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Rethinking strategy instruction: direct reading strategy instruction versus computer-based guided practice

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There are many established reading strategy training programmes, which explicitly teach strategic and meta-cognitive knowledge to improve reading comprehension. Although instruction in strategy knowledge leads to improvements in meta-cognitive skills, the effects do not always transfer to reading comprehension. Therefore, to investigate preconditions for knowledge transfer, two different strategy training programmes were implemented in nine classes of Grade 6 students ($N = 148$) over the course of one school year. One programme involved teacher-directed instruction of declarative meta-cognitive knowledge (*Reading Detectives*; Rühl & Souvignier, 2006). The other aimed at improving executive meta-cognition by guided practice: students worked with a computer program based on latent semantic analysis (LSA) (*conText*) and received immediate feedback on written summaries. Although both groups improved their strategy knowledge to the same extent, the *conText* group showed a greater improvement in reading comprehension. These findings suggest that guided practice, which is characterised by intensive practice and individualised corrective feedback, is superior to explicitly teaching strategy knowledge.

Comprehending written material is the ultimate goal of reading as well as reading instruction (e.g., Torgesen, 2002) and there is a vast body of evidence on the determinants of reading comprehension. Cromley and Azvedo (2007), for example, conducted a cross-sectional analysis with the data of students aged 14. At this age, background knowledge and vocabulary had the strongest influence, but fluency, inference and other reading strategies considerably influenced students' performance. These empirical findings essentially are consistent with models of text comprehension from cognitive psychology, such as the *Construction Integration Model* (Kintsch, 1998). This theoretical framework describes the formation of a mental representation of the contents of a text, postulating two main processes. In the construction process, the reader activates word meanings, produces elaborations and inferences, and uses background knowledge to form a propositional structure of the text contents. In a parallel process – the integration phase – the propositional structure is converted into a coherent form, the mental model or situational model. This mental

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representation is independent from the word base of the original text, and instead resembles the condensed summary of the original text in one's own words.

In recent decades, different approaches have been developed in order to foster reading comprehension. Meta-analyses implicate phonic awareness, phonics, fluency, vocabulary and comprehension programmes as being central approaches in literacy education (e.g. Hattie, 2009, p. 140). Beyond the initial acquisition of decoding skills, interventions directly targeting comprehension become especially important at the end of elementary school (Wanzek, Wexler, Vaughn & Ciullo, 2010) with a strong emphasis on meta-cognitive knowledge and strategic behaviour (e.g., predicting, summarising and comprehension monitoring; Van Kraayenoord, 2010).

Strategy training as a key concept in reading comprehension instruction

Over the last 40 years, research on strategy usage and self-regulated learning has continuously increased and the research results have been incorporated into recommendations for educational policy-makers and educational professionals (e.g. Artelt et al., 2007; National Reading Panel, 2000; RAND Reading Study Group, 2002). Initially, researchers focused on the use of cognitive strategies such as visualising, summarising and note-taking (Klauer, 2010). Early experiments showed promising results, but the high effect sizes were partly due to methodological flaws or the usage of self-constructed near transfer measures in laboratory settings (e. g. Souvignier, 2009; Wanzek et al., 2010). Later on, the complexity increased by combining isolated approaches to build more comprehensive programmes. For instance, the peer tutoring concept used by Palincsar and Brown (1984) is representative of a combined programme, marking a breakthrough in school-based reading comprehension intervention and sparking the development of subsequent strategy training programmes (e.g., Duffy, Roehler & Herrmann, 1988; Pressley et al., 1992). Finally, meta-cognitive components gained influence and today many well-known reading comprehension programmes include meta-cognitive aspects (Van Kraayenoord, 2010).

Currently, a plethora of training concepts is available. Many of these have been developed at the turn of the century or after (cf. Lenhard, 2009), and they cover a variety of different approaches to strategy instruction: programmes like *Informed Strategy Instruction* (Paris, Cross & Lipson, 1984), the work of Duffy et al. (1988), *Transactional Strategies Instruction* (Pressley, 2002) as well as the German programme *Reading Detectives* (Rühl & Souvignier, 2006) combine a set of reading strategies. These strategies are explicitly discussed by the teacher, especially in terms of why it is important to use them and how and when they should be used. Several other approaches like *Peer Tutoring* (Palincsar & Brown, 1984), *Collaborative Strategic Reading* (Kim et al., 2006) and *Peer-Assisted Learning Strategies* (Fuchs, Fuchs, Mathes & Simmons, 1997) use direct instruction of strategies as well, but place a much stronger focus on the exchange between students and the application of these strategies on text material within a social context. And finally, there are approaches that have a stronger focus on the content of the material and on reading motivation. The very comprehensive *Concept-Oriented Reading Instruction* (Guthrie, Wigfield & Perencevich, 2004) might be the most prominent representative for this point of view, and there are other, content-focused approaches like *Guided Comprehension* (McKeown, Beck & Blake, 2009) as well.

Research evaluating these programmes documents the possibility to improve reading comprehension of students in a broad age range and at varying aptitude levels. Depending on the

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grade of the students, effect sizes of $d = .40$ and $d = .60$ have been found (Berkeley, Scruggs & Mastropieri, 2010; Hattie, 2009, p. 136; Souvignier, 2009; Suggate, 2010), at least when the intervention was delivered by teachers and when standardised measures were used.

Many researchers today favour teaching meta-cognitive knowledge to improve reading comprehension (e.g. Baker, 2002; Paris, Wasik & Turner, 1991; Pressley, 2000; Pressley, Forrest-Pressley, Elliott-Faust & Miller, 1985; for an overview see Van Kraayenoord, 2010, p. 285). After all, declarative meta-cognitive knowledge is relatively easy to teach after elementary school and, therefore, it is potentially a targeted and cost-efficient approach. Practically, all strategy training programmes are fairly efficient in improving strategy knowledge (e.g., Gold, Trenk-Hinterberger & Souvignier, 2009). However, declarative meta-cognitive knowledge does not necessarily transfer to executive meta-cognition and strategic behaviour. As a consequence, strategy instruction does not always pay off in terms of enhanced performance (Hasselhorn, 1992). In some cases, there are mixed results with minimal or unexpected negative transfer effects even for theoretically well-grounded concepts (e.g., Streblow, Holodynski & Schiefele, 2007) or the effects are only found in students with particular levels of competence, such as above-average readers (Cross & Paris, 1988; Gold et al., 2009).

Importantly, from the beginning of the 1980s, there was an accentuation of cognitive approaches in the instruction of reading strategies. In many programmes, strategies were taught explicitly by reflecting, discussing and modelling useful strategies in class. Pressley, Borkowski and Schneider (1989), for example, suggested that strategies should be explicitly taught and demonstrated by the teacher and that there should be a thorough discussion of the usage and of the precursors for its success. They proposed not to teach too many strategies simultaneously and, afterwards, students should have plenty of time to practise. While these suggestions are intuitively reasonable, it has to be noted that the approach places a strong emphasis on cognitive learning and instruction, while practice is part of a later phase of learning. Of the 11 suggestions for successful strategy instruction of Pressley et al. (1989), seven deal with explicit instruction, three with preconditions and only one mentions practice. The application of strategies did feature in some suggestions yet it could be argued that it should be a more integral part of the training itself.

Currently, there is a debate on a number of questions. Should multiple strategies be taught, or is it better to concentrate on a small set or even single strategies (Gajria, Jitendra, Sood and Sacks, 2007)? What are the essential ingredients of strategy instruction necessary to ensure the transfer of declarative meta-cognitive knowledge to executive meta-cognition and strategic behaviour? How important is corrective feedback (Hattie & Timperley, 2007)? And finally, should reading strategies be taught explicitly, or is it better to focus on the text content and guide the students to build up coherent text representation and connect the main ideas (McKeown et al., 2009)?

To begin addressing these many questions, the current study contrasts two different approaches to strategy instruction. The first programme (*Reading Detectives*) focuses on the teacher-directed instruction of declarative meta-cognitive knowledge. It is a teacher-directed multiple strategy instruction and has a strong focus on summarisation skills which account for approximately 50% of the intervention. Capitalising on technology from the field of automatic speech processing, called Latent Semantic Analysis (LSA), the second programme (*conText*) aims at improving executive meta-cognition. *conText* is a computer-assisted and content-focused intervention that features a guided practice approach in order to grasp the meaning of a text, specifically by giving computer-based feedback on written summaries. The two programmes are multicomponent interventions and differ in several

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Table 1. Comparison of treatment conditions.

	Reading detectives	Context
Student population	sixth grade, secondary modern school	sixth grade, secondary modern school
Treatment	teacher-directed instruction of declarative meta-cognitive knowledge	training of summarisation skills via guided practice
Strategies	(1) pay attention to headlines, (2) handle difficult text passages, (3, 4) summarisation of narrative and expository texts	summarisation of expository texts
School subject	language arts	language arts
Number of lessons	20.0	15.8
Text type	narrative and expository	expository
Text length	approx. 150 words	approx. 150 words
Number of texts	6	11 to 13 (one small class only 3)

ways, but both have a strong focus on the development of reading comprehension by teaching summarisation skills. Both programmes are now briefly introduced (cf. also Table 1).

Text Detectives and Reading Detectives

Reading Detectives (Wir werden Lesedetektive; Rühl & Souvignier, 2006) is a strategy instruction programme in the German language that aims to teach strategy knowledge to improve reading comprehension. Key foci are on why and how to (a) handle difficult text passages, (b) activate prior knowledge by paying attention to headlines, (c) summarise narrative texts and (d) summarise expository texts. *Reading Detectives* is based on *Text Detectives* (Wir werden Textdetektive; Gold, Mokhlesgerami, Rühl, Schreblowski & Souvignier, 2004), one of the most well-known reading comprehension training programmes in Germany, which was originally inspired by the suggestions of Paris and Jacobs (1984). The *Reading Detectives* programme was adapted especially for students with lower levels of reading achievement, such as students with learning disabilities or struggling readers. It contains five learning units with a total of approximately 25–30 lessons. The *Reading Detectives* material consists of a teacher manual (72 pages) with lesson concepts and a student textbook (40 pages). Each learning unit includes short texts with questions, teacher-centred classroom instruction, advance organisers, recapitulations and checklists for self-evaluation of acquired knowledge. Within each unit, the teacher begins with explicit instruction about a specific strategy and demonstrates its use. In the second phase, the students work with the textbook, first in the form of a class conversation and then either as individual students or in pairs. Finally, the class discusses possible problems and conditions for the use of specific strategies. In total, the training includes six texts (three narrative and three expository texts) with approximately 150 words on which the students work repeatedly. *Text Detectives* and *Reading Detectives* have both been used with students in Grade 5 and 6 in various studies (for an overview see Gold et al., 2009). These studies involved over 4,000 students from 30 schools from different school types, and showed a moderate effect size ($d = .46$; $d = .36$ at follow-up) on strategy knowledge and small effects on reading comprehension ($d = .16$) which increased at follow-up 6 months later ($d = .27$). Results for students with learning disabilities, as well as students with advanced proficiency level seem to have larger effect sizes compared to secondary modern school

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pupils (please note the remarks on the German school system in the Method section), for whom the effect on reading comprehension was rather poor ($d = .38$ on strategy knowledge and $d = .03$ on comprehension in the follow-up).

The latent semantic analysis-based intelligent tutoring system conText

In comparison to *Reading Detectives*, *conText* (Improvement of Reading Comprehension by Working *with Texts*) is computer-based and focuses on guiding students in summarising texts by giving feedback on the content coverage of the drafts. It is based on LSA, a statistical technique from the field of natural language processing (Deerwester, Dumais, Furnas, Landauer & Harshman, 1990), which permits the extraction of the semantic relations between words based on their common occurrences in texts. The starting point for LSA are text corpora, which are first split into so-called documents, for example, paragraphs. Next, the occurrences of single words are counted and stored within a frequency matrix that contains the documents (rows) and the words (columns). Thus, the cells initially hold the frequency of a word type in a given document. After filtering for stop words and applying weighting schemas, the matrix is decomposed via Singular Value Decomposition (SVD) similar to the procession in a Principal Component Analysis (PCA). Contrary to the eigenvalue decomposition in PCA, where a decomposition of the square matrix of covariances is done, the SVD used in LSA is the decomposition of a rectangular matrix of weighted term frequencies (mathematical description, see Berry, Dumais & O'Brien, 1995; Martin & Berry, 2007). Afterwards, the number of extracted dimensions is reduced to a minimum (usually about 300) in order to exclude noise and to downsize data and memory consumption. Importantly, the dimension reduction leads to the generalisation of word and text meanings and the compression of knowledge. The retrieved vectorial representation of the semantic content – the so-called semantic space – is not simply some kind of word occurrence statistic any more, but rather an abstraction of the latent semantic content reflected by the common usage of words (thus *Latent Semantic Analysis*).

In order to process natural language, the generation of a semantic space has usually to be based on big text corpora. The semantic space used in this intervention contained the information from 65,000 documents with 311,000 different words (including flections and compounds) from the topics geology, geography, biology, meteorology and physics. Once it is at hand, new texts can be projected into the semantic space by adding the vectors of the single words of the text. LSA can then be used to automatically judge the semantic similarity between texts by calculating a similarity measure, as, for example, the cosine of the angle between the two text vectors. It has successfully been used in many different fields, for example cross-language information retrieval, automatic classification of texts, automatic essay scoring and intelligent search algorithms (Landauer, McNamara, Dennis & Kintsch, 2007). One application of LSA has been the construction of intelligent tutoring systems, where LSA is used to evaluate natural language and to give students immediate feedback on text productions. As a consequence, in the past decade, a number of LSA-based tutoring systems have been developed (cf. Lenhard, 2008) as, for example, *Summary Street* and the *Intelligent Essay Assessor*, which are accessible as commercial applications from Pearson Knowledge Technologies.

Despite a number of differences in the structure of the steps in the computer program, the functionality of *conText* is roughly comparable to *Summary Street* (Caccamise, Franzke, Eckhoff, Kintsch & Kintsch, 2007; Kintsch, Caccamise, Franzke, Johnson & Dooleay, 2007). In *conText,* the different steps follow a sequential order (see Figure 1): at the beginning, a

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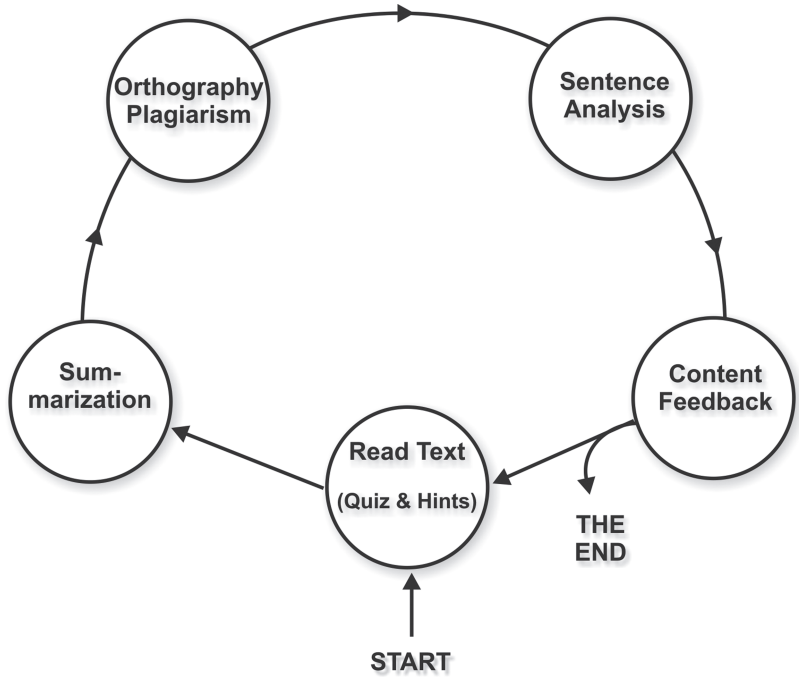

Figure 1. Sequential steps in the training cycle of *conText*: after reading the source text (probably enriched by hints and a quiz), the student summarises the source text. The draft is checked for orthography and plagiarism. Potentially irrelevant and redundant sentences are flagged, before the programme shows bar charts on the content coverage. Afterwards, the student has the possibility to further improve his or her draft.

short instruction is displayed that gives recommendations on how to best summarise a text and that briefly explains the usage of the computer tutor. Next, the student reads the source text, which he or she then summarises. The program flags spelling mistakes and plagiarised passages. Next, all sentences with a high semantic similarity are underlined. There might be an overlap between the content of these sentences and thus room for abridgement. Additionally, sentences with a poor semantic similarity with the source text are marked. These sentences are potentially irrelevant and may be deleted. In the final step, the tutor displays an evaluation of the content coverage of the source text and indicates which parts of the original text have not yet been sufficiently represented in the summary (see Figure 2). At this point, the student has the opportunity to revise the draft and to further improve the summary. The system gathers the drafts of the different revision cycles and the student is provided with an overview indicating how his or her scores evolved from revision to revision. In order to avoid shallow processing and a fast clicking through the steps without thorough revision, the number of cycles is restricted to eight by default. *conText* is available as a stand-alone desktop application, as well as a web-based e-learning environment.

In previous laboratory experiments with university students, *conText* was found to engage users in an intensive summarisation process (Lenhard, 2008). Compared to students who summarised texts without content feedback, they revised texts more often, spent more time in revision and made a greater improvement from the first to the final draft of the summary. The human-rated quality judgements of the summaries were higher for the group which received LSA-based content feedback. In the current study, we embedded *conText*

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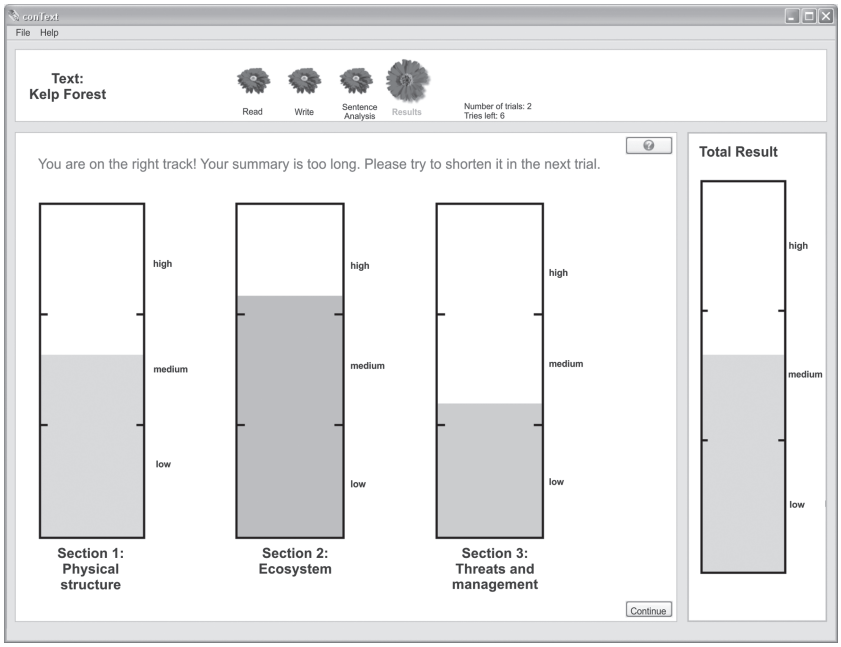

Figure 2. Screenshot of the feedback page of *conText*. The program displays a bar chart for each section of the source text, as well as the total result. Above the charts, a short verbal feedback is given. At the top, the program indicates the current position within the training cycle, as well as the remaining trials.

into the regular course by using schoolbook texts from the domains of biology, geography and history. The texts were approximately 150 words long (see Table 1). Students received a new text each session, except in cases where the texts turned out to be difficult and the teacher decided to complete the unfinished work of the last session.

Rationale and research questions

The aim of the current study was to assess the effects of the implicit computer-based strategy training programme *conText* in comparison to the explicit strategy training intervention *Reading Detectives* after it was embedded in a course across one school year. Both programmes aim to foster reading comprehension strategies. Although *Reading Detectives* is mainly based on the direct mediation of explicit strategy knowledge, *conText* uses a guided practice approach that focuses on the training of summarisation skills. Thus, this study can be seen as the comparison between teacher-directed instruction of declarative meta-cognitive knowledge versus the training of procedural meta-cognitive abilities by guided practice (cf. also Table 1).

Method

Participants and setting

We targeted students with proficiency levels below average because of the higher practical relevance of effective literacy intervention programmes for these pupils. In Germany,

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the school system is organised differently from region to region. In the regions, where the *Text Detectives* mainly had previously been evaluated (Hesse) and where this study was conducted (Bavaria), the school system is noninclusive and is structured at three different proficiency levels, namely (a) *Gymnasium* (grammar school) for high-achieving students, (b) *Realschule* for students of average proficiency level and (c) the *Hauptschule* (main school), which is attended by pupils aiming for manual jobs or working in the trades (e.g., electrician). After 4 years of elementary school, students choose one of these school forms. This decision is based both on the interests of the student as well as on their current grades in Grade 4. Currently, there is a strong trend towards a higher educational attainment. This has led to a dramatic decrease in student numbers of the *Hauptschule* as well as the proficiency level in this school form in recent years. As a consequence, the student population at *Hauptschule* currently represents the low performing third of the teenagers within the regular school system (Prenzel, Zimmer, Drechsel, Heidemeier & Draxler, 2005).

The sample consisted of 148 students from nine classes of the second school year of *Hauptschule* (sixth-grade level). Thus, we recruited low-performing students, but we did not select them individually. Instead, we drew a convenience sample of classes from the *Hauptschule*. The classes were randomly assigned to the treatment groups and participated as a whole.

Gatekeeper approval and consent

Prior to the study, we obtained the written permission of the school authorities and the schools, in accordance with ethics procedures for research. All parents provided written consent for their child's participation.

Study design and procedure

During the school year, which in Bavaria begins in the middle of September and ends at the end of July in the following year, the students either participated in the *Reading Detectives* intervention or the *conText* training programme. Both interventions were implemented by the teachers and embedded into the regular instruction of the language arts courses. Each class had a different teacher and was located at a different school. Four classes used the web-based training with *conText*, the other five used the direct strategy instruction programme *Reading Detectives*. The teachers of the *Reading Detectives* group implemented the training programme according to the manual and afterwards applied the acquired strategy knowledge in the regular courses. The *conText* group used the web-based version of the programme for this study and worked on texts from the regular schoolbooks in history, geography and biology according to the curriculum of the classes. Again, the students were not selected, but the class participated as a whole within the language arts instruction. It is important to note that in this way both programmes replaced normal content of the language arts instruction. However, the texts of the *conText* group were more closely related to contents of other school subjects.

We applied a pre- and post-test design to assess the effects of the training programmes. The pre-test took place 4 weeks after the beginning of the school year and the post-test was administered 8 months later at the end of June 2010. A total of 139 of 147 students completed both pre- and post-test (94.6%; see Table 2); the other eight students had left school or were absent due to illness at the post-test. No student withdrew his or her participation during the study. Seventeen students who were not present at the pre-test joined the classes

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Table 2. Sample statistics.

Group	*N*	Age *M* (*SD*)	Sex (male / female)	Non-native speaker (%)	Developmental dyslexia
conText	59	11.9 (0.6)	34 / 25	3	11
Reading Detectives	80	12.0 (0.6)	43 / 37	3	15

Note: Age differences were tested using *t*-tests. We used χ^2 tests to investigate differences in sex, immigration history and self-reported developmental dyslexia status. There were no significant differences between both groups.

during the year and participated in parts of the training programmes and the post-test. Because of the missing pre-test data, they were excluded from further data analysis.

We used analysis of covariance (ANCOVA) to analyse the outcome in the dependent post-test variables and estimated effect sizes with partial η^2. The pre-test scores entered the analysis as covariates.

Measures

The test materials consisted of a short questionnaire to obtain demographic information as well as tests that assessed the performance in four domains, namely *verbal intelligence*, *reading fluency*, *meta-cognitive knowledge in reading* and *reading comprehension*. We focused on reading comprehension and meta-cognitive knowledge but incorporated measures of verbal intelligence and reading fluency as well in order to assess far transfer and to have the possibility to include them as control variables in the analysis. The tests were taken from different measures from standardised psychological tests from German-speaking countries. The total administration of the test material took 70 minutes.

As an estimate for the *verbal intelligence*, we used the subtest 'analogies' from the *'Kognitiver Fähigkeitstest (KFT) 4-12+'* (*Cognitive Proficiency Test for Grades 4 to 12+*; Heller & Perleth, 2000). Here, students had to identify the relationship between the two words of a pair, and to transfer this relationship to another pair of words (e.g., fire is to hot as ice to xxx). The reliability of this subtest was $r_{tt} = .81$.

The reading fluency measure (*Salzburger Lesescreening 5-8; Salzburg Reading Screening, Grade 5 to 8*; Auer, Gruber, Mayringer & Wimmer, 2005) contained 67 statements with an ascending level of difficulty (e.g., sentences like 'Mercury is a planet, where teachers like to spend their holidays'). Students had 3 minutes to successively read the statements and to decide whether they were true or false. Reading fluency was the only test with a strict time cut-off and had a reliability of $r_{tt} = .89$.

The assessment of the meta-cognitive knowledge in reading consisted of five learning scenarios (Lingel, Neuenhaus, Artelt & Schneider, 2010). Each scenario included five or six suggestions about how to best solve the stated problem (e.g., which strategy students should choose to remember as much information from a text as possible). The students had to score the quality of each suggestion and this answer was compared to experts' ratings. Students could obtain a maximum score of 36 points in this test. The internal consistency of the meta-cognitive questionnaire was $cr_{\alpha} = .87$.

Finally, reading comprehension was assessed with the '*Frankfurter Leseverständnistest (FLVT) 5-6'* (*Frankfurt Reading Comprehension Test for Grade 5 and 6;* Souvignier, Trenk-Hinterberger, Adam-Schwebe & Gold, 2008). The FLVT 5-6 includes one expository and one narrative text each 570 words in length. Following reading the texts silently, students

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answered 18 multiple choice questions for each text, resulting in a total score of 36 points at most. At the pre-test, version A of the FLVT 5-6 was used, and at the post-test, version B was administered in order to reduce re-test effects. Due to the greater difficulty of version B (students obtain on average 2.93 less compared to version A), the post-test results were corrected by this constant. The test has an internal consistency of $cr_{\alpha} = .87$ and a parallel reliability of $r_{tt} = .71$.

Results

The groups did not differ in chronological age, gender, developmental dyslexia status and immigration history. We found an increased proportion of students with self-reported developmental dyslexia status, namely 18.4% of the participants. According to the International Classification of Mental Diseases (ICD-10, F81; Dilling, Mombour & Schmidt, 2000, p. 272), the estimated proportion amounts to roughly 3% in unselected student populations. Bearing in mind that the students in *Hauptschule secondary modern school* represent the weakest third of the total population and the literacy of the majority of these students is poor, a higher percentage of struggling readers in our sample was expected. The relatively small percentage of non-native speakers was presumably due to the fact that all of the schools were drawn from rural areas of Bavaria. The descriptive statistics for the complete sample are provided in Table 2 (age, gender, immigration history and developmental dyslexia).

Three classes in the *conText* group worked on 11–13 different texts. One smaller class, consisting of 14 students, only used three texts. In the usage statistics, we excluded all revision cycles, where students changed less than 10 letters in their draft, or where a very short time on-task of less than 30 seconds indicated, that this student had clicked through the checks of one cycle. On average, the students engaged in 5.7 revisions per text ($SD = 4.9$), with a time on-task of 31.0 minutes ($SD = 9.3$; not counting aborted cycles). The *Reading Detectives* consists of five parts with a variable number of lessons each. In a follow-up survey, teachers reported having spent on average 20.0 lessons on the training in the *Reading Detectives* group, and 15.8 lessons in the *conText* group with 45 minutes per lesson. Overall, students summarised one text per lesson. In some cases, the teacher decided to spend another training unit, because students needed more time. As students in the *conText* group focused on the work on texts, there was a higher number of texts (15.8 on average), whereas the *Reading Detectives* had only six different texts, but received a lot of additional instruction. On average, every 2 weeks, the classes spent one lesson on the training during the intervention period.

There were no significant differences in the pre-test scores of reading fluency, verbal intelligence, meta-cognitive knowledge and reading comprehension in both groups.

The ANCOVAs with the post-test results as the dependent measures and pre-test scores as covariates revealed a significant main effect in reading comprehension that was due to a greater improvement in the *conText* group, $F(1, 136) = 3.61$, $p < .05$, $\eta^2 = .026$, $d = .33$. Notably, the *conText* group improved their explicit meta-cognitive knowledge to the same extent as the *Reading Detective* group, $F(1,136) = .001$, $p = .972$. The effects in verbal intelligence and fluency were not significant either. We split up the reading comprehension measure into the narrative and the expository part and ran additional ANCOVAs. There were trends towards higher performances in the *conText* group in both parts of the test, but they failed to reach significance (narrative test: $p = .063$; expository test $p = .078$) due to

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Table 3. Results in the pre- and post-test in the different dependent measures for the comparison of *conText* and *Reading Detectives* groups.

	Reading Detectives (*N* = 80)			*conText* (*N* = 59)			*F*	*p*	*d*
	Pre *M* (*SD*)	Post *M* (*SD*)	Diff *M* (*SD*)	Pre *M* (*SD*)	Post *M* (*SD*)	Diff *M* (*SD*)			
Reading fluency	31.6 (6.9)	35.9 (7.1)	4.2 (6.8)	30.2 (6.2)	35.2 (6.6)	4.9 (3.6)	0.05	*ns*	*ns*
Verbal intelligence	9.2 (3.7)	10.8 (3.5)	1.6 (3.3)	9.9 (3.2)	10.4 (3.3)	0.6 (3.0)	2.36	*ns*	*ns*
Meta-cognitive knowledge	21.7 (5.1)	24.4 (5.3)	2.7 (6.5)	21.6 (5.4)	24.3 (5.0)	2.8 (5.5)	0.01	*ns*	*ns*
Reading comprehension	22.2 (5.9)	24.4 (5.3)	2.2 (5.3)	23.1 (5.5)	26.3 (4.6)	3.1 (4.9)	3.61	.03	.33

Note: The table reports means and standard deviations in pre-test, post-test and the raw value difference of the *Reading Detectives* and *conText* groups in the different dependent measures. ANCOVAs with the post-test value as dependent measure and the pre-test value as the covariate were used to test differences between *conText* and *Reading Detectives* (one-sided; $df = 1, 136$). For the calculation of effect sizes, we used partial η^2 and converted them to Cohen's *d* according to the formula of Cohen (1988, pp. 281f.).

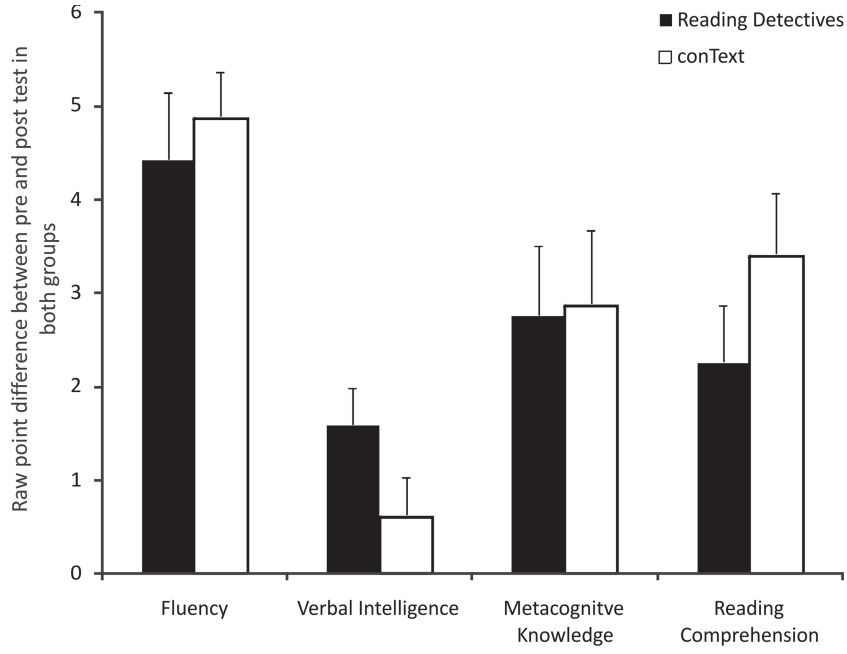

Figure 3. Raw point differences between pre- and post-test in the *Reading Detectives* and the *conText* groups. The difference in the variable *reading comprehension* is significant.

lower reliability of the test parts compared to the complete test. Table 3 and Figure 3 show the results of the performance measures.

Looking at the development across the 8-month period within each group, *t*-tests indicated significant improvement in each variable in both groups (see Table 4), with marked effects for fluency and reading comprehension within the *conText* group.

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Table 4. Improvement within *conText* and *Reading Detectives* groups.

Group	Variable	*df*	*T*	*P*	*d*
Reading Detectives	*Reading fluency*	79	5.54	.00	.60
	Verbal intelligence	79	4.32	.00	.44
	Meta-cognitive knowledge	79	3.67	.00	.52
	Reading comprehension	79	3.74	.00	.39
conText	*Reading fluency*	58	10.25	.00	.75
	Verbal intelligence	58	1.45	.07	.17
	Meta-cognitive knowledge	58	3.85	.00	.54
	Reading comprehension	58	4.87	.00	.60

Note: The analysis is based on dependent *t*-tests (one-sided) of the pre- and post-test scores within each group, and the effect sizes were estimated according to Dunlap, Cortina, Vaslow & Burke (1996, S.171). Please note, that this is not the regular d_{Cohen} but rather an approximation based on the dependent *t*-test statistics. The descriptive values can be found in Table 3.

Discussion

The aim of the current study was the evaluation and comparison of two different reading comprehension training programmes and their influence on the development of reading fluency, verbal intelligence, meta-cognitive knowledge in reading and reading comprehension. The *conText* group used an LSA-based intelligent tutoring system with a focus on the acquisition of summarisation skills through guided practice, whereas the *Reading Detectives* group participated in a strategy training programme, aiming at the teacher-directed instruction of declarative meta-cognitive knowledge. The *conText* group showed a greater increase in reading comprehension and acquired meta-cognitive knowledge to the same extent as the *Reading Detectives* group. The computer program thus was more effective than the explicit strategy training programme in terms of reading comprehension, while it was equally effective in teaching meta-cognitive knowledge.

Guided practice – the essential part of reading comprehension instruction

There is a vast body of literature underlining the importance and usefulness of comprehension strategy instruction (e.g., Hattie, 2009, p. 136; National Reading Panel, 2000, p. 14; Van Kraayenoord, 2010). Undoubtedly, among the reading comprehension strategies, written summarisation and similarly verbal retelling are key approaches. Many of the major reading comprehension training programmes (De Corte, Verschaffel & van den Ven, 2001; Fuchs et al., 1997; Guthrie et al., 2004; Kim et al., 2006; Palincsar & Brown, 1984; Pressley et al., 1992) make use of summarisation techniques. Kintsch et al. (2000) underline its importance as a vital learning technique, because it helps students to distinguish between unnecessary details and main ideas. It helps to develop a solid understanding of the text and to better integrate it into prior knowledge. To express the content concisely in an abridged form requires the combination and generalisation of ideas. Summarisation relies on the same processes that readers use to generate a gist representation of the underlying text material and thus leads to a more coherent representation of knowledge. For the student, it is a very useful tool to better comprehend written material and is also an adequate method to assess the students' understanding of a text.

Both intervention approaches in this study also rely heavily on summarisation, with one employing direct, explicit instruction and reflection on why it is useful to summarise, and

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the other utilising learning by doing and guided practice. Both intervention concepts were equally effective in the instruction of meta-cognitive knowledge. In the classrooms in this study, which may be described as an ecologically valid setting, the explicit approach only showed marginal effects on reading comprehension, whereas the guided practice approach improved reading comprehension considerably. Consequently, there is no guarantee that a standardised and well-researched strategy instruction programme necessarily works in actual school settings. Recent results on strategy programmes support these findings (Klauer, 2010). Specifically, the encouraging results from basic research have seldom been reproduced in ecologically valid settings. Thus, there seem to be crucial moderator variables associated with the transfer of strategy knowledge to the students' performance.

So what is the essential difference between the approaches? There are several well-known problems related to the acquisition and application of strategies that have been described in the meta-cognitive research literature (e.g., Schneider & Sodian, 1997). These include mediation, production and utilisation deficiencies. Since the students in both groups displayed considerable development in meta-cognitive knowledge, a mediation deficiency can clearly be excluded. We do not have data on how the students solved the reading comprehension test questions and whether they deliberately applied strategies. Our results suggest that the students in the *Reading Detectives* group did either not apply the acquired strategies (i.e., a production deficiency) or they were not able to benefit from their usage, suggesting a utilisation deficiency. The students from the *conText* group, who received almost no explicit instruction but simply worked on summarising texts and received immediate feedback, obviously profited from this form of guided practice: they acquired explicit meta-cognitive knowledge to the same extent as the *Reading Detectives* group. Think aloud and interview studies with *Summary Street* also indicate that students not only learn how to summarise texts, but they also become more aware of meta-cognitive strategies and are able to express them (Caccamise, Franzke, Eckhoff, Kintsch & Kintsch, 2007, p. 394). Moreover, students using intelligent tutors, like *Summary Street* or *conText,* not only acquire strategy knowledge, but also write better summaries (Franzke, Kintsch, Caccamise, Johnson & Dooley, 2005; Lenhard, 2008). In comparison to students with unguided summarisation practice and direct strategy instruction, they also showed higher scores in post-intervention comprehension tests. McKeown et al. (2009, p. 246) conclude in their study on the comparison of strategy versus content-based approaches that:

> strategies questions did prompt students to bring key ideas into the discussion but that students spent as much time focusing on the strategic actions themselves as on the content of what they were reading and seemed less likely to connect the ideas. The importance of making connections among ideas is paramount. Focusing on strategies during reading may leave students less aware of the overall process of interacting with text, especially in terms of the need to connect ideas they encounter and integrate those ideas into a coherent whole.

This might as well have been the case in the current study.

Limitations

There are a number of issues that limit the explanatory power of this study. First, both approaches differ in a number of ways. *conText* was more closely embedded in the regular courses by using expository schoolbook texts, whereas *Reading Detectives* uses its own narrative and expository texts. In *conText*, students work on their own, write summaries and receive immediate, individualised feedback, whereas *Reading Detectives* is mainly based

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on regular classroom coursework involving discussion, and the students are asked to read and answer questions. Therefore, teacher-directed strategy training versus guided practice is not the only difference between the two approaches.

Second, the study used a quasi-experimental approach and the effects may be associated with moderator variables that were not controlled. Our assumption at the outset of this study was not that *conText* outperforms *Reading Detectives* and, therefore, we thoroughly considered alternative explanations for the effects. However, we were unable to identify pre-existing differences in the participating classes that could be responsible for the divergent outcomes. A larger study using hierarchical linear models is necessary to replicate the results in a school setting.

Finally, there are no data on the stability of the effects, because classes are 'remixed' in 7th grade as many students leave their former schools and enter different school forms.

To know 'why' is not enough

We believe the results shed some light on the general conditions of effective, real world reading comprehension interventions.

First, it is much easier to acquire strategies and continue to use them, if they have been demonstrated with relevant and meaningful material (cf. McKeown et al., 2009). This is especially true for material which is part of the regular school curriculum. In our study, the training in reading comprehension skills was not obvious for the students of the *conText* group, even though they had been informed about the goals of the intervention in the beginning. Instead, they used the intelligent tutor programme simply as a medium for working on their normal schoolbook texts in subjects such as biology, history and geography. Therefore, we conclude that reading comprehension interventions can, or even should be, closely integrated in the regular courses and not be restricted to language arts.

Second, the magnitude of the effects of *context* was similar in expository and narrative texts. Thus, the guided practice with expository texts helped the students to develop more coherent representations of narrative texts, as well. This indicates a transfer effect to types of texts that were not explicitly trained.

Third, progress in learning depends heavily on the students' willingness to engage in a deep level of processing. Indeed, the teachers from the *conText* group were amazed at the levels of concentration and persistence of their students, many of whom were demotivated and frustrated in the regular courses. In one school, even the principal attended a training session, where he took photos and decided to write an article about the programme for the school magazine. It must be noted that the user interface of the programme is clean and businesslike, and we did not try to create a colourful, rich and entertaining interface.

Fourth and last, what creates the motivation to engage in that deep level of processing? It is possible that the greatest advantage of *conText* lies in the immediate, individual and neutral feedback for the students, followed by the chance to instantaneously improve one's own draft – an opportunity students rarely get in regular instruction. The graphical feedback of the computer in the form of bar charts indicates how much semantic content the summary already includes and therefore stimulates a promotion focus. Simultaneously, the student gets corrective feedback by pointing to text passages where he or she can further improve the draft. The feedback highlights problematic text passages, but the student has to elaborate on his or her own in order to find an appropriate solution. Therefore, the feedback is neither too broad nor too specific. The programme's suggestions, for example, the indication of potentially problematic sentences, are not presented as the right solution,

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but as a proposal to reflect on. This stimulates the motivation to revise, improve and to see whether the next revision receives a better rating. We believe that an adequate incorporation of corrective feedback is a prerequisite to the success of intervention programmes (see Bangert-Downs, Kulik, Kulik & Morgan, 1991).

The results of this study also align with more recent reviews that indicate the importance of corrective feedback and opportunities to practise (Hattie & Timperley, 2007; Shute, 2008; Wanzek et al., 2010). In order to develop reading expertise, students require a high amount of practising (Caccamise, Franzke, Eckhoff, Kintsch & Kintsch, 2007, p. 395). But sheer volume of practice alone does not necessarily lead to a high level of reading competence. It has to be guided by a sufficiently sensitive tutor, who is structuring and correcting the learning process.

LSA-based intelligent tutoring programmes of course are not able to replace human tutors. Their feedback nonetheless seems to be precise enough to support students in acquiring reading competence and to guide the acquisition of reading comprehension skills.

Surely, guided practice versus teacher-directed instruction of strategies is not a question of either versus or. We believe that explicit strategy training programmes and the instruction of meta-cognitive knowledge are important in literacy education. However, some strategy training programmes might overemphasise cognitive aspects of learning. Our results suggest that strategy instruction should be accompanied by guided practice in terms of frequent opportunities of application with immediate direct, individualised and corrective feedback as the central elements of an intervention. This way, strategy knowledge may transfer to reading comprehension and help students to master real-life situations.

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