The Journal of Systems and Software 82 (2009) 553–562

Contents lists available at ScienceDirect

The Journal of Systems and Software

journal homepage: www.elsevier.com/locate/jss

Using Wikis to support the Net Generation in improving knowledge acquisition in capstone projects

Eric Ras *, Jörg Rech

Fraunhofer Institute for Experimental Software Engineering, Fraunhofer-Platz 1, 67663 Kaiserslautern, Germany

ARTICLE INFO

Article history:
Received 5 August 2008
Received in revised form 1 December 2008
Accepted 27 December 2008
Available online 6 January 2009

Keywords:
Net Generation
Software engineering education
Capstone project
Web 2.0
Learning space
Knowledge acquisition

ABSTRACT

Students have to cope with new technologies, changing environments, and conflicting changes in capstone projects. They often lack practical experience, which might lead to failing to achieve a project's learning goals. In addition, the Net Generation students put new requirements upon software engineering education because they are digitally literate, always connected to the Internet and their social networks. They react fast and multitask, prefer an experimental working approach, are communicative, and need personalized learning and working environments. Reusing experiences from other students provides a first step towards building up practical knowledge and implementing experiential learning in higher education. In order to further improve knowledge acquisition during experience reuse, we present an approach based on Web 2.0 technologies that generates so-called learning spaces. This approach automatically enriches experiences with additional learning content and contextual information. To evaluate our approach, we conducted a controlled experiment, which showed a statistically significant improvement for knowledge acquisition of 204% compared to conventional experience descriptions. From a technical perspective, the approach provides a good basis for future applications that support learning at the workplace in academia and industry for the Net Generation.

1. Introduction

Professional software engineers are constantly faced with having to cope with ever-changing technologies, along with the need to keep their knowledge up to date. These changes, the short innovation cycles, and the fact that software engineering is a knowledge-intensive activity lead to many learning situations where new knowledge is required to solve the challenges and problems at hand. Furthermore, in practice learning, is less a reaction to 'being learned' but more the reaction to a variety of working situations and related problem-solving activities, which requires experience-based learning. Today, most software engineers are from the *Baby Boomers* generation (born 1946–1964) and from *Generation X* (born 1965–1980).

The Net Generation (born 1981–1994) differs from the previous generations in terms of commitment, interaction, and learning style and hence puts new challenges upon education and the usage of technology (Prensky, 2001). They have never known a world without computers, the WWW, interactive video games, MP3s, PDAs, and cellular phones. These technologies are internalized by this generation and shape the way they access and use information, as well as how they communicate. Prensky calls them "digital natives," referring to the fact that they have grown up with technology (Prensky, 2001).

In almost every software engineering curriculum, a capstone course is a mandatory curriculum component. Educational research in this domain has shown that practicing the learned methods and techniques is essential before the students get involved in industrial software development projects. Shaw et al., also stated the importance of practicing what was learned as a core pedagogical principle of software engineering education (Shaw et al., 2006). However, many capstone projects risk overloading students because they get overwhelmed with too many new topics, have to understand the different roles and responsibilities assigned, and must cope with a changing environment (e.g., software requirements). Teachers want to provide realistic projects and conflicting situations as they happen in the real world to prepare students for their jobs (Burnell et al., 2002). During capstone projects at the University of Kaiserslautern, we, too, made the experience that most students lack practical experience in software engineering.

In order to address the lack of practical experience, we started to let students gather their observations and experiences during the capstone project in an adapted Wiki-based system called Software Organization Platform (SOP), while keeping the characteristics of the Net Generation in mind. SOP has also been used for project management and requirements engineering as well as

* Corresponding author. Tel.: +49 (0) 631 6800 2141; fax: +49 (0) 631 6800 1599.
E-mail addresses: Eric.Ras@iese.fraunhofer.de (E. Ras), Joerg.Rech@iese.fraunhofer.de (J. Rech).

0164-1212/$ - see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.jss.2008.12.039

for the coordination of development tasks in capstone projects (Decker et al., 2007; Ras et al., 2007). In this platform inspired by the concept of the Experience Factory (Basili et al., 1994), experiences are consolidated by the teachers and fed back into future capstone projects in the following year. Nevertheless, the success of reusing experiences was reduced because of two central problems:

Bad understanding of reusable artifacts and experience packages: Understanding is a crucial component of successful reuse and the level of understanding impacts all phases of reuse. However, badly described experiences and their related context leads to bad understandability and applicability of the documented experience, and hence to low perceived information quality. In addition, no adequate support for improving understanding is available in software engineering reuse.
No explicit support for internalization of knowledge: Much R&D effort has been spent in the "upward, externalizing" direction, looking for valid experiences that can be formalized, generalized, and tailored. However, the hard part is the "downward, internalizing" direction. Current KM and EM approaches focus mainly on the product of learning and less on the learning processes themselves and on the needs of individuals. Most approaches transfer knowledge by using the "copy model", i.e., no adaptation of the information and structures takes place when expert knowledge is transferred – it is transferred as documented by experts. Furthermore, novices lack background knowledge and their knowledge is organized differently than the "routine" knowledge of experts. Hence, the copy model does not comply with the structures and processes of human information processing.

A more detailed summary of problems related to understanding and learning from documented experience can be found, for example, in Ras and Weibelzahl (2004) and Rech et al. (2007).

This paper first describes the characteristics of the Net Generation and shows which Web 2.0 technologies are compliant with these characteristics and could support the Net Generation in their daily activities (Section 2). Based on this mapping, the selection of the Wiki-based Software Organization Platform (SOP) is motivated. Section 3 presents the core features of the Wiki-based approach for generating so-called learning spaces. The approach supports learning at the workplace through the context-aware generation of learning spaces from previously developed learning content with collaboratively developed documents and experience descriptions. These learning spaces are intended to enhance the internalization of knowledge and are created based on context information from the experience package and information about the current situation. Section 4 explains the design and results of an experiment that was used to evaluate our approach, while Section 5 concludes the paper.

2. Background

Oblinger and Oblinger state that the Net Generation learns by doing and uses computers and the latest in technology in their class work and in their hobbies. They have a wide range of interests, outside their chosen area of study (Oblinger and Oblinger, 2005). Net Generation students are encouraged by the information technology and resources at their disposal. They are social and like to work in teams – the Internet becomes their vehicle of interaction. They are able to perform multitasking in a goal-oriented manner, and follow an immediate "let's build it" approach (Rickard and Oblinger, 2003).

2.1. Characteristics of the Net Generation

In the following, the main characteristics of the Net Generation are listed:

C1—Digitally literate: having grown up with widespread access to technology, the Net Generation is able to intuitively use a variety of information technology devices as well as the Internet (Oblinger and Oblinger, 2005). These technologies are omnipresent and are internalized by the students. The technologies shape the way of how information is created, structured, and disseminated and how social networks are built (see the next section about how the Net Generation perceives technology in general.)
C2—Connected: "as long as they've been alive, the world has been a connected place, and more than any preceding generation they have seized on the potential of networked media" (Crittenden, 2002). Of course this means that any kind of information is always accessible, that students have the possibility to stay up-to-date, and that they are part of a social network at any time.
C3—Immediate: the Net Generation is fast and concentrates more on speed than on accuracy. They multitask and are able to move quickly from one activity to another. The response times are short (e.g., answering to an instance message). They are more used to switch contexts compared to the previous generations.
C4—Experimental: most Net Generation learners prefer learning by doing rather by being told what to do. They best learn experientially and prefer the "let's build it approach" (Rickard and Oblinger, 2003). This implies that they follow a more practical approach and not a theory-based approach to learning and working.
C5—Communicative: the Net Generation is very communicative because they like interaction and collaboration. They like to build social networks and work in teams. The Net Generation uses technology extensively to network and socialize (Oblinger and Oblinger, 2005). Open content and open source technologies enable seamless information sharing, collaborative integration of tools, shared creation of media, and collective critiquing and judging.
C6 — Personalized: the Net Generation students demand personalized services on the one hand and like to personalize their environment by means of a right set of options on the other hand (e.g., according to interests, personal targets, or preferences such as the presentation of contents, the desired way of navigating through the learning contents, or the learning style) – a one-size-fit all education will not address their individual preferences and needs. They prefer flexible guidance in education. The personalization is guided by the students and not by the technology.
It can be seen, that the characteristics mesh very closely with the information technologies that increase mobility, their 24/7 availability, and their value as a communication medium. Hence, based on these characteristics, what are the implications for the classroom and the overall learning environment in software engineering education?

It is wrong to assume that Net Generation students prefer mediated interaction and online courses and that they want to use technologies heavily in their education because they grew up with computers and the Internet. Based on the study by Roberts (2005), this is wrong: They like face-to-face social interaction with their peers. While they may use technology in their daily lives, relationships are a driving force in the learning process. Also, Oblinger and