Assessing Cognitive and Metacognitive Learning Strategies in School Children: Construct Validity and Arising Questions

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Abstract

Self-regulated learning is a complex construct that has inspired innumerable research in recent years. The self-regulated activity of a learner and the awareness in a learning process are shaped by cognitive and metacognitive strategies students use. This study addresses the questions how metacognitive and cognitive learning strategies can be assessed and which different groups of strategies can be identified empirically. For this reason two studies were conducted with a self-report questionnaire. In study one learning strategies in elementary school children (N= 1083) were assessed; in the second study students of the fifth and sixth grade (N= 1067) of a secondary school were tested with the same instrument. The results of both studies show whereas for the cognitive subscales three different dimensions are clearly empirically separable, metacognitive processes in self-regulated learning are more interwoven. Our data reveals that only Planning as a metacognitive strategy can be separated from other metacognitive processes.

Keywords: Self-regulated learning, self-report measurements, learning strategies

Introduction

Self-regulated learning is a complex construct that has inspired innumerable research projects in recent years. It has been used in different theoretical traditions and examined with different methods. Even if there is no simple, consensual definition of self-regulated learning (cf. Boekaerts & Corno, 2005), there are some common assumptions: Strategic action, metacognition, and (intrinsic) motivation are considered to play a part in a learning process that can be labeled self-regulated learning (e.g. Boekaerts, 1999; Moschner, 2007; Winne & Perry, 2000). The activity and reflexivity of a learner are important aspects: "students are self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process" (Zimmerman, 2001, p. 5). This activity of a learner and the awareness in a learning process are shaped by cognitive and metacognitive strategies students use. "In the last decade it has become clear that one of the key issues in self-regulated learning is the students'

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ability to select, combine, and coordinate cognitive strategies in an effective way" (Boekaerts, 1999, p. 447).

Cognitive and metacognitive strategies are therefore seen as important aspect of self-regulated learning. How can strategies be assessed and which different groups of strategies can be identified empirically? Does this differ in different age groups? These questions will be addressed in the following article at first theoretically and then empirically.

Cognitive and Metacognitive Strategies in Different Models of Self-regulated Learning

Cognitive and metacognitive strategies are mentioned in every model of self-regulated learning but they are given varying importance. While some approaches distinguish different strategy groups they are more fused in other models. In the following, five different approaches to strategic action and self-regulated learning will be shortly presented to identify the role cognitive and metacognitive strategies play in each of these models.

Research on strategic action has a long tradition in educational psychology. Weinstein and Mayer (1986) differentiate between cognitive, metacognitive, and as a third group motivational and affective strategies. Cognitive strategies include rehearsal strategies, elaboration strategies, and organization strategies. Metacognitive strategies are characterized as comprehension monitoring strategies but are not divided into further subgroups (Weinstein & Mayer, 1986, p. 316).

In contrast to this, Boekaerts (1999) developed a three-layered model of self-regulated learning to capture different areas of regulation. The first layer contains the regulation of processing modes, which includes the choice and application of cognitive strategies. The second layer is the regulation of learning processes and implies the use of metacognitive knowledge and metacognitive skills to direct one's own learning. The third layer consists of the regulation of self and concerns more general aspects like choice of goals and resources.

Some other models have developed a more detailed description of cognitive and metacognitive processes that are involved. Models of information processing regard cognitive processes with complex feedback loops as the basis of self-regulated learning (Winne & Hadwin, 1998; Winne & Perry, 2000; Zimmerman, 2001). Different processes are distinguished according to their chronology in the learning episode which is conceptualized as information processing. Defining the task (1), setting goals and planning how to reach them (2), enacting tactics (3), and adapting metacognition (4) are the four phases that are separated by Winne and Hadwin (1998). Metacognitive monitoring and metacognitive control are distinguished as two events that are relevant in each of these phases.

Zimmerman (2000, 2001) postulates three phases, the forethought phase, the performance or volitional control phase, and the self-reflection phase. He distinguishes task analysis including goal setting and strategic

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planning in phase one, self-control (volitional control) and task-related strategies in phase two, and self-reflection and self-evaluation in phase three. In each of these phases, different metacognitive processes are relevant and different strategies can be applied for planning, controlling, and evaluating the learning process.

Pintrich (2000) has also developed a temporal model of the process of self-regulated learning in which four phases are distinguished. In his conceptualization the first phase is called forethought, planning and activation including goal setting. The second phase comprises the monitoring of the learning process. The third phase includes regulation and control, thus the use of control strategies is part of this phase. The fourth phase is called reaction and reflection and consists of all evaluations, judgments, and attributions that are made subsequently to a learning episode. Pintrich (2000) points out that the described phases represent a time-ordered sequence. However, all phases do not take place in every learning process and they do not always happen consecutively. According to Pintrich (2000), the four phases of self-regulated learning can occur in four different areas: cognition, motivation, behavior, and context. It is important to note that phases and areas of regulation are not necessarily independent and distinct. "The phases may overlap, occur simultaneously with multiple interactions among the different processes and components" (Pintrich, 2000, p. 456). Again, different strategies are to be applied in different chronological phases of the learning process. Metacognitive strategies of planning, monitoring, and evaluating are relevant as well as different cognitive strategies for dealing with a complex learning content.

Cognitive and metacognitive strategies are distinguished in these models but according to Veenman, Van Hout-Wouters, and Afflerbach (2006) the relationship between cognition and metacognition and between cognitive and metacognitive strategies is complex and not easy to disentangle. Metacognition is regarded as higher-order cognition about cognition. But at the same time metacognition is also cognition. Veenman et al. (2006) point out that metacognition is contingent on cognition. Domain-specific knowledge is necessary to apply metacognitive functions adequately. Metacognitive planning cannot be used without cognitive activities referring to the task at hand.

Developmental Aspects

Developmental aspects are crucial if we focus on self-regulated learning in school children. Using different research methods and different theoretical backgrounds the beginning of the use of cognitive and metacognitive strategies has been located in very different age groups from pre-school children to adolescents. However, it is beyond doubt that there is a considerable development from primary school children to adolescents. For cognitive as well as metacognitive strategies it can be summarized that their use advances with age which does not only concern the quantity of strategy use but also the quality (e.g. Artelt, 2006, Hasselhorn, 2004).

Around the age of ten a quantitative increase in the use of elaboration strategies as well as an improvement in the application of strategies has been reported (Artelt, 2006). Hasselhorn (2004) argues that children around the age of ten are beginning to be able to reflect about their own abilities, their own learning, and their knowledge in a more abstract manner and that this is the basis of metacognitive processing. According to Hasselhorn (2004), at this age cognitive learning strategies are also used spontaneously for the first time (cf. Hasselhorn, 1992). Between the age of eleven to twelve a considerable increase in cognitive and metacognitive processes is described, which is becoming more differentiated and more effective in twelve to sixteen year old adolescents (Hasselhorn, 2004).

Self-report Measures of Self-regulated Learning

While there are several possibilities to measure self-regulated learning, questionnaires using self-report items are the most frequently used instruments in large samples. The two predominating measures in Anglo-American studies which are based on cognitive theories are the "Learning and Study Strategies Inventory" (LASSI; Weinstein, Palmer, & Schulte, 1987) and the "Motivated Strategies for Learning Questionnaire" (MSLQ; Pintrich, Smith, Garcia & McKeachie, 1993). In Germany the most frequently used questionnaires are two instruments: the "LIST" (Lernstrategien im Studium; Wild & Schiefele, 1994) is constructed for the assessment of learning strategies in higher education, the "KSI" (Kieler Lernstrategieinventar ; Baumert, Heyn & Koeller, 1992) is appropriate for the assessment of learning strategies of school children. In the following these instruments and results of the dimensional structure of cognitive and metacognitive strategies are described briefly to illustrate theoretical assumptions in questionnaire construction and empirical findings in research.

LASSI - Learning and Study Strategies Inventory

Weinstein und Mayer (1986) differentiate three dimensions of learning strategies: cognitive, metacognitive, and affective strategies. The LASSI divides affective strategies into the six subscales Concentrating, Anxiety, Motivation, Attitude, Time-Management, and Test-Strategies. Cognitive strategies are operationalized by the three subscales Selecting the main ideas, Information Processing, and Study Aids. The scale Self-Testing includes metacognitive strategies. Reported reliabilities in the User´s Manual (Weinstein et al., 1987) are between α=.68 and α=.86. The authors themselves did not check the construct validity of the LASSI. Factor analyses of subsequent studies with the LASSI (e.g. Olaussen & Braten, 1998) did not prove the postulated structure; only three factors were distinguished. Factor 1 includes "Effort-related Activities"

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(Motivation, Time-Management, Concentration), factor 2 „Goal Orientation" (Information Processing, Study Aids, Self-Testing), and factor 3 „Cognitive Activities" (Selecting Main Ideas, Test Strategies, Anxiety).

MSLQ - Motivated Strategies for Learning Questionnaire

Pintrich and his colleagues (1993) developed another questionnaire based on the conception of Weinstein et al. The MSLQ (Pintrich et al., 1993) includes two main sections: Motivation on the one hand and learning strategies on the other. The learning strategies scales are divided into three categories: The use of metacognitive and cognitive strategies and the management of different learning resources. Cognitive strategies are separated into Rehearsal, Elaboration, Critical Thinking, and Organization. Subscales of the metacognitive strategies are Planning, Monitoring, and Regulation. The subscales measuring the Resource Management are Time Management, Study Environment, Effort Management, Peer Learning, and Help Seeking. The reported reliabilities of the scales are between α=.52 and α=.80. The factorial structure of the MSQL was proved in several studies. Only the structure of the metacognitive strategies could not be differentiated (Garcia & Pintrich, 1996).

LIST – Lernstrategien im Studium

The LIST questionnaire (Wild & Schiefele, 1994) is a German adaptation of the MSLQ. It includes the same scales and subscales as the original instrument. The authors report reliabilities between α=.64 and α=.90. Factor analyses show comparable results as were shown in studies with the MSLQ. Most subscales could be replicated, again only the metacognitive strategies could not be empirically differentiated.

GSSS - Goals and Strategies for Studying Science

Nolen and Haladyna (1990) developed an instrument for a younger target group (class 9 to 12). The GSSS consists of four scales: Three scales in order to assess the cognitive strategies Memorization, Elaboration, and Organization, and the scale Monitoring to measure metacognitive strategies. The assumed structure was proved in confirmatory and exploratory factor analyses. Reliabilities of the scales are between α=.64 and α=.81.

KSI - Kieler Lernstrategie-Inventar

Based on the instruments MSLQ, LASSI, and GSSS Baumert, Heyn, and Koeller (1992) developed six scales for their KSI. They constructed three subscales for measuring cognitive strategies (Memorization, Elaboration, Transformation) and three metacognitive

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subscales (Planning, Monitoring, Regulation). The reliabilities of the scales are between α=.77 and α=.92 (Baumert, 1993). The structure of the subscales was supported by a confirmatory factor analysis; however subsequent studies (e. g., Spoerer, 2004) could not differentiate the subscales of the metacognitive strategies.

To sum up, it is obvious that there are several reliable questionnaires for measuring learning strategies. But regarding the construct validity there are some open questions. On the one hand the structure of cognitive strategies is empirically proved and replicated several times. On the other hand the structure of the metacognitive strategies is still unclear. In most studies the subscales could not be differentiated.

Method Study 1

Participants

Participants of this study were *N*= 1083 German fourth grade elementary school children. There were 540 girls (49.9%) and 542 boys (50%) children (1 missing). The age group ranged from eight to twelve years, and the average age was 9.7 years (*SD*=.63).

Instrument

The questionnaire used in this study was developed to assess the use of learning strategies of elementary school children. Its structure is based on existing instruments and it consists of seven learning strategy scales and 46 items. The items have to be answered on a four-point likert-scale ranging from "not true" to "totally true" which is illustrated for the children with smilies. None of the participants expressed difficulties to understand the answering format. All categories were chosen.

In contrast to common self-report questionnaires this instrument aims at measuring the use of learning strategies as close to the learning process as possible. Therefore the respondents are confronted with a typical school situation at first. They have to read a non-fictional text and after that they have to answer some questions about it. Directly after this, when the learning process is still tangible, the respondents have to report their use of learning strategies. All items refer to this learning process explicitly, e.g. "While reading I asked myself if I had understood everything". The text ("Nights of the Pufflings") and the questions about the text were taken from the Progress in International Reading Literacy Study (PIRLS) (Mullis et al., 2003). They were designed according to the different competence levels of the PIRLS study. The curricular validity of this text was examined by international reading and curriculum experts. Some of the questions have to be answered in multiple choice format and others in an open answering format.

The seven scales of the instrument refer to cognitive and metacognitive learning strategies. Cognitive strategies include students' use of basic and complex strategies for the processing of information from texts and lectures (cf. Weinstein & Mayer, 1986). For assessing the cognitive learning strategies three subscales were designed.

Elaboration refers to the strategies students employ to understand information by activating their prior knowledge and creating analogies (8 items).

Rehearsal refers to strategies of memorization and involving rehearsing of items in order to remember them (7 items).

Organization refers to the strategies students employ to select information and construct connections (6 items).

For assessing metacognitive learning strategies four subscales were constructed (cf. Pintrich, 2000).

Planning involves setting educational as well as task analysis (7 items).

Monitoring strategies are used in order to observe the effectiveness of the learning performance and behavior. The scale includes strategies like focusing the attention, comprehension monitoring, and time management (6 items).

Regulation strategies are important if problems appear during the learning process. If learners have comprehension problems or use inadequate learning strategies, they should regulate their learning activities (6 items).

Evaluation strategies are used to check if planed educational goals are reached or not. Students control their own effort and draw conclusions for the next learning episode (6 items).

Procedures

The questionnaire was administered in school in regular classrooms by trained staff members of the University of Oldenburg (Germany). The children were informed orally that they were participating in a survey about the way children learn. Additionally, it was pointed out that it was not an achievement test that they would not get any marks, that their answers were handled anonymously, and that their teachers would not get an insight into their answers. Finally, the researcher stressed the importance of being honest.

After handing out the questionnaires the children had the opportunity to ask comprehension questions. Answering the likert scale was illustrated with an item example. There was a time limit of one school lesson (45 minutes) for the completion of the whole survey which includes reading the non-fictional text, answering the questions concerning the text, and answering the questionnaire items. In most cases less time was required, generally between 30 and 35 minutes.

Research Question

Referring to the results of research in self-regulated learning, especially with self-report instruments, we ask if the theoretically

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assumed and model-based multidimensionality in cognitive and metacognitive strategies can be found in empirical data. Combining this methodological research question with results of developmental aspects we want to investigate if the different dimensions of cognitive and metacognitive learning strategies can be empirically and statistically distinguished already in elementary school children.

Results Study 1

Construct Validation: Factor Analysis

According to the theoretical assumptions and the multidimensionality of self-regulated learning an exploratory factor analysis using principal component factoring with varimax rotation was conducted among the items assessing cognitive strategies and among the items measuring metacognitive strategies. In the factor extraction three procedures were used to identify the underlying factor structure: the Kaiser-Meyer-Olkin measure of sampling adequacy, the Kaiser-Guttman criteria (eigenvalues greater than one), and the scree plot by Catell (Field, 2009). Using all these methods and criteria for extracting the factor structure should reduce the risk of over or under extraction. The varimax rotation method was applied because it accounted for larger factor loadings under each of the factors that will be extracted. Analyzing the factor structure, there were different criteria defined in advance; items should be assigned to factors based on their factor loadings, items with factor loadings below .45 should be removed, and items with cross loadings in two or more factors should also be eliminated (Field, 2009).

Looking at the factor analysis of those items which theoretically referred to cognitive strategies (Elaboration, Rehearsal, and Organization) the KMO value of .851 suggests that it is reasonable to run a factor analysis on the data. Bartlett's test of sphericity is statistically significant (χ^2 (210) = 5268.23, $p < .001$) which shows that item correlations are good enough for conducting a factor analysis. The examination of the eigenvalues as well as the scree plot show that three factors can be produced which is in accordance to the theoretical model. Results of the three-factor principal component analysis with varimax rotation are shown in Table 1.

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Table 1
Results of the Rotated Component Matrix with Items Measuring Cognitive Strategies (N = 1083)

	factor 1	2	3
E1 While reading the title I wondered what the text was about.	**.45**	-.04	.14
E2 I have tried to visualize characters, objects, and situations that occur in the text.	**.53**	-.12	-.01
E3 I have wondered if I had ever had an experience like that.	**.63**	.18	.08
E4 I have wondered if anything I have read in the text could be useful in real life.	**.62**	.16	.18
E5 I have wondered if I had read anything similar to this before.	**.63**	.09	.16
E6 I have tried to think and feel like the characters in the text.	**.60**	.03	.17
E7 On reading the text some interesting questions occurred to me.	**.51**	.15	.10
E8 Finally I tried to imagine how the story could be continued.	**.63**	.06	.09
W1 I have tried to learn by heart the things that could be important.	.35	.12	.31
W2 In order to understand the text I had to read it several times.	.06	.18	**.67**
W3 I have read important parts of the text several times.	.15	.11	**.74**
W4 I had to read the text several times in order to grasp its meaning.	.07	.12	**.72**
W5 I have gone over difficult words in my mind several times.	.29	.05	**.53**
W6 I have memorized important points by repeating them in my mind.	.40	.02	**.50**
W7 I have read important passages several times.	.16	.04	**.77**
O1 I have marked important points in the text.	-.01	**.69**	.12
O2 I have made some notes in the text.	.12	**.62**	.09
O3 I have made some notes in the margins.	.10	**.69**	.02
O4 I have written some short comments directly into the text.	.09	**.58**	.10
O5 I have written down keywords or summaries.	.09	**.69**	.06
O6 I have marked words or sentences in the text.	-.02	**.76**	.11
Eigenvalues	4.90	2.41	1.66
Explained Variance	14.8%	13.9%	13.9%
Cronbach's α	.75	.77	.79

Note. Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser Normalization. Sufficient factor loadings over the criteria .45 are written in bold.

This factor solution accounts for 42.73% of the total variance, whereas factor 1 (Elaboration) explained 14.8%, factor 2 (Organization) explained 13.9% and factor 3 (Rehearsal) explained 13.9% of the total variance. The factor analysis converged in 5 iterations. Except for the item W1 ("I have tried to learn by heart the things that could be important.") all of the other items could be retained. The 20 items were classified based on their factor loadings as following: Elaboration (8 items), Organization (6 items), and Rehearsal (6 items). To sum up, this factor solution with three extracted factors is in line with the categories of the theoretical assumptions underlying the questionnaire construction.

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Table 2
Results of the Rotated Component Matrix with Items Measuring Metacognitive Strategies (N = 1083)

	factor 1	factor 2
P1 I have asked myself how much time I need for answering the questions.	.22	**.46**
P2 Before I started I checked to see how many questions there were.	.08	**.59**
P3 I have wondered how best to deal with the text.	**.49**	.24
P4 Before starting to read I checked the length of the text.	-.10	**.66**
P5 Before starting I wondered how best to divide the work.	.40	.42
P6 I wondered how much time I would need for reading the text.	.15	**.61**
P7 I flipped briefly through the text to get an overview.	.08	**.59**
U1 While reading I wondered which bits I had understood and which bits I hadn't.	**.46**	.12
U2 I have made a note of the text passages that could be important.	**.56**	.10
U3 To make sure that I had understood everything I asked myself questions about the text.	**.61**	.10
U4 To check if I had understood everything I mentally reviewed the text.	**.62**	.05
U5 While reading I asked myself if I had understood everything.	**.58**	.22
U6 I have taken care to be ready on time.	.32	.34
R1 If I noticed that certain points were not clear, I read the passage again.	**.52**	-.04
R2 If I didn´t understand a passage I went through it step by step.	**.61**	-.02
R3 Difficult passages I read slowly and with concentration.	**.59**	.02
R4 I have tried to explain unknown words to myself.	**.56**	.13
R5 If I didn't understand a word I asked someone about its meaning.	.20	.05
R6 I hurried to get everything done.	.05	**.45**
B1 Afterwards I wondered if I had made enough effort.	**.48**	.33
B2 After reading I asked myself if I had understood everything.	**.59**	.21
B3 At the end I considered what I had not yet done well.	**.55**	.27
B4 I have asked myself if I have achieved what I wanted.	**.51**	.35
B5 I have asked myself what I could have done better.	**.54**	.36
B6 I have asked myself what I would do differently the next time I had to deal with a text.	.43	.39
Eigenvalues	6.38	1.80
Explained Variance	20.7%	12.0%
Cronbach's α	.85	.64

Note. Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser Normalization. Sufficient factor loadings over the criteria .45 are written in bold.

The factor analysis of the items theoretically referring to metacognitive strategies (Planning, Monitoring, Regulation, and Evaluation) is shown in table 2. For the factor extraction and analysis the same statistical methods and criteria were used as mentioned above. Results of the KMO and Bartlett's test support the possibility of conducting a factor analysis. The KMO with a value of .923 suggest that running a factor analysis on these data is adequate. Bartlett's test of sphericity also indicates good values because of its statistical significance (χ^2 (300) = 5733.04, $p < .001$). Looking at the eigenvalues of the items as well as on the scree plot a two factorial solution is sustained. In contrast to the model-based assumptions which imply a segregation of the four aspects Planning, Monitoring, Regulation, and Evaluation, results of the factor extraction suggest (only) a two-dimensional structure of metacognitive strategies.

Factor 1 consists of items which are theoretically connected to the metacognitive strategies Monitoring, Regulation, and Evaluation except for the item R6 ("I hurried to get everything done.") which is theoretically associated to the metacognitive process of Regulation but loaded on the second factor. This newly emerged factor contains items dealing with monitoring processes and is therefore labeled as Monitoring. On the second factor items loaded which are related to the metacognitive process of Planning except for the item P3 ("I have wondered how best to deal with the text.") which loaded on the first factor. The two-factorial solution accounts for 32.72% of the total variance. Factor 1 (Monitoring) explained 20.7% of the variance, factor 2 (Planning) explained 12%. This factor solution converged in 3 iterations.

Reliability Analysis

Based on the results of the exploratory factor analysis the items were selected to test for reliability (internal consistency by Cronbach's α). An item was excluded from reliability analysis if it had a factor loading less than .45 and if it had communalities less than .30. The reliability of the subscales should be $\alpha \geq .60$ to construct a reliable subscale.

Elaboration. The subscale Elaboration has a reliability coefficient of $\alpha=.75$. The alpha if one of the items deleted does not suggest that deleting any existing items would increase the internal consistency so all items referring to the subscale Elaboration were retained. For this reason the subscale consists of 8 items.

Organization. The alpha coefficient of the subscale Organization shows also a reasonable value of $\alpha=.77$. All of the six items are included in the reliability analysis and had sufficient communalities. As was the case for the first factor alpha maximization would not increase the alpha so the subscale Organization consists of six items.

Rehearsal. The reliability analysis of the subscale Rehearsal is conducted with all theoretical hypothesized items except the item W1 which had an inadequate factor loading. The reliability with a value of $\alpha=.79$ suggests a good internal consistency of the subscale. As before all of the six items are included in building the subscale Rehearsal.

Monitoring. The new emerged subscale Monitoring consists of 14 items. The items U6 ("I have taken care to be ready on time."), R5 ("If I didn't understand a word I asked someone about its meaning."), and B6 ("I have asked myself what I would do differently the next time I had to deal with a text.") were excluded for these analyses because of inadequate factor loadings. Results of the reliability analysis show a good internal consistency with $\alpha=.85$. All 14 items were included in building the subscale Monitoring.

Planning. The subscale Planning contains the five items referring to the planning process based upon the model except for the item P5

("Before starting I wondered how best to divide the work.") with less factor loading than needed. Calculation of the internal consistency reveals a sufficient reliability with α=.64. The alpha if deleted does not suggest that deleting an item would increase the internal consistency so all items were retained.

According to the results of the factor and of the reliability analysis one can conclude that all theoretical and model-based assumptions about the multidimensional structure of cognitive strategies proved to be reliable. The analysis of the data provides the three strategies Elaboration, Organization, and Rehearsal to be categorized as independent dimensions during cognitive strategy processing. In comparison to that, the factor analysis and tests of reliable subscales indicate that metacognitive strategies do not empirically emerge as theoretically supposed. Whereas the four strategies Planning, Monitoring, Regulation, and Evaluation were assumed to be independent dimensions of the metacognitive process the statistical analysis only reveals a two factorial structure. The metacognitive processes Monitoring, Regulation, and Evaluation cannot be empirically distinguished based on this data. So far, only the process of planning can be regarded as an independent and reliable dimension of metacognitive strategies in self-regulated learning. At this point the theoretically assumed four-dimensionality of metacognitive strategies can be questioned.

Method Study 2

Participants

Subjects of the next study were N= 1067 students from a German Gymnasium, a high-achieving secondary school. 532 children were from fifth grade and 535 from sixth grade. There were 564 girls (52.9%) and 496 boys (46.5%), (7 missing). The age group ranged from nine to fourteen years, and the average age was 11.1 years (SD=.80).

Instrument and Procedures

The same questionnaire with the same non-fictional text and questions as in study 1 was used. It consists of 46 Items, and the seven scales Elaboration, Rehearsal, Organization, Planning, Monitoring, Regulation, and Evaluation.

Research Question

With regard to the results of study 1 with elementary school children and the model-based assumptions of the multidimensionality of cognitive and in particular in metacognitive strategies this study focuses also on the underlying structure of self-regulated learning. In this case we examined if the findings of the first study could be replicated with older children or if parts of - especially the metacognitive - processing of self-regulated learning becomes more differentiated in older children. In line with research on developmental aspects in this area it might be possible that self-regulated learning of children between the ages of 12 to 14 years does not only show a quantitative increase in the use of metacognitive strategies but also a qualitative change. In this case we hypothesized that the metacognitive structure gets more differentiated with age. For this reason we intended to test children of the fifth and sixth grades with the same instrument to get an insight into the multidimensional structure of cognitive and metacognitive strategies in this age group.

Results Study 2

Construct Validation: Factor Analysis

For answering the research question we used the same empirical and statistical tests as well as the criteria for all parts of the analysis as in study 1. We analyzed the data of fifth graders and sixth graders separately. So we conducted two exploratory factor analyses but in the following tables and descriptions they will be reported together in order to compare the results.

Results of the KMO and Bartlett's test of sphericity provide a factor analysis on both datasets. The KMO of the data of fifth graders with a value of .823 and with a value of .774 of the data of the sixth graders suggest both that it was reasonable to run a factor analysis on these data. Bartlett's test of sphericity was statistically significant on the dataset of fifth graders (χ^2 (210) = 3100.89, $p < .000$) and on the dataset of sixth graders (χ^2 (210) = 3257.82, $p < .000$).

Looking at the factor extraction of the items referring to the cognitive strategies (Elaboration, Rehearsal, and Organization) the eigenvalues as well as the scree plot indicate a three factor solution which follows the theoretical model and the results of the first study. Results of the three-factor principal component analysis with varimax rotation were shown in Table 3 contrasting the data of children in fifth and sixth class.

The factor solution of the fifth graders accounts for 42.9% of the total variance with Factor 1 (Elaboration) explaining 16.5%, factor 2 (Rehearsal) explaining 14%, and factor 3 (Organization) explaining 12.4% of the total variance. The factor structure of the 6th graders also provides three factors with nearly the same values of explained variance (43.5%). Factor 1 (Elaboration) explained 16.5%, factor 2 (Rehearsal) explained 14.8 %, and factor 3 (Organization) explained 12.2% of the total variance. Both factor analyses converged in 5 iterations. As in study 1 all of the other items could be retained except the item W1 ("I have tried to learn by heart the things that could be important.") which has an inadequate factor loading. The 20 items were classified based on their factor loadings and following the theoretical assumptions and the findings of the first study: Elaboration (8 items), Organization (6 items), and Rehearsal (6 items). In conclusion, these results, the factor extraction and analysis, provide the three dimensional structure of cognitive strategies. This is corresponding to the findings of the first study with elementary school children.

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Table 3
Results of the Rotated Component Matrix with Items Measuring Cognitive Strategies in Fifth Graders (N = 532) and Sixth Graders (N = 535)

	5th class			6th class		
Item	1	2	3	1	2	3
E1	**.51**	.08	-.08	**.48**	-.02	-.09
E2	**.47**	.15	.30	**.57**	.09	.02
E3	**.56**	.16	.12	**.61**	.23	.08
E4	**.53**	.02	-.02	**.55**	.09	-.23
E5	**.72**	.09	.09	**.65**	.07	.09
E6	**.71**	.17	.06	**.63**	.23	.10
E7	**.70**	.17	.05	**.65**	.11	.11
E8	**.60**	.25	.04	**.63**	.29	-.11
W1	.25	.21	.07	.27	.36	-.02
W2	.03	**.69**	.22	-.02	**.69**	.14
W3	.19	**.76**	.10	.21	**.74**	.12
W4	.14	**.65**	.06	-.03	**.71**	.08
W5	.36	**.63**	.05	.36	**.54**	.06
W6	.44	**.49**	-.02	.39	**.59**	-.05
W7	.17	**.73**	.03	.21	**.73**	.04
O1	.13	-.07	**.75**	.27	-.12	**.62**
O2	-.05	.16	**.54**	.00	.07	**.71**
O3	-.08	.08	**.60**	-.11	.16	**.63**
O4	.11	-.05	**.72**	.18	-.07	**.72**
O5	.08	.12	**.69**	-.01	.09	**.61**
O6	.10	.11	**.46**	-.12	.15	**.50**
Eigenvalues	5.02	2.34	1.64	4.75	2.56	1.82
Explained Variance	16.5%	14.0%	12.4%	16.5%	14.8%	12.2%
Cronbach's α	.79	.80	.71	.78	.80	.70

Note. Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser Normalization. Sufficient factor loadings over the criteria .45 are written in bold.

Opposite to this are the findings of the factor analysis with items measuring the metacognitive strategies Planning, Monitoring, Regulation, and Evaluation. Testing the KMO and Bartlett's test the values provide conducting a factor analysis of both datasets. The KMO of the data with fifth grade students is .888, the KMO value of the data with sixth graders is .897. Both suggest that running a factor analysis on these datasets is adequate. Bartlett's test of sphericity also indicates good values because of its statistical significance in the dataset of fifth class students (χ^2 (300) = 3776.84, $p < .000$) and of sixth class students (χ^2 (300) = 3690.01, $p < .000$).

Exploring the dimensional structure of the items referring to metacognitive strategies the factor extraction with the criteria of eigenvalues over one as well as the scree plot sustain a two factorial solution. As shown in the study before the four dimensions of metacognitive processing Planning, Monitoring, Regulation, and Evaluation could not be replicated with these two datasets. Both factorial analyses suggest only a two dimensional structure of metacognition. The two-factorial solution of both datasets is shown in table 4.

In line with the results of the first study, items of the three strategies Monitoring, Regulation, and Evaluation loaded on Factor 1. This factor (Monitoring) consists of all items theoretically referring to those strategies except for the items R6 ("I hurried to get everything done.") and U3 ("To make sure that I had understood everything I asked myself questions about the text.") which loaded on the second factor. On the second factor all the items of the metacognitive process Planning loaded except for the item P3 ("I have wondered how best to deal with the text.") as in the study mentioned above. The two factorial solution accounts for 35.9% of the total variance in the dataset with fifth graders with factor 1 (Monitoring) explaining 22.6% and factor 2 (Planning) explaining 13.3 %. In the data set with sixth graders the totally explained variance is 36.41% with Factor 1 (Monitoring) explaining 23.5% of the variance, and factor 2 (Planning) explaining 12.9 %. Both factor solutions converge in 3 iterations.

Table 4

Results of the Rotated Component Matrix with Items Measuring Metacognitive Strategies in Fifth Graders (N = 532) and Sixth Graders (N = 535)

	5th class		6th class	
	1	2	1	2
P1	.16	**.51**	.15	**.53**
P2	.03	**.60**	-.07	**.56**
P3	**.48**	.22	**.55**	.19
P4	-.15	**.73**	-.03	**.57**
P5	.41	.39	.36	**.50**
P6	.29	**.60**	.27	**.61**
P7	.09	**.64**	.05	**.61**
U1	**.60**	.09	**.66**	-.08
U3	.22	**.46**	.06	**.50**
U4	**.61**	.02	**.65**	.09
U5	**.59**	.06	**.57**	.07
U6	**.59**	-.01	**.64**	.07
U7	**.74**	.06	**.68**	.16
R1	**.48**	.14	**.58**	-.16
R2	**.55**	.14	**.69**	-.10
R3	**.62**	.07	**.68**	.02
R4	**.55**	.18	**.59**	.16
R5	.10	.14	.09	.04
R6	.04	**.55**	-.03	**.53**
B1	**.53**	.35	**.48**	.33
B2	**.63**	.03	**.69**	.10
B3	**.53**	.26	**.54**	.26
B4	**.55**	.34	**.52**	.39
B5	**.54**	.40	**.51**	.38
B6	**.54**	.34	.37	.39
Eigenvalues	6.77	2.20	6.61	2.49
Explained Variance	22.6%	13.3%	23.5%	12.9%
Cronbach's α	.88	.72	.89	.73

Note. Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser Normalization. Sufficient factor loadings over the criteria .45 are written in bold.

Reliability Analysis

As in study one the items are selected to test the reliability based on the results of the exploratory factor analysis and their factor loadings. All analyses showed a good internal consistency for all subscales as follows. The alphas if one of the items deleted does not suggest that deleting any existing items would increase the internal consistency so all items loading on one subscale were retained.

Elaboration. The subscale Elaboration has a reliability coefficient of α=.79 in the data of fifth and an alpha of .78 in the data of sixth graders. The subscale consists of 8 items in both datasets.

Rehearsal. The reliability analysis of this subscale was conducted with all theoretical hypothesized items except the item W1 which had an inadequate factor loading as in study 1. The reliability with a value of α=.80 in both analysis suggest a good internal consistency of the subscale. As before all of the six items are included in building the subscale Rehearsal.

Organization. The alpha coefficient of the subscale Organization shows also a reasonable value of α=.71 in the fifth class data set and α=.70 in the sixth class dataset. All of the six items are included in the reliability analysis and had sufficient communalities.

Monitoring. The newly emerged subscale Monitoring consists of 16 items in the data of the fifth graders. The items U6 ("I have taken care to be ready on time.") and R5 ("If I didn't understand a word I asked someone about its meaning.) are excluded from analyses because of inadequate factor loadings. Results of the reliability analysis show a good internal consistency with α=.88. In contrast to this the analysis of the data measuring Monitoring in sixth graders only 15 items loaded sufficiently on this factor. The item B6 ("I have asked myself what I would change the next time when I will read a text.") has an inadequate factor loading and was therefore excluded. The internal consistency of this subscale is α=.89.

Planning. Looking at the data of the fifth graders, the subscale Planning contains the five items referring to the planning process based upon the model except the item P5 ("Before starting I wondered how best to divide the work.") with less factor loading than needed. Calculation of the internal consistency reveals a good reliability with α=.72. Analyzing the data of the sixth graders the item P5 has a sufficient factor loading on the factor. In this case the subscale Planning consists of six items and also had a good internal consistency with a value of α=.73.

To sum up it can be concluded that in line with theoretical models of self-regulated learning the three-dimensional structure of cognitive strategies was confirmed by the results of these analyses comparing data

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of fifth and sixth grade students. In line with the theoretical assumptions we replicated the three strategies Elaboration, Organization, and Rehearsal as independent and reliable dimensions of the cognitive learning strategies. In contrast to this, the findings regarding the dimensionality of metacognition only suggest a two-factorial structure. Whereas several models of self-regulation assume a three or four phase structure of this metacognitive aspect the empirical data provides only evidence for monitoring and planning processes - at least for children between nine to fourteen years. According to this finding we had no hints for a more differentiated metacognitive processing than in elementary school children. The results hardly provide the two-dimensional structure of metacognitive strategies in school children.

Discussion

Our investigations clearly show that the assumed model of three separate factors for cognitive learning strategies can be found - like in many other studies - without doubt also in our data. In this respect it replicates the findings already reported by Weinstein and Mayer (1986), Wild and Schiefele (1994) and Garcia and Pintrich (1996).

On the other hand, the assumed model of four factors for metacognitive learning strategies was neither found in the first nor in the second study. What could be possible and plausible explanations for these results? We suggest that neither the formulation of our items nor the age of the sample is responsible for the misfit of theoretical model and empirical data with regard to the metacognitive strategies.

Our results might resemble to the model of Weinstein and Mayer (1986) which does not separate metacognitive strategies into further subgroups. But our data reveals that Planning as a metacognitive strategy can be separated from other metacognitive processes. Several other studies also had difficulties to separate metacognitive strategies (e.g. Garcia & Pintrich, 1996; Wild & Schiefele, 1994). Whereas for the cognitive subscales three different dimensions are clearly empirically separable, metacognitive processes in self- regulated learning are more interwoven and highly correlated. Pintrich (2000) states that there are four different phases in which different metacognitive strategies play their part. According to Pintrich (2000), these phases are not necessarily independent and distinct. Our analyses reveal at least one separable phase which is Planning. The three other theoretically assumed metacognitive strategies are highly correlated (e.g. monitoring and regulation) and interwoven in the learning process and can not be separated empirically from each other (as already Garcia and Pintrich (1996), Spoerer (2004) and Wild and Schiefele (1994) have reported). Therefore it has to be questioned if the underlying theoretical model should be changed. In our opinion changes in the theoretical models are not necessary.

On the contrary: The assumption of a highly differentiated process of metacognitive regulation helps to explain what is useful and necessary

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when trainings of metacognitive regulation are planned and administered. The process of metacognitive regulation can be illustrated easily by the different facets in a complex process, but like in a complex dance a separate step alone is not a representation for the nicely coordinated process. Therefore we would recommend not to reduce the theoretical model but to make clear that the underlying mechanisms of metacognitive regulation are rather helpful to explain and illustrate a complex picture of Regulation! But it should be made clear as well, that one strategy (e.g. regulation) is senseless without another strategy (e.g. monitoring).

To sum up: Our studies are in line with the theoretical models of self-regulated learning of Weinstein and Mayer (1986) and Garcia and Pintrich (1996). Both models postulate three different dimensions of cognitive learning (rehearsal, elaboration and organization), which we could clearly separate in two studies with children aged eight to fourteen years old. With respect to metacognitive processes the models differ. Whereas Weinstein and Mayer (1986) do not postulate any sub-dimensions of metacognitive learning, Pintrich (2000) conceptualize four different but interwoven metacognitive phases. Our data shows that only Planning is separable from the other metacognitive phases postulated by Pintrich (2000). However, we recommend to adhere to the model of Pintrich (2000) in order to illustrate different (but interwoven) processes of metacognitive self-regulation in training situations.

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