

A Collaborative Writing Approach to Wikis: Design, Implementation, and Evaluation

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Abstract

Wikis provide teachers with potentially significant opportunities for creating socially engaged tasks that require active student participation and collaboration. Wikis allow students to work together to develop content on the web, giving them a sense of how writing can be carried out collaboratively. Collaborative writing offers opportunities not only to practice literature review, academic reading and writing, but also to stimulate reflection, knowledge sharing, and critical thinking. However, despite the potential capabilities of wikis, true collaborative writing does not work by itself as the research literature clearly reveals. To foster collaborative writing, participation, and active involvement in wiki development, there is a need for a systematic approach to the construction of wikis. The aim of this paper is to allow students to develop wiki applications using a collaborative writing development approach based on rapid prototyping. The paper also reports on the evaluation of the approach by means of qualitative data collection and analysis methods. Finally, the implications of the approach for collaborative writing are critically discussed according to a set of requirements associated with software development considerations and pedagogical issues.

Keywords: Collaborative writing approach, MediaWiki, rapid prototyping, wiki, social constructivism

Introduction

Wikis are increasingly gaining in popularity in educational settings because of the potential benefits they bring to teaching and learning (Clark & Mason, 2008; Fitch, 2007). From a technical point of view, users of wikis do not need any specific software. A web browser would suffice. In addition, wiki users do not need to acquire advanced technical skills to create wikis. An editor is sufficient for constructing wiki applications. Furthermore, wiki technologies provide a number of useful functions, such as tracking of edits, comparison between different versions of edits, roll-backs to earlier versions of the wiki, threaded discussions, special and protected pages, customizable access to pages, read and edit rights, and use of different types of multimedia, e.g. images, graphics, sounds, and video.

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From a pedagogical point of view, wikis enable collaborative writing. They can be used in project development with peer-review, as a group authoring tool, to track a group project, to collect data for a class project, for class and teacher evaluation, and for tracking research groups (Parker & Chao, 2007). In addition, teachers can use wikis for collaborative curriculum design and for course

content authoring (Leung & Wah Chu, 2009; Matthew & Callaway, 2009; Mindel & Verma, 2006). Wikis provide teachers and educators with potentially significant opportunities for creating socially engaged tasks that require active student participation and collaboration, instead of passive and behaviorist learning, reproduction and transmission of knowledge.

The potential benefits of using wikis in education is that they allow students to work together to reach a common goal, giving them a sense of how writing can be performed in collaboration. In writing collaboratively with wikis, students need to agree on the structure and content of the wiki, and the methods that are necessary to accomplish collaborative writing. In these ways, wikis help to build mutually beneficial communities of writers (Vratulis & Dobson, 2008). However, despite the promising collaborative capabilities of wikis, their pedagogical usefulness regarding true collaboration is still questionable. Clearly, wiki alone cannot make collaborative writing happen, and students do not automatically become more active, participate, and collaborate with others when they use wikis for educational purposes, as the research literature clearly reveals (Chao & Lo, 2009; Cole, 2009). Students' willingness and motivation to use wiki in a collaborative way is important but not sufficient to initiate true collaboration. To foster collaborative writing, participation, and active involvement in wiki development there is a need for a systematic approach to the development of wiki applications.

The main goal of this work is to present a collaborative writing approach to wikis and to report on an application example in higher education that was carried out with students to investigate the effectiveness of the approach to support students' collaboration and active participation with fellow students. The aim is to let students create wiki applications using the collaborative writing approach and the MediaWiki technology as a platform to support collaborative writing projects within given subjects chosen by the students.

The paper is structured as follows. First, the research goal is described. Second, a literature review is undertaken. This is followed by the collaborative writing approach that is used to develop wiki applications. The article presents an application example in higher education. Then, the paper continues with a discussion and evaluation of the results and implications for the development of collaborative writing. Finally, the article ends with some conclusions and future research directions.

Research Methodology

The hypothesis of the work is that wiki alone cannot make collaborative writing happen, unless students know how to participate and collaborate with others when they develop wikis. However, collaborative writing is demanding in terms of cognitive efforts. It is an activity that transforms an initial document by more than one student into a collective text (Trentin, 2009). Collaborative writing requires students not only to practice literature review, academic reading and writing, but also group reflection, collaboration, knowledge sharing, and critical thinking (Kim, Hong, Bonk & Lim, 2009). In addition, various contextual (psychological, pedagogical, and institutional) factors in educational settings may influence collaborative writing processes. Clearly, collaborative writing is a complex task that needs to be structured in order to achieve educational goals. With other words, a systematic research methodology is needed to report on critical elements of collaborative writing in higher education. Given this background, the most appropriate methodology to investigate wiki-based collaborative writing is design-based research (Barab and Squire, 2004; The Design-Based Research Collective, 2003). Design-based research embodies a specific theoretical framework or approach to teaching and learning, and helps to understand how the approach is continuously developed through an iterative process of gradual refinement. Each cycle has four major steps: analysis, design, implementation, and evaluation. Likewise, when applied to wiki-based collaborative writing, design-based research involves the following four steps:

1. It begins with the review of the current state of research with the aim of understanding the problems associated with wiki-based collaborative writing.
2. It continues with the design of a collaborative writing approach to wiki that will be used to foster collaboration, participation and group interaction. The approach supports the designers' work, forming the foundation for implementation and evaluation.
3. The implementation step is concerned with the use of the approach in an educational setting using multiple methods for collecting empirical data.
4. The last step is concerned with the evaluation of the approach through the systematic analysis of the data collected by means of various methods.

Analysis, design, implementation, and evaluation are interdependent and reciprocal. Refinements are continually made through successive cycles of experimentations, where the shortcomings of each cycle are identified, re-designed, re-implemented, and re-evaluated.

Literature Review

Wikis are increasingly being accepted as a new breed of collaborative technology in education (Nordin & Klobas, 2006). A large body of research work exists on positive experiences with wiki technologies. For example, Carter (2009) reports on a wiki in a mathematics course, which demonstrated better student performance. According to the author, the use of the wiki was entirely positive as a teaching tool. Heafner and Friedman (2009) suggest that wikis used in secondary social studies facilitated a pedagogical shift from traditional teacher-centered instruction to student-oriented and constructivist learning. Likewise, Kasemvilas and Olfman (2009) pointed out that that MediaWiki could better facilitate the collaborative writing process with some extensions that support discussion and project management.

Despite positive results, there still are a number of criticisms regarding the pedagogical value of wiki-based writing in comparison to traditional ways of learning. Cole (2009) indicated that very few researchers highlight the negative consequences of the integration of a poorly designed wiki into existing formats. A number of research studies seem to confirm that students appear to favor individual work over collaboration using wikis. Karasavvdis (2010) reported on a number of studies regarding student resistance against wikis (Carr, Morrison, Cox, & Deacon, 2007; Elgort, Smith, & Toland, 2008; Ma & Yuen, 2008). First, Carr, Morrison, Cox, and Deacon (2007) concluded in their study that some students are reluctant to use wikis for online course work. Second, Elgort, Smith, and Toland (2008) indicated that a significant numbers of students thought that they could have done the task better on their own, although wikis are designed to facilitate collaboration among students. On the other hand, even if students do see the potentialities of wikis, their use does not automatically ensure collaboration. While on some occasions students worked collaboratively as a group, on others more individualistic approaches were evident. Third, Ma and Yuen (2008) pointed out that only half of the students were satisfied with the use of a wiki for collaborative writing. Finally, limited student contribution to the wiki seems to be a serious problem. In this regard, Cole (2009) reported that after five weeks, the students had not contributed to the wiki at all.

There are also reports of the unwillingness of students to engage effectively in collaboration because they do not want to change or modify others' work (Britcliffe & Walker 2007). On the other hand, Minocha and Thomas (2007) reported that students did not mind critiquing others' work, but the nature of the critical reviews was not perceived as being positive by some of the students. Furthermore, Meishar-Tal and Gorsky (2010) indicated that in accord with previous research, students most frequently add content to a wiki rather than delete existing text; and contrary to previous research, students modify existing texts to a greater extent than previously reported. The research literature also reports on the inappropriateness of existing wiki tools for collaboration. For example, Minocha and Thomas (2007) pointed out that is there is a need to support the dis-

discussion aspects of collaborative activities with more appropriate tools. Finally, another potential drawback of wikis is that they allow a user to change the content of a Website. This raises questions of copyright, because students may use others' work as their own (Heafner & Friedman, 2009).

Despite wikis' potential capabilities, Dron (2007) pointed out that the structure generated through social software, that is to say software that supports collaboration and group interaction such as wikis, may not be useful or pedagogically sound, and there are many ways that social software can fail to address the learners' needs. The most common solution to this problem is to use such software as a part of a "learning ecology" in educational settings (pp. 64), that is to say is an environment that is consistent with (not antagonistic to) how learners learn (Siemens, 2003)

As a result, the research literature does not provide sufficient experiences and evidence in order to draw meaningful conclusions that wiki technology is superior to traditional technologies and ways of learning. Majchrzak (2009) asserts that researchers and educators need to understand what is different about wikis in terms of affordances, functionalities, and behavioral use of patterns, compared to existing collaborative technologies in order to derive new theories or refine existing ones, improve or develop new pedagogical strategies to support student learning.

Collaborative Writing Approach to Wiki

The most important characteristic of wikis is that they provide support for the collaborative production of shared knowledge, documents, and study materials by means of reading, writing, group reflection and interaction. Collaborative writing requires technical skills associated with formatting, editing, use of fonts, color, input of multimedia elements (text, graphics, images, audio and video) onto wiki pages, hyper linking, etc. In addition, collaborative writing involves active participation of the project members, shared editing, reading and group writing strategies, revisions, peer-review, and group evaluations of contributions (Judd, Kennedy, & Cropper, 2010; Kim, Hong, Bonk, & Lim, 2009; Meishar-Tal & Gorsky, 2010). Hence, the development of wiki-based collaborative writing must differ from other approaches to software production in a number of aspects. Approaches that use conventional software development, such as the waterfall model (Pressman, 2000), or extensions of these approaches to Web-based learning (Horton & Lynch, 1999), to address the whole software process are not flexible enough, time-consuming, and too complicated, to be applied to collaborative writing projects. Domain-specific approaches that are exclusively devoted to Web-based development (Balasubramaniam, Pries-Hje & Baskerville, 2003; Baskerville, 1999; Murugesan & Ginige, 2001) do not explicitly address the specific characteristics that are proper to wikis, such as collaboration, participation, active involvement in the gradual production of texts and documents. Another important difference between conventional software production and wiki development is that wikis are mostly concerned with writing processes rather than software and programming activities, even though some programming skills (mostly html coding) are needed. In addition, a practical approach to collaborative writing needs to consider that wiki developers are not software experts. Nevertheless, some elements of software production are still important and need to be considered for wiki development, such as user involvement, architecture design, quality insurance, and component integration. Finally, evolutionary approaches such as rapid prototyping are more suitable to the collaborative character of wiki-based writing. Rapid prototyping is powerful to quickly generate an initial text that can be improved, changed, and modified collaboratively through incremental revisions.

Rapid Prototyping

Rapid prototyping is used to speed up the construction process of wikis over a short period of time (Shih, Tseng & Yang, 2008). It creates an iterative and dynamic process with a number of cyclical revisions that the project members quickly assess to meet the potential users' needs of the

wiki applications. A series of prototypes are developed through an iterative and incremental process on the basis of feedback from the instructor, group members, and peer-review to ensure that the objectives of the wikis are taken into consideration. Early and frequent assessments and revisions are important to ensure that the wiki applications meet the users' needs. Feedback ensures that formative evaluation occurs throughout the whole development process. It is used to guide the construction of the wiki applications to ensure that the requirements are kept in mind, and that the decisions made throughout the stages of the development process are achieved.

Wiki Construction Process

To take advantage of the potential capabilities that wiki offer for collaborative writing, the development of wiki applications need to be organized and structured so that the students are engaged and motivated to take part in the process of collaborative writing. This approach is similar to the one developed by Trentin (2009). Trentin's approach has been slightly modified to include software development issues, such design, quality insurance, and rapid prototyping aspects. To foster collaboration among project members, the approach needs to incorporate six phases or stages. First, the approach is centered around a group of collaborating students, because participation of the group members of the projects is given high priority. Then, the approach uses rapid prototyping to produce a number of prototypes that can be quickly revised through feedback (Farrell & Carr, 2007). Finally, the approach is incremental throughout the whole process, because a number of revisions are necessary to improve the quality of the wikis through a continuous cycle of gradual refinement. The development approach consists of six basic stages: Information gathering, wiki architecture, design of the various pages of the wiki, collaborative wiki development and links to pages created by others, quality assurance and integration of the pages, and overall evaluation (Figure 1).

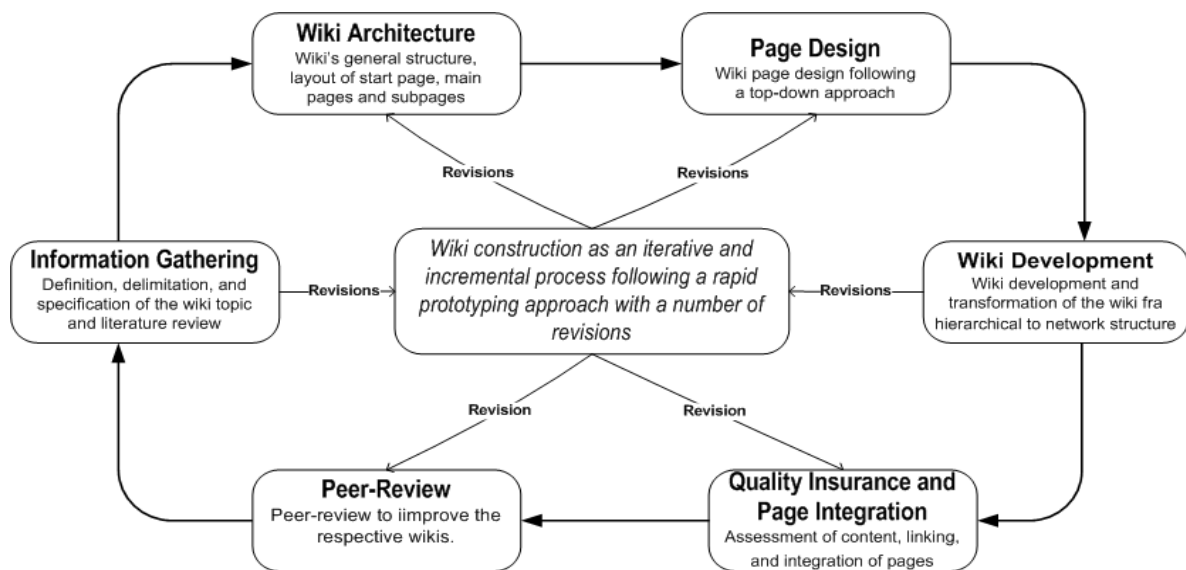


Figure 1: Wiki construction process

Information gathering

This phase is the initial phase of the project. The group members are required to start with data collection and review the literature for their projects. Data collected during this initial stage serves as the foundation for the development of wiki-based collaborative writing applications. First, the project members select, delimit, and specify the topic they want to study. Second, they

describe the objectives that need to be achieved with the wiki. Then, they need to gather information about the topic by means of literature review. Information about the topic can be found in articles, books, written and online documents, etc.

Wiki architecture

This phase is concerned with the wiki overall architecture, which is usually hierarchical with the top as the start page (Figure 2). The wiki is divided into main pages that have one or more sub-pages. The project members also define the layout and setup of the start page. The navigation through the wiki from one page to another is flexible with many entries. A number of pages are interactive and designed with multimedia elements. Users of the wiki have the possibility to control the order of the activities they do. They may skip and revisit pages. Control of sequence engages the students in flexible and nonlinear navigation paths.

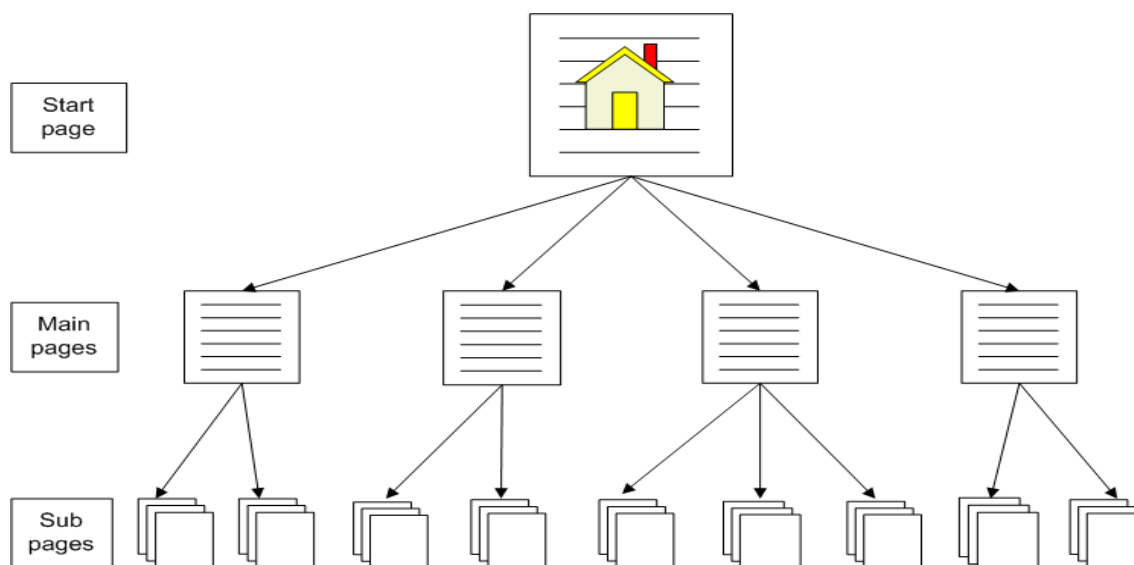


Figure 2: Wiki architecture

Page design

In the design phase, the project members develop individually the various parts of the wiki that are assigned to them, and in this manner create a collective document by means of a "top-down" procedure. The project members are advised to proceed step by step to design the various pages of the wiki. First, they write out a page with a summary of the main issues. Then, they need to highlight all the key words of the pages that need to be linked to other pages with detailed information. Finally, they format and edit the pages. The linking to external sites may be made here. Key words need to be discussed in the group.

Collaborative wiki development and linking

To prevent students from concentrating solely on their own part of the wiki, it is required that they examine the whole wiki collaboratively, and search for pages that are developed by other members, which may be conceptually (by means of key words) be linked to their own pages. This activity fosters a better understanding of the wiki and provides a more complete and overall picture of the wiki as a whole. The activity is an iterative process that should begin as early as possible and not end when the pages are finished. Students are encouraged to perform the activity while they actually develop their own pages and not leave it as a final refinement. The reading

and commenting of pages, that other members have developed, not only foster new ideas and improvements of the student's own pages, but also helps to avoid overlaps, repetition, and duplication, especially when two or more students work on subjects that are closely related to each other. This activity leads to a gradual change and transformation in the wiki from a hierarchical organization to a network structure. Student collaboration is supported by the discussion tool of the wiki attached to each wiki page, where dialogue can take place between group members. Figure 3 shows how project members (here student 1, 2, 3, and 4) work collaboratively to transform a document consisting of pages associated with each member to a collective text, resulting from the transformation of the text from hierarchical to network structure.

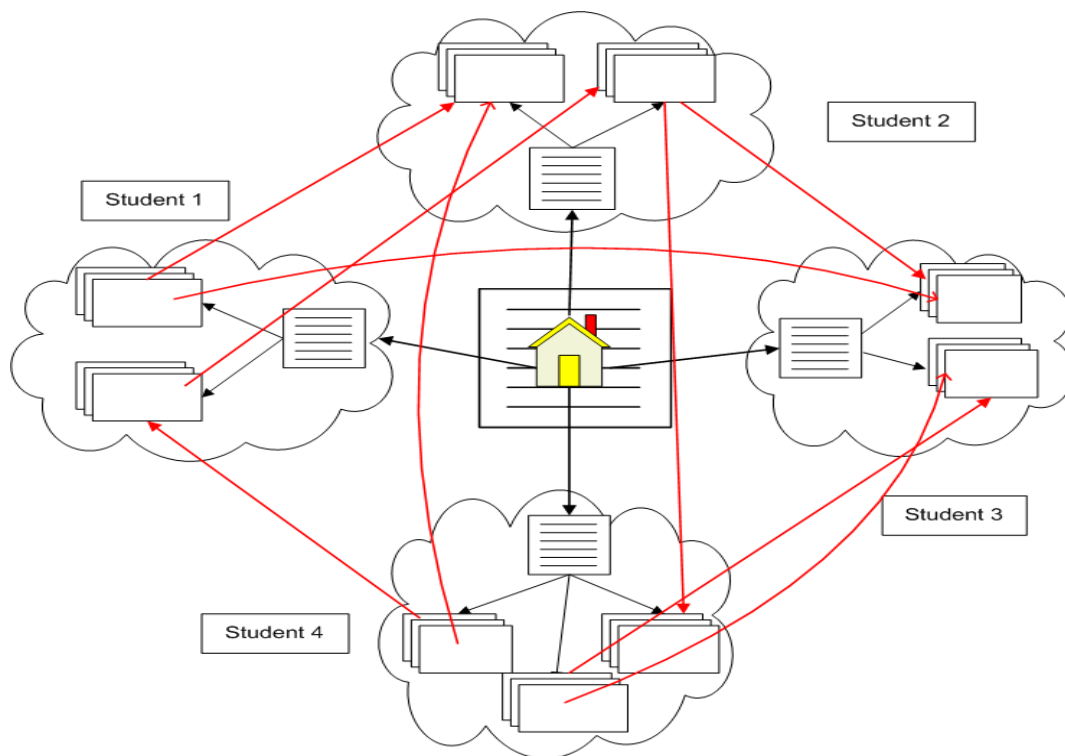


Figure 3: Transformation of the wiki from hierarchical (figure 2) to network structure

Quality assurance and integration of pages

This phase is concerned with an overall assessment and integration of the various pages of the wiki that have been developed and linked to each other in the previous stages. This activity consists of checking whether the wiki meets the requirements for content, linking, quality of information, and suggests improvements to the respective pages, as well as the way the pages will be integrated into a comprehensive wiki. This activity also includes content review with the intent of finding and correcting various errors, such as typographical mistakes, errors in content and graphical representations, cross referencing and navigation errors. This activity needs to be carried out collaboratively by all members of the project.

Peer-review

The wiki applications need to undergo a peer-review process with the goal of improving the quality of the final products. To achieve this, students are asked to evaluate each others' wikis and suggest improvements and constructive comments regarding content, linking, and integration of the pages. Students also need to assess whether the reviewed wiki applications meet design and

quality principles. Students need to use the “comments” function to review the respective wiki applications. Peer-review is an important activity that fosters interaction between the project groups.

Application Example

This work uses an application example to examine the pedagogical benefits and limitations of the collaborative writing approach that supports the development of wiki applications. The example is situated in a higher education context that provides insight into complex learning and teaching processes. The units of study were students’ wiki applications that were developed collaboratively using the MediaWiki tool (MediaWiki, 2008).

Participants

Participants were groups with 3, 3, and 2 students at the Faculty of Technology and Science taking a course in Web 2.0 technologies. Data from the case study came from students involved in wiki applications associated with three collaborative writing projects. The students were instructed to use the development approach to collaborative writing in their projects.

Wiki Applications

The subjects of the wiki applications were chosen by the students themselves in collaboration with the teacher. The objectives, topics and situations, in which the wiki applications were developed, are associated with the following subjects: Information and communication technologies (ICT) and learning in secondary education (Group 1), data security and privacy issues for young users (Group 2), and health and food issues and the link between them for all categories of people (Group 3).

The wiki applications were developed by three groups of students who used the collaborative writing approach to the development of wikis. The wiki applications were developed in collaboration with the university teacher, who provided academic supervision, on the one hand, and fellow students, who carried out peer-review, on the other hand. The students used the discussion forum of the wiki tool and other communication channels to share information and carry out peer-review. Students were required to meet a number of deadlines.

Methods

The group projects lasted for eight weeks, and were divided into six phases according the collaborative writing development approach. At the end, the students delivered a final project report to document the wiki application they developed using the MediaWiki tool as a platform to manage their writings. The instructor provided advice throughout the development process and good examples on wiki applications that may be reused with slight modifications. Basically, the students followed four steps to carry out their projects:

- a) Select a topic according their motivations, needs, and interest.
- b) Develop wiki applications using a rapid prototyping approach.
- c) Evaluate the value of the wiki applications using various data analysis methods.
- d) Deliver the project report and the final wiki product.

To investigate the value of the collaborative writing approach to wiki development, mixed methods were used to collect qualitative data: Self-evaluation and peer-review to assess the wiki products, informal discussion with the students over the duration of the projects, group supervision, analysis of the wiki final product and previous versions of the wikis (prototypes) associated with the students’ writings that they developed gradually, analysis of students’ discussion protocols in the respective wikis, and analysis of students’ written project reports. The MediaWiki tool was

particularly useful for a systematic data analysis because it kept track of the contributions to the wiki applications made by each member of the groups and between the groups.

Students' perceptions of collaborative writing were assessed by means of self-evaluation and peer-review. Self-evaluation is defined as students judging the quality of their own wiki, for the purpose of improving their work in the future (Hart, 1999). Students self-evaluated their own wiki as a team. Peer-review is a process used for evaluating each others' wikis. The goal of peer-review is to assess whether the wikis support collaborative writing. Peer-review was carried out individually by each student. The results of self-evaluation and peer-review were analyzed and interpreted qualitatively. Both self-evaluation and peer-review were carried out using five open-ended questions:

- a) Do you think that the wiki application fosters collaborative writing?
- b) What do you think about the degree of collaboration?
- c) Do you like seeing other students' interaction with material you posted in the Wiki?
- d) Do you like to interact with the material that other students posted in the wiki?
- e) Do you think that the MediaWiki tool supports collaborative writing?

Results

The findings describe the students' experiences with the collaborative writing development approach to wiki and their perceptions of collaborative writing after eight weeks of project work. The students' writings and discussions are also critically analyzed.

Students' Experiences with the Collaborative Writing Approach

The wiki applications were developed using the collaborative writing approach to the development process. The approach used rapid prototyping to speed up the process of developing wiki-based applications over a short period of time since traditional methodologies are time-consuming (Shih, Tseng & Yang, 2008). During the development process, the student groups were supposed to create a number of prototypes associated with collective texts that need to be gradually improved collaboratively. The student groups had four deadlines, one for each important prototype during the development process.

The data collected by means of informal discussions with the students, group supervision, and final project reports indicate that collaborative writing was not carried out according to the requirements of the development approach. Indeed, the deadlines were difficult to meet, depending on the students' ways of working, previous experiences with rapid prototyping, and the development pattern that the students choose to adopt depending on their pre-requisite knowledge, skill level in collaborative writing, and learning expectations. Given this background, the students encountered a number of problems:

- The information gathering phase was characterized by the difficulty of specifying the problem requirement, delimitating the problem scope, and understanding the users' needs.
- The groups were confronted with the task of finding reliable information about the content of the wikis. Many students used information found on the Internet and Wikipedia. Other used study material from textbooks.
- Also the question of size and content of the start page, main pages, and subpages created some difficulties. This created inconsistencies that needed to be resolved through a number of revisions of the wiki applications by means of rapid prototyping.
- The wiki architecture and page design also needed to be improved gradually.
- Difficulties to specify the key words (concepts) that need to be used to link clusters of pages.

- The quality insurance and page integration phase did not follow a systematic procedure resulting in inconsistencies, typographical errors, graphical representations, cross referencing and navigation errors, etc.
- Peer-review was mostly positive, with the exception of some critical considerations, due to the difficulty of criticizing fellow students or to engage effectively in collaboration because the students did not want to change or modify others' work.
- All group worked much as the last deadline approached, and did not follow the schedule assigned throughout the project period of eight weeks. This reduced the possibility of collaboration further.
- The wiki construction process starting from information gathering to peer-review was very demanding in terms of efforts and time.

As a result, the wiki applications were rather of average quality from the content point of view. The applications lacked graphics elements, illustrations, and background colors that may have made the wikis more attractive. Also the placement of graphics within the wikis was a point of discussion as this might influence the quality of the wikis' layout and structure. Some students also indicated that it was not always easy to illustrate the applications with appropriate pictures.

At the end, there still were some technical problems that needed to be solved, such as downloading a file, placing of images, and connection problems. It also appeared that multimedia objects cannot be easily edited on the current MediaWiki platform. Therefore, most of the multimedia objects were skipped because of the limitation of the tool. Consequently, the final products of the wiki applications were mainly composed of texts, tables, and some images. Finally, the storage of temporal versions of the application through the history function was challenging when the applications scaled up.

Despite the difficulties, students pointed out that the wiki applications were motivating and interesting to work with, because of their intrinsic value for them and the users. Finally, it seems that most students were aware of the fact that wikis alone cannot cover the entire knowledge level of the users.

Students' Perceptions of Collaborative Writing

An analysis of students' perceptions of collaborative writing by means of self-evaluation and peer-review indicate that most students characterized wiki-based collaboration as a meaningful activity that supports discussion and information sharing between group members, but the degree of the collaboration is difficult to measure, as one student posted: *"It is difficult to measure the degree of collaboration as it probably has been much face-to-face discussions directly between the students. Such discussions are not easy to transmit by means of the discussion forum"*. A similar view was also expressed by another student: *"You can collaborate by speaking and discussing. If this is the most ideal way to collaborate is another matter. It depends on how many students are in the group. To some extent the discussion forum tool fosters collaborative learning, but it is best to vary with group meetings, while using the discussion forum"*.

Most students perceived MediaWiki as not supporting online collaboration as this student's comment reveals: *"We have been quick to use the discussion forum, but it still feels a bit "forced". Own experience is that the discussion tool is too poor when used as a collaborative forum. Including name and date should automatically come up"*. The drawback of the discussion forum tool is that it does neither identify the contributor and the time, nor separate discussions about points so that a great deal of searching is required before a thread of a discussion can be followed. The tool cannot keep a sense of order to multiple discussions. To be useful, the date and the name of the contributor do not need to be written down by the students. Instead, they must appear automatically.

According to the students, the discussion forum is not the ideal arena through which to promote genuine collaboration. Rather, collaboration is more beneficial when the tool is combined with human communication by means of face-to-face dialogue, and supplemented with email, and eventually with social software tools such as FaceBook, Google Docs, and other Web 2.0 technologies. This indicates that the wiki tool was not used alone as the only communication channel between students. Apart from using the tool, the students discussed the task of developing wiki applications by other communication means.

Summarizing, students mostly focused on the following issues to express their perceptions of collaborative writing:

- The difficulty of judging the degree of collaboration between students
- The role that the MediaWiki tool played in collaborative writing
- The drawbacks of the discussion forum tool for collaboration
- The role of other communication and discussion channels (face-to-face meeting, e-mail, Web 2.0 technologies, e.g. FaceBook and Google Docs)
- The focus on technical aspects of the MediaWiki tool rather than participation, involvement, and group interaction.

Analysis of Students' Writings

Contrary to the students' perceptions, a more detailed and objective analysis of the wiki protocols once the wiki applications were implemented shows a very different picture of collaborative writing. Indeed, a careful analysis of the students' writings by means of the wiki prototypes show that collaboration was done in a relatively simple, uncritical, and unsophisticated manner, mostly by adding and formatting content to existing pages, sometimes deleting small portions of the text, discussing superficially, or suggesting improvements to the technical design, rather than substantially changing, modifying, and critically reflecting on others writing. Clearly, collaboration writing was not done by deeply transforming an existing text to a collective document. These findings are in line with the students' experiences with the collaborative writing approach to wikis.

The students' contributions were not evenly distributed among members of the same project groups. The degree to which students contributed to the wiki applications also varied considerably. Looking at the types of activities that the students performed, the following categories can be distinguished: add content, delete content, modify content that other students created, and format content. Extracts from the history of the groups reveal that few activities were associated with modify content that other members of the group created. Group members mostly worked on the individual sections that they were assigned. There were few occasions when the groups worked on the same section by revising substantially each other's work. Clearly, this cannot be considered as true collaborative writing. Instead, it seems that the students cooperated rather than collaborated.

To understand what collaborative writing means, it is worth to make a clear distinction between collaborative and cooperative behavior when students do work together. Cooperation is defined by the division of work between students who are faced with a joint activity, while collaboration involves the "*mutual engagement of participants in a coordinated effort to solve the problem*" (Dillenbourg, Baker, Blaye, & Malley, 1996, pp. 190, cited in Judd, Kennedy & Cropper (2010)). This distinction is defined as follows: "*Co-operation usually implies either splitting up the work or solving subtasks individually and combining the results into a final product. In contrast, collaboration can mean a coordinated attempt to solve and monitor a problem together, with perhaps some division of labour on aspects of the problem*" (Scanlon, 2000, pp. 464-465, cited in Judd, Kennedy & Cropper (2010)).

It is clear from the description above that students cooperated rather than collaborated in their contributions to the wiki. One reason for the poor quality of collaborative writing is the lack of collaborative skills. Another reason is the lack of motivation to use wiki in a collaborative manner. While wiki tools possess a number of features that can facilitate collaboration, it does not necessarily follow that they impose any “meaningful level of collaboration” between students (Judd, Kennedy & Cropper, 2010). Additionally, the data collected indicate that the wiki tool alone did not provide sufficient motivation to capture the students’ attention. While the students found the applications motivating and stimulating enough to invest time and efforts in developing them, the MediaWiki tool did not facilitate collaboration. Clearly, while the findings show that the students have the potential to be motivated by the topics of the wiki applications, their contributions to collaborative writing indicate low level of engagement, shortcuts in information analysis found on the Internet, heavy use of Wikipedia, poor writing and integration strategies, insufficient systematic testing, and lack of deadline awareness.

Nevertheless, even though collaborative writing was carried out in a simple, uncritical, and unsophisticated manner, it is worth mentioning that students benefited from the comments and feedback they received from fellow students by means of peer-review despite the poor quality of the discussion forum. Indeed, peer-review revealed that moderate and constructive feedbacks were valuable for most students. Unfortunately, these focused mostly on editing, formatting, and technical aspects. There were few comments to support the collaborative writing tasks.

Wiki Discussion Protocols

An analysis the data collected by means of the students’ discussion protocols shows similar tendencies regarding collaborative writing. Most comments were related to editing, formatting, and technical aspects of the wiki tool. Most students referred to the inappropriateness of the MediaWiki tool for discussion and collaboration. They felt the need to engage in some form of synchronous communication to exchange their ideas and share their concerns. The students were generally in agreement with the view that while the MediaWiki tool has strengths in recording decisions, it needs to be supported with some form of face-to-face or similar ways of discussion that facilitate collaboration. As a result, there was a high degree of agreement about the lack of support for collaboration provided by the discussion forum. All reported that face-to-face meetings, eventually supplemented with traditional forms of communication, such as emails and phone, but also new technologies for social interaction, such as FaceBook and Google Docs, are still important to their learning. They also believed that the combination of different forms of communication stimulate learning, because some students prefer information technologies, while other like more traditional ways of learning. Finally, students agreed that working in a group is more beneficial to the learning process than working alone.

Discussion

The development approach to collaborative writing presented in this paper was used to structure and organize the students’ wikis. It includes both software development considerations and pedagogical issues. Particularly important for wikis from the pedagogical point of view is the consideration of learning processes as emerging from collaborations between participants.

Hence, both software and pedagogical issues need to be considered to assess the value of the approach. To do this consistently, the approach is evaluated according to a framework of requirements based on the work of Montilva, Sandia, and Barrios (2002). This framework consists of general evaluation principles that may be applied to any development approach that involves educational settings and pedagogical considerations. The framework has been slightly modified to include the issue of collaborative writing, since this is a major feature of the approach. In addition, user involvement and usability properties are equally important for wikis as for any web-

based learning system. Accordingly, the work is evaluated on the basis of three general evaluation elements. The first element is concerned with the wiki collaborative process. The second element is the applicability domain of the approach in education. The last element is the wiki product model and associated user involvement and usability properties.

Wiki Collaborative Process

The wiki collaborative process is concerned with the activities underlying the development approach to collaborative writing. The findings indicate that the students encountered difficulties throughout all the development phases. The gathering of information, the linking of conceptually associated pages, as well as wiki architecture, the integration of pages, and quality assurance of the wiki pages, were not carried out as expected according to the requirements of the approach. Furthermore, while wikis are considered as potentially powerful tools to support collaboration, the findings reveal few processes and activities of true collaborative writing, reflecting some consistency with work reported in the research literature (Judd, Kennedy & Cropper, 2010; Karasavvidis, 2010; Luckin et al, 2009). True collaborative writing as defined above requires that one student to modify the content posted by another student. It is not simply adding content to an existing wiki page. The lack of engagement and involvement in the development process is partly due to the low quality level of the discussion forum tool and technical limitations of the wiki tool. However, this is not the only reason. There is also a lack of evidence of critical enquiry and engagement in the subject being studied throughout the whole wiki development process among students.

In fact, the “wiki” way of collaboration does not work by itself (Chao & Lo, 2009). Wikis alone cannot make collaborative writing happen, and students do not automatically become more active, participate, and collaborate with others. Notari (2006) asserts that collaboration is less likely to be a success without proper guidance and scaffolding. This means that students need input and guidance from a more able partner in order to collaborate effectively. Clearly, the role of the teacher cannot be underestimated in a shared field of interest. However, teachers alone cannot make collaboration happen, if students have not previously acquired collaborative skills. The time and efforts needed to supervise and monitor the students’ contributions to wikis may also be a real challenge for any teacher (Workman, 2008). Furthermore, true collaboration is dependent on students’ critical perceptions of the information posted on the wiki by other students. The limitations of existing wiki technologies can also restrict or constrain the students to express themselves naturally to avoid conflict and critical reflections with peers (Wheeler & Wheeler, 2009). Moreover, true collaborative writing throughout the whole development process may be a real challenge for many students as it is demanding in terms of cognitive efforts and time. Clearly, true collaboration in a wiki-based environment is difficult to achieve, unless students possess higher-order academic skills and critical awareness to judge the information and content posted by other students (McLoughlin & Lee, 2007). Otherwise, students tend to accumulate content on wiki pages as the history function of MediaWiki clearly shows.

Wiki Applicability Domain in Education

The collaborative writing approach to wiki is applicable to a wide range of situations, where academic institutions are expecting to gain learning benefits in investing in wiki applications associated with collaborative writing. It is flexible enough to be adapted to the specialized conditions of academic institutions. More specifically, its application domain includes different levels of higher education, ranging from graduate to postgraduate education. Apart from collaborative writing associated with academic subjects, a variety of wikis may be developed for a number of applications, such as generation of teaching materials, online peer assessment, and collection of data for a class project.

Furthermore, in line with the research literature (Weber 2008; Witts 2008), this work seems to confirm that the hybrid or blended pedagogical model that combines wiki-based technology with face-face interactions may provide the most beneficial learning scenario for wikis. Indeed, apart from using the online group discussion forum to engage in dialogue and reflection with peers, students also used other communication channels, such as face-to-face group meetings. However, the discussion forum tool in its present form is not the ideal arena through which to conduct genuine collaboration and participation. Student collaboration in a wiki-based environment is not just a matter of online dialogue, but it is a human relation as well. Clearly, the discussion forum cannot fully replace human dialogue and relationships in the process of collaborative writing. Given the current state of the technology, wikis still need to be used in conjunction with other ways of working and collaborating.

Wiki Product Model, User Involvement, and Usability Issues

The product model of the collaborative writing approach is concerned with the features of the final products that define the properties of the wikis in terms of coherence with the assigned topics, wiki architecture, conceptual structure, user requirements, information accuracy and completeness, sources of references, and writing style. The evaluation of the wiki final products was carried out by the students themselves by means of peer-review and self-evaluation, on the one hand, and the instructor through group meetings and supervision, on the other hand. The evaluation of the product model may include mixed, both qualitative and quantitative methods, to ensure that the wiki applications meet quality requirements.

Important for the product model are technical and pedagogical usability issues (Hadjerrouit, 2010; Nokelainen, 2006). Wiki applications must be easy to use and flexible enough to be adapted to a variety of educational situations. Wiki applications need also to take into account the users' needs to ensure that both technical and pedagogical usability elements are kept in mind. However, the consideration of usability issues does not necessarily imply that the wiki applications are usable for the users, because usability issues cannot be separated from testing the wikis with representative users (Nielsen, 2000). Furthermore, usability issues should be considered earlier in the development process to ensure that they are taken into account. Moving the emphasis on usability to the beginning of the development process and providing the developers with a set of principles and heuristics can have a positive impact on the technical and pedagogical quality of the final products. However, this is a difficult task that cannot be done without preparation, pre-work, and training.

Implications for Collaborative Writing

Despite adopting a disciplined approach to wikis that was intended to support collaborative writing, the students experienced several problems with collaborative writing, mostly because they lacked pre-requisite knowledge in wiki development, collaborative skills, and writing strategies. This work agrees with Karasavvidis (2010) that all the problems the students experienced hint at a "*fundamental problem, namely the dominant traditional practices and the associated learning epistemology which is compatible by such practices*" (pp. 226). This epistemology, which is behaviorist in nature, is incompatible with the social constructivist learning epistemology associated with wikis, which promotes participation and collaboration. The social constructivist learning epistemology (Vygotsky, 1978) and related theories, such as communities of practices (Wenger, 1998) are based on the idea that the way learners construct knowledge is shaped by their relationships with others.

Accordingly, this work suggests that the problems the students struggled with are to a large extent determined by the academic practices and associated learning epistemology in which the students are involved. Basically, existing pedagogical practices in higher education still rely on the behav-

iorist learning epistemology, which does not involve collaboration with fellow students. These practices are incompatible with the underlying epistemology of wiki technologies, which entail that collaboration and active participation become indispensable for learning (Karasavvidis, 2010).

As critical reflection, group interaction and discussion are necessary conditions for using wikis, collaborative writing cannot develop fully, unless the existing practices change radically. With other words, wikis' potential capabilities in supporting a collaborative approach to learning and writing cannot be realized without a shift from instructor-delivered teaching to student-facilitated and wiki-based learning where group discussion, peer-review, critical reading, and collaborative writing play an important role. According to Lamb (2004), true constructivist learning requires teachers to relinquish control to some degree in order to foster more collaborative learning activities. This requires that the teachers' role changes from transmitter of knowledge to facilitator and guide of learning in a wiki-based environment. Clearly, a constructivist epistemology that fosters collaboration would increase the likelihood of successful involvement with wikis and collaborative writing. As Cole (2009) pointed out, it is not enough to simply use wikis in courses without radical change of the pedagogy and learning paradigm, and expect students to automatically collaborate and participate. Rather, course content and pedagogy need to be redesigned to realize the potential capabilities of wiki-based collaborative writing in educational settings. It follows from these considerations that the collaborative writing approach presented in this paper will not work fully unless students are accustomed to collaborative learning and practices. Students should be given more time to experiment and familiarize with those practices and receive support throughout the course. Clearly, unless students are given the opportunity to experiment constructivist practices, the "wiki way" will not work by itself, and it will not make collaborative writing automatically happen.

Conclusions and Future Research

The results of this work cannot be generalized due to the small sample size, which limits the scope of the study, even though the findings reflect some consistency with those reported in the research literature. The data presented in this paper are only an initial pre-study of the pedagogical value of the collaborative writing approach. It serves as a basic for future studies in wiki-based collaborative writing. Future research work with more participants may lead to more robust results. Beyond the generalization issue, the second limitation are the methods used to judge the educational value of collaborative writing, in particular peer-review, which requires a high level of critical and analytical thinking, and deep level of engagement with the content. Obviously, this cannot be expected from most students without training in peer-review. It may also be necessary to refine the other instruments for measuring the students' perceptions of collaborative writing to ensure their validity and reliability. The third limitation that can promote or hinder the success of wikis in higher education is time. Eight weeks of group writing was too short to investigate the growth of writing capabilities. Indeed, research reveals that information technology can provide positive learning opportunities, but it takes time (Hayes, 2007; Teartle, 2004). Accordingly, the overall impression is that the use and evaluation of wikis is highly dependent upon the availability of time to think deeply about collaborative writing.

Despite the limitations, the applications were pivotal for both the instructor and the students as developers of the wikis, revealing the challenges of creating wiki-based applications from the ground on the basis of a collaborative writing development approach. The experiences that have been reported in this paper demonstrate that the use of a new technology that opens for collaborative writing and group interaction can never be easy or straightforward. Clearly, a number of technological, pedagogical, and cultural issues need to be addressed in order to promote wikis as collaborative learning tools.

Future work will focus on the refinement of the collaborative writing approach to wiki through a continuous cycle of gradual refinement according the Design-Based Research paradigm (The Design-Based Research Collective, 2003). It is also important to further investigate the factors that may influence the use of wiki-based environments in higher education. Finally, the approach will be further developed on the basis of a systematic review. To that end, future research will seek to extract theories from empirical studies that could explain whether or not the underlying pedagogical models used in wikis are considered as successful and whether they produce effective learning. The research will try to gain insights and explanations that would be generalizable across the range of different types of educational models.

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Biography



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