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Orchestrating Web-Based Collaborative Inquiry Learning with Small Group and Classroom Scripts

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Abstract: Collaborative inquiry learning is a promising approach to foster students' online search competence. Yet, to be effective, it needs to be structured appropriately. In a quasi-experimental field study employing a 2x2 design, we investigated the effects of a small-group collaboration script (present vs. absent), two variants of a classroom script (online search activities constantly located on the small group level vs. online search activities alternating between plenary and small group level) and their different combinations on online search competence during an inquiry learning unit on Genetic Engineering. Results indicate that scaffolding on at least one of the two levels (realizing plenary phases or providing a small group script) is necessary to reach higher levels of online search competence. However, combining classroom scripts that alternate between plenary and small-group phases and small-group scripts did not further improve online search competence.

Introduction

Scientific literacy is the capacity to deal with issues in everyday life that are related to science (Laugksch, 2000). As science progresses continuously, no body of domain-specific knowledge acquired in school will be sufficient for this purpose throughout a lifetime. However, the Internet brings up-to-date scientific findings in the reach of everyone. Accordingly, scientific literacy has to include online search competence as an integral part. Yet, as prior research has shown, searching and finding relevant, credible and scientifically substantiated information on the Internet is a challenging task for high-school students (Lazonder, 2005). Thus, it is a pressing question how online search competence can be facilitated during secondary education.

One promising approach to achieve this is inquiry learning (e.g., de Jong, 2006), during which students act similarly to scientists who are confronted with an authentic research problem. However, prior research has demonstrated that inquiry learning needs to be structured to lead to significant learning (de Jong & van Joolingen, 1998), especially when it involves small-group collaboration, since students rarely collaborate on a high level spontaneously (Cohen, 1994). We argue that when collaborative inquiry learning is embedded in a real classroom situation, this guidance can be provided in at least two ways. First, if large portions of classroom learning are realized in small groups, it can effectively be supported with *small-group collaboration scripts* (e.g., de Wever, van Keer, Schellens & Valcke, 2010; Kollar, Fischer & Slotta, 2007; Weinberger, Ertl, Fischer & Mandl, 2005). Second, so-called *classroom scripts* that distribute learning activities over the different social planes of the classroom (e.g., the plenary, a small group and an individual level; see Dillenbourg & Jermann, 2007) may foster the acquisition of online search competence .In this paper we investigate the effects of different small group collaboration scripts and classroom scripts as well as their different combinations on the acquisition of online search competence in a 4.5 weeks inquiry learning unit on Genetic Engineering.

Collaborative Inquiry Learning as an Approach to Foster Online Search Competence

The basic idea of inquiry learning is that students should acquire domain knowledge and research skills by being confronted with science problems and attempting to solve them by engaging in scientific activities such as hypothesis generation, experimentation and drawing conclusions (de Jong, 2006). The retrieval of information in scientific publications or other sources and the use of this information for the construction of scientifically valid arguments may be regarded as yet another typical inquiry activity. Broken down to student learning and given the fact that today the Internet is the main source for information on science-related debates for high school students, having them search the Internet for such information to create arguments they can use in scientific debates can be seen as a kind of inquiry learning that is especially needed today.

In empirical research, inquiry learning has often been employed in a collaborative mode (i.e. involving small groups of learners), since engaging in scientific activities individually may be and often is too a demanding task. That said and considering results from prior research on collaborative learning indicating that learners rarely collaborate on a high level spontaneously (e.g., Cohen, 1994), there is a clear need for instructional guidance in order to make collaborative inquiry learning a successful experience. Accordingly, research on collaborative inquiry learning has intensively studied and identified ways to scaffold and support small groups during their inquiry (e.g., Sandoval, 2003; van Joolingen et al., 2005).

Scripts as Scaffolds for Collaborative Inquiry Learning

Based on empirical evidence that demonstrates that students often have difficulty to collaborate on a high level (e.g. because they lack collaborative competences; e.g. Cohen, 1994), CSCL research has over the last years rediscovered scripts as promising tools to provide such support. When reflecting about how to foster the acquisition of online search competence in real classrooms that consist of a teacher and 20 or more students, scripts target at least two levels: First, so called "small group collaboration scripts" (Kollar et al., 2006) specify, distribute and sequence learning activities and roles among the partners of a *small group* (e.g., dyads or triads). Second, the script idea may be expanded to the classroom level by introducing "classroom scripts" (very similar to Dillenbourg and Jermann's, 2007, "macro-scripts") as an instructional means to specify, distribute and sequence learning activities *over the different social planes of the classroom* (the plenary, the small group and the individual level). Both notions of scripts are described next.

Small-group Collaboration Scripts

CSCL research has developed and empirically investigated an impressive collection of small group collaboration scripts designed to raise the quality of *collaboration processes* (Hämälainen, & Arvaja, 2009; Rummel & Spada, 2005; Schellens, de Wever, van Keer & Valcke, 2005) and *individual learning outcomes* (Ertl, Kopp & Mandl, 2007; Kollar et al., 2007; Wecker & Fischer, 2007; Weinberger et al., 2005) of learners collaborating in small groups (e.g., dyads or triads). For example, such a script may give one learner of a dyad the task to suggest key terms for a collaborative online search and his/her partner the task to comment on the adequacy of these terms. In a next step the script may ask one learner to suggest a link to click on, while the other learner may be asked to estimate whether the proposed linked is likely to contain the needed information etc.. While there are some studies that investigated the effects of collaboration scripts on *collaboration processes and outcomes* in field settings (e.g., Hämälainen & Arvaja, 2009; de Wever et al., 2010), the effects of collaboration scripts on *individual learning outcomes* have up to now largely been investigated in laboratory studies employing rather short learning phases. For example, Weinberger et al. (2005) report on a study in which triads of learners collaborated in an asynchronous discussion board with the task to collaboratively analyze authentic problem cases by aid of a psychological theory. To support collaboration, they used a small-group collaboration script which distributed the roles of a case analyst and two criticizers among the learning partners. These roles rotated among the learners and each role was supported with appropriate prompts. Results indicated that compared to unstructured CSCL, the small-group collaboration script helped students acquire higher levels of domain-specific knowledge. Other studies demonstrated positive effects of small-group collaboration scripts on the acquisition of more domain-general competences. For example, Kollar et al. (2007) could show that learners who were supported by an argumentation-related small-group collaboration script in an inquiry learning environment reached higher levels of argumentation competence (as a learning outcome) than learners who were not supported by a small group script. However, since the reported studies were conducted in lab contexts, it is unclear whether small group collaboration scripts will also lead to positive individual learning outcomes when used in field settings employing longer learning phases.

Classroom Scripts

When thinking about how to instructionally support learners during inquiry learning under real classroom conditions, i.e. in classrooms that involve a teacher and 20 or more students, scaffolding of small groups is only one of several options. In an expansion of the script concept to the whole classroom (as compared to the small group level only; see Dillenbourg & Jermann, 2007), activities and roles may also be specified, sequenced and distributed *over social planes of the classroom beyond the small group level*, namely also over the plenary and the individual level. For example, a lesson may start with the teacher modelling how to search for evidence on the Internet in front of the class (plenary activity), followed by student dyads searching for evidence together (small-group activity) and closing with a final phase in which students search the Internet individually (individual activity). In the following, such instructional interventions that structure learning activities through their distribution of different social levels will be called *classroom scripts*. It should be noted, however, that the term "classroom scripts" has in the past also been used in a descriptive meaning for culturally shared norms about interaction patterns occurring in a classroom that emerge without explicit external interventions (see Seidel et al., 2002). In contrast to this, we use the term in a prescriptive sense to refer to explicit instructional interventions that change the structure of activities in larger social entities like classrooms in the way described.

When taking a look at prominent instructional approaches from the literature, it is striking that very often a distribution of activities over the different social planes of the classroom is proposed (although not always over all three levels), i.e. research already provides a collection of classroom scripts designed for different purposes. For example, during Problem-based Learning (PBL; see for example Hmelo-Silver, 2004), small student groups and a tutor meet on a plenary level to jointly discuss an authentic problem case (e.g., a description of a patient with particular illness symptoms), and then split up to individually acquire knowledge on physiological processes that may account for the illness. After that, students come back to groups to discuss what they have found during their individual study and apply this knowledge to the case. Similar activity structures can be found in Reciprocal Teaching (Palincsar & Brown, 1984) and Learning by Design (Kolodner, 2007) Although the distribution of activities over different social planes obviously is regarded important for learning in these approaches, it is striking that there is hardly any research that systematically compares the effects of different classroom scripts differing in the way activities are distributed over the different social planes on learning processes and outcomes while other features of the classroom script are held constant. Therefore, it is an open empirical question how to best sequence and distribute learning activities during inquiry learning over the different social planes in order to help students reach high levels of competence.

Combining Small Group and Classroom Scripts - Synergistic Scaffolding or Over-scripting?

Based on theoretical considerations, specific combinations of small group and classroom scripts may be regarded as either beneficial or detrimental for learning. The expectation that a combination of a particular small-group collaboration script and a particular type of classroom script will lead to better learning outcomes than any of the two alone would be an example for "synergistic scaffolding" (Tabak, 2004). Synergistic scaffolding is realized when two different scaffolds mutually amplify their each specific effects on the same learning outcome. Applied to the notion of small group and classroom scripts, synergistic scaffolding would be realized when a combination of a small group script and one specific variant of a classroom script leads to higher competence levels than any of the two scripts alone.

However, two scaffolds may also inhibit each other's effects on competence acquisition and thus lead to what Dillenbourg (2002) called "over-scripting". In particular, it may be that adding a small group script to a classroom script that also includes modeling by the teacher (as a plenary activity (e.g., Rummel & Spada, 2005) may put too many constraints on the learners so that productive and creative search processes are undermined. This would result in less positive learning outcomes than if either a small-group collaboration script or a classroom script including plenary phases would have been presented alone.

Since prior research on the effects of different combinations of small group collaboration scripts and classroom scripts in the context of CSCL is scarce, it is hardly possible to opt for one and reject the other expectation right away. Therefore, in our empirical study we investigated not only the separate effects of a small group collaboration script and different variants of a classroom script, but also their combinations.

Research Questions and Hypotheses

We investigated the effects of a small-group collaboration script (present vs. not present) and two variants of a classroom script as well as their different combinations on the acquisition of online search competence during a 4.5 weeks inquiry learning curriculum unit. In one variant, the classroom script located online search activities solely on the small group (i.e., dyadic) level ("Small-group Level Only-" or "SLO classroom script"). The SLO classroom script can be regarded as the standard classroom script that would be employed when dyadic inquiry learning is realized. This was compared to a classroom script that realized online search activities alternating between the small group and the plenary level ("Alternations between Plenary and Small group level-" or "APS classroom script"). Online search processes on a plenary level were realized as phases in which online search was either modelled by the teacher and a student or two students in front of class. Our research questions were:

1. How do small group (present vs. absent) and classroom scripts (SLO vs. APS) play together to support online search competence in a Web-based collaborative inquiry environment?
2. When no small-group collaboration script is provided, what are the effects of an APS classroom script compared to the effects of an SLO classroom script on online search competence in a Web-based collaborative inquiry environment?
3. When the employed classroom script locates all search activities on the small group level (SLO classroom script), what are the effects of a small group collaboration script compared to non-scripted dyadic online search in a Web-based collaborative inquiry environment?

Concerning research question 1, we could not establish a clear hypothesis due to the lack of prior similar research. Two conflicting hypotheses can be justified: On the one hand, the combination of the APS classroom script and a small-group collaboration script may produce "synergistic scaffolding" (Tabak, 2004) and thus have the most positive effect on the acquisition of online search competence. On the other hand, this combination may produce "over-scripting" (Dillenbourg, 2002), i.e. too many constraints for the learners to perform high-level online searches and thus lead to lower levels of online search competence than each of the two scripts alone. With respect to research question 2, we hypothesized that when no a small-group collaboration script is provided, learners working with the APS classroom script acquire higher levels of online search competence than learners working with the SLO classroom script. Concerning research question 3, we expected that under standard classroom script conditions (i.e., the SLO classroom script),learners collaborating on the basis of a small group script reach higher levels of online search competence than students not supported by a small group collaboration script.

Method

Sample and Design

174 9th graders from eight secondary urban school classrooms in Germany participated in a quasi-experimental field study. 90 students were female, 84 students were male. We implemented a 2x2-factorial pre-post test design with the independent factors "type of classroom script" (SLO vs. APS) and "small-group collaboration script" (present vs. absent; see table 1). The comparably small N in the condition "without small-group collaboration script/APS classroom script" was due to a higher drop out due to illness and other factors beyond our influence in the two classes in which this treatment was realized than in the other classes. In fact, all subjects who missed one or more lessons over the 4.5 weeks curriculum unit were excluded from data analysis. Originally, the numbers of students in the aforementioned condition was 46 and thus comparable to the Ns in the other three conditions.

Table 1: Design of the empirical study.

		Small-group collaboration script	
		Without	With
Type of classroom script	Search activities solely located on the small group level (SLO)	N = 43 students (2 classes)	N = 52 students (2 classes)
	Search activities alternating between small group and plenary level (APS)	N = 28 students (2 classes)	N = 51 students (2 classes)

Instructional Setting

For the purpose of the study, a 4.5-weeks inquiry-based curriculum unit on Genetic Engineering was developed. The students' task was to develop a scientifically sound and valid position on whether "green" Genetic Engineering (i.e., the genetic modification of plants for food production) should be allowed or not. For this purpose, each student was equipped with a laptop computer which was connected to the Internet via a wireless LAN network. Overall, the unit spanned seven Biology lessons, which were led by the regular Biology teacher of the class, plus one pre- and one post-test lesson in which learners' online search competence (pre and post instruction) as well as demographic variables were assessed. The actual unit started with an introduction to Genetics and Genetic Engineering. Also, the teachers in all classes introduced the students to how to perform a successful online search. The core of the seven lessons were three consecutive content-specific cycles on different aspects of Genetic Engineering (one on economic, one on ecological, and one on health aspects of Genetic Engineering). Each of these content-specific cycles included three steps. First, student dyads were asked to browse through a web-based project library which included biological knowledge on Genetics and Genetic Engineering. This online library was implemented within the Web-based Inquiry Science Environment (WISE; Slotta & Linn, 2009) and was designed on the basis of regular 9th grade Biology text books. In step 2, either student dyads or (in case of the APS classroom script) the teacher or the student modelers collaboratively formulated an initial argument (e.g., that eating genetically modified food is dangerous for health) and searched the Internet for evidence that would support, modify or discard their initial argument. Online search activities were supported by a software named S-COL (Wecker et al., 2010) which allowed for collaborative Internet browsing, i.e. that during their online search, both learning partners of a dyad always saw the same web sites, no matter who of the two clicked on a link or entered search terms. In step 3, the teacher led a plenary discussion in which students brought together their arguments they were supposed to back up with their Internet findings. To reduce statistical dependencies in the sample, dyads were re-organized before each new search phase.

Independent Variables

Both script variables were during each of the three online search phases. The basis of the two treatments (the small-group and the classroom script) was a multiple-step online search process that was either to be performed by all student dyads or (during modeling phases) by the teacher together with one student or by one teacher-selected student dyad in front of the whole class. The search process to be adopted by the students was derived from a comprehensive literature review, a cognitive task analysis and an expert-novice comparison of Internet search activities using think-aloud methodologies prior to this study (see Kollar, Wecker & Fischer, 2009). Basically, both treatments split the dyadic online search processes up into a five-step strategy: (1) the *formulation of an initial argument and a sketch of the information needed*, (2) the *selection of search terms*, (3) the *evaluation of the hit list*, (4) the *localization of relevant information* on a web page, and (5) a *written formulation of the final elaborated argument*. For example, during the second step, the *selection of search terms*, learner A was prompted to suggest a set of search terms, while B was asked to first recall the information they had decided to look for, and comment on the adequacy of A's suggestions for the search terms.

In the *APS classroom script*, online search phases consisted of both dyadic online searches, during which all dyads performed a collaborative online search, and modeling phases in which the teacher picked either a student to model a successful online search with in front of the whole class, thereby employing specific steps of the search strategy just described, or pulled one student dyad out of the group to perform an online search in the plenary, while commenting on the quality of their online search process. That way, an alternation between search activities on the small-group and the plenary level was realized. The moments for each modeling phase were roughly chosen to be close to when all student dyads were performing the search steps that were modeled: Modeling of the first two search steps happened at the beginning of the first search activity, modeling of the third and fourth step happened at about half time of the second search activity, and modeling of the final step happened closer to the end of the third search activity. In the *SLO classroom script*, no such modeling phases were employed. Rather, students used the complete time allocated for online search within dyads.

The *small-group collaboration script* was technically implemented with the S-COL software (Wecker et al., 2010) and distributed cognitive and metacognitive activities related to each single step in the search process among the members of each dyad. To do so, S-COL divided the browser window in two frames (see Fig. 1). In the right part of the screen (the browsing area), students could view regular web. In the left part of the screen (the scaffolding area), each single learner received particular script prompts that guided him or her in what exactly to do during this step of search. To guarantee the display of "correct" prompts for each step, a software algorithm was used that was able to differentiate between (a) the Google start page, (b) the Google hit list or (c) any other web page. For example, when S-COL recognized the Google start page (i.e. during the selection of search terms), learner A receivec prompts such as "Please suggest a couple of search terms to your learning partner", while learner B was prompted "Listen to your partner's suggestions and estimate how well his/her search terms are suited to find what you are looking for". The two roles were switched after each search cycle. In the condition without small-group collaboration script, dyads performed unstructured online searches, i.e. their browsers were connected, but no scaffolding area appeared on the screen.

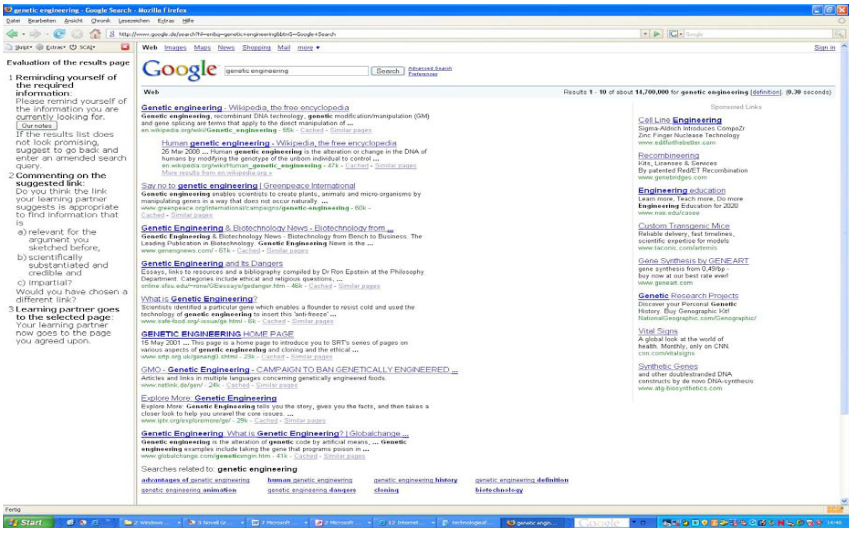

Figure 1. Screenshot of the Small-group Collaboration Script (left frame: prompts for one of the two learners; the learning partner at the same time received complementary prompts; right frame: regular Google hit list).

Dependent Variable

Online search competence was measured by an individual test that asked students to describe in as much detail as possible how they would proceed if they had to use the Internet to form a position on a science topic that was different from Genetic Engineering. In the pre-test, the topic was whether mobile phone transmitters should be banned from the immediate surroundings of kindergartens and day nurseries; in the post-test, the topic was whether nuclear power plants should be shut down. The test pre-structured the students' answers by using a number of lines and two columns. In the first column of the first line, participants were supposed to write the action they would take first, and in the second column to note quality criteria they would apply while taking this step. This could be repeated up to eight times for the following steps. A general expert solution, based on the steps of the to-be-acquired online search strategy (see above), guided the coding of the students' answers for the occurrence of each individual step and quality criterion contained in the expert solution. Two coders independently rated 15 % of the material, reaching a sufficiently high inter-rater agreement (*ICC* = .83 for the post test, *ICC* = .51 for the pre test).

Statistical Analyses

The alpha-level for all analyses was set to 5 %. To answer research question 1 (combination of small-group and classroom scripts), an analysis of covariance with the two script variables as fixed factors, classes as fixed factor nested within experimental conditions, and the scores in the online search competence post test as dependent variable were conducted. Pre test scores were used as a covariate. With respect to hypotheses 2 and 3, planned contrasts were conducted to compare the effects of the APS vs. SLO classroom scripts in the condition without small group collaboration script (hypothesis 2) and the effects of the conditions with vs. without small group collaboration script when the SLO classroom script was used (hypothesis 3). To avoid inflation of Alpha errors, Bonferroni corrections were applied, i.e. the two planned contrasts were tested on an alpha-level of 2.5 %.

Results

Table 3 shows the mean post test scores and standard deviations in the online search competence tests (note that experimental conditions did not differ significantly with respect to online search competence in the pre-test; $F(1,166) < 2.20$; *n.s.*). Descriptively, students who received both modeling of search strategies and had the opportunity to run online searches on their own (APS classroom script condition), but without the small-group collaboration script reached the highest post test scores. At the lower end of the spectrum were learners whose search activities were constantly located on the dyadic level (SLO classroom script condition) and who did not receive a small-group collaboration script. The means of the other two groups were about half-way in between.

Table 3: Means and standard deviations concerning online search competence in the post test in the four experimental conditions.

	Without small group collaboration script				With small group collaboration script			
	SLO classroom script		APS classroom script		SLO classroom script		APS classroom script	
	M	*SD*	M	*SD*	M	*SD*	M	*SD*
Online search competence (post test)	2.65	*2.27*	4.75	*2.15*	3.90	*2.58*	3.96	*2.54*

To the test the two competing hypotheses related to research question 1 (synergistic scaffolding hypothesis vs. over-scripting hypothesis), an ANCOVA revealed a significant interaction effect ($F(1,165) = 12.41$; $p < .01$; partial $Eta^2 = .07$), indicating that the small-group collaboration script was more helpful when the classroom script located all search activities on the small group level (SLO classroom script) than when search activities were realized alternately on the plenary and the small group level. When the classroom script alternated search activities between the small-group and the plenary level (APS classroom script),the small-group collaboration script seemed to have no effect. Based on this significant interaction effect, main effects of the two treatments were not further examined.

To test *hypothesis 2* ("If not provided with a small-group collaboration script, learners working with the APS classroom script acquire higher levels of online search competence than learners working with the SLO classroom script"), a planned comparison revealed a significant difference between the APS and the SLO classroom script when no small-group collaboration script was provided ($F(1,61) = 23.05$, $p < .01$, partial $Eta^2 = .27$). Thus, hypothesis 2 was confirmed. To test *hypothesis 3* ("If the SLO classroom script is employed, learners collaborating on the basis of the small group collaboration script reach higher levels of online search competence than students not supported by a small group collaboration script"), a planned comparison revealed a significant difference between the conditions with vs. without small group collaboration script when the SLO classroom script was employed ($F(1,88) = 8.89$, $p < .01$, partial $Eta^2 = .14$). Thus, hypothesis 3 was supported.

Discussion

In this study, we investigated to what extent a small-group collaboration script and particular types of classroom scripts as well as their different combinations facilitate the acquisition of online search competence in the context of a multiple-weeks web-based collaborative inquiry curriculum unit on Genetic Engineering. With respect to our first research question, namely how a small-group collaboration script and a classroom script that alternates between plenary and small-group activities (APS classroom script) play together to support the acquisition of online search competence, we established two competing hypotheses. On the one hand, we argued that combining the small-group script with the APS classroom script might represent an example of "synergistic scaffolding" (Tabak, 2004) and lead to the highest results in terms of students' acquisition of online search competence. On the other hand, we argued that this combination may produce "over-scripting" (Dillenbourg, 2002) such that this combination would lead to lower effects than each of the two treatments alone.

Upon close inspection of the results, both hypotheses need to be rejected: Clearly, no synergistic scaffolding effect was found because in the presence of the APS classroom script students working with the small group collaboration script did not reach higher scores in the posttest than learners who were not provided with a small group collaboration script. However, also no over-scripting effect has been observed: Adding an APS classroom script to a small group collaboration script neither enhanced nor harmed the effects of the small group script. Thus, our results rather indicate a kind of "functional equivalence" of small-group and classroom scripts: As the results related to hypotheses 2 and 3 show, both treatments alone had comparably large positive effects on online search competence when the other treatment was not used. When used in combination, however none of the two treatments adds substantially to the other.

Obviously, alternating search activities between a small group and a plenary level is a better way of distributing search-related activities over the classroom than having students perform such activities solely on the small group level. This adds to earlier research that has demonstrated the value of modeling on student learning (e.g., Palincsar & Brown, 1984; Rummel & Spada, 2005). Likewise, if students are supposed to perform online search activities in dyads without intermitting modeling phases, then supporting them with a small-group collaboration script is necessary. This corroborates findings from prior studies that have demonstrated the effectiveness of small-group collaboration scripts on individual learning outcomes (Ertl et al., 2007; Weinberger et al., 2005). However, combining the two scaffolds neither made learners perform worse than students in the control condition (without small group collaboration script and the SLO classroom script), which would have been expected following the over-scripting hypothesis, nor made learners perform on a higher level than could have been expected by adding the two individual effects as the synergism hypothesis would have predicted.

With respect to the differential effects of the two employed classroom scripts, our study is among the first ones to demonstrate that specific distributions over the different social planes of the classroom may have differential effects on student learning. This assumption has already been reflected in the classroom layouts of prominent instructional approaches such as Problem-based Learning (Hmelo-Silver, 2004), Learning-by-Design (Kolodner, 2007) or Reciprocal Teaching (Palincsar & Brown, 1984), but has hardly been systematically investigated before. Obviously, interweaving plenary activities into small-group activities is a good strategy to bring the expertise of the teacher to bear in (a) modeling a to-be-acquired strategy or competence and (b) in correcting developing misconceptions or shallow strategies that are used and beginning to be internalized by the students. Yet, these interpretations may be confirmed by process analyses that demonstrate direct sequential effects of modeling or of discussing small group script prompts on subsequent search activities of the dyads. Such analyses are currently under way.

In interpreting the results of our study, two *limitations* should be noted. First, the online search competence test that was employed did not ask students to really perform an online search themselves. Rather, the test asked learners to describe what they would do when they had the task to search the Internet to develop a well-grounded position in a science debate. Possibly, having learners actually perform a new search on a different science topic would yield somewhat different results. This should be tested in future research. Second, it should be noted that our variation on the classroom script level only included two social levels, the plenary and the small-group level. However, since the competence that we wanted students to acquire is in the end an individual one, it may be promising to also include phases on an individual level. It is not unlikely that, to reach a high level of online search competence, online searches should also be practiced individually - possibly with further guidance on the individual level. Also this question is subject to future research.

Yet, our study produced promising results which may be of value for educational practice. For teachers, it is very often a hard task to structure small-group activities. Our results indicate that such efforts may be neglected when instead small-group collaboration is from time to time interrupted by plenary activities during which the teacher sets the small groups "on the right track" again. Compared to how to structure small-group collaboration, teachers are very often more experienced in how to design such plenary level phases. Thus, the results of our study should encourage teachers to use their skills in designing high-level plenary activities and align them with small-group learning phases, without structuring the latter ones too severely.

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