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Differences in students’ metacognitive strategy knowledge, motivation, and strategy use: A typology of self-regulated learners

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ABSTRACT
Metacognitive strategy knowledge, motivation, and learning strategies play an important role in self-regulated learning (SRL). However, little is known about different profiles of self-regulated learners in schools that prepare students for the university entrance certificate. The aim of this study was to examine intraindividual differences in the patterns of students’ SRL. In this 2-wave longitudinal study, 897 students were involved. Latent class analyses revealed four-cluster solutions at the beginning as well as at the end of the school year. Maximal self-regulated learners with the highest levels on all cognitive, metacognitive, and motivational components of SRL reported the highest grades in the academic subject of German (first language) at both measurement points, followed by motivated and strategic learners. Students with a low level on several SRL components reported the lowest grades. Further, the results indicated changes in profiles of SRL over time.

Components of self-regulated learning
Metacognitive strategy knowledge is a subcomponent of metacognition that is broadly defined as cognition about cognition (Zohar, 2012). It is verbalizable and consciously accessible knowledge that affects the information and memory process (Pintrich, 2002). Flavell (1979) divided metacognitive knowledge into an individual’s knowledge about his or her own capacities to process information and the factors that influence his or her own performance (person dimension), knowledge about task characteristics and requirements (task dimension), and knowledge about strategies (strategy dimension). However, the concept of metacognitive strategy knowledge used in this study addresses the task and the strategy dimension and encompasses knowledge about task characteristics and requirements as well as about the appropriateness and effectiveness of learning strategies with respect to the (specific) task demands. Furthermore, metacognitive strategy knowledge refers to the knowledge of what measures can be taken to successfully solve a problem and encompasses knowledge of the relative benefit of a learning strategy over another. Therefore, metacognitive strategy knowledge enables students to know why and when a learning strategy is useful (Kuhn, 2000; Schraw, Crippen, & Hartley, 2006).

Learning strategies are considered a key component of SRL. From a cognitive-psychological view, learning strategies can be understood as behaviors and cognitions that learners activate more or less consciously to influence the processing of
information, the learning process, and their motivation (Bork-kaerts, 1999; Weinstein & Mayer, 1986). Cognitive strategies are required to process, transform, and organize information, whereas metacognitive strategies refer to the planning, monitoring, and evaluation of learning. Successful self-regulated learners might not only have an elaborated learning strategy repertoire, but also know how to use learning strategies adequately in order to reach their learning goals. Artelt and Neuenhaus (2010) found in their study that students with high metacognitive strategy knowledge and low frequency of strategy use outperformed those students with low metacognitive strategy knowledge and high frequency of strategy use. Students with the highest level on both components showed the highest level of performance in the German PISA reading comprehension test. It seems to be that not the frequency but the quality of the learning strategies use is crucial for superior performance.

The students’ ability to engage into the learning process, to be willing to complete tasks, and to regulate their own motivation is essential for SRL (Zimmerman & Schunk, 2008). Learning motivation includes motivational motives for learning (e.g., intrinsic motivation) as well as the ability to maintain concentration and effort even when difficulties arise (persistence; Heckhausen & Heckhausen, 2010; Ryan & Deci, 2000). Researchers have suggested that learners who are highly motivated are more attentive to their learning process, implement learning strategies more effectively, establish a more productive environment, provide greater effort, persist longer at tasks, and show higher metacognitive skills (Boekaerts, 1997; Coutinho & Neuman, 2008; Meneghetti & De Beni, 2010). Thus, learning motivation has a direct influence on the quality, scope, and results of learning activities. Broadly defined, self-concept can be understood as a person’s perception of himself (Rosenberg, 1979) and self-efficacy can be defined as individual confidence to overcome learning difficulties and to accomplish tasks successfully (Bandura, 1997). Self-concept and self-efficacy are strongly related to each other and share many similarities; for example, they are both formed through experiences with the environment. Further, both are strongly related to an individual’s strategic skills (Bong & Skaalvik, 2003; Schraw, 1998). Previous research findings have shown that self-concept and self-efficacy are meaningful predictors for students’ strategy use, metacognition, and performance (Diseth, 2011; Greene, Miller, Crowson, Duke, & Akey 2004; Liem, Lau, & Nie, 2008; Pintrich & De Groot, 1990; Robbins et al., 2004).

Interaction among metacognitive strategy knowledge, learning strategies, and motivation

In the last few years, models of SRL that take the interaction of cognition, metacognition, and motivation into consideration have received more attention (e.g., Borkowski, Chan, & Muthukrishna, 2000; Efklides, 2011). According to the model proposed by Borkowski et al., successful learners are characterized by a high level of metacognition as well as a motivation and have an elaborated learning strategy repertoire. Paris, Lipson, and Wixon (1983) declared that a major distinction between successful self-regulated learners and poor self-regulated learners is the development of self-controlled strategic behavior. While poor self-regulated learners may only control if they have reached their goal, successful self-regulated learners monitor their whole learning process and are more aware of when and how they have to adapt their strategic behavior (Paris & Winograd, 1990; Zimmerman, 1998). They are able to use their metacognitive strategy knowledge they had acquired by learning, by using learning strategies, and by handling previous task requirements in order to optimize their learning process. Therefore, successful self-regulated learners might achieve their desired goals and objectives through the adequate use of learning strategies (Bjork, Dunlosky, & Kornell, 2013). On the one hand, the appropriate use of learning strategies may hardly be possible without metacognitive strategy knowledge. On the other hand, metacognitive strategy knowledge may develop mainly through meaningful experiences with learning strategies (Borkowski & Turner, 1990). Empirical evidence indicates that students with higher metacognitive strategy knowledge are more likely to recognize adequate learning strategies compared to students with lower metacognitive knowledge (Meneghetti & De Beni, 2010). The choice and use of learning strategies might not only be influenced by metacognitive skills but also by motivational components of SRL (e.g., Artelt et al., 2001; Pintrich & DeGroot, 1990). Empirical results show that motivation, self-efficacy, and self-concept predict a higher use and report of learning strategies as well as a deeper learning approach (e.g., Berger & Karabenick, 2011; Pintrich & DeGroot, 1990). In her study, Thillmann (2007) found that motivation influences the extent to which metacognitive strategy knowledge affects learning strategies. It seems that students have to reach a certain level of motivation so that they are willing to engage in metacognitive and cognitive processes. Therefore, it is not surprising that considerable empirical evidence indicates a positive relationship between metacognitive strategy knowledge and several motivational components of SRL (e.g., Pierce & Lange, 2000; Sperling, Howard, Staley, & DuBois, 2004). For example, Kleitman and Stankow (2007) found that metacognitive processes and self-confidence are correlated with each other. Taken together, analogous to the model of Borkowski et al., successful self-regulated learners cognitively, metacognitively, and motivationally engage in their learning process. However, this model does not provide information about how the different SRL components have to interplay with each other and how far a specific SRL component has to be developed in order that self-regulated learners are successful. This raises the question which learning approaches or types of self-regulated learners might be successful.

Different types of self-regulated learners

Pintrich and Garcia (1993) found five different types of self-regulated learners at the two measurement points analyzed in their longitudinal study. Two cluster groups characterized by a high level of several motivational constructs showed higher course grades than self-regulated learners with a low motivational level. The two groups only differed from each other in their self-reported frequency of strategy use. Based on this result, the authors concluded that different pathways to successful learning may exist. In addition, they showed that the stability of cluster group membership over time is only partially
given, and that successful students tended to be more likely to have a similar type of SRL over time than less successful self-regulated learners. Cress and Friedrich (2000) found four different patterns of adult self-regulated learners. Two cluster groups showed highest grades: one group was characterized by a high level of complex learning strategy use (i.e., metacognitive strategies), previous knowledge, and self-efficacy. Especially a high level of self-efficacy, high previous knowledge, and a high level of previous knowledge, but a low frequency of strategy use, characterized the other group of self-regulated learners. In line with the result of Pintrich and Garcia (1993), the authors concluded that multiple successful patterns of self-regulated learners may exist. Based on an analysis of Programme for International Student Assessment (PISA) data, Artelt et al. (2001) found that a high level of metacognitive strategy knowledge, a high level of motivation and self-concept, and a high interest in reading characterized the students in the cluster group that reached the highest reading competency. According to previous research on profiles of SRL, Artelt et al. confirmed the minor role of learning strategies and the significance of motivation and self-confidence for performance. In another study with PISA data, also a high level on several components of SRL characterized high performers in mathematics (Artelt, Baumert, Julius-McElvany, & Peschar, 2004). Students in this group had a high level of self-efficacy and self-concept and reported a high frequency of complex learning strategies. In contrast, the cluster group of self-regulated learners with a low level on several SRL components showed the poorest performance in mathematics.

Taken together, a few studies could identify different profiles of self-regulated learners at different education levels. The results indicate that successful self-regulated learners may, to a certain degree, be characterized by different components of SRL. Further, the results indicate that especially self-regulated learners who demonstrated a high level on all measured SRL components showed highest performance. Overall, the different studies highlighted the importance of the motivational components for SRL. However, the results are not consistent and a clear picture about successful types of self-regulated learner is still missing. Moreover, previous results mainly derive from cross-sectional studies; yet, longitudinal studies are missing. In addition, only few studies have included broad range of SRL indicators to describe profiles of self-regulated learners and investigated the changes of these profiles over time.

Research questions and hypothesis
The aim of this study was to explore which type of self-regulated learners on the basis of cognitive, metacognitive, and motivational components of SRL can be identified at the upper secondary school level. It is explored how different types of self-regulated learners can be characterized along different SRL components and how the different types of self-regulated learners are related to grades in the subject of German. Moreover, a potential change in students’ type of self-regulated learners is examined. The following three hypotheses were the focus of this study.

First, I explored whether differences in students’ metacognitive strategy knowledge, motivation, and self-reported frequency of strategy use result in different types of self-regulated learners. According to previous research results (e.g., Artelt et al., 2001; Cress & Friedrich, 2000; Pintrich & Garcia, 1993), it was expected that different types of self-regulated learners would also be identified at the upper secondary school level (Hypothesis 1). Second, it was investigated whether types of self-regulated learners significantly differ from each other with respect to their school grades in the academic subject of German at Time 1 and Time 2. According to the theoretical and empirical literature (e.g., Artelt et al., 2004; Borkowski et al., 2000), it was expected that those types of self-regulated learners with the highest levels on all SRL components would also report the highest grades (Hypothesis 2). Third, it is examined to what extent changes in the profile of self-regulated learners from the beginning to the end of one school year can be found. Based on empirical findings (Pintrich & Gracia, 1993), it was assumed that students would show transitions over time (Hypotheses 3a). In more detail, it was expected that more successful self-regulated learners with high self-regulated skills would more likely to be stable over time than students with lower self-regulated skills (Hypothesis 3b).

Method

Participants and procedure
This two-wave longitudinal study included a representative cohort of students in Grades 10 and 11. Students were recruited from nearly all schools at the upper secondary education level (International Standard Classification of Education level 3A) in the canton of Zurich, Switzerland, which prepare students for the university entrance certificate over a period of three to four years. All these schools follow nine years of education since the beginning of ISCED level 1. Only students with the highest level of completion at the lower secondary education level can access to this type of school. Evaluable questionnaires were received from 1,272 students at Time 1 and 1,126 students at Time 2. This corresponds to a response rate of 93% at Time 1 and of 86% at Time 2. A total of 897 students provided full information at both measurement points and represent the longitudinal sample used for this study. This corresponds to 71% of the sample at Time 1. Reasons for dropout were missing individual matching codes as well as temporary absence at one of the two measurement points. 38.7% of the participants were young men and 61.3% were young women, and the mean age of the students was 16.4 years (SD = 0.97). In Swiss schools preparing students for university, female students are better represented than male students, whereas male students more likely attend vocational school at the upper secondary education level. The interval between the two measurement points was nine months. The online survey was conducted in class during two regular school lessons. Teachers supervised every class and ensured discipline.

Instruments

Metacognitive strategy knowledge

Toward the end of Swiss schools preparing for university, students have to write a longer essay to get their final certificate.
This requires multiple work steps over an extended period of time and the ability to successfully manage one’s own learning processes. Therefore, the metacognitive strategy knowledge test used in this study assessed the students’ metacognitive strategy knowledge in the context of tackling larger essays or projects that they encounter at school (Maag Merki, Ramseier, & Karlen, 2013). The design of this test is related to similar test instruments developed for other schooling levels and domains (e.g., Händel, Arltel, & Weinert, 2013; Neuenhaus, Arltel, Lingle, & Schneider, 2010). Seven different scenarios provide a description of learning situations related to the context of tackling larger essays, taking the process structures of SRL into account (Maag Merki, Ramseier, & Karlen, 2013). Each scenario is accompanied by a list of several strategies that vary in their degree of effectiveness for the given scenario (see the example in the Appendix). Students had to rate the effectiveness of each strategy on a six-point Likert-type scale from 1 (not useful at all) to 6 (very useful), taking the requirement of the specific learning scenario into consideration. For each scenario, not the estimated effectiveness of the single strategies but the student’s relative estimation of the effectiveness of one learning strategy compared to another (pairs of strategies) was evaluated. To compute the metacognitive strategy knowledge score, the student’s relative estimation of pair strategies was compared with the expert estimation. Students were given one point for each pair that they rated correctly and zero points for each pair that did not correspond to the expert estimation (see Maag Merki, Ramseier, & Karlen, 2013 for details). The mean score across all scenarios indicates the adequacy of the student ratings and varies from 0 (weak metacognitive strategy knowledge; 0% correspondence with the experts) to 1 (high metacognitive strategy knowledge; 100% correspondence with the experts). The reliability of both scales can be described as good (see Table 1).

**Learning motivation**

To assess the motivational dimensions of learning, four scales were included (see Table 1). The 4-point Likert-type response scale for all items ranged from 1 (not true at all) to 4 (very true). All scales used were adapted from Grob and Maag Merki (2001). The intrinsic and extrinsic (success orientation) motivational scales refer to reasons why a person spends time studying at school (e.g., Heckhausen & Heckhausen, 2010). Success orientation identifies to what degree success and achievement at school are valued. According to Ryan and Deci (2000), the scale of extrinsic motivation (success orientation) can be used for measuring either identified or integrated regulation. Similar to intrinsic motivation, such forms of regulation favor greater engagement and higher quality learning. High achievement motivation enables learners to master complex tasks, overcome difficulties, and assume personal responsibility for accomplishment. It describes a student’s hope for success in contrast to fear of failure. Persistence refers to the competence to stay on track with a task even when difficulties appear. Thus, all four scales are considered to be important indicators to initiate, guide, and maintain SRL. Confirmatory factor analysis (CFA)

<table>
<thead>
<tr>
<th>Scales (number of items)</th>
<th>Sample item</th>
<th>Time 1</th>
<th>Time 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSK (7 subscales)</td>
<td>Have difficulties in finding a topic for a complex assignment</td>
<td>2.70 (0.99/0.04)</td>
<td>.66–.68</td>
</tr>
<tr>
<td>Intrinsic motivation</td>
<td>I study because I am very interested in different facets of this subject</td>
<td>0.42 (1.00/0.00)</td>
<td>.74–.84</td>
</tr>
<tr>
<td>Extrinsic motivation</td>
<td>I study because I want to perform well</td>
<td>0.63 (1.00/0.00)</td>
<td>.66–.88</td>
</tr>
<tr>
<td>Persistence (6 items)</td>
<td>Even with difficult assignments, I don’t give up until I am finished</td>
<td>2.66 (0.99/0.04)</td>
<td>.56–.77</td>
</tr>
<tr>
<td>Achievement motivation (8 items)</td>
<td>I like tasks, which are difficult to complete</td>
<td>.43 (1.00/0.02)</td>
<td>.28–.76</td>
</tr>
<tr>
<td>Self-concept (3 items)</td>
<td>I have always been successful in this school subject</td>
<td>.02 (1.00/0.00)</td>
<td>.73–.87</td>
</tr>
<tr>
<td>Self-efficacy (4 items)</td>
<td>I do not have difficulties in understanding new subject matter</td>
<td>.74 (1.00/0.00)</td>
<td>.66–.79</td>
</tr>
<tr>
<td>Transformation (4 items)</td>
<td>... I make a sketch of it</td>
<td>.08 (1.00/0.00)</td>
<td>.31–.85</td>
</tr>
<tr>
<td>Elaboration (5 items)</td>
<td>... I think about whether I have ever accomplished a similar task before</td>
<td>2.70 (0.98/0.04)</td>
<td>.24–.82</td>
</tr>
<tr>
<td>Evaluation (5 items)</td>
<td>... I try to find out what I did well and what I didn’t do so well</td>
<td>1.26 (1.00/0.02)</td>
<td>.25–.81</td>
</tr>
<tr>
<td>Planning (5 items)</td>
<td>... I plan exactly how to best accomplish the task</td>
<td>1.94 (1.00/0.03)</td>
<td>.58–.65</td>
</tr>
<tr>
<td>Monitoring (5 items)</td>
<td>... I often think about how it might make sense to change my approach</td>
<td>1.69 (0.99/0.03)</td>
<td>.39–.63</td>
</tr>
</tbody>
</table>

*All learning strategies had the same introduction: “When I have to complete a difficult assignment…”*
was conducted to test for the fit of the factor structure (see Table 1). Overall, the internal consistencies of the scales can be described as good.

**Self-concept and self-efficacy**

Students’ perception of themselves was assessed with a self-concept scale adapted from the PISA study (PISA-Konsortium Deutschland, 2000), while self-efficacy determined students’ self-judgment of how well they can accomplish a task or solve a problem. This scale was adapted from Jerusalem and Satow (1999). For each item, the students rated the strength of their self-confidence as well as self-efficacy using a 4-point Likert-type scale ranging from 1 (not true at all) to 4 (very true). A CFA was conducted to test for the fit of the factor structure (see Table 1). The reliability of both scales can be described as good.

**Self-reported frequency of strategy use.** To assess the self-reported frequency of strategy use, five different scales adapted from Grob and Maag Merki (2001) were applied. Cognitive learning strategies are represented by transformation strategies that refer to students’ use of strategies such as making mind maps or write summaries and elaboration strategies that are defined as students’ use of strategies that connect new knowledge with previous knowledge. Metacognitive strategies are represented by planning strategies that reflect students’ tendency to set goals or to think through a task before starting with it, monitoring strategies that refer to how often students reflect on their approach, and evaluation strategies that refers to students’ use of strategies to evaluate their own learning. All learning strategies comprise the tackling of challenging tasks at school. The 4-point Likert-type response scale for all items ranged from 1 (not true at all) to 4 (very true). A CFA was conducted to test for the fit of the factor structure (see Table 1).

**Grade.** Grades in the academic subject of German (first language) used in this study were based on students’ self-reports from their last report cards at Time 1 and at Time 2. Conforming to the Swiss grading system, the grades ranged from 1 (lowest grade) to 6 (highest grade). Caprara et al. (2008) showed that self-reported grades are consistent with recorded school grades. Grades are important indicators for measuring performance at school and have, in particular, a prognostic and a selective function. As shown in several studies, grades in schools preparing for university have a highly predictive value regarding future study success at university (e.g., Gold & Souvignier, 2005; Trappmann, Hell, Weigand, & Schuler, 2007). Moreover, Baumert and Watermann (2000) showed that grades and performance in achievement tests are highly correlated. In Switzerland, grades in the academic subject of German refer to the competence to write essays or small papers and do not only refer to correct spelling and writing style.

By analogy with grades, all learning motivation scales, self-concept, and self-efficacy were framed specifically for the academic subject of German. Further, all learning strategies were adapted to the context of tackling larger essays that they encounter at school. Therefore, a relationship between self-reported grades in German and all included cognitive, metacognitive, and motivational subscales of SRL might at least be given on a theoretical level.

**Statistical analyses**

Latent class analyses (LCA) were performed using Mplus 6.0 (Muthén & Muthén, 1998–2010). LCA is a statistical analytic method useful for classifying persons into latent classes based on different variables observed and to identify interindividual differences in item responses. Persons within one latent class have identical solution probabilities for the included items, while persons from diverse latent classes differ with respect to their response probabilities. LCA enable researchers to detect typological differences between persons (Finch & Bronk, 2011). As the determination of the appropriate number of classes that fits the best with the observed data is complex, several fit indices were considered (for an overview, see Finch & Bronk, 2011; Geiser, Lehmann, & Eid, 2006). The Lo-Mendell-Rubin (LMR) test described by Nylund, Asparouhov, and Muthén (2007) and the Bootstrap-Likelihood-Ratio (BLR) test (Langeheine, Pannekoek, & van de Pol, 1996) were used to determine the appropriate number of classes. These fit provide information about how appropriate a latent class model with k classes fits the data compared to a k−1 class model. For example, a significant LMR test value for a k class model indicates that this model significantly fits data better than a model with one class less. Further, the sample size adjusted Bayesian information criterion (aBic) value, which represents an information criterion to compare the fit of several LCA models, was considered. LCA models with the lowest aBic value may fit the data best (Finch & Bronk, 2011; Glück, Machat, Jirasko, & Rollett, 2001). As additional valuable fit indices, the average cluster probability and the entropy parameter were considered. These two fit indices provide information about the reliability of the classification. According to Rost (2006), the average latent class probabilities for the most likely latent class membership as well as the entropy parameters should be higher than .80. Finally, multivariate analysis of variance (MANOVA) and follow-up analyses of variance (ANOVA) were performed with SPSS 19 to examine the overall differences between the cluster groups and the differences with respect to cluster variables and grades between the different types of self-regulated learners.

All scores were z-transformed, so that they were equally calibrated. This was mainly necessary to give appropriate weight to the metacognitive strategy knowledge test whose maximum range is 1 compared to 4 of the other scales. The full information maximum likelihood method (FIML) as well as the maximum likelihood robust estimator (MLR) that are both available in Mplus were used to deal with missing values and the non-normality distribution of the data.

**Results**

**Descriptive statistics**

As shown in Table 2, results from the separate t test with repeated measures indicated several changes in the self-reported frequency of strategy use and in several motivation indicators over time. The strongest significant effect (d = .36), t (889) = 5.27, p < .001, was found for planning strategies; followed by evaluation strategies (significant effect of d = .16), t (890) = 4.48, p < .001; and elaboration strategies (significant effect of d = .12), t(890) = 3.14, p < .01. As can be seen from
Table 2. Descriptive statistics of the scales on motivation, self-concept, self-efficacy, learning strategies, and metacognitive strategy knowledge (n = 897).

<table>
<thead>
<tr>
<th></th>
<th>Time 1 M</th>
<th>Time 1 SD</th>
<th>Time 1 Skew</th>
<th>Time 1 SE</th>
<th>Time 2 M</th>
<th>Time 2 SD</th>
<th>Time 2 Skew</th>
<th>Time 2 SE</th>
<th>Time 2 – Time 1 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSK</td>
<td>0.58</td>
<td>0.19</td>
<td>−0.41</td>
<td>0.08</td>
<td>0.59</td>
<td>0.21</td>
<td>−0.49</td>
<td>0.08</td>
<td>ns</td>
</tr>
<tr>
<td>Intrinsic motivation</td>
<td>2.76</td>
<td>0.77</td>
<td>−0.38</td>
<td>0.08</td>
<td>2.78</td>
<td>0.80</td>
<td>−0.38</td>
<td>0.08</td>
<td>ns</td>
</tr>
<tr>
<td>Extricin motivation</td>
<td>2.37</td>
<td>0.67</td>
<td>−0.01</td>
<td>0.08</td>
<td>3.27</td>
<td>0.69</td>
<td>−0.02</td>
<td>0.08</td>
<td>ns</td>
</tr>
<tr>
<td>Persistence</td>
<td>2.87</td>
<td>0.58</td>
<td>−0.27</td>
<td>0.08</td>
<td>2.93</td>
<td>0.58</td>
<td>−0.36</td>
<td>0.08</td>
<td>0.09**</td>
</tr>
<tr>
<td>Achievement motivation</td>
<td>2.75</td>
<td>0.57</td>
<td>−0.03</td>
<td>0.08</td>
<td>2.82</td>
<td>0.57</td>
<td>0.02</td>
<td>0.08</td>
<td>0.13***</td>
</tr>
<tr>
<td>Self-concept</td>
<td>2.94</td>
<td>0.75</td>
<td>−0.37</td>
<td>0.08</td>
<td>2.95</td>
<td>0.75</td>
<td>−0.41</td>
<td>0.08</td>
<td>ns</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>3.13</td>
<td>0.60</td>
<td>−0.67</td>
<td>0.08</td>
<td>3.19</td>
<td>0.61</td>
<td>−0.69</td>
<td>0.08</td>
<td>0.09**</td>
</tr>
<tr>
<td>Transformation strategies</td>
<td>2.78</td>
<td>0.65</td>
<td>−0.27</td>
<td>0.08</td>
<td>2.81</td>
<td>0.63</td>
<td>−0.35</td>
<td>0.08</td>
<td>ns</td>
</tr>
<tr>
<td>Elaboration strategies</td>
<td>2.90</td>
<td>0.54</td>
<td>−0.31</td>
<td>0.08</td>
<td>2.96</td>
<td>0.53</td>
<td>−0.38</td>
<td>0.08</td>
<td>0.12**</td>
</tr>
<tr>
<td>Evaluation strategies</td>
<td>2.68</td>
<td>0.58</td>
<td>−0.35</td>
<td>0.08</td>
<td>2.77</td>
<td>0.58</td>
<td>−0.41</td>
<td>0.08</td>
<td>0.16***</td>
</tr>
<tr>
<td>Planning strategies</td>
<td>2.53</td>
<td>0.63</td>
<td>−0.02</td>
<td>0.08</td>
<td>2.74</td>
<td>0.51</td>
<td>−0.09</td>
<td>0.08</td>
<td>0.36***</td>
</tr>
<tr>
<td>Monitoring strategies</td>
<td>2.64</td>
<td>0.51</td>
<td>−0.22</td>
<td>0.08</td>
<td>2.65</td>
<td>0.64</td>
<td>−0.31</td>
<td>0.08</td>
<td>ns</td>
</tr>
</tbody>
</table>

Table 3, several motivational indicators remained stable over time. Positive changes over time were found for achievement motivation (d = .13, t(896) = 4.39; p < .001; persistence (d = .09), t (895) = 3.25, p < .01; and self-efficacy (d =.09), t(882) = 2.83, p < .1. No significant change in metacognitive strategy knowledge over time could be observed. Overall, the effect sizes can be described as very small.

Table 3 presents the correlations between all measured variables at Time 1 and Time 2. Overall, all variables were significant positively but only low to moderately associated with each other. The correlations at Time 1 and Time 2 showed positively low to moderate associations between metacognitive strategy knowledge and the reported frequency of strategy use from r = .17 to r = .32. The correlations between metacognitive strategy knowledge and the different learning motivation scales were nearly equivalent for both measurement points (from r = .11 to r = .27).

Cluster analysis

The first question concerned the intraindividual difference in students’ metacognitive knowledge, motivation, and self-reported frequency of strategy use. At Time 1 and at Time 2, a four-cluster solution appeared to be most appropriate for the data. The consideration and comparison of several fit indices lead to that decision: First, at both measurement points, cluster solutions with more than five clusters had at least one cluster group that contained less than 5% of the participants. Such cluster groups are too small to represent adequate types of self-regulated learners. Moreover, the LMR test was not significant, indicating that the five-cluster solution is not more appropriate than the four-cluster solution. As a next step, all latent class solutions with less than five cluster groups were examined. Compared to the k–1 class solutions, the four-cluster solutions showed the lowest aBIC value at both measurement points, indicating that the four-cluster solution appears to be most appropriate for the data. Moreover, significant BLR tests (p < .001) indicated that the four-class solution fits the data better than the three-cluster solution. As a further step, the appropriateness of the four-cluster solution was examined by comparing the goodness of further fit indices. At Time 1, the four-cluster solution showed, as recommend in the literature, cluster probabilities (.92, .85, .85, .94) and an entropy value of .81, higher than > .80. At Time 2, the four-cluster solution showed high cluster probabilities (.91, .94, .86, .88) and a high entropy value of .82. Moreover the significant LMR test (p < .05) indicated that the four-cluster solution is more appropriate than the three-cluster solution. In sum, based on LCA, students were
grouped into four cluster groups of self-regulated learners at Time 1 and Time 2 (see Figures 1 and 2).

**Description of different types of self-regulated learners**

One-way multivariate analysis of variance (MANOVA) for the cluster solution at Time 1 indicated a significant overall difference between the four cluster groups: Pillai’s trace = 1.23, $F(36, 2586) = 49.62, p < .001, \eta^2 = .41$; Hotelling’s trace = 4.19, $F(36, 2576) = 99.90, p < .001, \eta^2 = .58$. Follow-up tests (ANOVAs including Scheffe tests) showed that cluster groups partially differed from each other with respect to the cluster variables (metacognitive strategy knowledge, motivation, self-efficacy, self-concept, and learning strategies; see Table 4).

Cluster 1.1: With 7.6% of all students ($n = 66$), this was the smallest cluster group at Time 1. These students had low levels on all SRL components. Compared to students from other clusters, they showed a low level of metacognitive strategy knowledge and reported a generally low frequency of strategy use. The lowest level of learning motivation as well as self-efficacy and self-concept especially characterizes students of this profile. Therefore, these students were identified as unmotivated learners.

Cluster 1.2: Approximately one quarter (25.3%) of all students ($n = 227$) were clustered in this group. These students reported significantly higher learning motivation (achievement motivation and persistence) as well as self-concept and self-efficacy than students in cluster groups 1.1 and 1.3. Similar to students from cluster 1.1, they had a low level of metacognitive strategy knowledge and reported a generally low frequency of strategy use. Students in this cluster were more likely to be motivated and confident than strategically be involved in learning. Therefore, this cluster group was labeled as confident learners.

Cluster 1.3: This cluster included 236 students (26.3%). The lowest values within this cluster group were found for self-concept, self-efficacy, and achievement motivation, which were significantly lower than the values of cluster groups 1.2 and 1.4 but still significantly higher than the values of cluster group 1.1. Students in this cluster group mainly had the highest level of
metacognitive strategy knowledge and reported a high frequency of strategy use, which both did not significantly differ from those of students in cluster group 1.4. According to the high values on metacognitive and cognitive components of SRL, this cluster group was labeled as strategic learners.

Cluster 1.4: With 365 students (40.8%), this was the largest group. These students were identified as maximal learners with a favorable learning type since they were characterized as having the highest level on all SRL components measured. Students from this cluster group reported especially significantly higher levels on learning motivation, self-efficacy, and self-concept in comparison to the other types of self-regulated learners.

As at Time 1, one-way MANOVA at Time 2 indicated overall differences between the four cluster groups Pillai’s trace = 1.22, F(36, 2472) = 47.12, p < .001, η² = .41; Hotelling’s trace = 4.63, F(36, 2462) = 105.45, p < .001, η² = .61. Follow-up analyses of variance (ANOVA including post hoc Scheffé tests) showed that the four cluster groups partially differed from each other with respect to metacognitive strategy knowledge, motivation, self-concept, self-efficacy, and self-reported frequency of strategy use (see Table 4).

Cluster 2.1: This was the smallest group with 100 students (11.1%). The students in this cluster showed an unfavorable learning type, which was characterized by a partially low level on all SRL components. They reported the lowest level on all learning motivational variables as well as on self-concept and self-efficacy. They were also characterized by a lower level of metacognitive strategy knowledge and reported a lower frequency of strategy use, although these were still higher than those of students from cluster 2.2. According to the cluster group at Time 1, this type of learners was labeled as unmotivated learners.

Cluster 2.2: This cluster included 135 students (15.1%), whose strength was that they showed a higher level of learning motivation, self-concept, and self-efficacy than students in cluster 2.1. Their levels of self-concept and self-efficacy were on an average level and not significantly different from those of students from cluster 2.3. Compared to students from other clusters, they reported the lowest frequency of strategy use and showed the lowest level of metacognitive strategy knowledge. In sum, their somewhat higher level of achievement motivation, self-concept, and self-efficacy mainly characterized students in this cluster group. This cluster group was also labeled as confident learners.

Cluster 2.3: The 358 students (40%) in this cluster showed a significantly higher level of metacognitive strategy knowledge than students from clusters 2.1 and 2.2. Together with students from cluster 2.4, they reported the highest frequency of strategy use. Further, they presented the same levels of self-concept, self-efficacy, and achievement motivation as students from cluster 2.2. Students from this cluster were labeled as strategic learners, because of their average level of metacognitive strategy knowledge and their highest frequency of strategy use.

Cluster 2.4: With nearly one third of all students (n = 302; 33.8%), this was the second biggest cluster group at Time 2.
Analogous to students form cluster group 1.3, the students in this cluster reported a high frequency of strategy use. Further, they were highly motivated as well as self-efficacious and self-confident, and had the highest level of metacognitive strategy knowledge. Students in this cluster groups can be described as maximal learners.

**Differences in grades among the different types of self-regulated learners**

The results in Table 4 indicate that, at Time 1, all cluster groups differed significantly from each other regarding their reported grades in the academic subject of German. Unmotivated learners from cluster 1.1 reported the lowest grades, followed by strategic learners from cluster 1.3 (M = 4.4, SD = .43). Further, the data indicate that maximal learners (cluster 1.4) reached the highest grades in the academic subject of German. Confident learners (cluster 1.2) reached an average grade level (M = 4.6, SD = .45). At Time 2, analogous to Time 1, it is also apparent that maximal learners (cluster 2.4) reported the highest grades and that unmotivated learners (cluster 2.1) with low levels on all SRL components reported the lowest grade in the academic subject of German. The two groups, which were characterized by the same level of achievement motivation, self-concept, and self-efficacy, but which differed regarding the other SRL components, reported the same grade level: On the one hand, confident learners (cluster 2.2) showed with M = 4.6 (SD = 0.49) an average grade level. On the other hand, strategic learners (cluster 2.3) reported also an average grade level (M = 4.6, SD = 0.42). Taken together, at the beginning as well as at the end of the school year, maximal learners who were characterized by the highest level on all SRL components (clusters 1.4 and 2.4) reported the highest grades in German. In contrast, students that were characterized by a low level on all SRL components (clusters 1.2 and 2.1) reported the lowest grades. Whereas at Time 1 all cluster groups differed from each other regarding their reported grades, at Time 2, students from clusters 2.2 and 2.3, both characterized by the same level of achievement motivation, self-concept, and self-efficacy, reported the same average grade level.

**Change of self-regulated learners in cluster membership over time**

Figure 3 summarizes the students’ individual transitions based on cross-sectional LCA. Meaningful changes from Time 1 to Time 2 could be identified. 53% of the unmotivated learners (cluster 1.1) transited to a latent type of self-regulated learners (clusters 2.2, 2.3, and 2.4) at Time 2, which differed clearly from their profile of self-regulated learners at Time 1. 34% of the confident students at Time 1 passed at Time 2 into a similar type of self-regulation (cluster 2.2), whereas 66% of these students transited into a different cluster group. This represented the highest changes. On the contrary, there was more stability for the students from cluster 1.3; 64% of students characterized as strategy learners passed into a similar cluster group at Time 2 (clusters 2.3). Students with a high level on all SRL components, who where clustered into the latent group labeled as maximal learners at Time 1 (cluster 1.4), showed the lowest tendency of transition to another learning type. 67% of these

![Figure 3](image-url)
students remained in the similar cluster group at Time 2 that is also labeled as maximal learners (cluster 2.4). Only 33% of these students transited into another latent cluster group at Time 2 (clusters 2.1, 2.2, and 2.3).

Taken together, 53% of all students had a similar type of SRL at both measurement points and can therefore be described as stayers, whereas 47% of the students were movers who clearly changed their type of SRL over time. When transitions are considered in relation to the reported grades, 29% of the students reported a higher grade, 21% a lower grade, and 50% the same grade when transited from a specific type of SRL approach to another specific type of SRL approach over time.

Discussion

The aim of the present study was to determine intraindividual differences in patterns of students’ metacognitive strategy knowledge, learning motivation, self-concept, self-efficacy, and self-reported frequency of strategy use, to investigate possible changes of SRL types over time, and to examine differences between different types of self-regulated learners regarding their reported grades in the academic subject of German. The first hypothesis concerned the determination of different types of self-regulated learners. Systematically interindividual differences in the patterns of students’ metacognitive strategy knowledge, learning motivation, self-concept, and self-efficacy as well as self-reported frequency of strategy use were found at Time 1 and Time 2, indicating that clearly distinguishable types of self-regulated learners exist, therefore confirming Hypothesis 1. For Time 1 and Time 2, LCA indicated a four-cluster solution that showed similar learning typologies at both measurement points. Unmotivated learners (clusters 1.1 and 2.1) showed the lowest level on the motivational components of SRL as well as a low level of metacognitive strategy knowledge and a low frequency of strategy use. In contrast, maximal learners (clusters 1.4 and 2.4) were clustered in groups characterized by the highest level on all SRL components. Further, students that were labeled as confident learners (clusters 1.2 and 2.2) are characterized by a higher level on achievement motivation, self-concept, and self-efficacy and a lower level on metacognitive strategy knowledge as well as reported strategy use. In contrast, students from cluster groups labeled as strategic learners (clusters 1.3 and 2.3) were identified as more strategic than motivated learners as relatively high levels of metacognitive strategy knowledge and reported strategy use characterized them. Taken together, students in schools that prepare them for the university entrance certificate differ in their approaches and competences they have for self-regulating their learning process. This result is consistent with findings from other studies, which also identified different profiles of self-regulated learners at other education levels (e.g., Artelt et al., 2004; Cress & Friedrich, 2000; Pintrich & Garcia, 1993).

The second hypothesis examined how different types of self-regulated learners would differ in regard to their self-reported grades in the academic subject of German. Unmotivated learners (clusters 1.1 and 2.1) reported the lowest grades at both measurement points. In this respect, maximal learners (clusters 1.4 and 2.4) outperformed all other types of learners. Confident learners (clusters 1.2 and 2.2) and strategic learners (clusters 1.3 and 2.3) reported an average grade level. Taken together, this result is not in line with Pintrich and Garcia (1993) and Cress and Friedrich (2000), who found multiple types of self-regulated learners that showed highest grades. Consistent with the theoretical model proposed by Borkowski et al. (2000) and other empirical findings (Artelt et al., 2001; Artelt et al., 2004), the results of this study indicate that only learners who are characterized by a high level of metacognitive strategy knowledge, high learning motivation, are self-confident, and self-efficacious, and with a high frequency of strategy use reported the highest grades, therefore confirming Hypothesis 2. At Time 1, confident learners reported higher grades than strategic learner. Confident learners had a higher level of self-efficacy, self-concept, and achievement motivation, but a lower level of reported strategy use and metacognitive strategy knowledge than strategic learners. The assumption of Artelt and Neuenhaus (2010) that metacognitive strategy knowledge is an important but not a sufficient precondition for successful learning might be supported by this result. Self-regulated learners may also be motivated and feel confident to engage in their metacognitive and cognitive processes. At Time 2, confident learners and strategic learners reported the same grade level. Even though they differed regarding the levels of metacognitive strategy knowledge and reported frequency of strategy use, both types of learners had at this time the same level of self-efficacy, self-concept, and achievement motivation. On the one hand, this is in line with findings from other studies, which highlighted the importance of these components for SRL (Greene et al., 2004; Liem et al., 2008; Robbins et al., 2004) and showed that self-regulated learners who are characterized by high levels self-concept and self-efficacy even though they had moderate level on other SRL components showed good performance (Cress & Friedrich, 2000; Pintrich & Gracia, 1993). On the other hand, this may also be an indication that, to a certain degree, a lower level on metacognitive and cognitive SRL components might be compensated by a higher level on the motivational component of SRL. However, compared to maximal learners, only a partially high level on certain components of SRL may not be sufficient for highest grades. In this context, the following three questions arises: How low can levels on metacognitive and cognitive components be that they still can be compensated by a higher level on motivational components of SRL? How high must the motivational level be, so that this compensation function may have its positive effect? And in general, how far might higher levels on specific components of SRL compensate lower levels on other components of SRL? Further research is needed to explore these assumptions and to find answers to these questions.

Third, it was expected that students would show changes in type of SRL over time (Hypothesis 3a). The results of the present study are in favor with this hypothesis: Overall, 47% of all students were movers and changed their type of SRL from Time 1 to Time 2. It might be assumed that a specific approach of SRL can change over time and can thus not be seen as something constant. As discussed in literature, it may be assumed that learning preferences interact with the specific learning situation, the scope of the tasks, and the learners’ resources (Ferguson & Braten, 2013). Hence, students may adapt their learning type to the learning circumstances and context. For example,
over 50% of the unmotivated learners (cluster 1.1) at Time 1 that reported the lowest grades transited to another type of self-regulated learners at Time 2. In contrast, maximal learners at Time 1 that reported the highest grades (cluster 1.4) were more likely to be stayers. These findings suggest that students with a more successful SRL type are rather stayers than movers, which is in line with Hypothesis 3b. It can be assumed that for more successful self-regulated learners there is no need to change their learning type. However, further research is strongly needed to paint a more nuanced picture of the reasons for these changes and to validate the raised assumption.

This study had several limitations. First, the results are limited to the ways the subscales of SRL were measured. The frequency of strategy use was measured by self-reported data. Self-reported strategy use represents student’s learning preferences and not actual behavior. In the literature, limitations of self-reported data have been controversially discussed (Spörer & Brunstein, 2006; Wirth & Leutner, 2008). However, self-reported data remain an important measurement method for larger samples. Nevertheless, further research should consider (new) additional methodological approaches to assess learning strategies in a reliable and economic way at school. Further, the measurements of the frequency of strategy use and metacognitive strategy knowledge are limited to the context of tackling complex and larger essays at school. As shown by Neuenhaus et al. (2010), metacognitive strategy knowledge is to a certain degree domain specific. Therefore, future studies might assess different types of metacognitive strategy knowledge. Second, this study was limited by its focus on the academic subject of German. Therefore, the current results cannot be generalized or transferred to other school subjects. In this regard, further researchers should investigate whether learning typologies are merely subject-specific or valid for different domains. Third, it has to be pointed out that performance could not be tested directly. Students’ self-reported grades from their last report cards were used. In the published literature, it was shown that grades and students’ actual performance and achievement are highly correlated with each other (e.g., Baumert & Waterman, 2000; Organization for Economic Cooperation and Development, 2012). Grades can also reflect an individual’s development, which was in the foreground of this study (Schrader & Helmkne, 2001). However, the use of more complex performance parameters should be considered in future studies. Therefore, the use of actual performance data is strongly recommended. Furthermore, IQ data were missing in this study. IQ scores may have influenced the grade differences between the cluster groups (see Cress & Friedrich, 2000). As discussed in the literature (e.g., Alexander & Schwenkflugel, 1994), advantages in strategy regulation, metacognitive strategy knowledge development, and higher performance are associated with intelligence. Therefore, further research on learning typologies should consider including data on students’ intelligence as a control variable.

Despite the limitations, the results of this study provide new knowledge about different profiles of self-regulated learners at school that prepare students for the university entrance certificate, how students may change their self-regulated type within one school year, and how these different profiles of self-regulated learners might differ with regard to their grades in the academic subject of German. With results from other studies (e.g., Artelt et al., 2004; Pintrich & Garcia, 1993), it could be shown that different types of learners can be identified from lower secondary education level to adulthood. This informs teachers about different types of learners that may exist and develop in school as well as that self-regulated learner have different levels of SRL skills. Some groups of learners may be at risk of falling behind in class because they reported lower grades as well as showed low SRL skills. The identification of different types of learners also shows that individual needs exist, which require different support by teachers. Whereas some students may need some support regarding their metacognitive and cognitive SRL competences, other students might need strong support regarding their motivation. For a large group of learners, it might be important to address this lack of SRL competences at school and for teachers to target especially less successful self-regulated learners. Teachers might assist these students to become successful learners and take their role as expert in learning stronger into account. Therefore, teaching and instruction should give space for meaningful experiences in the context of an individual’s own SRL and willfully support the development of self-regulated competences. In this context, it may be helpful if teachers provide feedback and reflection on the individual student’s learning. Empirical evidence shows that SRL can successfully be fostered directly through teaching and indirectly through the design of a productive learning environment that offers meaningful opportunities for SRL (e.g., Paris & Paris, 2001). In general, the results indicate that not all students at the upper secondary level are already successful self-regulated learners. For that reason, teachers in schools that prepare students for the university entrance certificate cannot assume that their students are already highly skilled self-regulated learners. Therefore, from primary school to the upper secondary education level, students may benefit from a systematical and continuous support of SRL in school.

References
Baumert, J., & Watermann, R. (2000). Institutionelle und regionale Variabilität und die Sicherung gemeinsamer Standards in der gymnasiellen...


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**Appendix: Example task of the metacognitive strategy knowledge test**

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A I think about which areas I am interested in</td>
<td>2</td>
</tr>
<tr>
<td>B I wait for my teacher to suggest a topic</td>
<td>3</td>
</tr>
<tr>
<td>C I discuss possible report topics with others (e.g., parents, friends)</td>
<td>4</td>
</tr>
<tr>
<td>D I wait until a topic eventually comes to mind</td>
<td>5</td>
</tr>
<tr>
<td>E I go to the library and browse through books</td>
<td>6</td>
</tr>
<tr>
<td>F I consider different topics and assess which ones are most practical</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: Examples pair of strategies for this scenario that are rated equally by 75% of the experts and used for the metacognitive strategy knowledge score: A > B, A > D, C > B, C > D, E > D, F > D, F > B