Scripted and Unscripted Aspects of Creative Work With Knowledge

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Abstract: Advances in scripting theory and advances in support for student-driven knowledge construction call for a reconsideration of long-standing issues of guidance, control, and agency. This symposium undertakes a fresh analysis based on the relations between two widely adopted approaches that may be poles apart but arguably viewed as variations within a common applied epistemological framework. The two approaches are scripted collaboration and Knowledge Building. Rather than focusing on similarities and differences, the symposium will address deeper problems such as reconciling external supports of all kinds with the self-organizing character of knowledge construction and integrating such supports into classrooms viewed as knowledge-creating communities. The centerpiece of the symposium is a panel discussion that includes experts who provide different theoretical viewpoints. In its synthesis the symposium will capture and make sense of what is strongest in the two approaches and provide a broad conceptual basis for next-generation initiatives.

Introduction

In their original formulation of the idea of scripts, Schank and Abelson (1977) defined them as recurrent, conventional, predictable, and relatively fixed patterns of behavior. Early educational applications of scripts stayed close to this conception, emphasizing roles and prescribed behavior associated with those roles (O'Donnell, Dansereau, & Rocklin, 1987). The prescriptive nature of such scripting seemed to put it at odds with constructivist educational approaches that place a premium on student epistemic agency, exploration, and explanation or theory building. In more recent developments, however, concepts of scripts and scripting have broadened to encompass much of what more open educational approaches espouse. In one formulation, "internal collaboration scripts" are taken to include small, reusable pieces of procedural knowledge that can be assembled into novel wholes (Fischer, Kollar, Stegmann, & Wecker, 2013). However, "external collaboration scripts," as used in a variety of applications, continue to have a prescriptive character (King, 2007), although recent work advocates flexible (Dillenbourg & Tchounikine, 2007) and adaptive external scripts (Adamson et al., 2014; Diziol et al., 2010) that seem to resemble much more the notion of scaffolding. Clearly, the relation between scripting, scaffolding, and knowledge construction needs to be examined anew. The self-organizing character of thought and action scarcely entered the discourse of 30 years ago, but it is now a fundamental conception. At the same time, refinements in ways of supporting collaborative knowledge construction and problem solving have cast doubt on the old antinomies regarding structure and agency.

The purpose of this symposium is to have a constructive discussion focused on two educational approaches that from some standpoints are poles apart but that from another viewpoint represent potentially compatible variations within a common applied epistemological framework. The two approaches are scripting, as represented in the "Script Theory of Guidance" (Fischer et al., 2013), and Knowledge Building, as represented in "Knowledge Building: Theory, Pedagogy, and Technology" (Scardamalia & Bereiter, 2014). At a minimum the symposium should develop a new map of the conceptual field taking into account recent conceptual developments in both areas, providing a firmer conceptual foundation for future research. Hopefully the symposium will go beyond this in the direction of an integrative framework to resolve long-standing differences.

Plan of the symposium

The plan of the symposium is to devote the first 25 minutes to introductory comment and two presentations setting forth views on the support of collaborative knowledge construction from the respective standpoints of script theory and knowledge building theory. Following this will be a moderated panel discussion in which the two presenters will be joined by three other participants for a back-and-forth aimed at building upon or resolving issues raised in the initial presentations. The moderator will determine the point at which to open the discussion to the audience, but an expected minimum of 20 minutes will be available for audience participation.

Initial presentations

Frank Fischer and Freydis Vogel

In our presentation from the standpoint of script theory we introduce the development of the understanding of (internal) scripts as rather rigid cognitive structures to the dynamic reconfiguration of its smaller components and how scaffolding or external scripts can be created to support learners regarding the use and development of their internal scripts. The introduction is arranged in four parts that represent the different notions of script theory and its current developments.

In the first part of the presentation, we sketch our view on the development of the script concept from a relatively rigid cognitive structure resulting from repeated encounters with identical and highly similar situations to the current view of scripts as flexibly adaptive support for groups targeted at activating existing internal (cognitive) script components (Schank, 1999; Schank & Abelson, 1977).

In the second part we present a summary of one theoretical model that uses this more recent notion of scripts and scripting, namely the Script Theory of Guidance for computer-supported collaborative learning (SToG, Fischer et al., 2013). With four types of components of internal and external scripts (play, scene, role, and scriptlet) and seven principles, this theory aims at explaining how CSCL practices are shaped by dynamically re-configured internal collaboration script components. It gives answers to the question how internal collaboration scripts develop through participation in CSCL practices. It tries to conceptually link the role of subject matter knowledge and knowledge on collaboration. The theory also suggests that transactive forms of knowledge application will better facilitate learning than non-transactive forms. Further, the theory explains how external collaboration scripts modify CSCL practices and how they influence the development of internal collaboration scripts. The principles specify an optimal scaffolding level for external collaboration scripts and allow for the formulation of hypotheses about the fading of external collaboration scripts. We will report empirical results partly in support of the model, partly challenging some of the principles (Vogel et al., 2016).

In the third part we will apply SToG to explain some phenomena of collaborative knowledge construction. For example, there is a series of experimental studies on facilitating competences of mathematical argumentation. These studies indicate that external collaboration scripts that facilitate transactive argumentation in the process of collaboration have positive effects on social-discursive aspects of the mathematical argumentation skills of the individuals involved (Vogel, Wecker, Kollar, & Fischer, in press). Transactive arguments are arguments that contain ideas that (a) go beyond what is given in the learning environment and (b) build on arguments of the learning partners. This finding can be seen as evidence for the claims that externally scripted environments can indeed facilitate creative and substantive processes and that the stimulated processes are causally related to improved mathematical argumentation skills.

SToG enables predictions with respect to the necessary level of scaffolding for learners with different internal collaboration scripts. The SToG would predict positive effects of even micro-managing the composition of a contribution if it turned out that students cannot access reasonably suitable internal scriptlet components. Furthermore, SToG would predict that removing the few existing scaffolds that are given in Knowledge Building are beneficial for advanced learners. Advanced learners dispose of the respective self-regulation capabilities or in other words, the necessary internal collaboration script components.

In a final part we will address the aspect of flexibility through adaptivity and adaptability of external collaboration scripts and put forward the argument that this flexibility is a defining feature of scaffolding (Dillenbourg & Tchounikine, 2007). Adaptivity refers to the technology diagnosing and adjusting the scaffolding level automatically (e.g. Diziol, Walker, Rummel, & Koedinger, 2010). Adaptability, in contrast, means that the external script can be changed by the learners using it. Both adaptivity and adaptability of external scripts seem to be promising ways to improve learning. While adaptivity needs automatic analysis of learning data in real-time (e.g. Mu, Stegmann, Mayfield, Rosé, & Fischer, 2012; Rosé et al. 2008), the adaptability needs less resources and lets students learn in a more self-regulated way. All means of implementing flexibility to external scripts have the goal to adapt the amount of scripting to the learners' needs

that are related to the development of their internal scripts. Regarding the SToG perspective notion of creating external guidance that is perfectly adapted to the learners' internal scripts, Knowledge Building is in part "under-scripted", meaning that too little external guidance is provided for beginning learners who do not yet have access to productive internal script components because the CSCL activity of Knowledge Building is radically new for many of them. In other parts, Knowledge Building is possibly sometimes "over-scripted" when scaffolding like semantic pointers remain although they are no longer needed. Thus, we will raise the question to what extent flexibly adaptive and adaptable scaffolding could strengthen Knowledge Building. In the first part of the presentation, we sketch our view on the development of the script concept from a relatively rigid cognitive structure resulting from repeated encounters with highly similar situations to the current view of external collaboration scripts as flexibly adaptive group supports facilitating the configuration and re-configuration of networks of existing internal script components.

Carl Bereiter and Marlene Scardamalia

Knowledge Building is a principles-based rather than a procedures-based approach to knowledge construction (Hong & Sullivan, 2007). The need for pedagogical and technological supports for novice knowledge builders is recognized, but care is taken not to undermine such principles as epistemic agency, pervasive knowledge building, collective responsibility for idea improvement, and identification with the worldwide knowledge-creating community (Scardamalia, 2002; Bereiter & Scardamalia, 2014). This means maximizing the intelligence operative among the students in proportion to the intelligence contributed by the teacher and the teacher's tools (of which external scripting would be one kind of tool). The most script-like elements of Knowledge Building technology are what we call "epistemic markers," but which are commonly called "scaffolds," a term also common in the scripting literature. A typical set of markers for theory building includes "My theory," "I need to understand," "A better theory," and "This theory does not explain." Unlike other approaches that use such supports, in Knowledge Building their use is not obligatory and there is no fixed order. Thereby hangs an anecdote that casts an interesting light on the question of whether epistemic markers are a form of scripts. The children in one primary grade class decided they didn't need so many markers, so they reduced them to two—"My theory" and "Did you know"—and these appeared to be working very well. However, the teacher had introduced the students to the distinction between "knowledge telling" and "knowledge transforming" (Scardamalia, Bereiter, & Steinbach, 1984), "knowledge telling" being a composing strategy that outputs topically relevant information without the processing that would have any transforming effect on the writer's personal knowledge. One student remarked that what he and classmates were doing in response to the "Did you know" scaffold was knowledge telling. The others agreed and they proceeded to restore the epistemic markers that signaled a more serious effort at theory building. If this is to be called scripting, then we need to consider the possibility of students scripting their own collaborative behavior and that this sort of action could be an important step toward full competence in collaborative knowledge building. Despite their being optional, students use them, partly because the technology provides an easy way to insert them in text, just by clicking on the item. In this sense they are more like having a personal scribe than a script, and they remain useful, becoming part of the vocabulary students use in their collaborative work, whether online or in oral conversation. They can be revised or turned off by the teacher or students as a collective decision. The epistemic markers, however, are only one element in an epistemically rich environment that Knowledge Building teachers have been able to foster—even in kindergarten, where there is no Knowledge Forum and no epistemic markers. Other important elements of an epistemically rich environment are knowledge-building concepts such as building on, rising above, explaining, and idea improvement. Young students initially understand these in very limited ways, but gradually, through their own knowledge building efforts and with help from their teachers and peers, the concepts take on fuller meaning and become not just supports for action but part of how they see the world, part of their culture. Consistent with this expectation, a comparative experiment showed that students engaged in Knowledge Building gain better understanding of the nature of science than students pursuing more guided inquiry (Chuy, et al., 2010).

Knowledge Building, like knowledge creation in general, achieves its objectives mainly through what is coming to be called "design thinking," a generalization of the kind of thinking that goes on in creative design groups such as Ideo (Brown, 2009). This is in contrast to what may be called analytical/evaluative thinking (Martin, 2009), which has been the prevailing form of thought in formal education since ancient times. Analytical/evaluative thinking has a role to play in knowledge advancement, but it does not generally produce new knowledge—theories, inventions, problem solutions, and the like. Its main function is assessing the validity of knowledge claims.

Analytical/evaluative thinking is eminently scriptable, as witness the abundant work on scripting argumentation (Andriessen, Baker, & Suthers, 2003). One can find on the Web efforts to script design thinking,

but they are not very impressive. Design thinking is a self-organizing process par excellence (with explanation building or theory building as one type of it especially relevant in education). Its products are emergents, not predictable from their constituent elements. If we are serious about students being genuine creators of knowledge and not just play-acting the roles of scientists and other knowledge creators, then the education system must find ways to support design thinking—not only in the arts and engineering, where design thinking more or less comes with the territory, but also in core work with the "big ideas" of the disciplines. This is a new challenge for educators—a distinctly 21st century challenge. There are no doubt teachable elements, which may be treated as reusable components of internal scripts. But when it comes to external scripting, there is a danger that the kinds of scripts that work for argumentative evaluation of knowledge claims will be heedlessly applied to design thinking, with potentially stultifying effects. One type of support for Knowledge Building that is currently under active development and showing great promise is feedback tools students themselves can use to assess progress at the group level and to identify shortcomings—for instance a domain vocabulary tool that allows students to compare the vocabulary used in their discussion with the vocabulary used by experts discussing the same topic and another tool that graphs frequency of use of the various epistemic markers (Resendes, Scardamalia, Bereiter, Chen, & Halewood, 2015). These supports are obviously not scripts, although the use students make of them is potentially scriptable. But is that necessary or desirable?

The crucial role of the teacher in Knowledge Building is community development. All teachers devote effort to community development and are often very effective at it. The particular challenge, however, is building a community organized around the collective development of community knowledge. This is something beyond organizing for collaborative pursuit of individual learning goals. It is comparable to the effort of progressive disciplines of all sorts to advance the state of knowledge in their domains. Experienced Knowledge Building teachers tell us that it can take upwards of half a year to build such a community from scratch, but that it is worth the effort because once it is achieved the community has its own dynamic of advancing knowledge frontiers and the teacher does not have to work constantly to make it happen; benefits are exponential if the teacher does not need to start from scratch each year. But are we talking about students internalizing a knowledge-creating script? This is an interesting question to explore, but we sense that scripts are not the most informative way to look at what goes on. Concepts such as ethos, values, self-identity, and community-level goals seem to get closer to the heart of the educational challenge.

We suggest that the relation between Knowledge Building and scripting be thought of as consisting of two diverging paths of support for students' thinking. At the lowest level of support, common to both paths, are what may be described most simply as reminders—epitomized by IBM's famous motto, "THINK," and Apple's more recent "think different." It is assumed that users already understand and appreciate these injunctions but can benefit from being reminded of them. One path of increasing support leads in the direction of algorithms, that is to say rule-based systems, as epitomized in John Anderson's (1993) *Rules of the Mind*. Various levels of scripting may be found along this path, though generally stopping short of full embodiment of a production system. The other path leads in the direction of self-organizing group knowledge-creating processes fostered through support for increasingly complex forms of interaction and feedback, including for example visualizations of epistemic markers used in the discourse and multiple visualizations to help participants criss-crossing the landscape of their ideas (Scardamalia & Bereiter. 2016).

Panel discussion participants

The moderator will steer the participants toward highly interactive discussion related to ideas and issues raised in the presentations and away from separate presentation of prepared remarks. Participants are:

Ulrike Cress (moderator). Since 2008 Ulrike Cress is Professor of the University Tuebingen and since 2017 she is also Director of the Leibniz-Institut für Wissensmedien (Knowledge Media Research Center) in Tuebingen. She works on mass collaboration and knowledge creation with social media. In her work (Cress & Kimmerle, 2008, 2017) she aims to combine different methodological approaches (experiments; big data studies; discourse analysis) and she links different theoretical perspectives (information-processing perspective, socio-cultural perspective). This makes her a boundary spanner between the different poles the symposion deals with.

Carl Bereiter is one of the originators of Knowledge Building as an educational approach and has been active in research related to it and to supportive technology design. His particular interest has been in the epistemological aspects of knowledge production (Bereiter, 2002, 2014, 2016).

Frank Fischer co-developed the Script Theory of Guidance for CSCL (Fischer et al., 2013; Stegmann et al., 2016) and has been involved in experimental field and laboratory studies on collaborative learning with a focus on facilitating scientific reasoning and argumentation. In collaboration with Carolyn Rosé he has also

explored ways to automatically analyse argumentation (Rosé et al., 2008; Mu et al., 2012) to enable flexible scripting.

Kai Hakkarainen has studied technology-mediated learning more than two decades. He has developed a knowledge-creating learning framework that integrates knowledge building and activity theory (Paavola & Hakkarainen, 2014; Paavola, Lipponen, & Hakkarainen, 2004). His work on "knowledge practice" deals with relations between knowledge building and social practices (Hakkarainen, 2009).

Marlene Scardamalia invented CSILE, the first networked collaborative learning environment and is active in all aspects of research on Knowledge Building and Knowledge Building technology. As holder of the Presidents' Chair in Learning and Knowledge Technology at the University of Toronto, she has led an international network of researchers and innovators in education devoted to extending the limits of the possible in students' functioning as knowledge-creating communities.

Freydis Vogel, in her research, is concerned with scripts for computer-supported learning since 2009 and conducted a series of studies about argumentation scripts in the context of mathematics (Kollar et al. 2014, Vogel et al. 2016). She also co-authored the first meta-analysis about computer-supported collaboration scripts (Vogel, Wecker, Kollar, & Fischer, 2016). Her future research plans are to follow the question how learning with scripts can be designed in a way that it supports and demands more self-regulated learning.

The moderator will determine when to open the discussion to audience participation, based on progress being made in the panel discussion and on signs of audience interest. It is assumed that the topic of the symposium and the contrasting positions will generate enough audience interest that it will not be necessary to pose issues for discussion.

Key issues

The following are issues raised in the prepared presentations that are expected to be further developed through the panel discussion and audience input:

- Does script theory encompass all forms of external support for knowledge construction? If not, what are unscripted supports?
- If knowledge construction is a self-organizing process at both individual cognitive and at collaborative group levels, what implications does this have for the design of external supports and supportive environments? What kinds of flexible/open structuring can provide needed support for engaging students in authentic scientific inquiries and design practices while maintaining openness to emergence?
- Is it realistic to empower students to collectively design their own scripts or other forms of support?
- Is the production of public or community knowledge (the kind of thing mature research teams do) a viable objective for the school curriculum? If so, how does it fit with objectives framed in terms of individual knowledge and skills?
- In the development of community ethos, norms, and identity, what are potentially scriptable and unscriptable aspects?
- What is the place in collaborative knowledge construction of group level assessment (of discussion quality, for instance, or the state of intellectual and disciplinary norms) as distinct from assessment at the individual level? Does this have implications for the use of more prescriptive forms of support?
- To the extent that there is a fundamental difference between the approaches discussed in this symposium, what does this mean for educational policy? In particular, what does it mean for the popular belief that a more highly structured or guided approach is needed for certain types of students while others may profit from a less regulated approach?

Significance of the symposium for the CSCL community and the CSCL 2017 theme

In recent years both scripting and Knowledge Building have had a substantial presence in CSCL and ISLS meetings and publications. Both, moreover, have enjoyed an expanding influence in educational practice. They have, however, tended to occupy separate universes, with their own vocabularies and knowledge claims. Their differences could be matter for a lively debate. However, on the basis of informal discussion, the applicants have felt that there is enough common ground to justify a symposium focusing our diverse views on issues that underlie all efforts to promote collaborative knowledge construction. The issues briefly itemized in this proposal are ones that go to the heart of what CSCL and collaborative knowledge construction are about. The issues are

also relevant at a deep level to the conference theme of "prioritizing equity and access." It would be easy to conclude, and many educators may already have concluded, that scripting is best for the academically less prepared students and Knowledge Building is appropriate for the more advanced. This would be an unfortunate resolution from the standpoints of both approaches. To go beyond such over-simplification, to provide an education that is accessible to all yet does not exclude some students from the opportunity to become full members of a knowledge society, a convincing and realistic resolution is need of the issues that are the focus of this symposium.

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