The wiki as an integrative tool in project work

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Abstract. The paper provides insights on how wikis support project work and what characteristics of wikis make them adequate for this purpose. The findings are based on a case study of software engineering projects in an educational setting. Project wikis are found to serve an integrative role along several dimensions of project work, enabled by the flexibility and automatic support for capturing history offered by the technology. The findings demonstrate that a project wiki can serve as a knowledge repository, a means for staging the project, a coordination mechanism, and a shared workspace. To many projects in need of project management and collaboration support, project wikis should be seen as an attractive, lightweight, all-purpose alternative.

Keywords: wikis, cooperation technology, project work, software engineering

1 Introduction

> *"When we had a wiki up and running in the first place, we wanted to use it for as much as possible"*   (Project manager, Team A)

Wikis are lightweight technology supporting easy creation and maintenance of web pages. The flexible structuring of contents is a particular feature making wikis adequate and popular as knowledge repositories. A wiki may be used for keeping the shared information resources of a group such as an organizational unit or and internet community, allowing the members add and modify contents. The contents of a wiki may be shared with the world or restricted to a group or community [1].

Lightweight project management (PM) solutions are often sought when 'heavy' PM is not feasible, as seen in open source software development. Louridas [2] points to potential advantages of wikis to support software engineering (SE) work: comprehensive versioning and change control, the provision of a shared workspace for producing and storing project documentation, and the possibility of having input from many participants in a more effective way than e.g. over email. Louridas argues that wikis are especially useful as discussion media, the advantages over discussion lists being general user-friendliness and the fact that discussion items can be placed in context. Further, he points to the democratic aspect: a project wiki gives a voice to everybody in the project. Chao [3] presents survey findings of innovative forms of wiki use in student SE teams.

As course staff in SE project courses we have seen many student teams using wikis during the last couple of years. The project wikis contain or provide links to various project artifacts, convey team-internal as well as information for external stakeholders and generally seem to reflect a mixture of administrative, development-related and socio-emotional aspects of project work. Existing research literature does not address in depth how project wikis aid different aspects of SE practice. For instance, the work of Chao on wiki use in SE projects identifies different types of use, but only on an overview level based. Louridas addresses the *potential* of wikis in SE projects without presenting empirical findings on actual use.

The objective of the work presented in this paper has been to gain insights on the actual work practices involving wiki use in SE teams and the purposes for which the wikis are used in these teams. In what follows, we provide an account of related research. Next, we describe our case and research method. We present findings on how the wikis in our case serve to integrate aspects of project work along several dimensions, providing illustrative examples. Finally, we relate this to a set of different roles played by the wikis in the projects, before concluding the paper.

2   Related work

Whereas our focus is on the role of wikis in *SE work*, it is worthwile to examine the body of research on wikis in educational contexts. Much of this research turns on the use of one wiki for an entire course [4] and/or possible pedagogical extensions of wiki functionality addressing teacher-student interaction, e.g. [5, 6]. We believe that there are important differences between course wikis and project wikis (while some wikis may be hybrids). The analytic distinction provided by Riel and Polin [7] between practice-based, knowledge-based and task-based learning communities captures a major point: A SE student project is mainly *task-based*. In the type of project considered in our case, which is industry projects with a high degree of independence on part of the project teams, the project wikis are established by the team to support their work towards project completion and the cooperative development of a product. The wiki is typically not intended to be re-used across projects (as might be the case if knowledge building or sustained practice within a course or organization were the objectives). In other words, to understand the usage of a SE project wiki with particular heed to the perspective of its users, it is reasonable to view it as *collaboration technology used by a project team* even if the particular setting is that of a university course.

Brown et al. [8] addressed how wikis can be used as a collaboration tool among students of ethnography. The type of wiki in question resembles a course wiki more than a project wiki, but there are aspects of its use which resembles project wiki usage in SE teams. In particular, Brown et al studied the use of wikis for collaboration over the writing of field notes, students sharing, comparing and discussing their notes in the wiki. Findings address e.g. the willingness of wiki users to share personal fieldnotes on an open wiki and the very limited editing of what is perceived as others' documents in the wiki. A finding of particular relevance to SE work is the combined distributed and co-located wiki use found in the groups of ethnography students. This

type of use can be seen as an example of how teams in a situation of partly distributed, nomadic work [9] find ways to utilize the flexibility of the wiki to serve their situated needs.

In the context of project work in general, the usefulness of wikis has increasingly been recognized [2, 10]. Singh et al. [11] show how interdisciplinary projects can use social bookmarking to support personalized access to wiki content. As mentioned in the introduction, Louridas sees a number of advantages of wikis in SE work [2]. Wikis can be seen as a form of collaboration technology fitting the philosophy and practices of free and open source development [12]. Mullick and colleagues [10] introduced a wiki in a simulated global software development project to improve coordination among distributed teams, finding that a common portal to project information was necessary to coordinate the design work across teams.

Chao's study of wiki use in student SE teams [3] unveiled satisfaction with the use of wikis as a lightweight collaboration tool. In what follows, we expand on Chao's work to find what it is about project wikis that serves SE teams so well.

3   Case and research method

We conducted a field study during the spring 2007 among software engineering student teams developing software solutions for external customers. Teams of 3-5 students work half time on their projects throughout their sixth (and last) semester, drawing on and integrating knowledge from other courses in the software engineering program. The overarching learning objective is to *gain experience with development work in a team for a customer*, the management of the team-customer relationship intended to be a major challenge and source of learning for the students. Each team has an external customer providing a development task unique to that team. The customer is responsible for providing necessary information on requirements and feedback on the development of the product. Further, each team has a supervisor from course staff providing guidance on the project process. Each team receives one grade, which is set in cooperation between the supervisor and an external examiner.

Status reporting and bi-weekly meetings with the supervisor are mandatory, as are the delivery of two preliminary versions of a project report before the final project delivery. Apart from this, strong independence on part of the students is encouraged. It is up to the teams to organize themselves, to manage the communication and relationship with project stakeholders, and to choose and adapt an appropriate development methodology / process model as well as collaboration and development tools. The choices made by the teams depend on the customer's preferences or requirements, team members' prior knowledge and experience, team member's wish to learn, and the availability of the technology (e.g. through university license, as freeware, or provided by the customer).

Four out of the nine teams in the 2007 cohort made use of project wikis, and three teams (hereby denoted team A, team T and team D) were active wiki users throughout the entire project. The project deliverables included a report (electronic and on paper) and source code, but the wiki was not itself a deliverable.

Following an interpretive approach [13], we collected data on these teams through participant observation, interviews with the various stakeholders (teams, supervisors and customers), examination of project documentation and project wikis. The data has been coded based on themes emerging through the analysis, without explicit reference to one theoretical framework, but with the use of core CSCW concepts as deemed useful. Students from the teams A, T and D were encouraged to provide feedback on the full version of the paper, but we did not succeed in having their opinion.

4 Findings and analysis

In our analysis, we investigate wiki usage in teams A, T and D, assuming the projects to be similar enough to make it possible to draw a picture of wiki usage across cases. All the teams had the necessary technical competence to solve their task. They were successful with the project in terms of achieving a good grade and delivering a product to their customer in accordance with specifications. They had a project manager being a project blog sponsor/enthusiast, creating the blog and taking the main responsibility for updating it (while all other team members also contributed, to varying degrees). They used their project wiki as a shared project workspace and main channel for updated and official project status information, as will be elaborated They regularly updated a to-do-list and other memo/task-oriented lists on the wiki. They password-protected the wiki or avoided informing widely about the web address, but made the wiki accessible to customer and supervisor. Finally, they used a version management system separate from the wiki for the software development

Some more detail on each of the teams illustrates the differences and provides context for some of the findings presented in this section:

Team D appeared very structured and ambitious. There were 3 members, one of which was absent during a large part of the project period due to serious illness. The two others were the lead developers and relatively old students, experienced with project management and software engineering. The project work was almost solely done in a distributed fashion. The customer was located in the same city as the students and the university. The development task was technically challenging. The application used for generating the project wiki was DokuWiki. After a while during the project period the team included a wiki plug-in to manage project activities.

Team A had 5 members who were mostly collocated in their project work. Their customer was located in a different part of the country during the first part of the project. The application used for the project wiki was MediaWiki. After the mid-term project report delivery, the project manager developed a script for collaboratively writing the final project report in the wiki and having the report auto-generated.

Team T had 5 members. Their project work was largely collocated. The customer was located in the same city as the team and the university. T. Among the three teams in our study, team T had the greatest number of personal and emotional expressions in their wiki, which was a MediaWiki. The team used only standard wiki functionality.

In the three project teams, we found that the project wikis serve a role in the teams' efforts to address and balance considerations typically competing for project resources and attention. The overarching perspective of our analysis thus evolved to

become *integration*, and we identified several dimensions along which this integration seemed to receive wiki support. The dimensions are, as will be seen, interwoven.

4.1 Wiki usage: Integrating across the social and the task-oriented

In this section we elaborate on the use of project wikis to convey task-oriented as well as social/emotional information. We address how to-do-lists are used, how individual project contributions are made visible, and how project status information is conveyed through the structuring of the main page.

The wiki main page is used for reflecting project status, in particular remaining tasks, but also the social and emotional state of affairs.

"The wiki quickly proved itself to be an invaluable tool for information management and collaboration, with the front page being used primarily as an editable bulletin board describing the current messages/tasks, and sub pages holding the actual content." [..] (interview, team D)

The teams were very selective in terms of what should go into the main page. Issues that could be resolved elsewhere, e.g. in weekly meetings or over msn, need not, and should not – according to the students - be put in the wiki. To-do-lists and news bulletins on the main page were for conveying and reading the project status.

Each team kept a to-do-list on their main page. In addition, there were various other lists, their number, position and purpose varying across teams and between phases of the project. Examples include individual to-do-lists, a project news bulletin, and separate to-do-lists for the project report and the testing.

"What is put on sub pages tends to be forgotten. What is current, what is to be done now, should be on the main page. What is most recent should be on top of the list." (interview, team A)

The lists of remaining tasks continuously changed throughout the projects, growing and shrinking depending on the phase of the project and the distance to the next deadline. At need, a dedicated list (e.g. for the final report) was branched out.

The process of assigning tasks to team members was typically done in face-to-face work settings, but also through the wiki: from the list of currently unresolved tasks, a team member could just pick one and work on it, in case of one of the teams by moving the item to his/her individual list in the wiki. To-do-lists were thus not only supplementing (on a day-to-day level) but in fact partly substituting other project planning or development artifacts such as a ticket system for managing software changes. Team T saw the wiki as "an easy way out" in terms of change management:

"The ticket system does have some features that might be better; you can.. integrate it with SVN, then, the versioning control, when you make a new change, you may write something particular that makes the ticket system pick it up, and see that things have been changed, but it becomes so advanced, that ..people do not bother to get into it, you know. And then it is easier only to have a wiki-page." (interview, team T)

Team D, on the other hand, integrated a wiki plug-in for the management of activity lists, thus taking a more structured approach to software changes in their wiki.

Strikethroughs were extensively used as a means for making visible the completion of tasks in the wiki to-do-lists. An item with a strikethrough typically remained in the list until the overall task (e.g. a preliminary report) had been completed.

Project logos and other visual material were used to achieve a certain personalization of the web page, related to a team identity, but also to individuals. An example of the latter is that the wiki responsible team member of team T included a link to a website which provided a new random picture of a cat with each click – cats being a strong personal area of interest to the team member.

Emotional expressions in the wiki relating to the management of tasks ranged from individual team members' comments by the descriptions of tasks ("Finally!", "What to do with the graphics?") via the project manager's use of red, large-size fonts for urgent messages to pictures representing the general feeling of a deadline approaching (Fig.1):

Fig. 1: Part of the wiki main page of team T towards final deadline.

Strong outbursts were often quickly diminished or removed by their creators in subsequent wiki versions. The flexibility to easily *remove* material thus possibly encourages the (sometimes brief) exposure of such material on the wiki.

Individual to-do-lists indicated that individuals had, or had taken, responsibility for specific tasks. Initials by tasks in a common task list served the same purpose. Effort made was indicated by strikethroughs and comments, e.g. on difficulties with the task.

A cake list was launched on team T's main page as a kind of pillory. Members being late for meetings had their names put in the list. The team thus made visible that it was not acceptable to break team rules, and the rule breakers received a small penalty by having their name exposed. At the same time, they were offered the opportunity to make amends through a social contribution (making a cake for the team). Viewed as part of the account of the status of the project, names on the cake list indicated (minor) project management challenges, *and* their being addressed.

A wiki main page can easily be re-structured while other pages remain unchanged. The main pages in our study were resized along with the phases and needs of the

project. Typically, a clean-up was performed after a completed deadline, and spin-offs (e.g. new sub-pages or separate headings on the main page) resulted from increased activity in certain areas or the recognition of new needs and objectives.The restructuring thus reflects a coordination of tasks, but it also has an emotional side, e.g. making visible that something has been accomplished, or that the team is turning over a new leaf. A fully packed main page, maybe slightly more chaotic than usual, expresses something different about how the project is currently experienced by its members than a sparsely populated page with short to-do-lists.

4.2 Wiki usage: Integrating team-internal and team-external information

From the above account of task-oriented and social/emotional use of the wiki, it is evident that the project wikis were used for team-internal purposes. The wikis were however also used for providing external stakeholders (customer, supervisor and possibly others) with information about the status of the project (e.g. project plan, status report, latest revision of requirements specification).

Making the wiki externally available means, to some extent, providing a desirable image of the project. A nicely structured wiki with tasks gradually getting their strikethroughs convey an image of a process under control. The emotional expressions found on the pages, however, reveal emotional sides of the project work to external stakeholders. The teams in our study found this acceptable, but allowed for different amounts of informal and emotionally laden contents on their wikis.

Team D saw the wiki as very central in communicating project status to the customer. In their final report, the wiki was placed in the middle of a figure showing the collaboration structure of the project. The wiki was shown as the link between the team and the other stakeholders. To the surprise of team D, however, the customer, in his evaluation report on the project, expressed satisfaction with everything in the project *except* that he would have wanted more face to face meetings instead of updates only through the wiki. In the case of teams A and T, the supervisor told the team that he wanted them to use a wiki and give him access to it, which most likely influenced the teams' choice to use wiki technology.

When asked if they would have liked to share wiki contents with other teams in the course, the teams in our cases were generally positive. The project manager of team A however thought that they might not want to display task lists full of uncompleted tasks because it would reveal a lack of control. This comment reflects the general competitive attitude among the project teams in the course.

Communication through the wiki seemed to happen largely one-way, from the team to other stakeholders. Customer and supervisor generally provided feedback through other channels. In the case of team A, however, the customer was situated in another city during the first half of the project and frequently visited the wiki. If there was something of particular importance in the wiki, the team would send him email about it. The team had a couple of conferences with the customer over msn and Skype, and, the customer had been visiting the wiki before the meetings, examining for instance the current version of the requirement specification. Further, the customer maintained a separate page in the project wiki containing non-functional requirements for the system under development. In the case of team T, one of two customer

contacts once made comments directly in the requirements specification in the project wiki. He later explained that he found it interesting to try out new technology for this purpose. A typical customer attitude to project wiki pages, however, seems to be that they are the students' area, even when other stakeholders are given write permission.

4.3 Wiki usage: Integrating across artifacts

Major project artifacts, e.g. minutes, status reports, plans and implementation related information, were typically accessible from the main page. Also, the wikis contained links to relevant web pages with data e.g. about the customer or a tool.

The project task of the teams in our study was a SE task, and coding was done in separate environments. Wiki integration with code versioning was very limited. None of the teams were familiar with wikis providing support for such integration. Lightweight and more manual solutions were however helpful. Team A did not use a separate versioning system, but used their customer's code repository, to which access was restricted. The project manager uploaded modified source code to wiki pages for each member to download locally (as the team could not consecutively run their code on a shared server), using msn to notify when a new download should be made.

Text formatting in wikis is not compatible with commonly used text editors. The teams accordingly 'wikified' documentation by adding the necessary tags to unformatted text. This was time-consuming, annoying and infeasible for the full project report. None of the teams were familiar with wiki functionality for generating printable pages from wiki pages. The low-threshold alternative to integrating the report into the wiki was to make it accessible through a link. One team developed a script converting report chapters in the wiki into Latex, making it possible to perform joint editing within the wiki and generate a printable version at any time.

The wikis are used in combination with other collaboration tools to work on and discuss project artifacts. The teams are very clear about which tools are used for which purpose. Discussions typically happen face-to-face or over instant messaging. Chat among distributed programmers is done in parallel with programming work, and unresolved work issues might be added to the wiki to-do-list during the work session. Email is preferred for formal communication, particularly when the customer is involved and there is a need for documentation.

5 Discussion

One way of accounting for the richness and versatility of the observed integrative wiki usage in the SE projects is to distinguish between different roles served by the wikis in the projects. We find that the project wikis simultaneously serve as knowledge repositories, stages, coordination mechanisms, and shared workspaces. In the light of these roles, we will elaborate on current wiki usage.

5.1 The wiki as a knowledge repository

Our findings indicate that the project wikis serve a role as knowledge repositories for the teams and other stakeholders. In all the wikis of our study, project artifacts and useful resources were included or linked in, "so we know where to find it". We may regard this as 'traditional' usage of wiki technology.

Apart from the current version of the wiki at any point, historical information is stored in the wiki. Each wiki version can be seen as forming a point, of greater or lesser significance, along a project trajectory. *Trajectory* has been described as "(1) the course of any experienced phenomenon as it evolves over time [..] and (2) the actions and interactions contributing to its evolution" [14](p.53-54). The development over time of certain aspects of the project, or artifacts such as the software product, may be seen as forming sub-trajectories that are, to some degree, represented in the wiki. Ideas developing into artifacts can be seen as trajectories of interaction, reflecting social as well as technical/task-oriented aspects of the project process.

5.2 The wiki as a stage

The teams provide certain types of information on the wiki while withholding other information. This can be seen as providing a certain image of the project, internally and externally. This is particularly evident from the main page, being loaded with status information of a technical as well as social and emotional nature. The latter type of material becomes somewhat restricted through the teams' practice of not conducting discussions in the wikis (in spite of the potential benefits [2]), and through the fairly quick moderation or removal of some material.

Internally in the team, the 'staged' picture of the project not only provides a status update but also potentially serves a role in conveying a project identity for team members to share. The inclusion of project logos and informal material such as humorous pictures may contribute to a feeling of project identity.

For external use, a professional appearance might be of greater importance. Information on the wiki constitutes part of the controlled information flow between project stakeholders. This is important e.g. in managing customer expectations. The team's version of project status as shown on the wiki should be regarded as one-way information in need of some channel for feedback (whether in the wiki or in another channel), as indicated by customer D's wish for more face-to-face interaction.

In the projects of our study, the project wikis were not deliverables, whether to customer or course staff. The wikis were however accessible to the supervisors, who played an important role in the formal evaluation of the team. Our data are not sufficient for making inferences about how this particular aspect of the course design affected wiki usage, e.g. the allowance for informal and unstructured contents.

5.3 The wiki as a coordination mechanism

We have seen how the to-do-lists provide a means for planning, monitoring and re-planning project work in a very flexible way. The linkability and malleability of the

tool [15] may be seen as major enablers of this usage, in combination with the history function which makes it possible to capture a picture of the process over time as part of the current status.

The to-do-lists have a team-internal coordinative role, but also play a role in coordination with external stakeholders who monitor project status in order to act upon it. We argue that is not only the strictly task-oriented aspects but also the social and emotional side of the lists that constitute and inform articulation work in the teams, providing cues about how to appropriately approach current challenges.

Louridas suggested that wikis are good for project democracy. In our study, we see that the project manager, being the major wiki sponsor in the team, uses the wiki to set or visualize the agenda for the project, thus manifesting his power. All team members are wiki users, to varying degrees, making visible their contributions. We may only speculate that the wiki offers better visibility for the viewpoints of those who fail to get their voice through in face-to-face meetings.

5.4 The wiki as shared workspace

The wiki constitutes a workspace providing shared access to various artifacts. The inherent wiki functionality for handling access conflicts to pages or page sections is appreciated by the teams in our study. However, we have seen that the current use of wikis for collaborative writing is so far limited. Taken from team members' viewpoints on how they would want to use their wikis, it seems that lack of knowledge of, or access to, adequate technology (e.g. for converting between formats) was a major reason why e.g. the project reports were not written in the wikis directly.

Some workspace awareness [16] is achieved as the wiki is used in combination with other development and collaboration tools, e.g. instant messaging. Also, the history of the wiki and information on the main page on who recently did what, provides awareness of team members' work. The project wikis may be seen as socially translucent [17], providing social cues about team members and their effort – both what they actually did and, to some extent, how they felt about it. A wiki main page with its to-do-list, individual comments and strikethroughs provides visibility and accountability of team members as well as of the team as a whole.

Turning to the project trajectory in context of the shared workspace, the concept of *locale* [18] is useful. Fitzpatrick made interaction trajectory one of the core aspects of the locale – "the place constituted in the ongoing relationship between people in a particular social world and the 'site and means' they se to meet their interactional needs, i.e. the space together with the resources and things available there" (p.9) A project wiki may be regarded as part of these 'site and means' in the project, and the history function of the wiki as a potentially valuable resource for reviewing the project trajectory in order to learn from it and/or work on its future course.

A final remark should be made on the emotional and social contents of the wikis in our study. These contents are mostly about reflecting and supporting a task-oriented project process by providing some social awareness. In the teams, social interaction generally takes place on other arenas. Accordingly, the project wikis should not be considered as 'social software'.

6. Conclusion

We have shown how project teams make use of wikis in a way integrating aspects of their project work. The wikis are simultaneously knowledge repositories, means of staging the projects, coordination mechanisms and shared workspaces.

We believe that a core issue in determining the appropriateness of using a project wiki in a specific project is how much predefined structure is sought for the management of the project. This relates to the choice of development methodology and lifecycle model. Agile development and open source projects tend to favour lightweight and flexible tools [12]. Further, project size, heterogeneity and degree of distributed vs. collocated work impacts on the overall complexity and need for computerized coordination mechanisms [19]. The development of safety-critical projects require a more rigid development process than projects involving less risk.

We suggest that the use of a project wiki as a lightweight project management tool is appropriate for projects that are not safety critical. We see project wikis as relevant for SE student projects, small SE projects (particularly if work is at least partially distributed), teams within larger SE projects, and open source SE projects.

Our findings demonstrated the potential of a wiki to serve many roles in SE project work besides that of coordination mechanism. If the wiki were to be supplemented with a project management tool in which coordination was handled, it is difficult to predict how the wiki might serves its other roles (knowledge repository, stage, shared workspace). This topic might be pursued through empirical research.

Whereas our main research agenda has been to provide a descriptive account of current wiki usage, we would like to point to alternative usage and further research. First, there is a potential for utilizing the knowledge repository of the individual projects *across* projects. Students express interest in looking at earlier project reports to learn from them, and this is relevant to industry settings as well. If a project is staged to be accessible and intelligible to all stakeholders, it is likely to be of potential value to other project teams. Project wikis may generally have a place in the broader picture of knowledge management in an organization. Second, given the effort currently made by the teams to create and maintain informative wiki pages, there is a potential to conduct project-external communication through this channel to a larger extent than what we see in the teams today. Generally, the practice of using the customer's preferred channel (typically email) to convey wiki contents by including links to the relevant wiki pages, seems to be successful as a way of providing a slight information push. Third, better opportunities for collaborative writing were requested by our teams. Having the wiki tool manage versioning and access conflicts *and* offer functionality to generate nicely formatted reports would significantly increase the value of wikis as shared workspace. Some existing wikis provide such solutions.

Taken from our findings, there is only limited use of historical information in the SE project wikis. History stored in the wiki can be utilized for purposes of reflection, e.g. in post-mortem project reviews. Our research continues along this line.

Acknowledgements

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