Clearing House Unterricht

Short Review

Does computer-supported collaborative learning promote students' argumentation skills and knowledge acquisition?

A wide variety of computer-based learning programs are designed with the intention to support schoolchildren and university students in improving their argumentative skills and expanding their subject knowledge. Whether this can be confirmed empirically is tested by the meta-analysis presented here, "Where is the evidence? A meta-analysis on the role of argumentation for the acquisition of domain-specific knowledge in computer-supported collaborative learning" by Wecker and Fischer (2014).

INTRODUCTION. Currently, more and more computer-supported collaborative learning (CSCL) programs are available for the STEM fields. Among them, numerous programs specialize in promoting learners' argumentative skills through collaborative discussions on the computer.

Often, these programs first provide information on how to argue well, and then give guidance on how to translate subject-matter content into sound arguments through pre-structured group discussions. Learning research expects that such learning programs will not only enable users to learn how to argue well (»learning to argue«), but also acquire better subject-specific knowledge through the process of arguing (»arguing to learn«).

META-ANALYSIS AT A GLANCE

Focus of the study	Effects of computer-supported collaborative learning (CSCL) programs on the quality of argumentation skills and knowledge acquisition
Target group	1,235 students from K-12 and university
Average effect size	CSCL programs had a small effect for reasoning on argumentation skills (d = 0.39); no effect on knowledge acquisition (d = 0.00)
Further findings	CSCL learning programs are particularly effective for the quality of argumentation, when argumentation knowledge was measured after the learning phase (d = 0.79)

Based on this assumption, previous studies have often report findings in terms of argumentation quality and subject-specific knowledge independently, but do not examine their relationship. Further, meta-analyses have yet to systematically examine the association between the two.

The present meta-analysis summarizes key study findings and, for the first time, examines the effectiveness of CSCL collaborative reasoning on the quality of argumentation and the acquisition of subject-specific knowledge. Moreover, it investigates whether there is a statistical connection between these two outcomes.

WHAT IS THIS STUDY ABOUT? This meta-analysis investigates how reasoning-focused computer-supported collaborative learning programs affect the quality of learners' argumentation (argumentation skills) and their knowledge acquisition. In addition, in the sense of "arguing to learn", it was important to find out whether learners who improve their argumentation skills also acquire more subject-specific knowledge as a result.

For their analysis, the authors selected primary studies with an experimental study research design in which both variables were simultaneously measured. A prerequisite for inclusion in the meta-analysis was that an intervention group or several intervention groups were compared with a control group that received no specific learning support. Twelve primary studies between 2004 and 2010 met these criteria. In total, data from 1,235 learners are included in the meta-analysis.

Different types of CSCL programs were used in the considered primary studies, which use two different structuring formats to support the reasoning process:

Argumentation Maps are tree-like supportive visualizations, or cognitive road maps, in which assertions and evidence are logically linked with arrows. Collaboration Scripts, on the other hand, structure discursive learning activities between learners with prompts and specific instructions. For example, they give the learners instructions about which role they have in the learning process (e.g. who starts with an argument), or when and how appropriate argumentation modules should be entered into the given text fields.

Since the measurement for the quality of the argumentation varied from study to study, the authors also included the respective measurement methods as a moderator variable. They differentiate between three measurements:

(1) A post-test measure of learners' explicit factual knowledge about good argumentation (declarative argumentation knowledge);

(2) The occurrence of certain functional argumentative features within learners' discussions—that is, argument building blocks such as assertions or justifications; or

(3) Content plausibility and correctness from learners' discussion statements.

All of these variables are examined in the meta-analysis with moderation analyses.

WHAT DID THIS STUDY FIND? Overall, learners in the CSCL programs demonstrated better argumentation skills compared to the respective control groups that did not have specific learning support (d = 0.39, small overall effect). Based on five studies, there was a large, significant effect for Collaboration Scripts (d = 0.91). Argumentation Maps were only examined in two studies. The resulting small and insignificant effect (d = 0.17) can therefore only be regarded as provisional and not very reliable.

The way in which the quality of argumentation was measured had a significant impact on the effect. The greatest learning gains were observed when the quality of argumentation was measured with a post-test on declarative argumentation knowledge (d = 0.79; 5 primary studies). The use of certain functional argumentative features also led to a relatively large learning gain (d = 0.72; 7 primary studies).

With regard to the plausibility and content correctness of argumentative statements, there was a small but significant effect on learning success (d = 0.40; 2 primary studies). Concerning subject-specific knowledge, the learners did not differ between the experimental and control groups (d = 0.00, no significant effect). Corresponding moderation analyzes could not provide any significant findings that could explain the lack of effect.

In line with the assumption mentioned above, there was a positive correlation between the quality of argumentation and the acquisition of subject-specific knowledge, but this correlation was not significant and is therefore not statistically reliable.

HOW DOES THE CLEARING HOUSE UNTERRICHT EVALUATE THIS STUDY? The *Clearing House Unterricht Research Group* evaluates the meta-analysis using the following five questions, guided by the Abelson criteria (1995):

How substantial are the effects? According to Cohen's (1988) classification, computer-supported collaborative learning programs for reasoning development have a small effect on the quality of argumentation (d = 0.39) in this meta-analysis. Converted, this effect means that 65% of the participants with the CSCL program demonstrate greater learning gains for this outcome than the average of the participants in the control group. The moderation analyzes indicated that the effect strongly depends on how the quality of the argumentation was measured. For example, in five studies, the quality of argumentation was measured via the acquired declarative knowledge about good argumentation: a medium to large effect was found here (d = 0.79).

How differentiated are the results? In this meta-analysis, the results on the effectiveness of reasoning CSCL programs are separately presented for two different measures of learning success: the quality of argumentation and subject-specific knowledge. No separate effect sizes were reported for different school subjects or age groups. Due to the small number of primary studies (12), further differentiation did not seem to be sensible.

How generalizable are the findings? The *Clearing House Unterricht Research Group* assesses whether and how the effects of computer-supported learning programs for collaborative argumentation can be generalized on the basis of the moderator analyzes carried out. The method of measuring the quality of argumentation was a significant moderator, since the results varied widely for different types of measurements. However, they are all significant and positive. Accordingly, these effects can be generalized in terms of their positive direction, but not in terms of effect size. Moreover, since there were no differences in the moderator analysis between the different types of structuring formats for argumentation support (i.e.,

Argumentation Maps; Collaboration Scripts), the effect of CSCL reasoning programs can be generalized across formats.

What makes this meta-analysis scientifically relevant? The meta-analysis investigates the effects of CSCL programs for argumentation on the quality of argumentation and, at the same time, on subject-matter knowledge. In addition, it sheds light on the theoretically-assumed connection between them for the first time. The meta-analysis also shows that there are only a few studies available on this research focus so far, and thus the current state of research is based only on initial and preliminary evidence.

How methodologically reliable are the findings? The disclosure and justification of the methodological procedure partly meets the standards criteria of common requirement guides (e.g. APA Meta-Analysis Reporting Standards). The individual steps in the preparation of the meta-analysis are easy to understand in some parts. For example, the search for primary studies and the statistical analyzes are clearly described. However, more transparency would have been desirable in the area primary study coding. For example, it remains unclear which study characteristics (e.g., age group, subjects) of the primary studies were coded.

Further information on the assessment of the methodical approach can be found in our rating sheet.

CONCLUSION FOR CLASSROOM PRACTICE. The meta-analysis provides significant findings which demonstrate that computer-supported collaborative learning programs for reasoning can significantly improve learners' argumentation skills. Learning programs that instruct learners, before or during the learning session, on how good argumentation works and that provide argumentation structures for delivering content knowledge in argumentative discourse, can be helpful tools in the classroom for promoting school students' (and university students') argumentative skills.

The spectrum of structuring formats ranges from simple schematic visualizations such as text fields to be filled, to programs that provide suitable sentence building blocks, to collaboration scripts that comprehensively guide collaboration between the learners and the distribution of their tasks. A study by Kollar and colleagues (2007) shows how students can use Collaboration Scripts to improve their argumentative skills (see study example).

According to the current state of research, there is no evidence for the assumption that improved argumentation skills are also associated with subject-matter knowledge gains. When this meta-analysis was carried out, only a few primary studies on this topic had been published. Thus, the findings presented here should be regarded as preliminary.

EXAMPLE STUDY

A study by Kollar and colleagues (2007) was carried out using a computer-supported collaborative learning program on biology classroom content with 90 eighth and tenth grade students. The authors investigated the extent to which CSCL Collaboration Scripts promoted students' argumentative skills. For one session (120 minutes), students worked in pairs on various topics from the field of genetic engineering (e.g., "deformed frogs"). In addition to the subject-specific content, the program also provided students with explanations and examples of how a good logical argument can be constructed and how students should best bring the available information into the discussion and work together on the individual components of an argument.

The individual parts of the argument were entered into the text fields provided with the help of action instructions (e.g. which learner should work on which part, or sentence starters to help properly introduce the parts of the argument).

The results showed that CSCL Collaboration Scripts, which structured collaboration and learning through the joint development of good, well-founded arguments and provided precise instructions were the support structures that promoted the acquisition of argumentation knowledge.

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LINKS.

To the meta-analysis from Wecker & Fischer (2014).

To the study example from Kollar et al. (2007).

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