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de Wever, Bram; Strijbos, Jan-Willem

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Roles for Structuring Groups for Collaboration

Bram De Wever and Jan-Willem Strijbos

Abstract The emergence of productive collaboration benefits from support for group interaction. Structuring is a broad way to refer to such support, as part of which roles have become a boundary object in computer-supported collaborative learning. The term structuring is related to—yet distinct from—other approaches to support such as scaffolding, structured interdependence, and scripting. Roles can be conceived as a specific (set of) behavior(s) that can be taken up by an individual within a group. They can be assigned in advance or emerge during group interaction. Roles raise individual group member's awareness of their own and fellow group member's responsibilities, and they make an individual's responsibilities toward the group's functioning visible for all group members. In future research, pedagogical issues with respect to role design, assignment, and rotation as well as automated detection and visualization of emergent roles, should be addressed.

Keywords Roles · Structuring · CSCL · Scripting · Scaffolding · Regulating

1 Definitions and Scope

It is well established that groups, in particular, ad hoc groups without a common history, do not automatically develop productive ways of collaborating and that there is a need to *structure* them to enhance collaborative learning in face-to-face and computer-supported settings (Cohen, 1994a, 1994b; De Wever, Van Keer, Schellens, & Valcke, 2010a; Johnson & Johnson, 1994, 2009; Kagan, 1994; Slavin,

B. De Wever (✉)
Tecolab Research Unit, Department of Educational Studies, Ghent University, Ghent, Belgium
e-mail: Bram.DeWever@UGent.be

J.-W. Strijbos
Faculty of Behavioural and Social Sciences, Department of Educational Sciences, University of Groningen, Groningen, The Netherlands
e-mail: j.w.strijbos@rug.nl

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1995; Strijbos, Martens, Jochems, & Broers, 2004b, 2007). The term *structuring* can be broadly defined as a pedagogical approach by which the enactment of the collaborative process is organized (typically by the teacher or by computer technology) in order to guide the unfolding group interaction in such a way that the envisioned learning benefits are most likely achieved. In this chapter, we specifically focus on structuring by means of *roles* and how this can be used to foster computer-supported collaborative learning (CSCL).

There are many types of roles that have been applied and studied in face-to-face and CSCL settings. Following Strijbos and Weinberger (2010), roles can be defined as more or less stated functions or responsibilities that guide individual behavior and regulate group interaction (see also Hare, 1994). Roles can furthermore promote individual responsibility and group cohesion (see also Forsyth, 1999; Mudrack & Farrell, 1995) as well as positive interdependence and individual accountability (see also Brush, 1998), which are central support factors in collaborative learning arrangements (De Hei, Strijbos, Sjoer, & Admiraal, 2016; Slavin, 1996; Strijbos, Martens, & Jochems, 2004a). Roles can also facilitate group members' awareness of overall group performance and of peer contributions (Mudrack & Farrell, 1995; Strijbos et al., 2007; Strijbos, Martens, Jochems, & Broers, 2004b) and are most relevant for distributing, coordinating, and integrating subtasks to attain a shared goal.

Not surprisingly, roles were of interest early-on in research on collaborative learning (Cohen, 1994a; Johnson & Johnson, 1994). With the advent of networking technologies in universities and schools in the late 1990s and early 2000s, as well as the increased availability of computers in regular classrooms and at students' homes, opportunities for CSCL increased. In these computer-supported environments, pedagogical approaches were brought in from earlier face-to-face classroom practices. As a result, roles quite naturally became an important focus for research on structuring in CSCL. Over time, many different roles have been introduced. Strijbos and De Laat (2010) conducted a scoping review of roles used in CSCL research and distinguished three levels of the role concept: (a) role as a specified activity focused on the collaborative product or process (role as a task; micro level), (b) role as multiple tasks focused on the product, process, or a combination (role as a pattern; meso level), and (c) role as an individuals' participative pattern based on their attitude towards the task and collaborative learning (role as a stance; macro level). Typical micro-level roles in a CSCL discussion environment are, for example, Starter and Wrapper (Hara, Bonk, & Angeli, 2000), examples of meso-level roles are Moderator or Summarizer (De Wever et al., 2010a), and examples of macro-level roles are Communicative Learner and Quiet Learner (Hammond, 1999).

In the remainder of this chapter, we will first elaborate on the history and development of structuring, before moving on to the history and development of roles for structuring. This is followed by a summary of the current state of the art and we will conclude with trends for future research.

2 History and Development

2.1 History and Development of Structuring

In our introduction, we defined structuring very broadly, and indeed structuring is mostly used as a general term. As a result, it has been used in several ways, sometimes as a synonym for different individual concepts, sometimes as an overarching term for multiple concepts. In addition, the term structuring is also often used without explicitly providing a definition or description. This makes it hard to see the forest for the trees, however, in this section, we provide an overview of the different interpretations that we have found, together with the history and development. We will first focus on structuring as scaffolding, structured interdependence, scripting, pre-intervention decisions, and structuring as an overall term encompassing all the previous ones. Second, we will delve more deeply into the use of roles for structuring (computer-supported) collaborative learning.

The first way in which structuring is interpreted is as a synonym for *scaffolding*. The concept of scaffolding is often associated with Vygotsky's zone of proximal development, in which scaffolding is the activity of guiding students from their actual developmental level to the level of their potential development (Vygotsky, 1978; see also De Wever et al., 2010a). Following Pata, Sarapuu, and Lehtinen (2005), scaffolding means providing assistance to students on an "as-needed"-basis with fading out of such assistance as their competence or mastery increases. Especially the "fading out" aspect can be considered typical for scaffolding. Regarding its history, it is hard to pinpoint an exact date for the development of scaffolding in (CS)CL. However, Pinantoan (2013) argues that the term scaffolding was first coined in 1976 by Wood, Bruner, and Ross, and that the term was subsequently refined in 1978 after the release of the collected works by Vygotsky (1978) in the book "Mind in Society." Since the late 1970s and early 1980s, scaffolding received growing attention in the field of learning and instruction, and thus also in (computer-supported) collaborative learning. As we will discuss later on, roles can be used as scaffolds to support group interaction and learning.

A second way of interpreting structuring is to see it as originating from Aronson and Bridgeman's (1979) concept of *structured interdependence*. They deliberately "structured" group interaction in such a way that students were "forced" to work together, and thus developed an intervention that focused on structuring group work. The "Jigsaw" structure they proposed, and which is nowadays broadly known in the field of the learning sciences, not only improved social inclusion of minority students but also their achievement. In this way, the impact of structuring group interaction on learning can be considered as a side effect of Aronson and Bridgeman's (1979) research on stereotype reduction and inclusion of minorities in classrooms.

A third way in which the term structuring is interpreted is as a synonym for *scripting*. The term "script" was borrowed from the theatre context, emphasizing how specific roles are assigned and specific activities are sequenced, and was already

used in the 1990s (O'Donnell & Dansereau, 1992). Within some research in the 1990s, scripts were used to specify roles and the specific nature and timing of cognitive activities, such as elaborating (e.g., O'Donnell & Dansereau, 1992), explaining (e.g., King, 1997), and argumenting (e.g., Kuhn, Shaw, & Felton, 1997). The idea was that scripts stimulate students to engage in specific cognitive activities that were proven to be important for learning. In the early 2000s, scripting was more and more used in CSCL settings, as its use expanded due to technological advances (among others, e.g., the increased use of asynchronous discussion groups, and later on wikis, together with more advanced CSCL tools). The term "script" also quickly became a boundary term in CSCL research, around which researchers from diverse backgrounds (psychology, education, and computer science) could gather, and which they could use as a shared term with mostly (but not completely) shared understanding. There were some differences in how scripting was defined: (1) the term "script" was known by computer scientists, where it indicates a list of commands to be executed in a sequential way, (2) the scripted cooperation approach (O'Donnell & Dansereau, 1992) was known among educational scientists and educational psychologists, although (3) within cognitive psychology scripts are often conceived—in line with Schank and Abelson (1977)—as a term "to refer to culturally shared knowledge about the world that provides information about the conditions, processes, and consequences of particular everyday situations" (Kollar, Fischer, & Hesse, 2006, p. 161).

Several efforts have been made to further define and conceptualize CSCL scripts (see e.g., Kobbe et al., 2007; Kollar et al., 2006) and develop a theoretical framework for them (e.g., Fischer, Kollar, Stegmann, & Wecker, 2013). Following Kollar et al. (2006) and Fischer et al. (2013), collaboration scripts aim to scaffold the interactive processes between collaborators in a face-to-face or computer-mediated learning environment. In this way, these authors separate these types of interaction scaffolds from scaffolds that provide support on a content- or conceptual level. Collaboration scripts are conceived as "scaffolds that structure the interactive processes of collaborative learning [and] shape collaboration by specifying different roles and associated activities to be carried out by the collaborators" (Kollar et al., 2006, p. 160), and according to Fischer et al. (2013) they generally consist of at least four components: (a) play level (i.e., knowledge about the learning and collaboration setting), (b) scene level (i.e., knowledge about types of activities within the setting), (c) scriptlet level (i.e., knowledge of sequences of activities within the setting), and (d) role level (i.e., knowledge of roles that organize activities by specific participants with the setting). A more extensive discussion on scripting and how it was employed in the field of CSCL can be found in Sect. 3.1 of this handbook (Vogel, Weinberger, & Fischer, this volume).

A fourth interpretation of structuring is based on the timing of the instructional intervention, i.e., structuring as an overarching term for pre-intervention decisions. In this interpretation, structuring is about *prescribing and prespecifying the collaboration processes*, thus structuring is something that is done in *advance* to favor the emergence of productive interactions (De Hei et al., 2016; Strijbos, Martens, & Jochems, 2004a), and it is different from *regulating* interactions, which is something

that happens *during* the interactive process (Dillenbourg, 2002). According to Dillenbourg, interventions done before the collaboration are termed structuring (e.g., the design and selection of structured communication tools and specific collaboration scripts), and the interventions done during the collaboration are termed regulating (e.g., tools that allow students to regulate their contribution to collaboration, co-regulation with the help of a tutor/teacher, and/or foster groups' shared regulation; Järvelä & Hadwin, 2013; Järvelä et al., 2015; see also the reflective supports for student-directed regulation and structuration as mentioned by Law, Zhang, & Peppler, this volume).

A fifth and final interpretation of structuring is to conceptualize structuring as a *broader and more overarching term* that incorporates the different types of activities and interventions, such as the abovementioned scripting and regulating. This is for example done by De Wever et al. (2010a), comparing two different ways of structuring the collaboration in asynchronous discussion groups by either scripting via assigning roles to students in those discussion groups or by regulating the collaboration through the assignment of cross-age peer tutors to each discussion group. This is also how we defined structuring at the start of this chapter, i.e., as a broad concept encompassing multiple specific approaches, with the aim of guiding the unfolding group interaction in such a way that collaborative learning can take place.

What is clear from these five interpretations is that structuring is not as well-defined as often assumed in the field of CSCL and it is used in several ways by different (groups of) authors. We are fully aware that this is complex—especially for researchers new to the field of CSCL. However, rather than oversimplifying what structuring is and where it came from, we decided to show the complex nature of its definition and history. Regarding the five interpretations, we can conclude that they overlap or even encompass each other. A case in point is the fourth interpretation, following Dillenbourg (2002), in which scripting is a part of structuring, but structuring is something different than regulating. In fact, if we use structuring as an overarching term (fifth interpretation), then all scripting, scaffolding, and regulating is structuring, but not necessarily the other way around. Moreover, all scripting and regulating can be conceived as (part of) structuring, but not all structuring (and regulating) has the characteristics that are attributed to scripting. Finally, in the way that scripting of interactive processes (third interpretation) is typically defined, scaffolding (first interpretation) seems to be an integral part of it. In other words, most definitions of collaboration scripts share the inherent idea that these scaffolds should be removed after a while (and somehow be internalized by the collaborators). However, such a "fading out" principle is not always present in scripting research in the field of CSCL. In all, this multiplex of interpretations of "structuring" clearly signals a future task for the CSCL community to clarify the terminology, for example, in a systematic review.

Regarding the history, the whole idea of structuring—in its broadest sense—of CSCL could be attributed as originating from either scaffolding, scripting (both the O'Donnell and Dansereau (1992) and Schank and Abelson (1977) approach), or from structured interdependence (Aronson & Bridgeman, 1979). However, we

consider it more likely that these developments somehow started independently from each other. Regardless, it is undisputed that in the 1980s and 1990s many structuring approaches were developed. Some have their origins more strongly in social psychology, utilizing group dynamics to foster individual learning, e.g., "Jigsaw" (Aronson & Bridgeman, 1979), "Student Teams Achievement Divisions" (Slavin, 1995), "Learning Together" (Johnson & Johnson, 1994), and the "Structural Approach" (Kagan, 1994); or to foster intrinsic motivation such as the "Group Investigation" approach (Sharan & Sharan, 1992; Sharan, Sharan, & Tan, 2013). Others have their origins more strongly in cognitive psychology emphasizing specific cognitive activities such as elaborating, explaining, and argumentation to foster student learning, e.g., "Scripted Cooperation" (O'Donnell & Dansereau, 1992) and "Complex Instruction" (Cohen, 1994a, 1994b) as well as the research by Webb on "student helping behavior" (e.g., Webb, 1989, 2013). Over time, the central tenet of structuring approaches has transcended these origins and it is nowadays acknowledged that their effects operate on the cognitive, social, and motivational planes of collaborative learning.

2.2 History and Development of Roles

In the broadest sense, a role within a team (or group) can be conceived as a specific (set of) behavior(s) that can be taken up by an individual within a group (Mudrack & Farrell, 1995), and according to Driskell, Driskell, Burke, and Salas (2017), these roles can vary along the dimensions of dominance, sociability, and task orientation. Likewise, within the field of (computer-supported) collaborative learning, roles are always conceived as embedded within the context of the group process, and thus in relation to other individuals and their roles. Such roles can be either specifically assigned to individuals or they can emerge in more naturalistic settings (Strijbos & Weinberger, 2010). When used for structuring collaboration, roles are often (but not necessarily) a specific case of a priori structuring, meaning that the roles are usually assigned in advance to several participants in a group, and roles are more or less well defined (i.e., the activities that should be taken up by the participant who was assigned a role are communicated prior to collaborating).

Assigning roles to students in view of supporting them in their collaboration is not new. As with most pedagogical approaches, it first existed in regular (noncomputer supported) collaboration practices in classroom settings (Cohen, 1994a; Johnson & Johnson, 1994). Assigning roles to structure collaboration did however receive renewed attention when CSCL environments were set up. Cohen (1994a, 1994b) already discussed a number of roles in the context of face-to-face classroom discussions and distinguished between "how" roles and "what" roles. The "how" roles are more general roles indicating how students could tackle a specific collaborative task. Examples of "how" roles are resource person, materials manager, cleanup person, facilitator, reporter, recorder, spokesperson, synthesizer or summarizer, safety officer, and checker (Cohen, 1994a, 1994b; see also De Wever,

Schellens, Van Keer, & Valcke, 2008). The "what" roles are more content-specific roles, indicating what students need to tackle when dividing tasks. Examples of "what" roles in a specific context are camera person, director, storywriter, and actor (De Wever et al., 2008). This distinction is related to the distinction that Strijbos, Martens, Jochems, and Broers (2004b) made in the context of CSCL: they distinguished process-based roles, on the one hand, focusing on individual responsibilities for the coordination of the group process, and content-based roles, on the other hand, focusing on differences in individual responsibility regarding the content and task activities. In a later stage of CSCL research, Wise, Saghafian, and Padmanabhan (2012) suggested in the context of asynchronous discussions to focus on the conversational functions as a conceptual tool for role design. They reviewed role descriptions using the constant comparative method and identified seven functions that roles can fulfill during asynchronous discussions: motivate, give direction, add new ideas, bring in source, use theory, respond, and summarize. It is clear that the use of roles in CSCL research developed over time. In the state of the art below, we discuss the conceptualization of roles in CSCL further, before discussing the effects of roles.

3 State of the Art: What We Know about Roles for Structuring CSCL

3.1 Conceptualization of Roles in CSCL Research

During the past decade, some efforts have been undertaken to conceptualize roles. Strijbos and De Laat (2010) developed a framework to analyze the broad spectrum of available roles in the current literature in CSCL. This framework distinguished roles along three dimensions. The first dimension distinguishes between a priori assigned roles and emergent roles. The former are assigned by a teacher, with the aim to structure the collaborative learning process, while the latter "emerge spontaneously or are negotiated spontaneously by group members without interference by the teacher" (p. 496). The second dimension distinguishes between product-oriented roles and process-oriented roles. Product-oriented roles focus on developing or delivering a (part of a) product or performance, for example, a group member with the role of summarizer writing a summary at the end of a discussion. In contrast, process-oriented roles focus more on facilitating the group processes, for example, a moderator making sure that all group members are encouraged to participate in the discussion. The third dimension concerns the granularity of the role concept, resulting in roles that are conceptualized differently at the micro-, meso-, or macro level. We already briefly introduced these levels at the start of this chapter, but provide some more elaboration in the next paragraph.

At the micro level, roles are conceived as a task and/or a "specified activity focused on the collaborative product or process" (p. 496). Strijbos and De Laat (2010) claim that in most of the CSCL literature roles are essentially made up of single tasks and they attribute this to the fact that the idea of structuring collaboration with the help of roles originated in primary education. At the meso level, roles are conceptualized as multiple tasks focused on the product, process, or a combination of both. At this level, the one-to-one relationship of a role and a specific task is abandoned, and a role can be related to multiple tasks. De Wever et al. (2008) observed that students with a specific role assigned to them comparatively enact the associated role behaviors more often than students who do not have that role, but students also showed behavior that was associated with the other assigned roles in the group. Likewise, Wise et al. (2012) observed in relation to their concept of conversational functions that indeed several of those functions are combined in one role. Finally, roles at the macro level are understood as individuals' participative stances which are behavioral patterns based on their general attitude toward the task and the collaborative learning setting. Strijbos and De Laat (2010) distinguished eight participative stances, depending on the group size (large group vs. small group), students' orientations (individual- vs. Group orientation), and students' effort investment in the collaborative assignment (low vs. high).

Apart from the three dimensions identified by Strijbos and De Laat (2010) and discussed in the first paragraph of this section, there is a fourth dimension that should be considered: the concept of role as a way to induce students to approach a problem by enacting in line with a specific perspective. Such perspective induction is what role-playing typically tries to achieve. For example, Arvaja, Rasku-Puttonen, Häkkinen, and Eteläpelto (2003) used meso-level roles based on occupational or social roles representing a British and Indian society during the nineteenth century. The role-play was for students to study (and experience) imperialism and social status by acting out several distinguished societal roles or occupations. The students chose an occupational or social role and learned about their function and social responsibility before acting them out in the discussion forum. The students composed messages while keeping the perspective of their own role character during that period in history in mind, which prevented, for example, a farmer from contacting a British bishop.

3.2 Effects of Roles in CSCL Research

There is broad consensus that roles (a) raise individual group member's awareness of their own and fellow group member's responsibilities and (b) make an individual's responsibilities toward the group's functioning visible for their fellow group members. As such roles either promote (in the case of a priori assigned roles) or uncover (in the case of emergent roles) the degree to which individual accountability and positive interdependence exist and/or are enacted. The enhanced awareness is more salient when roles are assigned, but in the event that emergent roles become

observable (e.g., with the help of activity and/or behavior visualization) awareness can be enhanced as well. Assigned roles can enhance participation, coordination, performance, and learning, but this depends on the collaborative context and the specific group task at hand.

Earlier research showed that roles certainly can enhance participation and coordination during group projects in online education (Gu, Shao, Guo, & Lim, 2015; Strijbos et al., 2007; Strijbos, Martens, Jochems, & Broers, 2004b). Furthermore, assigning roles to students in collaborative groups has shown to be favorable for enhancing knowledge construction processes with bachelor-level students who were involved in online discussions (Schellens, Van Keer, De Wever, & Valcke, 2007) when compared to collaborative groups of bachelor students without assigned roles. Yet, students' learning benefits can vary according to the enacted role they were assigned. For example, a study comparing the levels of knowledge construction in students' online discussion messages (De Wever, Van Keer, Schellens, & Valcke, 2010b) showed that students with the role of moderator, theoretician, and summarizer reached significantly higher levels of knowledge construction (compared to students in groups without role assignment), whereas this was not the case for students that were assigned the role of starter or source searcher. And while assigning roles was beneficial for enhancing knowledge construction, groups with additional cross-age peer tutor regulation outperformed groups with assigned roles only (De Wever et al., 2010a).

More recently, research of Ouyang and Chang (2019) identified six social participatory emerging roles—i.e., leader, starter, influencer, mediator, regular, and peripheral—that were critical indicators for knowledge inquiry and knowledge construction contributions, namely students enacting the roles of leader, starter, and influencer made more contributions to knowledge inquiry and knowledge construction compared to the other three roles. Regarding motivation, group cohesion, and learning performance, Zheng, Huang, and Yu (2014) compared a condition with assigned roles (i.e., information searcher, explainer, coordinator, and summarizer) with a condition without role assignment and showed that there were significant differences in motivation and task cohesion; however, no significant differences in social cohesion and learning performance were found. In sum, we can conclude that assigned or emergent roles can positively affect both the processes and outcome(s) of (computer-supported) collaborative learning, but there are also no definitive guarantees.

4 The Future: Pedagogical Approaches and Technological Evolutions as Two Tracks for Future Development

Over the past decades, there have been significant advances in the use and refinement of preexisting approaches to structuring group interaction—including roles—as well as understanding their effects in CSCL settings. Likewise, initial steps have been

made to expand our understanding of the nature of assigned and emergent roles, how these can be differentiated, and used to guide the collaborative process. However, notwithstanding these accomplishments, there are in our view two major tracks for future research. First, more insight into the pedagogical approach of roles for structuring collaborative group practices is still wanting. This research can be done both within and outside the field of CSCL; however, we think that research within the field of CSCL can utilize existing technology to assist teachers in the design of structuring in general, as well as in their decisions as to whether and when to assign roles. Second, more insight is needed as to how technology in CSCL environments can be leveraged to automate or facilitate working with roles.

Regarding the first track, the pedagogical approach of roles to structure collaboration, many decisions need to be made by teachers (or instructional designers). We will list some of those here, together with four issues for teachers that we believe are important to further investigate, in order to make more informed decisions on roles in future pedagogical design. The first issue is whether to assign roles a priori or not; and in the latter case, how to deal with emerging roles. When a teacher decides to assign roles, a second issue is at which level the roles need to be introduced, i.e., at the micro-, meso-, or macro level. Thus far, most studies have predominantly focused on one level only—typically the micro level. Hence, future research could investigate whether roles on different levels can be combined; and if so, whether such a combination of levels would require different ways of monitoring and technological support.

A third issue is what kind of roles a teacher can or should assign given the collaborative settings. As argued previously, roles can focus more on the collaborative processes, or on the collaborative product. In addition, roles can also be used to have students adopt different perspectives by introducing role-play. In this respect, more research is needed in view of building a stronger theory for role design and role assignment. While some attempts have been made to conceptualize roles and role assignment (see e.g., Strijbos & De Laat, 2010; Wise et al., 2012), currently, there is no overarching theoretical framework to describe (or even prescribe) the implementation of roles as a way to structure collaboration. Reflecting on our own studies, we noticed that some of the roles we implemented to structure collaboration were based on earlier research evidence and on the techniques described therein. For example, the starter and summarizer role of De Wever et al. (2008) was based on the starter–wrapper technique described by Hara et al. (2000). In contrast, other roles arose from a need to stimulate students in specific activities. For example, the theoretician role of De Wever et al. (2008) was specifically introduced to stimulate activities that would not occur in the unstructured collaborative environment. Likewise, the roles described in Strijbos, Martens, Jochems, and Broers (2004b)—project planner, communicator, editor, and data collector—were partly based on the functional role perspective outlined by Mudrack and Farrell (1995) and on activities that are typical for project work. Some roles in our own studies were thus (initially) in part (or to a considerable extent) based on a combination of existing techniques and frameworks, existing approaches to the structuring of collaboration, and (to some extent) our intuition—rather than extensive research evidence. This is in line with what Hoadley

(Hoadley, 2010, based on Simon, 1969) describes as design science, where designers:

> use processes to solve problems where there is no closed solution. They explore problems as part of solving them, they iterate, and they apply metaknowledge and craft to create solutions that work, even though the science is insufficient to predict the outcomes of the designer's choices (p. 552)

In light of (a) the mix of evidence-based and intuitive design practices, as well as (b) the lack of an overarching design framework, a systematic and integrative review on both the design and effect of roles in (computer-supported) collaborative learning will be highly welcomed.

A fourth pedagogical issue is whether or not roles should be rotated, and if so, when and how. Role rotation means that roles are "rotated" or "switched" between individual participants throughout a group's collaboration. Spada (2010) suggests "that it would not be wise to wait for role rotation to emerge, but instead script the rotation of roles [. . .]" (p. 549). As previously stated, assigning roles can support and stimulate students in undertaking specific activities that they would otherwise not engage in. The moderator role, for instance, is often assigned to ensure that all opinions are heard in online discussions (see e.g., De Wever et al., 2010a). However, assigning roles can also often make students feel uncomfortable, that is, whereas one student may feel empowered by the moderator role and conceive the assigned role as supportive, another student may feel uneasy or anxious when asked to take up such a center-stage role. How assigned roles interact with student characteristics has, thus far, not been given attention in CSCL research. Related considerations are whether students should be assigned roles that they are comfortable with, or whether they should also be forced to take up roles that they are uncomfortable with. The same applies to their level of competence: should students only perform roles they are already competent in (some are born natural leaders), or should they also perform the other roles? Stempfle, Hübner, and Badke-Schaub (2001) showed that roles can be assigned to student software developers to maximize their group performance; but although such performance maximization might mirror the typical role and task distribution in a workplace context, such role assignment also negates learning of roles, tasks, and activities which a student has not yet mastered. These issues are also related to the question whether students can choose the roles that they will perform, whether the roles are simply preassigned by the instructor or the technical system, and whether roles will rotate or not. For answering these questions, more research effort could be devoted to the aim of role assignment in the first place. Are roles assigned to ensure that the collaboration is fluent and the end product meets the required standard? Are roles assigned to ensure that students learn from enacting them? What is the importance of the collaborative and learning processes versus the quality of the final product or outcomes of the group and/or individual group members? Are roles fixed for the entire duration of the collaborative process or will they rotate during the collaboration? Are roles to be faded, and if so, when?

Regarding the second track, how technology in CSCL environments can be leveraged to automate or facilitate working with roles, it is hard to predict what

future technological developments will bring us with respect to roles for structuring collaboration. However, we assume that the evolving technology will at least support teachers, instructional designers, and researchers in view of the pedagogical issues discussed. At a lower level, technology can be preprogrammed to automatically and randomly assign roles to participants in groups, and foster rotation of these roles. If we take asynchronous discussion groups as an example: software could create small groups of five students and assign each student one of five predefined roles, and for example inform them about role rotation after 2 weeks of discussion. Technology could also be used for group formation based on student characteristics. A case in point is the arguegraph script of Dillenbourg and Jermann (2007) in which dyads were automatically formed based on students' answers on a questionnaire that collected students' views on a contentious topic and subsequently grouped two students with opposing views into a dyad.

However, at a higher level, future technological developments could enable more adaptive regulation of collaborative group processes. In this respect, the advancement of learning analytics, in combination with pedagogical design for learning environments, offers interesting opportunities. Automated detection of role behaviors (such as those identified by Wise et al., 2012)—irrespective of whether these behaviors are due to assigned or emergent roles—can be facilitated with the help of dedicated application of network learning analytics to identify (adherence to) role behaviors in online courses (Gasevic, Joksimovic, Eagan, & Shaffer, 2019). This kind of data, extracted from learning analytics, could be directly processed and made immediately available for several purposes. We will briefly discuss four purposes that come to mind.

First, learning analytics can facilitate automatic group formation based on previous behavior in online courses. Thus, instead of group formation based on questionnaires, collaborative groups could be formed based on previous assigned roles and/or the quality of students' enactment of those roles. Second, assigned roles could be rotated based on information from these analytics. For example, students could be instructed to switch roles once the automated analysis showed that each student performed their role well, and thus the learning effect due to role enactment is "saturated" and students can move on to another role. At that time a student could be assigned a role that they had not yet taken up spontaneously, for example, a student who never recapitulated parts of the online discussion could be assigned the role of summarizer. Third, the analytics could be used to stimulate students to enact their role(s) more actively. This could be done at the group level, for example, if no one is summarizing the discussion, the analytics-based agent can remind the entire group that a summary is needed and/or assign the role of summarizer to a group member. At the individual level, an analytics-based agent could remind participants to pay attention to their roles, based on their actual performance. Even just being aware of what the others are doing in a group, might improve group collaboration (see also the group awareness chapter of Buder, Bodemer, & Ogata, this volume). Fourth, the analytics could be visualized to assist teachers, as well as the group and/or individual group members. These visualizations could stimulate students to regulate their behavior, or inform teachers in view of making decisions on role assignment or rotation.

With the rapid expanse of online and distance learning environments, such as Virtual Classrooms, Massive Open Online Courses, or other large-scale collaborations (Chen, Håklev, & Rosé, this volume), and the increased interest in collaborative learning in such settings, roles for structuring collaborations— especially the automated analysis of role behavior in view of developing scalable collaborative learning experiences—may lead to future technological developments. Although learning analytic procedures are promising (Wise, Knight, & Buckingham Shum, this volume), applications of this kind are still in their infancy. Implementing automatic role assignment, role rotation, role stimulation, or role visualization, based on self-reported behavior—such as asking participants to tag their contributions in online discussions (see e.g., Schellens, Van Keer, De Wever, & Valcke, 2009)—is rather straightforward. Doing so on the basis of automated coding of written or spoken discussion contributions and role-based communicative acts therein is one step beyond, although initial steps have been taken in that direction (see e.g., Erkens & Janssen, 2008; Lämsä et al., 2019; Mu, Stegmann, Mayfield, Rosé, & Fischer, 2012). However, for automated analysis of collaborative talk in face-to-face or virtual classrooms, much is yet to be done. Nevertheless, some preliminary analyses showed that prosodic features of talk could be aligned with the content of talk. More specifically, vocal characteristics—such as pitch variation and stress pattern, pausing, tempo, mean pitch and loudness, and vocal quality—could be related to specific types of talk, such as cumulative, promotive, or disputational talk (Hämäläinen, De Wever, Waaramaa, Laukkanen, & Lämsä, 2018), and subsequently related to roles and specific role behavior. While more research into learning analytics and their application to the structuring of collaboration is needed, as well as in relation to roles, in particular, we are confident that current and future technological developments can be leveraged to develop sophisticated support to roles when structuring CSCL.

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Further Readings

De Hei, M., Strijbos, J. W., Sjoer, E., & Admiraal, W. F. (2016). Thematic review of approaches to design group learning activities in higher education: The development of a comprehensive framework. *Educational Research Review, 18*, 33–45. https://doi.org/10.1016/j.edurev.2016.01.001. This paper describes a thematic review on collaborative learning design that resulted in the Group Learning Activities Instructional Design (GLAID) framework, comprising eight components: (1) interaction, (2) learning objectives and outcomes, (3) assessment, (4) task characteristics, (5) structuring, (6) guidance, (7) group constellation, and (8) facilities.

De Wever, B., Schellens, T., Van Keer, H., & Valcke, M. (2008). Structuring asynchronous discussion groups by introducing roles: Do students act in line with assigned roles? *Small Group Research, 39*(6), 770–794. https://doi.org/10.1177/1046496408323227. This study investigated to what extent first-year bachelor students enacted assigned roles (source searcher, theoretician, summarizer, moderator, and starter) in an online asynchronous discussion environment. Quantitative content analysis was applied and the study showed that all participants enacted the roles they were assigned and that they did not neglect other activities while discussing.

Hoadley, C. (2010). Roles, design, and the nature of CSCL. *Computers in Human Behavior, 26*(4), 551–555. https://doi.org/10.1016/j.chb.2009.08.012. This commentary as part of the special issue on "Scripted and emergent roles" (Strijbos & Weinberger), reflects not only on the included studies but also on the concept of roles in general as well as their specific potential as a boundary object for CSCL research.

Strijbos, J. W., & De Laat, M. F. (2010). Developing the role concept for computer-supported collaborative learning: An explorative synthesis. *Computers in Human Behavior, 26*(4), 495–505. https://doi.org/10.1016/j.chb.2009.08.014. This paper reports a framework to synthesize and conceptualize roles, by discerning three dimensions: Assigned versus emergent roles, product-oriented versus process-oriented roles, and the granularity of roles in terms of micro (role as task), meso (role as pattern), and macro (role as stance).

Wise, A. F., Saghafian, M., & Padmanabhan, P. (2012). Towards more precise design guidance: Specifying and testing the functions of assigned student roles in online discussions. *Educational Technology Research and Development, 60*(1), 55–82. https://doi.org/10.1007/s11423-011-9212-7. This paper explored assigned student roles in online discussions and identified a set of seven common functions. Based on this literature review, a targeted set of role descriptions was created, together with a content analysis scheme to assess the fulfillment of the functions. Role assignment was implemented and analyzed in an empirical study.