



Tracing knowledge co-evolution in a realistic course setting: A wiki-based field experiment



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ABSTRACT

The co-evolution model of collaborative knowledge building by Cress and Kimmerle (2008) assumes that cognitive and social processes interact when users build knowledge with shared digital artifacts. While these assumptions have been tested in various lab experiments, a test under natural field conditions in educational settings has not been conducted. Here, we present a field experiment where we triggered knowledge co-evolution in an accommodation and an assimilation condition, and measured effects on student knowledge building outside the laboratory in the context of two university courses. Therefore, 48 students received different kinds of prompts that triggered external accommodation and assimilation while writing a wiki text. Knowledge building was measured with a content analysis of the students' texts and comments (externalization), and with concept maps and association tests (internalization). The findings reveal that (a) different modes of externalization (accommodation and assimilation) could be triggered with prompts, (b) across both conditions, this externalization co-occurred with internalization (student learning), and (c) there is some evidence that external assimilation and accommodation had differential effects on internal assimilation and accommodation. Thus, the field experiment supports the assumptions of the co-evolution model in a realistic course setting. On a more general note, the study provides an example of how wikis can be used successfully for collaborative knowledge building within educational contexts.

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1. Introduction

Social media, such as wikis, weblogs or social networking tools have been widely used to support learning in educational settings (Alexander, 2006; Bennett, Bishop, Dalgarno, Waycott, & Kennedy, 2012; Bonderup Dohn, 2009; Dron, 2007; Kang & Glassmann, 2011). In particular, there is great potential to employ social media for collaborative knowledge building (Scardamalia & Bereiter, 1994), a form of learning that stresses the active, social and constructive character of learning (Cacciamani, Cesareni, Martini, Ferrini, & Fujita, 2012; Larusson & Alterman, 2009). Specifically, wikis have been popular means to apply novel teaching methods in classrooms (e.g., Barry, 2012; Biasutti, 2011; Everett, 2011; Heafner & Friedman, 2008; Ioannou, 2011; Larusson & Alterman, 2009; Naismith, Lee, & Pilkington, 2011; Pifarré & Kleine Staarman, 2011; Wheeler, Yeomans, & Wheeler, 2008), albeit with mixed success (Cole, 2009).

To describe social and cognitive processes that take place during collaborative knowledge building with shared digital artifacts such as wikis, Cress and Kimmerle (2008; see also Kimmerle, Cress, & Held, 2010) suggested a co-evolution model. The basic assumption of the co-evolution model is that individual cognitive structures co-evolve with the information that is documented in a shared digital artifact. The cognitive structures are modified as a result of internalization of knowledge (by processing information from the shared artifact), and the information that is documented in the shared artifact is modified through externalization of knowledge (from the cognitive system). While in knowledge building research significant theoretical (e.g., Stahl, 2002) and methodological (e.g., Suthers, Dwyer, Medina, & Vatrappu, 2010; Suthers &

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Medina, 2011) progress has been made in looking at artifact-mediated collaborative learning processes in the field of educational practice, the co-evolution model offers a distinct contribution in that it looks at how cognitive and social processes mutually influence each other.

The co-evolution model has been developed based on exploratory evidence from the online-encyclopedia Wikipedia (Cress & Kimmerle, 2008; Kimmerle, Moskaliuk, Bientzle, Thiel, & Cress, 2012), and has since provided the basis for a number of experiments under laboratory conditions (e.g., Kimmerle, Moskaliuk, & Cress, 2011; Ley, Schweiger, & Seitzinger, 2011; Moskaliuk, Kimmerle, & Cress, 2009, 2012). However, to investigate the interplay of cognitive and social processes, a setting is needed that allows collaborative growth and development of knowledge to emerge naturally from a social, artifact-mediated interaction. Therefore, the aim of this paper was to investigate knowledge co-evolution in a realistic course setting in an educational context. In such a setting and in the context of students' typical learning activities, would it be possible to trigger external accommodation and assimilation (in the wiki)? And, if so, what would be the effect on the internalization that would take place (in the cognitive systems of the individuals)?

To answer these questions, we designed a rigorous field experiment and compared an accommodation and an assimilation condition. We gave learners the opportunity to interact with each other over a two week period in a relatively unconstrained manner. The experiment was part of two university courses where dyads of students had to accomplish a collaborative wiki writing task during two weeks allowing us to trace co-evolution in a realistic field setting. We expected that students in the accommodation condition would show more external accommodation than students in the assimilation condition, and vice versa. Following the assumptions of the co-evolution model, this should also have an impact on the internalization of knowledge: different forms of externalization should co-occur with different forms of internalization.

The paper is organized as follows. We briefly introduce the co-evolution model and present findings from previous studies. We then highlight challenges for measuring external and internal accommodation and assimilation, especially in a realistic educational setting in the field, and suggest approaches to tackle these challenges. Afterwards, we present the experimental setup, methods and operationalizations, and report the findings separately for externalization and internalization processes. We then draw conclusions on the co-evolution model and our methodology, and discuss pedagogical implications of our work.

2. The co-evolution model of knowledge building

2.1. Basic assumptions of the co-evolution model

Following a constructivist tradition, the co-evolution model suggested by Cress and Kimmerle (2008) posits learning as an active construction of knowledge. The co-evolution model builds on Luhmann's system theory of social systems (1995), and views individual learning and collaborative knowledge building (e.g., Scardamalia & Bereiter, 1994) as two interrelated processes: When people construct knowledge through shared digital artifacts, individual learning processes mutually influence each other (see also Kafai, 2005; Scardamalia & Bereiter, 1994). One main assumption of the co-evolution model is that knowledge documented in the artifact co-evolves with knowledge in the cognitive systems of the individual contributors.

Internalization and externalization, then, build the basis for the co-evolution of knowledge. Externalization is the activity by which people communicate their knowledge; that is, they introduce some information that corresponds to what they know into the shared digital artifact. Internalization is a cognitive activity by which people process information from the shared artifact, and as a result integrate some new pieces of information into their own cognitive structures; that is, they learn. Applying Piaget's (1977, cf. Miller, 2010) ideas to the co-evolution model has led to its second main assumption: According to Piaget, individual learning is triggered by a cognitive conflict that results from an incongruity of information encountered in the external world and the prior knowledge of a person. To resolve the cognitive conflict, individuals may either assimilate new information to any prior knowledge, or they may modify some existing knowledge to accommodate new insights. The co-evolution model assumes that this distinction of cognitive processes (i.e., during internalization) can similarly be observed in the process of externalization: External assimilation occurs when information is introduced into an artifact (e.g., a wiki article) that does not change the organization of the artifact, its structure and general line of argumentation. External accommodation takes place when the organization of the artifact is changed to accommodate the newly introduced information, for example, by integrating information which modifies, improves or corrects the argumentation (see also Majchrzak, Wagner, & Yates, 2006).

The co-evolution model assumes that accommodation and assimilation both occur within the cognitive system, as well as in the artifact that is collaboratively created by users of the social software. Similar arguments have been made by Fu (2008) who assumes that artifacts created in the use of social software can lead to changes in cognitive schemas.

2.2. Field evidence of the co-evolution model

The development of the co-evolution model was based on exploratory field evidence (Cress & Kimmerle, 2008; Kimmerle, Moskaliuk, Harrer, & Cress, 2010; Kimmerle et al., 2012). Cress and Kimmerle (2008) analyzed external assimilation and accommodation within two articles of the online-encyclopedia Wikipedia. They compared different versions of the text to illustrate the development of a text from a first idea that was brought in, reformulated and finally integrated in the text. Methods based on social network analysis (e.g., Wasserman & Faust, 1994) were also used to examine the mutual development of cognitive and social systems. In another exploratory study, Kimmerle et al. (2010) analyzed a set of Wikipedia articles and described the development of the artifact network. They found a similar development of the authors' clustering (derived from a content analysis of the articles they were working on) and the clustering of the network (measured by the link-structure of the network), and interpreted their findings as indicators for the mutual development of the cognitive system of the authors and the artifact network. Because the study was based on an analysis of modifications of 'real' Wikipedia articles, a limitation of these findings is that no direct measure of internalized knowledge could be employed.

2.3. Laboratory studies building on the co-evolution model

The limitation of directly measuring internalized knowledge has been overcome in several empirical investigations under laboratory conditions to understand the mechanisms of co-evolution. Kimmerle et al. (2011), Moskaliuk et al. (2009), and Moskaliuk et al. (2012)

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