



ARGUMENTATION-BASED COMPUTER SUPPORTED COLLABORATIVE LEARNING (ABCSCCL): THE ROLE OF INSTRUCTIONAL SUPPORTS

Omid Norooziⁱ

Chair Group of Education and Learning Sciences,
Wageningen University and Research,
The Netherlands

Abstract:

This paper investigates the role of instructional supports for argumentation-based computer supported collaborative learning (ABCSCCL), a teaching approach that improves the quality of learning processes and outcomes. Relevant literature has been reviewed to identify the instructional supports in ABCSCCL environments. A range of instructional supports in ABCSCCL is proposed including scaffolding, scripting, and representational tools. Each of these instructional supports are discussed in detail. Furthermore, the extent to which and the way in which such instructional supports can be applied in ABCSCCL environments are discussed. Finally, suggestions for future work and implications for the design of ABCSCCL environments are provided.

Keywords: argumentation, argumentation-based learning, learning, instructional support

1. Introduction

With the swift growth of information and communication technology platforms and the widespread accessibility of the WorldWideWeb, it is inevitable that professionals in all fields will be confronted with rapidly changing wicked global problems and complex issues. These complexities demand for appropriate actions, also in the field of education. There is a consensus that proper educational designs have the potential to prepare and train learners to become capable and qualified professionals, who can analyse, conceptualize, synthesize, and cope with complex and authentic problems (see Noroozi & McAlister, 2017). According to many scholars in the field of learning sciences, collaborative learning provide fruitful environments to prepare learners to adjust to and cope with today's complex issues and challenges (e.g. Farrokhnia et al., 2019; Latifi et al., 2020; Noroozi et al., 2011, 2016, 2018, 2020; Valero Haro et al., 2019, 2020; Veldhuis-

ⁱ Correspondence: email omid.noroozi@wur.nl

Diermanse et al., 2006). Collaborative learning environments encourage learners to discuss their ideas, concepts and problems from different viewpoints in order to reconstruct and co-construct knowledge while solving complex problems (Latifi et al., 2019; Noroozi, 2017, Noroozi & Busstra et al., 2012; Noroozi & Hatami, 2019; Noroozi & Mulder, 2017).

Argumentation has been one of the most important trends in collaborative learning, whereby learners gain a comprehensive understanding of a problem through the process of trying to convince each other. They learn to express their ideas, questions and arguments using examples, evidence, logic words and reasons. The root of argumentation dates back to theorists such as Plato and Socrates, who encouraged their learners to discuss and criticize complex topics and issues. In this regard, Schwarz & Glassner (2007, p. 449) stated: "*Plato's dialogues (or Socrates' dialogues), such as Meno or Protagoras, show how critical discussions may help participants reach eternal truths*". Toulmin (1958) is one of the best-known theorists who focused on the word of argumentation in the 19th century. From his point of view, an argument consists of six interconnected parts: claim, data, warrant, backing, rebuttal, and qualifier.

The claim refers to learners' position on an argument. Each learner takes a position in favor of or against the statement by expressing a claim. Data refers to factual information that is expressed to support the acceptance of the claim. Learners, for example, may support their claims by their observations. Warrant refers to justifying the inference between data and claim might be expressed for, example, by definitions, theories, and rules depending on the context of the course. Backing refers to reasonable evidence and examples such as statistics or expert ideas which is in accordance with the warrant. Qualifiers and their interrelated rebuttals refer qualifying the relationship between claim and warrant. They both might be used in an argumentative process to limit the validity of a claim. More explicit, qualifier refers to expressing a potential limitation and rebuttal has to do with further explanation when the claim is not valid (Stegman, Weinberger & Fisher, 2007).

It might be difficult to ask learners engage in argumentation using the whole elements of Tolmin's model in higher education due to its complexity and appropriateness. In order to simplify Tolmin's complex model, Stegman, Weinberger and Fisher (2007) employed a simplified version of Tolmin's model focusing on the elements claim, ground (data, warrant, and backing), and qualifier to explain construction of single arguments. Baker (1999), recently, revised Toulmin's model concentrating on collaborative discourse aspect of argument. Leitao developed a model for the sequence of argument focusing on argument, counter-argument and integration (Leitao, 2000). From Baker's point of view, "*Argumentation is a form of interaction in which, minimally, speakers propose arguments in favor of views (propositions, statements, utterances, claims, conceptual viewpoints, ... depending on the theoretical approach adopted), and counter-arguments in disfavor of them*" (Van Amelsvoort, 2006, p 19). Moreover, changing attitude, generating explicit thoughts, co-constructing new knowledge and conceptual changes are the main

characteristics of Baker's view of argumentation in collaborative discourses (Van Amelsvoort, 2006).

Quoting from Van Amelsvoort, Andriessen, & Kanselaar (2007, p. 486), "*collaborative argumentation-based learning (CABLE) is increasingly used in education because current practice values peer collaboration and construction of knowledge*". Learners in CABLE can pass judgment on their own and other learners' contributions, can ask peer learners for enlightenment and clarification, and can give counter-arguments to broaden and deepen their arguments (Newman, Johnson, Webb, & Cochrane, 1999). In order to broaden an issue or topic, learners need to look at the topic from different perspectives and aspects to clarify different subtopics, while in order to deepen a topic or issue, learners need to elaborate their ideas in depth by using reasonable evidence and examples (Van Amelsvoort, Andriessen, & Kanselaar, 2008; Munneke, 2007). Despite the fact that implementation of CABLE in a variety of educational studies has resulted in positive learning effects (cited in Van Amelsvoort et al., 2007), it is also argued that implementing CABLE without instructional support might limit its positive effects (Baker, 1999), especially if it is used as a tool to support and facilitate learning through argumentative problem solving. An argument or the nature of argument is in fact not linear, so it is not a simple task to broaden and deepen the space of debate during sequential linear discussion (Rummel & Spada, 2005; McCutchen, 1987). To cope with the non-linearity and complex nature of argument, a variety of instructional approaches have been proposed, tested, and developed to support CABLE; for example, computer-supported collaborative learning (CSCL).

In addition, a variety of graphical schemes have been introduced, tested, and developed to support argumentation in design-based settings. IBIS (Issue-based information systems) was introduced to support fundamental principles for the design processes of argumentative problem solving, including three main nodes, namely issue, position, and argument (Conklin & Begeman, 1988; Van Bruggen, 2003). Many applications and developments of IBIS have been introduced in different fields of interest, in which diverse viewpoints on a single problem need to be collected to cope with complex problem designs (Kim, Suh, & Whinston, 1993). gIBIS (graphical IBIS) is a hypertext-based environment aimed at supporting and facilitating interactions and arguments between participants for issue-based communication, critical thinking, and solving complex problems (Conklin & Begeman, 1988).

CSCL has recently been seen as an important and achievable instructional strategy to facilitate and support CABLE and thereby help learners achieve a deeper understanding and productive arguments (Koschmann, 2003). In today's information and communication era, CSCL is gradually moving into the mainstream of educational designs, so that it is currently receiving enormous attention in universities and schools throughout the world (Claudia, Steil, & Todesco, 2004; Ellis & Calvo, 2004; Hung, Tan, & Chen, 2005; Wang & Woo, 2007). When learners are expected to solve complex problems and reach a deeper understanding, argumentation-based computer-supported collaborative learning (ABCSCCL) provides a fruitful environment in which to integrate

different perspectives, theories and ideas with their own arguments, counter-arguments, clarifications, and discussions (Van Bruggen, 2003).

However, it has also been argued that learners may have difficulty arguing in rich CSCL (Van Amelsvoort, 2006) and design-based environments (Van Bruggen, 2003). For example, Van Bruggen (2003) noted that although using design-based environments supports the argumentation process in solving complex problems, it may create an additional burden for the learner because of the complexities and demanding tasks involved. It can take a substantial amount of time for learners to broaden and deepen their knowledge extensively enough to achieve an adequate level of expertise for solving authentic problems.

One could argue that these difficulties can be solved or at least minimized by the use of various instructional supports such as scaffolding, scripting and representational tools. Given the complex nature of the authentic problems to be solved by learners, achieving the desired learning outcomes by learners requires well designed environments. Explicit attention needs to be taken into account by planners and teachers who run ABCSCCL environments in their courses. This paper aims to address and conceptualize various types of instructional supports in ABCSCCL environments. Instructional supports in this study are composed of scaffolding, scripting, and representational tools.

2. Results

Scripts provide some instructions for learners regarding how group members should collaborate and complete tasks. Variety of scripts in CSCL and ABCSCCL environments have been introduced, tested and explored over the last decade such as: Sentence starters (note starters), buttons with open text-boxes for particular speech acts, assigning and rotating roles, peer interactions and question prompts including procedural, elaboration and reflection prompts, and input text fields. Representational tools such as writing argumentative texts, diagrams, and matrices aim at fostering and supporting interactive argumentation.

2.1 Scaffolding

Scaffolding learners with the aim of facilitating learning has lately received a remarkable amount of attention by researchers in field of CSCLearning (Azevedo & Hadwin, 2005). Scaffolding plays a critical role in CSCL settings by providing guidelines that further the learners' activities to a point where support is no longer required (McLoughlin & Marshall, 2000). There are different sources of scaffold supports in CSCL environments: scaffolding by learners such as questioning and asking for feedback; scaffolding through a CSCL tool such as embedding static prompts or templates in a CSCL platform; and scaffolding by an external person or artificial agent (Azevedo & Hadwin, 2005). Scaffolding shows learners how to appropriately approach a task and to choose different paths. Scaffolding plays a critical role in the development of the learners' declarative,

conceptual, procedural, and meta-cognitive knowledge in ABCSCCL environments (Azevedo & Hadwin, 2005).

Scaffolding demands a series of sequential provisions that may need to be tackled through a sequence of activities with loops and branches (Kobbe et al., 2007). Traversal (allowing students to follow a series of the same activities with different sets of data while only one element is tackled at any given time), rotation (allowing students to engage in each activity by changing the order of elements in a given set), and fading (allowing students to work with scaffolding that is gradually increased “faded in” or decreased “faded out”) are three common sequencing patterns in ABCSCCL (Kobbe et al. 2007).

Depending on the degree of scaffolding, students’ activities in ABCSCCL might be different. For example, students with the Universanté scaffolding (see Dillenbourg & Jermann, 2006) are supposed to follow activities such as a) analysing and elaborating the case; b) summarizing and explaining; c) analysing, comparing, and relating new information to prior knowledge; d) giving feedback and critiquing; and e) problem-solving. ABCSCCL prompted with the ArgueGraph (Dillenbourg & Jermann, 2006) demands activities such as a) justifying opinions and constructing arguments; b) comparing, evaluating, and elaborating; c) negotiating and constructing arguments; d) explaining and justifying opinions; and e) summarizing and making connections. ABCSCCL scaffolded with a peer-review support (see Noroozi et al., 2011, 2012a, 2012b, 2013a, 2013b, 2013c, 2016, 2017, 2018, 2019a, 2019b) encourages students to engage in activities such as a) applying theoretical concepts to cases and constructing arguments; b) critiquing, initially scaffolded with prompts for eliciting clarification, identifying conflicting views, and constructing counter-arguments.

2.2 Scripting

Scripts are complex instructions that stipulate the type and sequence of collaborative learning activities in ABCSCCL environments. Scripts thus provide some instructions for learners regarding how group members should collaborate and complete tasks. Collaboration scripts provide detailed and explicit guidelines for small groups of learners to clarify what, when and by whom certain activities need to be executed (Weinberger, Stegmann, Fisher, & Mandl, 2007). According to Kollar, Fisher, & Hesse (2006), the common characteristics of collaboration scripts are that they (a) induce certain activities to be carried out by the learners, (b) provide specific sequences concerning when to perform each activity, and (c) provide participants with collaboration roles specifying who is supposed to engage in the activities.

In this article, three types of scripts are distinguished: epistemic, argumentative, and social scripts (Weinberger & Fisher, 2006; Weinberger et al., 2007). Epistemic scripts have to do with structuring and sequencing discourse activities in ABCSCCL environments with respect to the content and task strategies (Weinberger et al., 2007). Such a script provides guidelines for learners to appropriately engage in task-oriented activities (Weinberger, Ertl, Fischer, & Mandl, 2005). An argumentative script has to do with structuring and formulating the construction of arguments in ABCSCCL

environments. It provides guidelines for learners to construct and formulate better-elaborated arguments in terms of warranting and qualifying claims (Weinberger & Fisher, 2006; Weinberger et al., 2007). A social script specifies and sequences the interaction of learners so that they can adopt adequate interaction strategies such as eliciting (asking critical questions to elicit information) and transactivity (responding critically to their partners' contributions) (Weinberger et al., 2007).

During the past few years, a variety of scripts in CSCL and ABCSCCL environments have been introduced, tested and explored (Jermann & Dillenbourg, 2003). Sentence starters (Weinberger, 2003), note starters (Nussbaum, Hartley, Sinatra, Reynolds, & Bendixen, 2002), buttons with open text-boxes (Baker & Lund, 1997), assigning and rotating roles (Schellens, Van Keer, De Wever, & Valcke, 2007), peer interactions and question prompts including procedural, elaboration and reflection prompts (Ge & Land, 2004) and input text fields (Kollar et al., 2006) are some examples of scripts that have resulted in positive learning outcomes. In a study conducted by Li & Lim (2008), it was concluded that scaffolding with two fixed scripts (written prompts and an argumentation template) and two adaptive scripts benefitted the learners' learning outcomes. The content-oriented scripts or epistemic scripts facilitate the construction of declarative and procedural knowledge as well as inducing meta-cognitive activities (Schellens et al., 2007). The communication-oriented scripts or social scripts stimulate interaction between the participants, which in turn influences the cognitive processes indirectly. Social scripts also evoke and stimulate the learners' internal cognitive processes, which in turn influences the meta-cognitive processes (Schellens et al., 2007).

Question prompts have been one of the most useful strategies to scaffold learning in CSCL and ABCSCCL environments that serve cognitive and meta-cognitive learning purposes (Ge & Land, 2004; Morris, Hadwin, Gress, Miller, Fior, Church, & Winne, 2009). Prompts, which are known as sentence starters, sentence openers, or question stems, provide learners with guidelines, hints, and suggestions that facilitate enacting of scripts (Ge & Land, 2004). Having different cognitive and meta-cognitive purposes, prompts comprise procedural prompts, elaboration prompts, and reflection prompts.

Scripting by assigning and rotating roles has been seen as one of the best-known social-specific techniques for creating structure in CSCL environments. Having determined roles compels learners to focus on specific activities that they themselves are responsible for (Schellens et al., 2007). Assigning roles for learners has resulted in positive learning outcomes, such as engaging effectively and smoothly in learning processes (Cohen, 1994). Having a critical role has resulted in better task performance (Zigurs & Kozar, 1994). Having a specified role has encouraged passive learners to actively participate in learning processes (Cohen, 1994). Different types of roles have been used to facilitate the quality of learning processes and outcomes. Four assigning roles (helper, feedback provider, resource manager, and process reflector) were used in a study conducted by Aviv (2000) to help the learners encourage and facilitate each others' efforts to reach the learning goals. Starter (initiate discussion by asking related questions) and wrapper (summarize the discussion) were used in a different study as roles to facilitate

knowledge construction (Zhu, 1996). Five roles (starter, summarizer, moderator, theoretician, and source searcher) were designed for learners in a research study conducted by De Wever, Van Keer, Schellens, & Valcke (2007). The overall conclusion of this study was that learners enacted the roles they were assigned without ignoring the activities related to the other roles. The researchers thus recommended scaffolding learning (through assigning roles) as a successful structuring intervention (De Wever et al., 2007). The scores of the final exam demonstrated that assigning roles improved the learners' acquisition of domain-specific knowledge; however, it did not increase their level of knowledge construction. For the theoreticians and moderators, no differences emerged compared to the non-scripted groups. Unexpectedly, source researchers achieved a lower level of knowledge construction compared to the non-scripted groups. It was argued that source researchers looked at interesting websites, articles, or books, but failed to link them to the ongoing discussion or to discuss the supplied external sources. In the end, the researchers suggested that teachers should clearly define and explain the roles to learners and give sufficient attention to all dimensions (Schellens et al., 2007). In contrast, in another study on similar roles conducted by De Wever et al. (2007), it was concluded that only the summarizers achieve higher levels of knowledge construction.

There are two kinds of scripts with respect to knowledge construction in collaborative argumentation: external and internal scripts (Kollar et al., 2007). External scripts are embedded in the external surroundings of learners, not in the learners' cognitive system. External scripts, which come in different forms (explicit or implicit; graphically embedded in a CSCL tool or a teacher's oral presentation or in handout materials), provide learners with guidelines for desired or undesired actions (Kollar et al., 2006). External tools are likely to be either gradually internalized or they fade over time (Kollar, Fischer, & Slotta, 2007). External scripts can be used in two ways: The first approach aims at the internalization of the external scripted activities. This has been termed "*scaffolding approaches to scripting*" (Pea, 2004) or "*tools for learning*" (Carmien, Kollar, Fischer, & Fischer, 2007). The second approach uses external aids for better understanding of complex domain concepts or processes. This has been termed "*distributed intelligence approaches to scripting*" (Pea, 2004) or "*tools for living*" (Carmien et al., 2007). The main characteristic of the first approach is that learners are persuaded to utilize learned skills without external support being provided through fading mechanisms. The main characteristic of the second approach is that teachers help learners accomplish their tasks by being continuously accessible in the learning environment (Carmien et al., 2007). Tools for learning can be regarded as tools for living if learners lack the capability to internalize external scripts (Carmien et al., 2007).

An internal script is a set of knowledge and strategies that determines how a person will act in and understand particular situations in ABCSCL environments (Kollar et al., 2007; Carmien et al., 2007). Internal scripts are very flexible and vary between individuals (Kollar et al., 2007; Carmien et al., 2007). Some individuals, for example, may be good at giving explicit reasonable evidence and reasons in arguments (Kollar et al.,

2007). Some learners might know how to attack an argument by creating counter arguments (Carmien et al., 2007). Few studies have investigated the interaction between internal and external scripts in ABCSCCL environments (Kollar et al., 2007). This must be taken into account, however, before designing external scripts in ABCSCCL environments (Carmien et al., 2007). Different internal scripts brought into ABCSCCL environments by different individuals can be complemented only by different external scripts (Carmien et al., 2007).

Scripts for collaborative learning differ according to how structured they are. While some theorists provide rather rough guidelines for specific activities, sequences and roles, others may provide rather highly structured scripts, including very detailed instructions for learners regarding what activities should be applied, when and by whom (Kollar et al., 2007). Although highly structured scripts have resulted in better learning outcomes than less-structured scripts (Weinberger et al., 2007), too-detailed scripts or “over-scripting” has been rejected (Dillenbourg, 2002) since it makes the ABCSCCL environments unnatural, leads to less productive collaboration processes and yields non-intended side-effects (Weinberger, Stegmann, & Fischer, 2005).

2.3 Representational tools

Representational tools are believed to foster and support interactive argumentation in ABCSCCL environments (Bell, 2004; Suthers, 1999; Veerman, 2000). Accordingly, various types of representational tools have been used in recent years. Whilst Coirier & Golder (1993) and Veerman, Andriessen, & Kanselaar (2002) have emphasized the benefits of writing argumentative texts, Suthers & Hundhausen (2003) have focused on the effects of argumentative diagrams in ABCSCCL environments. These authors point out the role played by different external representations (diagrams, matrices and text) in collaborative problem solving (Suthers, 2003; Suthers, & Hundhausen, 2003). In summary, representational tools in ABCSCCL environments help learners clarify their arguments (Bell, 2004; Van Bruggen & Kirschner, 2003), keep their arguments on track (Veerman, 2000), argue more effectively, consider all aspects and perspectives of a topic (Suthers & Hundhausen, 2003), formulate statements in the space of a debate, take different opinions, perspectives and critiques into account (Kolodner & Guzdial, 1996), discover and clarify new relationships and find patterns (Suthers, 1999, 2001, 2003). The tools furthermore help illustrate the structure of argumentation, give a general overview (Larkin & Simon, 1987; Schwarz et al., 2000) and broaden and deepen topics (Van Amelsvoort, 2006). In spite of the great advantages of representational tools, however, little has been done to identify how, when and which representational tools could be more useful in ABCSCCL environments (Lund, Molinari, Sejourne, & Baker, 2007; Munneke, 2007; Munneke, Andriessen, Kanselaar, & Kirschner, 2007). In this regard, some educational theorists have claimed that when the purpose of ABCSCCL is to deepen student’s knowledge or produce productive arguments, writing tasks and argumentative texts could be the most useful (Giroud, 1999; Klein, 1999; Veerman, 2000). When the intention is to identify relations in a topic, a matrix is considered to be a good

representational tool; whereas graphs are useful for elaborating on a topic while keeping learners focused on the relevant aspect of the debate (Baker, Andriessen, Lund, Van Amelsvoort, & Quignard, 2007).

3. Conclusion

Argumentation has been one of the most important trends of collaborative learning, whereby learners express their ideas, questions, and arguments in order to convince each other through examples, evidence, logical words and reasons to get a comprehensive understanding. Collaborative argumentation-based learning (CABLE) has been used to facilitate peer collaboration and knowledge construction. Computer supported collaborative learning (CSCL) recently has been seen as an important and achievable instructional strategy to facilitate and support CABLE for deeper understanding and providing productive arguments. Despite the fact that implementing CABLE in a variety of educational studies has resulted positive learning effects; however, it is also argued that employing CABLE without instructional supports might limit its positive effects since argument or the nature of argument is not linear and thus the broadening and deepening the space of debate during sequential linear discussion does not happen simply. In order to cope with the linearity and complexity nature of argument, a variety of instructional approaches; for example, scaffolding, scripting, and representational tools have been proposed, tested, and developed to support CABLE. Scaffolding in ABCSCCL environments shows learners to appropriately approach a task and to choose different paths to get different solutions. Scripts are complex instructional means that stipulate and sequence collaborative learning activities in CSCL and ABCSCCL environments. Scripts provide some instructions for learners regarding how group members should collaborate and complete tasks. Variety of scripts in CSCL and ABCSCCL environments have been introduced, tested and explored over the last decade such as: Sentence starters (note starters), buttons with open text-boxes for particular speech acts, assigning and rotating roles, peer interactions and question prompts including procedural, elaboration and reflection prompts, and input text fields. Representational tools such as writing argumentative texts, diagrams, and matrices aim at fostering and supporting interactive argumentation. Making argument visible, clear and explicit, increasing quality of argumentation, considering all aspects and perspectives of the topic, illustrating the structure of argumentation and giving general overview, broadening and deepening topics in different ways, discovering and clarifying new relationships and finding patterns, as well as formulating statements in the space of debate are some benefits of using representational tools in ABCSCCL environments. Further studies need to be performed to find out the way in which different internal scripts interplay with different external scripts and how this interaction influences argumentative knowledge construction in ABCSCCL environments. It is wise to shed light on the extent in which learners can internalize and stabilize scripts over time. How long, how, and under what conditions do learners need to interact to internalize external scripts? How detailed and

specify external scripts should be designed to prevent frustration among learners by over-scripting? Considering representational tools, it is necessary to disclose under which conditions, when, how and which tools in ABCSCCL can lead to the productive learning outcomes.

Conflict of interest

The author confirms that there is no conflict of interest. Furthermore, the author declares that there is no significant financial aid received for this study. It is also declared that there is no any external factor affecting the study outcomes.

About the author

Omid Noroozi is an associate professor at Wageningen University and Research (WUR). He graduated with a PhD degree (Cum Laude) on Educational Technology where he studied the relations among technology, pedagogy, and learning argumentation in higher education. He has designed, implemented, evaluated and improved various type of online learning modules to facilitate students' argumentation competence development and to improve their learning outcomes. Omid has been involved in various education innovation projects at WUR aiming at enhancements of students' argumentation and reasoning skills and ultimately improving learning and quality of teaching and education. Omid is very keen in linking theory with practice. His involvement in education innovation projects has been the subject of many scientific awards (most promising publication award, junior research award, best researcher award, various international travel awards) he has received. Omid has been a visiting scholar at University of Michigan and Oulu University to work on various international projects related to educational technology. Omid has presented over 50 papers at international conferences and published various articles in top-ranked journals. Omid is an active member of various scientific associations e.g. AERA, ISLS, ICO and the EARLI and serve as an active reviewer for many international conferences and journals.

References

- Aviv, R. (2000). Educational performance of ALN via content analysis. *Journal of Asynchronous Learning Networks*, 4, 53-72.
- Azevedo, R., & Hadwin, A.F. (2005). Scaffolding self-regulated learning and metacognition- implications for the design of computer-based scaffolds. *Instructional Science*, 33, 367-379.
- Baker, M. (1999). Argumentation and constructive interaction. In G. Rijlaarsdam., & E. Esperet (series Eds.) & J. Andriessen., & P. Coirier (Eds.). *Studies in Writing: Vol 5. Foundations of argumentative text processing* (pp. 179-202) Amsterdam: Amsterdam University Press.

- Baker, M., Andriessen, J., Lund, K., Van Amelsvoort, M., & Quignard, M. (2007). Rainbow: A framework for analysing computer-mediated pedagogical debates. *International Journal of Computer-Supported Collaborative Learning*, 2, 315-357.
- Baker, M., & Lund, K. (1997). Promoting reflective interactions in a CSCL environment. *Journal of Computer Assisted Learning*, 13, 175-193.
- Bell, P. (2004). Promoting students' argument construction and collaborative debate in the Science classroom. In M.C. Linn., E.A. Davis., & P. Bell (Eds.), *Internet Environments for Science Education* (pp. 341-353). Mahwah, NJ: Lawrence Erlbaum.
- Carmien, S., Kollar, I., Fischer, G., & Fischer, F. (2007). The interplay of internal and external scripts- a distributed cognition perspective. In F. Fischer, H. Mandl, J. Haake & I. Kollar (Eds.), *Scripting computer-supported collaborative learning: Cognitive, computational, and educational perspectives* (pp. 303-326). New York: Springer.
- Claudia, M., Steil, A., & Todesco, J. (2004). Factors influencing the adoption of the Internet as a teaching tool at foreign language schools. *Computers and Education*, 42(4), 353-374.
- Cohen, E.G. (1994) Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research*, 64 (1), 1-35.
- Coirier, P., & Golder, C. (1993). Writing argumentative text: A developmental study of the acquisition of supporting structures. *European Journal of Psychology of Education*, 8(2),169-181.
- Conklin, J., & Begeman, M.L. (1988). gIBIS: A Hypertext Tool for Exploratory Policy Discussion. *ACM Transactions on Office Information Systems*, 4(6), 303-331.
- De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2007). [Applying multilevel modelling on content analysis data: Methodological issues in the study of the impact of role assignment in asynchronous discussion groups](#). *Learning and Instruction*, 17, 436-447.
- Dillenbourg, P. (2002). Over-scripting CSCL: the risks of blending collaborative learning with instructional design. In P.A. Kirschner (Ed.), *Three worlds of CSCL. Can we support CSCL* (pp. 61-91). Heerlen: Open Universiteit Nederland.
- Dillenbourg, P., & Jermann, P. (2006). Designing integrative scripts. In: F. Fischer., I. Kollar., H. Mandl., & J. Haake (Eds.), *Scripting computer-supported collaborative learning: Cognitive, computational and educational perspectives* (pp. 275-301). New York: Springer.
- Ellis, R.A., & Calvo, R.A. (2004). Learning through discussions in blended environments. *Educational Media International*, 41(3), 263-274.
- Farrokhnia, M., Pijera-Díaz, H. J., Noroozi, O., & Hatami, J. (2019). Computer-supported collaborative concept mapping: The effects of different instructional designs on conceptual understanding and knowledge co-construction. *Computers and Education*, 142, 103640. <https://doi.org/10.1016/j.compedu.2019.103640>.

- Ge, Xun., & Land, S.M. (2004). A conceptual framework for scaffolding ill-structured problem-solving processes using question prompts and peer interactions. *ETR&D*, 52(2), 5-22.
- Giroud, A. (1999). Studying argumentative text processing through collaborative writing. In J.E.B. Andriessen., & P. Coirier (Eds.), *Foundations of argumentative text processing* (pp. 149-179). Amsterdam: Amsterdam University Press.
- Hung, D., Tan, S.C., & Chen, D.T. (2005). How the internet facilitates learning as dialog: design considerations for online discussions. *International Journal of Instructional Media*, 32(1), 37-46.
- Jermann, P., & Dillenbourg, P. (2003). Elaborating new arguments through a CSCL script. In P. Dillenbourg (Ed.), *Learning to argue* (Vol. 1, pp. 205–226). Dordrecht, The Netherlands: Kluwer.
- Kim, W., Suh, Y., & Whinston, A.B. (1993). An IBIS and object-oriented approach to scientific research data management. *Journal of System Software*, 23, 183-197.
- Klein, P.D. (1999). Reopening inquiry into cognitive processes in writing-to-learn. *Educational Psychology Review*, 11(3), 203-270.
- 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(2-3), 211-224.
- Kollar, I., Fischer, F., & Hesse, F.W. (2006). Collaboration scripts e a conceptual analysis. *Educational Psychology Review*, 18(2), 159-185.
- Kollar, I., Fischer, F., Slotta, D.J. (2007). Internal and external scripts in computer-supported collaborative inquiry learning. *Learning and Instruction* 17, 708-721.
- Kolodner, J.L., & Guzdial, M. (1996). Effects with and of CSCL: Tracking learning in a new paradigm. In T. Koschmann (Ed.) *CSCL: Theory and Practice of an emerging paradigm* (pp. 307-320). Mahwah, NJ: Lawrence Erlbaum Associates.
- Koschmann, T. (2003) CSCL, Argumentation, and Deweyan Inquiry: argumentation is learning, in J. Andriessen, M. Baker., & D. Suthers (Eds), *Arguing to Learn. Confronting Cognitions in Computer-supported Collaborative Learning Environments*. Dordrecht: Kluwer.
- Latifi, S., Noroozi, O., Hatami, J., & Biemans, H.J.A. (2019). How does online peer feedback improve argumentative essay writing and learning?. *Innovations in Education and Teaching International*.
<https://doi.org/10.1080/14703297.2019.1687005>.
- Latifi, S., Noroozi, O., & Talaei, E. (2020). Worked example or scripting? Fostering students' online argumentative peer feedback, essay writing and learning. *Interactive Learning Environments*, 1-15.
<https://doi.org/10.1080/10494820.2020.1799032>.
- Leitao, S. (2000). The potential of argument in knowledge building. *Human Development*, 43, 332-360.
- Lund, K., Molinari, J., Sejourne, A., & Baker, M. (2007). How do argumentation diagrams compare when student pairs use them as a means for debate or as a tool for

- representing debate? *International Journal of Computer-Supported Collaborative Learning*, 2 (2-3), 273-295.
- McLoughlin, C., & Marshall, L. (2000). Scaffolding: A model for learner support in an online teaching environment. In A. Herrmann., & M.M. Kulski (Eds.), *Flexible futures in tertiary teaching. Proceedings of the 9th Annual Teaching Learning, Forum*, 2-4 February 2000. Perth: Curtin University of Technology.
- Morris, R., Hadwin, A.F., Gress C.L.Z., Miller, M., Fior, M., Church, H., & Winne, PH. (2009). Designing roles, scripts, and prompts to support CSCL in gStudy. *Computers in Human Behavior*, xxx (2009) xxx-xxx.
- Munneke, L. (2007). *Arguing to learn. Supporting interactive argumentation through Computer- Supported Collaborative Learning*. PhD dissertation, Utrecht University, The Netherlands.
- Munneke, L., Andriessen, J., Kanselaar, G., & Kirschner, P. (2007). Supporting interactive argumentation: Influence of representational tools on discussing a wicked problem. *Computers in Human Behavior* 23, 1072-1088.
- Newman, D.R., Johnson, C., Webb, B. & Cochrane, C. (1999) Evaluating the Quality of Learning in Computer Supported Co-operative Learning. *Journal of American Society for Information Science*, 48, 484-495.
- Noroozi, O. (2017). Considering students' epistemic beliefs to facilitate their argumentative discourse and attitudinal change with a digital dialogue game. *Innovations in Education and Teaching International*. <http://dx.doi.org/10.1080/14703297.2016.1208112>.
- Noroozi, O., Alikhani, I., Jarvela, S., Kirschner, P.A., Juuso, I., & Seppänen, T. (2019a). Multimodal data to design visual learning analytics for understanding regulation of learning. *Computers in Human Behavior*. <https://doi.org/10.1016/j.chb.2018.12.019>.
- Noroozi, O., Biemans, H.J.A., & Mulder, M. (2016). Relations between scripted online peer feedback processes and quality of written argumentative essay. *Internet and Higher Education*, 31, 20-31.
- Noroozi, O., Biemans, H.J.A., Busstra, M.C., Mulder, M., & Chizari, M. (2011). Differences in learning processes between successful and less successful students in computer-supported collaborative learning in the field of human nutrition and health. *Computers in Human Behaviour*, 27(1), 309-318.
- Noroozi, O., Biemans, H.J.A., Busstra, M.C., Mulder, M., Popov, V., & Chizari, M. (2012a). Effects of the Drewlite CSCL platform on students' learning outcomes. In A. Juan., T. Daradoumis., M. Roca., S.E. Grasman., & J. Faulin. (Eds.), *Collaborative and distributed E-research: Innovations in technologies, strategies and applications* (pp. 276-289). IGI Global. <http://dx.doi.org/10.4018/978-1-46660-125-3>.
- Noroozi, O., Biemans, H.J.A., Weinberger, A., Mulder, M., & Chizari, M. (2013a). Scripting for construction of a transactive memory system in multidisciplinary CSCL environments. *Learning and Instruction*, 25(1), 1-12.
- Noroozi, O., Busstra, M.C., Mulder, M., Biemans, H.J.A., Tobi, H., Geelen, M.M.E.E., van't Veer, P., & Chizari, M. (2012). Online discussion compensates for suboptimal

- timing of supportive information presentation in a digitally supported learning environment. *Educational Technology Research and Development*, 60(2), 193-221. <http://dx.doi.org/10.1007/s11423-011-9217-2>.
- Noroozi, O., Dehghanzadeh, H., & Talaei, E. (2020). A systematic review on the impacts of game-based learning on argumentation skills. *Entertainment Computing*, 100369. <https://doi.org/10.1016/j.entcom.2020.100369>.
- Noroozi, O., & Hatami, J. (2019). The effects of online peer feedback and epistemic beliefs on students' argumentation-based learning. *Innovations in Education and Teaching International*, 56(5), 548-557. <https://doi.org/10.1080/14703297.2018.1431143>.
- Noroozi, O., Hatami, J., Biemans, H.J.A., van Ginkel, S., & Bayat, A. (2019b). Students' online argumentative peer feedback, essay writing, and content learning: Does gender matter?. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2018.1543200>.
- Noroozi, O., Kirschner, P., Biemans, H.J.A., & Mulder, M. (2018). Promoting argumentation competence: Extending from first- to second-order scaffolding through adaptive fading. *Educational Psychology Review*, 30, 153-176.
- Noroozi, O., & McAlister, S. (2017). Software tools for scaffolding argumentation competence development. In M. Mulder, (Ed.), *Competence-based vocational and professional education. Bridging the worlds of work and education* (pp.819-839). Cham: Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-41713-4_38.
- Noroozi, O., & Mulder, M. (2017). Design and evaluation of a digital module with guided peer feedback for student learning biotechnology and molecular life sciences, attitudinal change, and satisfaction. *Biochemistry and Molecular Biology Education*, 45(1), 31-39.
- Noroozi, O., Weinberger, A., Biemans, H.J.A., Mulder, M., & Chizari, M. (2012b). Argumentation-based computer supported collaborative learning (ABCSCCL). A systematic review and synthesis of fifteen years of research. *Educational Research Review*, 7, 79-106.
- Noroozi, O., Teasley, S.D., Biemans, H.J.A., Weinberger, A., & Mulder, M. (2013b). Facilitating learning in multidisciplinary groups with transactive CSCL scripts. *International Journal of Computer-Supported Collaborative Learning*, 8(2), 189-223.
- Noroozi, O., Weinberger, A., Biemans, H.J.A., Mulder, M., & Chizari, M. (2013c). Facilitating argumentative knowledge construction through a transactive discussion script in CSCL. *Computers and Education*, 61, 59-76.
- Nussbaum, E.M., Hartley, K., Sinatra, G.M., Reynolds, R.E., & Bendixen, L.D. (2002). Enhancing the quality of online discussions. *Paper presented at the Annual meeting of the American Educational Research Association*, New Orleans: LA.
- Pea, R.D (2004). The social and technological dimensions of scaffolding and related theoretical concepts for learning, education, and human activity. *Journal of the Learning Sciences*, 13(3), 423-451.

- Rummel, N., & Spada, H. (2005). Learning to collaborate: An instructional approach to promoting collaborative problem solving in computer-mediated settings. *The Journal of the Learning Sciences*, 14, 201-241.
- Schellens, T., Van Keer, H., De Wever, B., & Valcke, M. (2007). Scripting by assigning roles: Does it improve knowledge Construction in asynchronous discussion groups? *Computer-Supported Collaborative Learning*, 2, 225-246.
- Schwarz, B.B., & Glassner, A. (2007). The role of floor control and of ontology in argumentative activities with discussion-based tools. *Computer-Supported Collaborative Learning*, 2, 449-478.
- Stegmann, K., Weinberger, A., & Fischer, F. (2007). Facilitating argumentative knowledge construction with computer-supported collaboration scripts. *International Journal of Computer-Supported Collaborative Learning*, 2(4), 421-447.
- Suthers, D. (1999). Representational support for collaborative inquiry. *Proceedings of the 32nd Hawai'i International Conference on the System Sciences (HICSS-32, CD-ROM)*. Maui, Hawai'i: Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- Suthers, D. (2001). Towards a systematic study of representational guidance for collaborative learning discourse. *Journal of Universal Computer Science*, 7, 254-277.
- Suthers, D. (2003). Representational guidance for collaborative inquiry. In J. Andriessen, M. Baker., & D. Suthers (Eds.), *Arguing to learn: Confronting cognitions in computer-supported collaborative learning environments* (pp. 27-46). Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Suthers, D., & Hundhausen, C. (2003). An empirical study of the effects of representational guidance on collaborative learning. *Journal of the Learning Sciences*, 12(2), 183-219.
- Toulmin, S. (1958). *The Uses of Argument*, Cambridge University Press, Cambridge, UK.
- Valero Haro, A., Noroozi, O., Biemans, H.J.A., & Mulder, M. (2019). First-and second-order scaffolding of argumentation competence and domain-specific knowledge acquisition: a systematic review. *Technology, Pedagogy and Education*, 28(3), 329-345. <https://doi.org/10.1080/1475939X.2019.1612772>.
- Valero Haro, A, Noroozi, O., Biemans, H.J.A., & Mulder, M. (2020). Students' argumentation knowledge, behavior and attitude and their relationships with domain-specific knowledge acquisition. *Journal of Constructivist Psychology*. <https://doi.org/10.1080/10720537.2020.1734995>.
- Van Amelsvoort, M. (2006). A Space for Debate. *How diagrams support collaborative argumentation-based learning*. PhD dissertation, Utrecht University, The Netherlands.
- Van Amelsvoort, M., Andriessen, J., & Kanselaar, G. (2007). Representational tools in computer-supported collaborative argumentation-based learning: How dyads work with constructed and inspected argumentative diagrams. *Journal of the Learning Sciences*, 16(4), 485-521.

- Van Bruggen, J.M. (2003). *Explorations in graphical argumentation: the use of external representations in collaborative problem solving*. PhD dissertation, Open University, The Netherlands.
- Van Bruggen, J.M., & Kirschner, P.A. (2003). Designing external representations to support solving wicked problems. In J. Andriessen, M. Baker, & D. Suthers (Eds.), *Arguing to learn: Confronting cognitions in computer-supported collaborative learning environments* (pp. 177-204). Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Veerman, A.L. (2000). *Computer supported collaborative learning through argumentation*. PhD dissertation, Utrecht University, The Netherlands.
- Veerman, A.L., Andriessen, J.E.B., & Kanselaar, G. (2002). Collaborative argumentation in academic education. *Instructional Science*, 30(3), 155-186.
- Wang, Q.Y., & Woo, H.L. (2007). Comparing asynchronous online discussions and face-to-face discussions in a classroom setting. *British Journal of Educational Technology*, 38(2), 272-286.
- Weinberger, A. (2003). *Scripts for Computer-Supported Collaborative Learning Effects of social and epistemic cooperation scripts on collaborative knowledge construction*. PhD dissertation, Munchen University, Germany.
- Weinberger, A., Ertl, B., Fischer, F., & Mandl, H. (2005). Epistemic and social scripts in computer-supported collaborative learning. *Instructional Science*, 33(1), 1-30.
- Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & Education*, 46, 71-95.
- Weinberger, A., Stegmann, K., Fischer, F., & Mandl, H. (2007). Scripting argumentative knowledge construction in computer-supported learning environments. In F. Fischer., H. Mandl., J. Haake., & I. Kollar (Eds.), *Scripting computer-supported communication of knowledge - cognitive, computational and educational perspectives* (pp. 191-211). New York: Springer.
- Zhu, E. (1996). Meaning negotiation, knowledge construction, and mentoring in a distance learning course. In *Proceedings of selected research and development presentations at the 1996 National Convention of the Association for Educational Communications and Technology* (pp. 821-844).
- Zigurs, I., & Kozar, K.A. (1994). An exploratory study of roles in computer-supported groups. *MIS Quarterly*, 18, 277-297.

Creative Commons licensing terms

Authors will retain the copyright of their published articles agreeing that a Creative Commons Attribution 4.0 International License (CC BY 4.0) terms will be applied to their work. Under the terms of this license, no permission is required from the author(s) or publisher for members of the community to copy, distribute, transmit or adapt the article content, providing a proper, prominent and unambiguous attribution to the authors in a manner that makes clear that the materials are being reused under permission of a Creative Commons License. Views, opinions and conclusions expressed in this research article are views, opinions and conclusions of the author(s). Open Access Publishing Group and European Journal of Open Education and E-learning Studies shall not be responsible or answerable for any loss, damage or liability caused in relation to/arising out of conflict of interests, copyright violations and inappropriate or inaccurate use of any kind content related or integrated on the research work. All the published works are meeting the Open Access Publishing requirements and can be freely accessed, shared, modified, distributed and used in educational, commercial and non-commercial purposes under a [Creative Commons Attribution 4.0 International License \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).