



How patterns support computer-mediated exchange of knowledge-in-use



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ABSTRACT

In times of knowledge exchange across geographical and temporal borders, the question arises as to how not only explicit or factual knowledge can be exchanged over distance, but also knowledge-in-use, with its high amount of tacit knowledge. This article introduces patterns as an established method for supporting the exchange of this knowledge-in-use. We first provide a theoretical basis for our assumption that patterns facilitate the exchange of knowledge-in-use, because they are *external* representations that are highly analog to people's *internal* knowledge representation.

We then present two experiments testing this assumption: A field study with practitioners ($n = 46$) who had accumulated experiential knowledge-in-use over a period of several years, and a laboratory study ($n = 61$) where the students acquired knowledge-in-use during a standard learning period. Both experiments support the hypothesis that patterns facilitate the externalization of knowledge-in-use. With patterns, users described more solution-relevant features of a problem and focused more on abstract features of a solution than participants who explained their experiences without a pattern.

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1. Introduction

Over the last several years technological innovations, and especially the use of social software, have changed education a lot. It is becoming more and more obvious that people do not just learn in formal courses at schools or universities, where teachers directly instruct students. Education and knowledge acquisition also take place when people participate in communities and social networks (Dede, 2004; Hsu, Ju, Yen, & Chang, 2007; Junco, 2012; Scherer Bassani, 2011; Yang & Chen, 2008), exchange their experiences in forums (Blooma, Kurian, Chua, Goh, & Lien, 2013; Wachter, Gupta, & Quaddus, 2000; Watabe, Hamalainen, & Whinston, 1995), wikis (Kump, Moskaliuk, Dennerlein, & Ley, 2013; Moskaliuk, Kimmerle, & Cress, 2012) or databases (Cress, Barquero, Schwan, & Hesse, 2007; Cress, Held, & Kimmerle, 2013; Schwind, Buder, Cress, & Hesse, 2012). In such informal settings students and practitioners increase their knowledge and skills and swap ideas with other participants.

Most studies about learning in these informal settings take into consideration the exchange of explicit knowledge. But what seems to be at least as important is the exchange of personal experiences, or the exchange of *how* to perform an activity. In the *AP teacher community* (a community of teachers for courses that offer college-level curriculum and examinations to high school students in the United States) (<http://www.apcommunity.collegeboard.org>) or in *TeachQuest* (<http://www.teachquest.com>) for instance, teachers discuss their teaching strategies and lesson plans online with their mentors, share their experiences and materials and can connect themselves with other practitioners (Lin, Lin, & Huang, 2008; Matzat, 2013).

Such *knowledge-in-use* (de Jong & Ferguson-Hessler, 1996) is embedded in daily experience (cf. Greeno, 1998). It can be characterized as being a combination of declarative knowledge and procedural knowledge (see e.g. Bereiter (2013) who makes the same point about, as he names it, principled practical knowledge). That is, knowledge-in-use contains both knowledge about facts and terms that can easily be externalized and knowledge that is much more difficult to externalize, since it is mainly tacit (Polanyi, 1966) and is used unconsciously and automatically (Anderson, 1983; Smith, 2001).

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That means that in order to ensure effective and permanent communication, exchanging personal experiences *over distance* needs special support for externalizing the tacit parts of knowledge-in-use. Our main hypothesis is that patterns, as they first were described by Alexander, Ishikawa, and Silverstein (1977) and then taken up by others, provide this kind of support. We assume that they provide external structures that are highly analogous to the internal representation of knowledge in human memory (Kohls & Scheiter, 2008; Wodzicki, Moskaliuk, & Cress, 2011).

In the following we first describe what patterns are. We then present two experiments that investigate in detail how patterns support the externalization of knowledge-in-use. Experiment 1 was conducted as a field-study with participants who had to externalize knowledge-in-use they had acquired during their own work practice over a period of several years. Experiment 2 was conducted in a laboratory setting with participants who acquired knowledge-in-use just during the experiment. This enabled us to reexamine the results we had gained in the field. So the two experiments cover both a situation where people are heterogeneous with regard to their level of expertise and a situation in the laboratory, where everything is controlled and people differ only with regard to the use of patterns. Because of their experimental design (which compares groups with and without pattern) these studies are the first to provide causal evidence for the effect of patterns.

2. Patterns as external representation of knowledge-in-use

The use of patterns was first described by Alexander et al. (1977) for knowledge transfer in the area of architecture, and then taken up by many other researchers in several domains (Avgeriou, Papasalouros, Retalis, & Skordalakis, 2003; Beck & Cunningham, 1987; Carroll & Farooq, 2007; Derntl & Motschnig-Pitrik, 2005; Frauenberger & Stockmann, 2009; Gamma, Helm, Johnson, & Vlissides, 1995; Goodyear et al., 2004; Köhne, 2005; Manns & Rising, 2005; Matschke, Moskaliuk, Arnold & Cress, 2010; May & Taylor, 2003; Wedekind, 2011; Wodzicki et al., 2011). Generally speaking, a pattern provides a structure that supports users in externalizing their knowledge-in-use and in collecting the knowledge of practitioners, based on proven solutions for recurring problems. A pattern forces users to structure their own individual contributions into pre-defined categories, with the aim of stimulating abstraction. That is, “each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million time times over, without ever doing it the same way twice” (Alexander et al., 1977, preface pp. x). Thus, patterns contain problem–solutions pairs that are abstracted from individual cases and that include the invariant aspects of a solution relevant for all problems of one class (Frauenberger & Stockmann, 2009; Kohls & Scheiter, 2008; Kohls & Uttecht, 2009; Wodzicki et al., 2011). In its basic form, a pattern describes the *problem* which occurred, the associated *solution* that proved successful, the *situation* in which the solution may be useful and *forces* which contain competing requirements that influence the solution of the problem (Alexander et al., 1977). Many patterns also provide concrete *examples* from real life to illustrate and clarify the invariant aspects of different cases. Coherent patterns that generate an interconnected set which is used to solve problems in a specific problem domain are called a *pattern language* (Kolfshoten, Lukosch, Verbraeck, Valentin, & Vreede, 2010; Lukosch & Schümmer, 2006; Manns & Rising, 2005). Fig. 1 shows an example of a pattern structure. The pattern structure serves as an input-format for a repository. Thus the pattern and the repository provide an example for a pattern-based knowledge exchange (see also Matschke, Moskaliuk, & Cress, 2012).

<p>NAME: SUNDAY SCHOOL FOR NEXT SUNDAY</p> <p>SITUATION Sunday school that happens weekly, attended by (on average) ten kids. The age range run from eight to 12 years. Especialness: For some time past, kids from Spain attend as well. We do not know anything about their German language skills.</p> <p>DIFFICULTIES The kids from Spain would be excluded from a large part of the service, if they do not understand or speak German. With kids at that age we often have the problem that they cannot listen and sit still until the end of a longer story. The age difference between the children could be a problem as the younger ones may do not understand the story but the older ones are bored.</p> <p>ORGANIZATION OF THE SUNDAY SCHOOL <i>Starting:</i> - After welcoming we can dance so that all kids can participate. - To facilitate the Spanish Kids the integration into the group, we can also play an icebreaker. In this way, all kids perceive each other with their names. - Short psalm verse, the kids join in. <i>Proclamation part:</i> -The story for this Sunday is being told. We consciously take care to formulate it with words suitable for children. To elaborate the story, the kids should re-enact the story after listening (speechless, only with gesture). <i>Terminal element:</i> -A song capture the story once more. - Rogation, the kids are included through repeating out loud. - Lord's Prayer with motions. - Farewell.</p>
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Fig. 1. Example of a pattern from a participant (subject 2) of the field study about organizing a Sunday school.

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