The Myth of Over-scripting: Can Novices be Supported Too Much?

Karsten Stegmann, Jin Mu, Vera Gehlen-Baum, Frank Fischer, LMU München, Leopoldstrasse 13, 80802 München, GERMANY
Email: karsten.stegmann@psy.lmu.de, jin.mu@psy.lmu.de, vera.baum@psy.lmu.de, frank.fischer@psy.lmu.de

Abstract: Despite the fact that many researchers in CSCL use the term over-scripting to interpret negative effects of scripts, the term is not clearly defined. Our contribution is to reframe the term according to concepts of internal and external scripts. We further conceptualize potential interferences between internal and external scripts in terms of cognitive processes and motivation. In an empirical study ($N = 81$) we varied the degree of an argumentative script (low vs. medium vs. high) and examined the effects on processes and outcomes of argumentative knowledge construction. Our results show positive effects of the medium and high degree of scripting on argumentative knowledge construction. We found negative effects of the medium and high degree of scripting on motivation, however, but low motivation did not negatively interfere with knowledge acquisition. Furthermore, our reframing of over-scripting allowed us to differentiate between under-scripting, over-scripting and, finally, malfunctional scripts.

Origin of Over-scripting

In 2002, Pierre Dillenbourg wrote an influential paper with the title 'Over-scripting CSCL: The risks of blending collaborative learning with instructional design.' Since then, many authors have referred to the term over-scripting when they talk about the design and (negative, unexpected) effects of collaboration scripts (e.g. Beers et al., 2005; Karakostas & Demetriadis, 2009; Kollar et al., 2007). Over-scripting seems to be implicitly defined as a negative learning outcome when collaboration is scripted, rather than as the specific cognitive or motivational effect of scripts on collaborative processes. Thus, whereas the term over-scripting may help researchers to articulate their concerns regarding 'too much script', it is of doubtful value as a theoretical concept to guide research on the effects of collaboration scripts on collaborative knowledge construction. Using the term over-scripting in its current meaning to explain negative effects of scripts is therefore not of much help in the endeavour to understand better the mechanisms leading to positive or negative collaboration script effects.

Therefore, we will try to reframe the idea of 'too much script' regarding cognitive and motivational aspects in this contribution. Further, we aim to answer the question whether there can be too much collaboration script to support collaborating novices during online discussions of cases in an experimental study.

Reframing Over-scripting in Terms of Internal and External Scripts

Novices in terms of computer-supported collaborative learning can be regarded having a low-structured internal (collaboration) script (cf. Kollar et al., 2007). Schank and Abelson (1977) introduced the term to describe cognitive structures that represent context-dependent knowledge in sequences of activities and roles in specific situations (e.g., knowledge about sequence and roles during a school lesson). Scripts are abstract mental structures that organize the processing of sequences of events.

With respect to external collaboration scripts we follow the definition that they specify and sequence learning activities and/or assign roles to different learners (Kollar, Fischer, & Hesse, 2006) and can consequently facilitate specific discourse activities such as the construction of arguments or specific interaction patterns (e.g. Schellens et al., 2005; Weinberger et al., 2010). Kobbe and colleagues (2007) specified that the components of a collaboration script are *participants, activities, roles, resources,* and *groups*. The mechanisms of CSCL scripts that manipulate the components are *task distribution*, *group formation*, and *sequencing* (Kobbe et al., 2007).

Research on collaborative learning in online discussions has provided evidence that at least two argumentative internal scripts are related to learning: epistemic activities and providing warrants for claims. A central epistemic activity is the application of conceptual knowledge on problem information (cf. Weinberger & Fischer, 2006). The higher the amount of the application of conceptual knowledge, the higher the epistemic quality of argumentation and the higher the knowledge acquisition is. Providing warrants for the relation between grounds and claims has been regarded as a process very similar to self-explanations (cf. Baker, 2003). The more claims and grounds are connected with a warrant, the higher the quality of argumentation.

The next two sections will now focus on problems that may occur if external and internal scripts interfere. We identified two main areas where internal and external scripts may interfere and potentially undermine collaborative knowledge construction: First, suboptimal fit of internal and external scripts may have negative effects on cognitive processes during collaboration. Second, external regulation may have negative effects on motivation of learners during collaboration.

Potential Interference between Internal and External Scripts on Cognitive Processes

The perfect fit between external and internal collaboration would be if existing (but not activated) internal scripts are activated by an external script and enough information is provided regarding all activities that are not yet part of the internal script of a learner. This perfect fit is, however, the ideal rather than the typical case. It is more likely that an external script addresses scenes (e.g. 'Please provide a counterargument!') without sufficient information on the activity or addresses scripts that are not known (e.g. 'Please engage in knowledge building by integrating pros and cons!'). The domain-specific knowledge acquisition as well as the internalization of the script is not supported. This kind of interference between internal and external scripts might be called 'cognitive under-scripting'.

If an external script provides scaffolds that guide procedures for which internal scripts are already represented by the learner or where a learner might even hold more effective or efficient internal script, the performance of the learner will decrease. Instead of performing highly automated cognitive skills, learners slowdown because they have to follow the external script. The time-in-task is reduced, whereas the time on handling the script is unnecessarily increased. The internalization of the script is restricted to scripts that were not held before. The acquisition of domain-specific knowledge is not facilitated owing to the lowered efficiency. This kind of interference between internal and external scripts might be called 'cognitive over-scripting'.

If collaboration lasts a certain amount of time, the originally perfect fit of internal and external script may change towards cognitive over-scripting owing to an ongoing internalization of the script (cf. Wecker & Fischer, 2009). To avoid this cognitive over-scripting, the script might be faded out, i.e. components like examples and explanations vanish or several small steps collapse to bigger steps. A script may ask the learner to provide a complete argument instead of asking for claim, ground and warrant (e.g. Kollar et al., 2007).

Last but not least, an external collaboration script asks the learner to perform activities that do not facilitate collaborative knowledge construction. Such an external script may even have a positive effect on the internalization of the script, but the domain-specific knowledge acquisition might be hindered. At this point we have to clarify that a script might lead to a 'better' online discussion, but not to better learning processes. The negative effect of the script on domain-specific knowledge acquisition compared with an unsupported control condition should *not* be regarded as 'over-scripting'. This kind of interference between internal and external scripts produces a malfunctional scripting. The script is functioning, but with negative effects on collaborative knowledge construction.

The interference between internal and external scripts depends on the degree to which the (internal or external) script specifies activities. The more details of activities are specified the higher the degree of scripting.

Potential Interferences between Internal and External Scripts on Motivation

Motivation is an important factor in learning. Motivation is usually regarded as affecting the effort a learner is willing to invest, i.e. to what extent a learner contributes to collaboration. If instruction reduces motivation it carries the risk that engagement in collaborative knowledge construction will decrease. Even the best (internal or external) script does not foster learning if learners are not motivated to activate or use it, respectively.

Deci and Ryan (1991) posited that a decrease of the feeling of autonomy may cause a loss of intrinsic motivation. External collaboration scripts usually reduce the degree of freedom of learners and lower their perceived autonomy. Therefore, learners may put less effort into activity or strategy guided by the script. As a consequence, processes and outcomes of collaborative knowledge construction might be negatively affected. This effect might occur independently of the internal script of a learner, but is related to the extent of how autonomy is reduced. Against this background, scripts that scaffold procedures on the low level of activities should always have negative effects on intrinsic motivation. The reduction of autonomy and thereby intrinsic motivation is then mainly script immanent. The goal, however, has to be to realize scripts that are as 'motivation friendly' as possible.

Research Questions

We are investigating the effects of degree of scripting on processes and outcomes of argumentative knowledge construction in online discussions. The goal is to examine whether a non-malfunctional script can cause over-scripting when novice (regarding argumentative knowledge construction) are supported. The first research question examines, therefore, the central perquisite, that the scripted activites are positively related to domain-specific knowledge acquisition.

RQ1: To what extent are epistemic quality and quality of argumentation related to acquisition of domain-specific knowledge? According to the approach of argumentative knowledge acquisition we assume that both, the epistemic quality as well as the quality of argumentation is positively related to domain-specific knowledge acquisition.

RQ2: To what extent does the degree of scripting (without/low vs. medium vs. high) have on effect on the quality of argumentative knowledge construction? If the collaboration script is not malfunctional, it should

have positive effects on the epistemic quality and/or quality of argumentation, but not decrease the quality of argumentative knowledge construction.

RQ3: To what extent does the degree of scripting (without/low vs. medium vs. high) have an effect on motivation during argumentative knowledge construction? According to our reframing of motivational interferences between external and internal scripts, the self-reported intrinsic motivation as well as the objectively measured amount of contributions to online discussion during collaboration might be negatively affected by the degree of scripting. The higher the degree of scripting, the lower the intrinsic motivation and amount of contributions should be.

RQ4: To what extent has the degree of scripting (without/low vs. medium vs. high) effects on the acquisition of domain-specific knowledge and knowledge of argumentation? The degree of scripting is expected to have a positive effect on domain-specific knowledge as well as knowledge of argumentation. If, however, the medium degree of scripting out-performs the high degree scripting condition, cognitive over-scripting occurrs (if RQ1 and RQ2 provided evidence that the script is not malfunctional).

RQ5: To what extent does quality of argumentative knowledge construction and motivation during argumentative knowledge construction predict the acquisition of domain-specific knowledge? This research question finally examines, which of the aspects that might be negatively affected by interferences between external and internal scripts has the strongest influence on domain-specific knowledge acquisition. The answer to this question may allow us to weigh potential negative effects on motivation against positive effects on specific scripts.

Methods

Participants and Design

Eighty-one (81) students of Educational Science at the University of Munich participated in this study during the summer term 2010. The mean age of the participants was $M = 23.36$ ($SD = 3.85$) years. Participation was a requirement for receiving course credit in a mandatory introductory course for undergraduates because the experimental learning environment was part of the regular curriculum. We manipulated the variable 'degree of scripting' (without/low vs. medium vs. high) by means of a computer-supported collaboration script for argumentative knowledge construction that is described below. The participants were randomly assigned to groups of three. The groups were then randomly assigned to one of the three experimental conditions in the one-factorial design.

Learning Environment and Implementation of Collaboration Scripts

The subject of the learning environment was Weiner's attribution theory (1985) and its application in education. The students read the text of this theory and the text of introducing argumentation individually before the experimental session. In the present study, three problem cases from practical contexts were used as a basis for online discussions. The group's task was to analyze the three cases and to come up with a joint solution for each case. The three students in each group were distributed within a laboratory room, i.e. they were together in one room, but not sitting next to each other. An asynchronous, text-based discussion board was used for collaboration. This discussion board allowed the exchange of text messages that resembled emails.

The computer-based learning environment used in this experiment is a modified version of the one employed by Stegmann, Weinberger and Fischer (2007). All of the instructions are presented in the form of standard videos which vary according to the treatments. The collaboration scripts for supporting argumentative knowledge construction were implemented in a tool called S-COL (Scripting for Collaborative Online Learning) which allows for the sustainable development of scripts and scaffolds that can be used with a broad variety of content and platforms (Wecker et al., 2010).

(1) The script in the condition with a high degree of scripting consisted of several components. Each learner was responsible for the analysis of one of the three cases. The collaboration phase was divided into ten phases. Each learner was asked to provide an analysis for her or his case in the first phase. During the next phases two and three, each learner had to provide counterarguments for the first analysis of her or his learning partners. During the fourth phase, the learner had to integrate the counterarguments of her or his learning partners into the analysis. Phases two to four were repeated twice. During the tenth phase, however, the learners were tasked with writing the final analysis for their case. The progression from phase to phase was automatized, i.e. after a certain time, learners were automatically forwarded to the next phase. In each phase the script specified several steps. The script guided learners first to analyse the case or the arguments of the learning partners and second to construct (counter)arguments. For example, the script for the construction of single arguments asked learners to select a person, acting in the case, to analyse it, to specify a concept from theory that was applicable to the subject, to formulate a claim using the subject and the theoretical concept, to provide a ground (i.e. case information) that supported the claim and finally to provide a warrant that explained why the ground supported the claim. For each step of the script the system provided an explanation. For each step of the

script an example was provided. Despite the fact the script specified these steps, however, the learners were not forced to follow them. They always had the chance to write 'unscripted' statements in the message box.

(2) The medium degree of scripting was realized through fading-out of the steps during the different phases as well as the fading-out of the explanations and examples. We decided us against a more or less randomly selected degree of scripting between low and high, because that would have meant that learners received different amounts of information regarding the script. Through implementing the medium degree of scripting using fading, we are able to provide subjects wihtin in this condition the very same information on the script, but have different degree of scripting on average.

(3) The condition with low degree of scripting received no additional support in solving the three problem cases, i.e. the condition can be regarded as without script. All participants, however, also in this condition, were advised to argue well according to the text on argumentation they had to read before the experimental session.

Procedure

First, the participants completed pre-tests that were designed to measure domain-specific prior knowledge and prior knowledge of argumentation. The data from these tests were used to control randomization. All instructions were presented in the form of videos to standardize the procedure. The groups collaborated for 80 minutes, trying to develop analyses for the three cases and to reach agreement about them. In the final phase (about 35 minutes), the students took individual post-tests on domain-specific knowledge and knowledge of argumentation. Time-on-task was held constant for the three conditions.

Data Sources

Online discussions of five problem cases (one pretest case, three cases during collaboration, and one posttest case) served as data sources. The online discussions were coded in terms of epistemic quality and quality of argumentation. Furthermore, amount of contributions was measured on the basis of the online discussion on the three cases during collaboration. Intrinsic motivation and knowledge on argumentation were measured using an online questionnaire after the online discussion of the post-test case.

We used individual sentences or parts of a compound sentence as the unit of analysis (segment) (cf. Strijbos et al., 2005). Each sentence was coded whether it was a claim (i.e., a statement that advances the position learners take to analyse case with attribution theory), a ground (i.e., evidence from case to support claim), a warrant (i.e. logical connections between the grounds and claims that present the theoretical reason why a claim is valid) or something else (i.e. all other sentences).

Two human coders analysed almost one tenth of the raw discourse corpora (distributed over five cases), which have been further used for training the customized algorithms for automatic coding on the multiple categories by SIDE tool (Mayfield & Rosé, 2010). We achieved a high value of Cohen's Kappa = .96 for segmentation, and the inter-rater agreement between two human coders to classify the text was Cohen's Kappa = .71. A human coder and SIDE achieved an agreement of Cohen's Kappa = .97 (accuracy = 99.3%) to segment the conversational data into the units of analysis. The objectivity across all cases comparing SIDE with a human coder was sufficiently high (Cohen's Kappa = .81; accuracy = 84.5%).

Subsequently, all claims were analysed regarding epistemic activities, i.e. the correctness of application of theoretical concepts on case information. The median of reliability between two human coders was sufficiently high with Cohen's Kappa value = .89.

Dependent Variables

Prior domain-specific knowledge. Appropriately applied concepts from the Weiner's attribution theory in the context of analysing the pre-test case were used to measure prior domain-specific knowledge.

Prior knowledge of argumentation. The proportion of sentences in the online discussion on the pre-test case that was coded as warrant was used to measure the application of argumentative knowledge during online discussion. By using the proportion instead of the total amount, the value is controlled for the influence of domain-specific knowledge.

Amount of contributions in pre-test discussion. The amount of contributions during pretest discussion was measured by the number of sentences written by a learner during the online discussions of the pre-test case.

Intrinsic motivation. The instrument used to investigate the motivational processes that occur during learning was a questionnaire developed by Prenzel and colleagues (1993). The reliability of the scale was sufficiently high (Cronbach's alpha = .73).

Amount of contributions during collaboration. The amount of contributions during pretest discussion was measured by the number of sentences written by a learner during the online discussions of the three cases.

Epistemic quality. The number of appropriately applied concepts from Weiner's attribution theory in the context of analysing the cases *during collaboration* was used to measure the epistemic quality.

Quality of argumentation. The quality of argumentation during online discussion was measured in the same way as the prior knowledge on argumentation, but using the online discussion during the collaborative learning phase as data source.

Domain-specific knowledge. The number of appropriately applied concepts from Weiner's attribution theory in the context of analysing the post-test case was used to measure domain-specific knowledge.

Knowledge of argumentation. Participants were asked to name the components of a formally complete single argument and to formulate a single argument on the topic of smoking. One point was given for each of the three correctly applied components, i.e. claim, ground and warrant. Hence, the test scores could range from zero to six points. Two trained coders evaluated the tests independently with a sufficiently high reliability (Cohen's Kappa = .94).

Application of argumentative knowledge. The proportion of sentences in the online discussion on the post-test case that were coded as warrant was used to measure the application of argumentative knowledge.

Statistical Tests

To examine the effects of the degree of scripting, we used a linear regression analysis with the dummy variables script (without vs. with) and degree of scripting (medium vs. high). This method allowed us to examine effects of the script in general and effects of the degree of scripting in particular with only one statistical analysis. Therefore, it is more efficient than an ONEWAY ANOVA with two subsequent analyses of contrasts. To control for differences prior to the treatments within the different conditions and no effects of specific scripting degrees are expected, we compared the three different conditions using an ONEWAY ANOVA.

Results

Preliminary Data Analyses

First, we controlled for differences between conditions prior to the intervention by applying an ONEWAY ANOVA. No significant effects of the degree of script regarding epistemic quality, $F_{(2, 78)} = 0.11$, $p = .90$, $\eta < .01$, quality of argumentation, $F_{(2, 78)} = 2.15$, $p = .12$, $\eta^2 = .05$, or amount of contributions, $F_{(2, 78)} = 0.18$, $p = .833$, $\eta^2 < .01$, in the online discussion on the pre-test case were found.

RQ1: Relation between Quality of Argumentation and Domain Specific Knowledge

The first research question is intended to provide evidence that the processes that we are going to foster with the collaboration script are related to individual knowledge acquisition. For both aspects, epistemic quality and quality of argumentation, partial correlation with domain-specific knowledge in the post-test was computed to control for prior knowledge.

Significant partial correlation have been found between epistemic quality and knowledge acquisition, $r_{par} = .26$, $df = 69$, $p = .01$, one-tailed, as well as regarding quality of argumentation, $r_{par} = .29$, $df = 69$, $p = .01$. Our assumption that the quality of argumentative knowledge construction during online discussion is associated with the acquisition of domain-specific knowledge is supported by this result.

Table 1: Epistemic quality, quality of argumentation, intrinsic motivation and amount of contributions during online discussion by experimental condition: means (m) and standard deviations (SD).

		Degree of scripting		
		Without script/low	medium	high
Epistemic quality	*M*	13.24	10.52	10.47
	SD	12.00	8.78	7.00
Quality of argumentation	*M*	8.75	11.77	15.88
	SD	6.11	6.91	8.80
Intrinsic motivation	*M*	2.53	2.03	1.94
	SD	0.90	0.65	0.62
Amount of contributions	*M*	57.65	33.50	24.88
	SD	20.60	11.60	12.39

RQ2: Quality of Argumentative Knowledge Construction

The effects of the degree of scripting on the quality of argumentative knowledge construction will be examined regarding two different aspects: epistemic quality and quality of argumentation.

Epistemic quality. The regression model regarding epistemic quality was not significant, $R^2 = .02$, $F_{(2,78)} = 0.66$, $p = .52$. Neither the factor script, $\beta_{stand.} = -.14$, $p = .29$, nor the factor degree of scripting, $\beta_{stand.} < .01$, $p =$

.98, were significant predictors of the epistemic quality during the online discussion. The script did not facilitate the epistemic quality of the online discussion (see table 1 for descriptive values).

Quality of argumentation. The model using the predictors script and degree of scripting explained about 12% of the variance of the quality of argumentation, $R^2 = .12$, $F_{(2, 78)} = 5.25$, $p = .01$. The factor script had a significant positive effect on the quality of argumentation, $\beta_{stand.} = .37$, $p < .01$. Learners supported by a script (medium as well as high degree of scripting) had a higher quality of argumentation during online discussion than learners without script. The factor degree of scripting had a marginally positive effect (significant at the 10%-level) on the quality of argumentation, $\beta_{stand.} = .22$, $p = .07$. Learners with the medium degree of scripting benefited less regarding the quality of argumentation than learners with the high degree of scripting (see table 1 for descriptive values).

RQ3: Motivation during Argumentative Knowledge Construction

The effects of the degree of scripting was examined with respect to two different measures: intrinsic motivation and amount of contributions.

Intrinsic motivation. The regression model regarding intrinsic motivation was significant, $R^2 = .107$, $F_{(2, 78)} = 4.57$, $p = .01$. The factor script had a significant negative effect on intrinsic motivation, $\beta_{stand.} = -.35$, $p < .01$. Learners supported by a script (medium as well as high degree of scripting) showed lower intrinsic motivation than learners without script. The factor degree of scripting had no effect on intrinsic motivation, $\beta_{stand.} = .06$, $p = .60$. The fading of the script neither positively nor negatively affected intrinsic motivation of learners (see table 1 for descriptive values.

Amount of contributions. The regression model regarding amount of contributions was significant, $R^2 = .42$, $F_{(2, 78)} = 28.30$, $p < .001$. The factor script had a significant negative effect on amount of contributions, $\beta_{stand.} = -.71$, $p < .001$. Learners supported by a script (medium as well as high degree of script) contributed less sentences to the online discussion than learners without script. The factor degree of scripting had a positive effect on amount of contributions, $\beta_{stand.} = .22$, $p = .03$. The medium degree of script diminished the negative effect of the script on amount of contributions, i.e. learners with a medium degree of script contributed more sentences to the online discussion than learners with the high degree of script (see table 1 for descriptive values).

Post hoc, the question was, to what extent the effects of script and degree of scripting on amount of contributions are mediated by intrinsic motivation. We have to clarify whether this negative effect on amount of contributions through a loss of motivation or not. Therefore, we conducted a mediator analysis, i.e. we computed the residual of the model where intrinsic motivation predict amount of contributions and checked whether the factors script and degree of scripting still had an effect on the residual. If the effect disappears or the effect size is much smaller than on the initial variable, mediation has taken place. If no mediation can be found, other, non-motivational, factors, may have mediated the effect of script and degree of scripting on motivation.

Mediator analysis. Predicting amount of contributions with intrinsic motivation resulted in a significant model, $R^2 = .13$, $F_{(2, 78)} = 11.52$, $p = .001$. Intrinsic motivation is a significant positive predictor of amount of contributions, $\beta_{stand.} = .36$, $p = .001$. The higher the intrinsic motivation of learners, the higher the number of sentences they contributed to the online discussion. The factors script and degree of scripting, however, are still significant predictors of the residual, $R^2 = .36$, $F_{(2, 78)} = 21.05$, $p < .001$. The explained variance regarding the residual is 15% lower than regarding amount of contributions directly. Thus, intrinsic motivation partly mediates the effect of script and degree of scripting on amount of contributions, but a major part of the variance cannot be explained by motivation.

RQ4: Acquisition of Domain-specific Knowledge and Knowledge of Argumentation

The effects of the degree of scripting on knowledge acquisition were examined regarding three different aspects: domain specific knowledge, declarative knowledge of argumentation, and script internalization.

Domain specific knowledge. No effect of the degree of scripting on domain-specific knowledge could be found, $R^2 = .02$, $F_{(2, 78)} = 0.76$, $p = .47$. Neither the factor script, $\beta_{stand.} = .12$, $p = .38$, nor the factor degree of scripting, $\beta_{stand.} = .05$, $p = .68$, were significant predictors of domain-specific knowledge in the post-test (see table 2 for descriptive values).

Knowledge of argumentation. The model using the factors script and degree of scripting to predict the knowledge of argumentation was significant, $R^2 = .20$, $F_{(2, 78)} = 9.53$, $p < .001$. The factor script had a significant positive effect on declarative knowledge of argumentation, $\beta_{stand.} = .34$, $p = .003$. Learners supported by a script (medium as well as high degree of scripting) were better able to list components of single arguments according to Toulmin (1958) and to provide a complete argument on smoking than learners without script. The factor degree of scripting had no significant effect on declarative knowledge of argumentation, $\beta_{stand.} = .18$, $p = .12$ (see table 2 for descriptive values).

Application of argumentative knowledge. While the overall model predicting the application of argumentative knowledge using the factors script and degree of scripting failed to reach significance, $R^2 = .05$,

$F_{(2, 78)} = 1.91$, $p = .16$, the factor script had a marginal significant positive effect, $\beta_{stand.} = .24$, $p = .05$. The factor degree of scripting, $\beta_{stand.} = -.12$, $p = .33$, was not a significant predictor of the internal script on argumentation. Learners supported by the script seemingly developed a better internal script. The fading of the script in the condition with a medium degree of scripting did not interfere with this effect (see table 2 for descriptive values).

Table 2: Domain-specific knowledge, knowledge of argumentation and application of argumentative knowledge by experimental condition: means (m) and standard deviations (SD).

		Degree of scripting		
		Without script/low	medium	high
Domain-specific knowledge	*M*	4.62	5.76	5.40
	SD	2.91	3.28	3.07
Knowledge on argumentation	*M*	3.14	4.90	4.20
	SD	1.80	0.89	1.19
Application of argumentative knowledge	*M*	9.64	12.91	15.64
	SD	9.89	11.04	11.64

RQ5: Predicting Domain-specific Knowledge with Quality of Argumentative Knowledge Construction and Motivation

This research question aimed to answer which of the aforementioned aspects of collaborative learning in online discussions, i.e. intrinsic motivation, amount of contributions, epistemic quality and quality of argumentation are most relevant for the acquisition of domain-specific knowledge. Therefore, we tested a regression model for domain specific-knowledge in the posttest with the predictors intrinsic motivation, amount of contributions, epistemic quality, and quality of argumentation. The overall model was significant, $R^2 = .15$, $F_{(2, 78)} = 2.82$, $p = .03$. Aspects of quality of argumentative knowledge construction, epistemic quality, $\beta_{stand.} = .27$, p = .03, as well as quality of argumentation, $\beta_{stand.} = .27$, $p = .04$, were significant positive predictors of domain-specific knowledge in the posttest. The more inferences between case information and theoretical concepts are drawn and the higher the proportion of warrants, the higher is the domain-specific knowledge in the posttest. Intrinsic motivation, $\beta_{stand.} = .12$, $p = .35$, as well as amount of contributions, $\beta_{stand.} = -.06$, $p = .66$, *were not* significant predictors of domain-specific knowledge in the posttest.

Discussion

Our results provide evidence for the basic assumptions of argumentative knowledge construction. Both epistemic quality and quality of argumentation are positively related to domain-specific knowledge acquisition. Furthermore, we have shown that our collaboration script fostered the quality of argumentation without impairing epistemic quality during online discussions.

As expected, the script affected intrinsic motivation negatively. A lower degree of scripting could, however, not reduce this effect. The perceived over-scriptedness seems rather dichotomous than continuous. Furthermore, the script had a negative effect on amount of contributions. This effect was less strong for the medium degree scripting than for the high degree scripting. A mediator analysis revealed that the negative effect of the script on the amount of contributions could not fully be explained by the loss of motivation. Instead, it seems to be more probable that learners supported by a script spent more time with learning processes that did not lead directly to more contributions to the online discussion, e.g. deeper elaboration (Stegmann et al., in press).

The script had a positive effect on both knowledge of argumentation and the internal script on argumentation. Learners supported by the script had more explicit knowledge of argumentation in a knowledge test on argumentation and, much more importantly, applied the script more frequently in an unsupported online discussion after the learning phase. Findings by Kollar and colleagues (2007) showed that learners with highly structured internal argumentation script outperformed learners with low structured internal scripts on argumentation regarding domain-specific knowledge acquisition. It can be argued that the script might have a sustainable effect, because the internalised script might facilitate future collaborative learning.

A positive effect of the script, however, could not be found with respect to domain-specific knowledge immediatley after the collaboration. In line with the argumentation on amount of contributions, we argue that this can be seen as a trade-of function: given constant time, learners who elaborate single concepts in more depth do have less time to elaborate a broad range of concepts and vice versa. The regression analysis showed that, the epistemic quality as well as the quality of argumentation is a significant predictor of domain-specific knowledge gains. Motivation and amount of contributions are less predictive here. These results show that for predicting learning outcomes, learning activities are better than motivational aspects. Intrinsic motivation can be helpful for collaborative learning, but it is not a prerequisite. In particular, novices to collaborative learning need

to acquire internal scripts for successful collaboration. This process can be supported through collaboration scripts. In summary, this study did not provide any evidence of cognitive over-scripting of novices using computer-supported collaboration scripts.

Finally, the reframing of over-scripting allows differentiation between under-scripting, over-scripting, and malfunctional scripting. Our conceptualization allows us to classify scripts using result patterns of the effects of the script on process and outcomes as well as the relations between processes and outcomes. This is a substantial improvement compared with the conceptualization of over-scripting so far. Our approach will not be sufficient, however, for those researchers who are describing over-scripting *only* as "disturbing 'natural' interactions and 'natural' problem solving processes". These problems are problems of 'too much script', but only if learners have access to functional internal scripts on collaboration that can be disturbed. In particular novices on collaboration have not. Therefore, negative effects of scripts on outcomes or processes should not any longer simply be classified as over-scripting. Instead, it has to be shown that the externally provided script is not just a malfunctional script.

References

Baker, M. (2003). Computer-mediated argumentative interactions for the co-elaboration of scientiWc notions. In J. Andriessen, M. Baker, & D. Suthers (Eds.), *Arguing to learn: confronting cognitions in computer-supported collaborative learning environments* (Vol. 1, pp. 1–25). Dordrecht: Kluwer.

Beers, P. J., Boshuizen, H. P. A., Kirschner, P. A., & Gijselaers, W. H. (2005). Computer support for knowledge construction in collaborative learning environments. *Computers in Human Behavior*, *21*, 623-643.

Black, A. E. & Deci, E. L. (2000). The effects of instructors' autonomy support and students' autonmous motivation on learning organic chemistry: A self-determination theory perspective. *Science Education*, *84*(6), 740-756.

Deci, E.L. & Ryan, R.M. (1991). A motivational approach to the self: integration in personality. In R.A. Dienstbier (Ed.). *Perspectives on motivation. Nebraska Symposium on Motivation*, (Vol. 38, 237-88). Lincoln: University of Nebraska Press.

Dillenbourg, P. (2002). Over-scripting CSCL. In P. A. Kirschner (Ed.), *Three worlds of CSCL: Can we support CSCL* (pp. 61-91). Heerlen: Open University of the Netherlands.

Karakostas, A., Demetriadis, S. (2009). Adaptation patterns in systems for scripted collaboration. Paper presented at *CSCL 2009*. International Society of the Learning Sciences (ISLS).

Kobbe, L., Weinberger, A., Dillenbourg, P., Harrer, A., Hämäläinen, R., Häkkinen, P., & Fischer, F. (2007). Specifying Computer-Supported Collaboration Scripts. *International Journal of Computer-Supported Collaborative Learning*, *2*, 211-224.

Kollar, I., Fischer, F., & Hesse, F. W. (2006). Collaboration scripts - a conceptual analysis. *Educational Psychology Review*, *18*(2), 159-185.

Kollar, I., Fischer, F., & Slotta, J. D. (2007). Internal and external scripts in computer-supported collaborative inquiry learning. *Learning & Instruction*, *17*(6), 708-721.

Mayfield, E. & Rosé, C. P. (2010). An Interactive Tool for Supporting Error Analysis for Text Mining. In *Proceedings of the North American Chapter of the Association for Computational Linguistics*

Prenzel, M., Eitel, F., Holzbach, R., Schoenheinz, R. J. & Schweiberer, L. (1993). Lernmotivation im studentischen Unterricht in der Chirurgie. *Zeitschrift für Pädagogische Psychologie*, *7*(2/3), 125-137.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals and understanding*. Hillsdale, NJ: Erlbaum.

Schellens, T., Van Keer, H., & Valcke, M. (2005). The impact of role assignment on knowledge construction in asynchronous discussion groups: A multilevel analysis. *Small Group Research*, *36*, 704-745.

Stegmann, K., Wecker, C., Weinberger, A., & Fischer, F. (in press). Collaborative Argumentation and Cognitive Elaboration in a Computer-Supported Collaborative Learning Environment. *Instructional Science*.

Strijbos, J-W, Martens, R. L., Prins, F. J., Jochems, W.M.G. (2006). Content analysis: What are they talking about? *Computers & Education*, *46*, 29–48.

Toulmin, S. (1958). *The uses of argument*. Cambridge: Cambridge Universty Press.

Wecker, C., & Fischer, F. (2009). Preventing relapses into novice strategies during the fading of instructional scripts: The role of distributed control. Paper presented at *EARLI 2009*, August 25 to 29, 2009.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computersupported collaborative learning. *Computers & Education*, *46*(1), 71-95.

Weinberger, A., Stegmann, K., & Fischer, F. (2010). Learning to argue online: Scripted groups surpass individuals (unscripted groups do not). *Computers in Human Behavior*, *26*, 506–515.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review*, *92*, 548-573.