986), "Self-Leadership: Toward an Expanded Theory of Self-Influence Processes in Organizations," *Academy of Management Review* 11 (3), 585–600, https://doi.org/10.5465/amr.1986.4306232.

Manz, C. C. (1992), "Self-Leadership…The Heart of Empowerment," *The Journal for Quality and Participation* 15 (4), 1–11.

Megheirkouni, M., & Mejheirkouni, A. (2020), "Leadership development trends and challenges in the twenty-first century: rethinking the priorities," *Journal of Management Development* 39 (1), 97–124, https://doi.org/10.1108/JMD-04-2019-0114.

Mei, J. (2016), "Learning Management System Calendar Reminders and Effects on Time Management and Academic Performance," *International Research and Review* 6 (1), 29–45.

Moldoveanu, M., & Narayandas, D. (2019), "The Future of Leadership Development," *Harvard Business Review* 97 (2), 40–48.

Mooij, T., Steffens, K., & Andrade, M. S. (2014), "Self-Regulated and Technology-Enhanced Learning: A European Perspective," *European Educational Research Journal* 13 (5), 519–528, https://doi.org/10.2304/eerj.2014.13.5.519.

Neck, C. P., & Houghton, J. D. (2006), "Two Decades of Self-leadership Theory and Research," *Journal of Managerial Psychology* 21 (4), 270–295.

Offermann, P., Blom, S., Schönherr, M., & Bub, U. (2010), "Artifact Types in Information Systems Design Science: A Literature Review," in: R. Winter, J. L. Zhao, & S. Aier (eds.) *Global Perspectives on Design Science Research: Lecture Notes in Computer Science*, Springer, Berlin, Heidelberg, https://doi.org/10.1007/978-3-642-13335-0_6.

Panadero, E. (2017), "A Review of Self-regulated Learning: Six Models and Four Directions for Research," *Frontiers in Psychology* 8, 1–28, https://doi.org/10.3389/fpsyg.2017.00422.

Pérez-Álvarez, R., Maldonado-Mahauad, J., & Pérez-Sanagustín, M. (2018), "Tools to Support Self-Regulated Learning in Online Environments: Literature Review," in: V. Pammer-Schindler, M. Pérez-Sanagustín, H. Drachsler, R. Elferink, & M. Scheffel (eds.), *Lecture Notes in Computer Science. Lifelong Technology-Enhanced Learning*, Springer, https://doi.org/10.1007/978-3-319-98572-5_2.

Pintrich, P. R., & Groot, E. V. de (1990), "Motivational and Self-Regulated Learning Components of Classroom Academic Performance," *Journal of Educational Psychology* 82 (1), 33–40, https://doi.org/10.1037/0022-0663.82.1.33.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993), "Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ)," *Educational and Psychological Measurement* 53 (3), 801–813, https://doi.org/10.1177/0013164493053003024.

Reyes, D. L., Dinh, J., Lacerenza, C. N., Marlow, S. L., Joseph, D. L., & Salas, E. (2019), "The state of higher education leadership development program evaluation: A meta-analysis, critical review, and recommendations," *The Leadership Quarterly* 30 (5), 101311, https://doi.org/10.1016/j.leaqua.2019.101311.

Rienovita, E., Taniguchi, M., Kawahara, M., Hayashi, Y., & Takeuchi, Y. (2018), "Implementation of Interactive Peer Learning Environment Enhances Learners' Self-Esteem and Self-Efficacy," *International Journal of Learning Technologies and Learning Environments* 1 (1), 1–24, https://doi.org/10.52731/ijltle.v1.i1.227.

Sande, J. B., & Ghosh, M. (2018), "Endogeneity in survey research," *International Journal of Research in Marketing* 35 (2), 185–204, https://doi.org/10.1016/j.ijresmar.2018.01.005.

Scheu, S., & Benke, I. (2022), "Digital Assistants for Self-Regulated Learning: Towards a State-Of-The-Art Overview, " in: S. Matook, R. Helms, M. Wiener, L. Rusu, & T. Tuunanen (eds.) *Thirtieth European Conference on Information Systems,* Timișoara, Romania.

Schultz, C. M. (2021), "The relationship between self-leadership, the future of human resource management, and work engagement," *SA Journal of Human Resource Management* 19, 12.

Shine, B., & Heath, S. E. (2020), "Techniques for Fostering Self-Regulated Learning Via Learning Management Systems in On-Campus and Online Courses," *Journal of Teaching and Learning with Technology* 9 (1), 119–126, https://doi.org/10.14434/jotlt.v9i1.29014.

Steffens, K. (2006), "Self-Regulated Learning in Technology-Enhanced Learning Environments: lessons of a European peer review," *European Journal of Education* 41 (3-4), 353–379, https://doi.org/10.1111/j.1465-3435.2006.00271.x.

Steinherr, V. (2021), "LANA–A Behavior Change Support System towards Self-regulated Learning, " in: A. Benoit, G. Pare, & W. Chin (eds.) *Proceedings of the 27th American Conference of Information Systems,* Montreal, Kanada.

Steinherr, V. (2023), "Design Requirements for Behavior Change Support Systems with High Use Continuance: Insights for the Target Group of Students," in: Tung Bui (ed.) *Proceedings of the 56th Hawaii International Conference on System Sciences*, Lāhainā, USA.

Steinherr, V., & Vay, C. (2022), "Personal Skills in the BISE Curriculum: An Integrative Approach, " in: Sven Laumer & Martin Matzner (eds.), *17th International Conference on Wirtschaftsinformatik,* Nuremberg, Germany.

Stergiou, M., El Raheb, K., & Ioannidis, Y. (2019), "Imagery and metaphors: from movement practices to digital and immersive environments, " in: G. Coleman (ed.), *6th International Conference on Movement and Computing,* Tempe, USA.

Stewart, G. L., Courtright, S. H., & Manz, C. C. (2011), "Self-Leadership: A Multilevel Review," *Journal of Management* 37 (1), 185–222, https://doi.org/10.1177/0149206310383911.

Vay, C., & Steinherr, V. (2023), "Leadership in a digitalized and crisis-ridden world: towards a comprehensive overview of relevant competencies for leaders," in: Tung Bui (ed.) *Proceedings of the 56th Hawaii International Conference on System Sciences*, Lāhainā, USA.

Wan, Z., Compeau, D., & Haggerty, N. (2012), "The Effects of Self-Regulated Learning Processes on E-Learning Outcomes in Organizational Settings," *Journal of Management Information Systems* 29 (1), 307–339, https://doi.org/10.2753/MIS0742-1222290109.

Wang, Y., Gao, H., Sun, c., Liu, J., & Fan, X. (2021), "Academic procrastination in college students: The role of self-leadership," *Personality and Individual Differences* 178 (1), https://doi.org/10.1016/j.paid.2021.110866.

Watkin, D., Earnhardt, M., Pittenger, L., Roberts, R., Rietsema, K., & Cosman-Ross, J. (2017), "Thriving in Complexity: A Framework for Leadership Education," *Journal of Leadership Education* 16 (4), 148–163, https://doi.org/10.12806/V16/I4/T4.

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.

Wild, K.-P. (1994), "Lernstrategien im Studium: Ergebnisse zur Faktorenstruktur und Reliabilität eines neuen Fragebogens," *Zeitschrift Für Differentielle Und Diagnostische Psychologie* 15 (4), 185–200.

Wong, J., Baars, M., Davis, D., van der Zee, T., Houben, G.-J., & Paas, F. (2019), "Supporting Self-Regulated Learning in Online Learning Environments and MOOCs: A Systematic Review," *International Journal of Human–Computer Interaction* 35 (4-5), 356–373, https://doi.org/10.1080/10447318.2018.1543084.

Yot-Domínguez, C., & Marcelo, C. (2017), "University students' self-regulated learning using digital technologies," *International Journal of Educational Technology in Higher Education* 14 (1), 1–18, https://doi.org/10.1186/s41239-017-0076-8.

Zimmerman, B. J. (1990), "Self-Regulated Learning and Academic Achievement: An Overview," *Educational Psychologist* 25 (1), 3–17, https://doi.org/10.1207/s15326985ep2501_2.

Zimmerman, B. J., & Schunk, D. H. (2011), "Self-Regulated Learning and Performance: An Introduction and an Overview," in: B. J. Zimmerman (ed.) *Handbook of Self-Regulation of Learning and Performance*, Routledge.