Effects of individual prior knowledge on collaborative knowledge construction and individual learning outcomes

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Abstract

This paper deals with collaborative knowledge construction in videoconferencing. The main issue is about how to predict individual learning outcome, in particular how far individual prior knowledge and the collaborative knowledge construction can influence individual learning outcomes. In this context, the influence of prior knowledge and two measures of instructional support, a collaboration script and a content scheme were analyzed concerning the collaborative knowledge construction. An empirical study was conducted with 159 University students as sample. Students learned collaboratively in groups of three in a case based learning environment in videoconferencing and were supported by the instructional support measures. Results show that collaborative knowledge construction had more impact on individual learning outcome than individual prior knowledge.

Keywords: prior knowledge, cooperative/collaborative learning, collaboration script, content scheme, collaborative knowledge construction

1. Theoretical framework

Individual prior knowledge is known to be an important prerequisite for *individual* knowledge construction and learning outcome. Theoretical approaches stress the importance of learners' prior knowledge when acquiring new learning material (see Weinert & Helmke, 1998) and empirical studies show the influence of prior knowledge on individual learning outcomes (e.g. Kalyuga, Chandler & Sweller, 2001; Shapiro, 2004).

In studies about collaborative learning, the individuals' prior knowledge plays often a role in group composition (see Cohen, 1994), while its influence as prerequisite for collaborative knowledge construction remains often unconsidered. However, studies of O'Donnell and Dansereau (2000) investigating effects of prior knowledge in collaboration indicate its influence also in collaborative scenarios. Furthermore, they found that prior knowledge could interact with other moderators of the collaborative knowledge construction – like instructional support measures for learners (e.g. collaboration scripts, content schemes). This means that it may effect results of collaborative knowledge construction (see Ertl, Kopp & Mandl, 2005; Ertl & Mandl, 2006).

2. Research Questions

For getting insights in these issues, we conducted an empirical study with following research questions:

- *Research question 1:* to what extent does individual prior knowledge affect the quality of collaborative knowledge construction supported by a collaboration script and a content scheme and
- *Research question 2:* to what extent do individual prior knowledge and the quality of collaborative knowledge construction affect learners' individual learning outcome regarding conceptual and applicable knowledge.

3. Method

An empirical study was conducted in the laboratory of Ludwig Maximilian University. The study comprised an individual and a collaborative learning unit (see figure 1). During the individual learning unit, learners acquired knowledge about attribution theory on basis of a theory text. After working on this text, learners' individual prior knowledge was assessed by an individual case solution and a short-answer test about conceptual knowledge. For collaboration, learners were connected with a desktop video-conferencing system, which included an audio- and video-connection and a shared application. Using this videoconferencing environment, learners had to solve a learning case according to attribution theory collaboratively. During collaboration, learners worked in one of four conditions of a 2x2-factorial design. We varied the factors collaboration script (with vs. without) and content scheme (with vs. without). 159 undergraduates of educational sciences took part in this experiment. There were 13 triads in each experimental condition and 12 triads in the control condition. After the collaborative learning unit, learners' knowledge was assessed on an individual base by solving a case and a short-answer test.

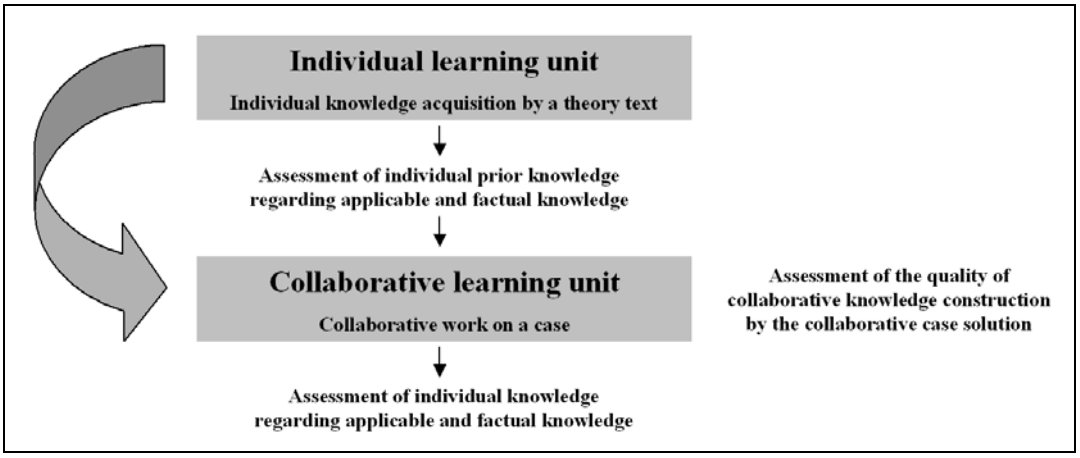

Figure 1: Design of the experiment

3.1 Instructional Support for Collaborative Knowledge Construction

As instructional support for the collaborative knowledge construction, a collaboration script, a content scheme and a combination of both was used and compared with a control condition. Collaboration script as well as content scheme pre-structured the collaboration of the triads.

The *collaboration script* structured the collaborative unit into four phases. In the *first* phase, learners had to read case material and extract important information on an individual basis. In the *second* phase, learners had to exchange information and resolve comprehension questions collaboratively. They used the shared application for writing down concepts that were important for the case solution. In the *third* phase, learners had to reflect individually and in the *fourth* phase, learners had to develop the case solution collaboratively.

The *content scheme* pre-structured the shared application and was realized as a table, which was divided into three main categories: *Cause,* for identifying possible causes for the problem described in the case, *Information* for case information and for giving evidence for the causes and *Attribution* for identifying the correct attribution of the cause. The categories *Information* and *Attribution* each contained two subcategories: *Information* was divided in columns for *Consensus* and *Consistency* for making these two aspects of attribution theory salient. *Attribution* was divided into two sections according to the theories of Kelley (1973) and Heider (1958) to help learners attribute each cause to the relevant source. Using this content scheme, learners were guided to formulate complete attributions according to Kelley and Heider with causes and case information about consensus and consistency.

3.2 Data Sources

Individual prior knowledge: conceptual knowledge was measured by a short-answer test. This test consisted of 8 items ($M = 26.3$; $SD = 9.51$; empirical max. = 43). The consistency of this test was sufficient ($\alpha = .69$).

Concerning *individual prior knowledge: applicable knowledge*, learners worked on a case individually. For assessment, this case solution was analyzed with respect to theory concepts and case information. Items used correctly for the individual case solution were summed up to a score ($M = 15.0$; $SD = 6.68$; empirical max. = 31). For ensuring inter-rater reliability of data, two evaluators marked analysis 10%. The consistency between these evaluations was high regarding all subscales ($\kappa_w > .91$).

For assessing the *quality of collaborative knowledge construction*, a collaboratively solved case was analyzed with respect to correctly used theory concepts and case information. A sum was built as measure for the quality of collaborative knowledge construction ($M = 58.0$; $SD = 18.73$; empirical max. = 92). For ensuring inter-rater reliability of data, two evaluators marked analysis 10%. The consistency between these evaluations was high regarding all subscales ($r > .87$).

Individual learning outcome: conceptual knowledge was measured by a short-answer test. It consisted of 8 items ($M = 29.1$; $SD = 7.75$; empirical max. = 42), which were similar to the items of the pre-test. The consistency of this test was sufficient ($\alpha = .62$).

For getting *individual learning outcome: applicable knowledge*, learners solved a case individually after collaboration. Scores were given for case information and theoretical concepts. The points for each category were summed together into a score ($M = 18.58$; $SD = 6.88$; empirical max. = 32). For ensuring inter-rater reliability of data, two evaluators marked analysis 10%. The consistency between these evaluations was high regarding all subscales ($\kappa_w > .90$).

4. Results

4.1 Research Question 1

As the results in table 1 show, over 45 % of the variance regarding the collaborative knowledge construction could be predicted by prior knowledge and the support measures. The strongest predictor was the content scheme, while the individual prior knowledge (conceptual) played only a marginal role. The collaboration script and individual prior knowledge (applicable) were not significant as predictor.

Table 1: Regression for predicting the quality of collaborative knowledge construction by prior knowledge, content scheme and collaboration script: Statistically significant predictors ($p < .05$) with standardized β-weights.

	Collaborative knowledge construction
Prior knowledge (conceptual)	.18
Content scheme	.68
R^2	.49
Adjust. R^2	.48

4.2 Research Question 2

With respect to applicable knowledge, 40% of the variance could be predicted by individual prior knowledge and collaborative knowledge construction. In the context of applicable knowledge, collaborative knowledge construction had more influence than each single measure of individual prior knowledge. The content scheme did not prove to be a significant predictor. However, content scheme may have had an indirect influence, as it is the main predictor for the collaborative knowledge construction. The collaboration script did not prove to be a predictor, again.

Table 2: Regression for the prediction of individual learning (applicable knowledge) outcome by prior knowledge, content scheme, collaboration script and collaborative knowledge construction: Statistically significant predictors ($p < .05$) with standardized β-weights.

	Individual learning outcome (applicable knowledge)
Prior knowledge (conceptual)	.27
Prior knowledge (applicable)	.22
Collaborative knowledge construction	.40
R^2	.41
Adjust. R^2	.40

Analyzing conceptual knowledge, 60 % of total variance was predictable (cf. table 3). The main predictor was conceptual prior knowledge; applicable prior knowledge played a minor role. Neither the collaborative knowledge construction nor the interventions proved to be significant predictors. However, one has to state that both tests for conceptual knowledge comprised similar items, even if arranged differently.

Table 3: Regression for the prediction of individual learning outcome (conceptual knowledge) by prior knowledge, content scheme, collaboration script and collaborative knowledge construction: Statistically significant predictors ($p < .05$) with standardized β-weights.

	Individual learning outcome (conceptual knowledge)

Prior knowledge (conceptual)	.68
Prior knowledge (applicable)	.16
R^2	.61
Adjust. R^2	.60

5. Summary and conclusion

These results show that the effects of individual prior knowledge are quite different regarding the quality of collaborative knowledge construction and individual learning outcome. For *collaborative knowledge construction*, the influence of individual prior knowledge is quite small compared to the influence of support measures, in particular the content scheme. Furthermore, conceptual knowledge proved to be a significant predictor while the influence of applicable knowledge was not significant. Our interpretation is that the conceptual prior knowledge provides the "bricks" for collaborative knowledge construction and the instructional support, the content scheme, provided the building plan for the collaborative knowledge.

In the context of *individual learning outcomes* one has to distinguish between applicable and conceptual knowledge. With respect to applicable knowledge, the quality of collaborative knowledge construction has more influence than both kinds of prior knowledge. Considering conceptual knowledge, there was no influence of the collaboration. Even, if all learners improved their level of conceptual knowledge, the main predictor was individual prior knowledge. However, this effect may be attributed to the similarity of the test items between pre- and the post-test.

These results are a first step to explain influences on collaborative knowledge construction and its outcomes. One can assume that during collaborative knowledge construction, the collaboration effect, including the effect of instructional support measures is much stronger than the individual learners' prerequisites. This means that collaborative knowledge construction can be modified quite fundamentally by instructional support. In contrast, regarding individual benefits from collaboration, the individual prerequisites show their importance.

To sum up, collaborative knowledge construction can be influenced by a well-designed intervention much more than by individual prior knowledge. Yet, individual prior knowledge gains weight regarding individual learning outcome, even if collaborative knowledge construction has still a great influence in this area.

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