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A Co-writing Development Approachto Wikis: PedagogicalIssues and Implications

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Abstract**—**Wikis are promoted as collaborative writing tools that allow students to transform a text into a collective document by information sharing and group reflection. However, despite the promising collaborative capabilities of wikis, their pedagogical value regarding collaborative writing is still questionable. Wiki alone cannot make collaborative writing happen, and students do not automatically become more active, participate, and collaborate with others when they use wikis. To foster collaborative writing and active involvement in wiki development there is a need for a systematic approach to wikis. Themain goal of this paper is to propose and evaluate a co-writing approach to the development of wikis, along with the study of three wiki applications to report on pedagogical implications of collaborative writing in higher education.

Keywords**—**Co-writing development approach, MediaWiki, socio-constructivist epistemology, wiki.

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I. INTRODUCTION

WIKIS enable the collaborative building of Web-based pages. 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. In addition, teachers can use wikis for collaborative curriculum design and for course content authoring [1], [2], [3], [4], [5]. Clearly, wikis provide teachers and educators with potentially significant opportunities for creating socially engaged tasks that require active student participation and collaboration. The collaborative dimension of wikis allow students to work together to build, create, and develop content on the Web, giving them a sense of how writing can be performed in collaboration.

However, despite the potential capabilities of wikis, true collaboration does not work by itself as the research literature clearly reveals [6], [7], [8], [9]. To foster collaborative writing, participation, and active involvement in wiki development, there is a need for a systematic development approach to wikis. The main goal of this work is to design and evaluate a co-writing approach to wikis that can be used to create wiki applications in higher education.

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The remainder of this article is structured as follows. First, the research goal of the work is presented. Second, the co-writingapproach to wikis is outlined. Third, a case study is presented. This is followed by the discussion of the findings and pedagogical implications of collaborative writing. Finally, the challenges of collaborative writingand future research directions conclude the article.

II. RESEARCH GOAL

The aim of this paper is to propose and evaluate a co-writing approach to the development of wikis, along with the study of three wiki applications to report on pedagogicalissues and implications of wiki-based collaborative writing in higher education.Pedagogical issues include the students' experiences with the co-writing approach, the students' subjective perceptions of collaborative writing, and a critical analysis of the students' writings.

The main characteristic of collaborative writing is that it involves the production of a document by more than one author [10], [11]. Accordingly, collaborative writing is an activity that transforms an initial document into a collective text following a co-writing development approach. Collaborative writing offers opportunities not only to practice literature review, academic reading and writing, but also to stimulate reflection, collaboration, knowledge sharing, and critical thinking [12].

III. LITERATURE REVIEW

A large body of research work exists on positive experiences with wikis, for example [2], [12], [14], [15]. However, despite positive results, there still are a number of criticisms regarding the pedagogical value of wikis in comparison with traditional ways of learning.

First, Cole [6] indicated that very few researchers highlight the negative consequences of the integration of a poorly designed wiki into existing formats. Furthermore, a number of research studies seem to confirm that students appear to favor individual work over collaboration using wikis.

Second, Elgort, Smith, and Toland [16] pointed out that a significant number 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 [17] reported 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

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to be a serious problem. In this regard, Cole [6] reported that after five weeks, the students had not contributed to the wiki at all.

In addition, 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 [19]. In this regard, Minocha and Thomas [4] 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.

Moreover, Meishar-Tal and Gorsky [8] 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 [4] pointed out that there is a need to support the discussion aspects of collaborative activities with more appropriate tools. 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 [14].

Finally, despite wikis' potential capabilities, Dron [7] 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 they are many ways that social software can fail to address the learners' needs.

IV. CO-WRITING APPROACH TO WIKIS

To foster collaborative writing, participation, and active involvement in the development of wiki, there is a need for a systematic co-writing approach to wikis. The approach includes both software development considerations and pedagogical issues. Particularly important for wikis from the pedagogical point of view is the consideration of writing processes as emerging from collaborations between students.

The approach is similar to the one developed by Trentin [11], which has been slightly modified to include wiki architecture, page integration, and rapid prototyping to speed up the process of developing wiki-based applications over a short period of time since traditional methodologies are time-consuming [19]. In addition, the approach is iterativethroughout the whole development process, because a number of revisions are necessary to improve the quality of the wikis through a continuous cycle of gradual refinement.

The proposed approach is used to structure and organize the development process of the wikis. It has four major stages (Figure 1):

- Information gathering
- wiki architecture
- creation of wiki content and page integration, and
- peer review

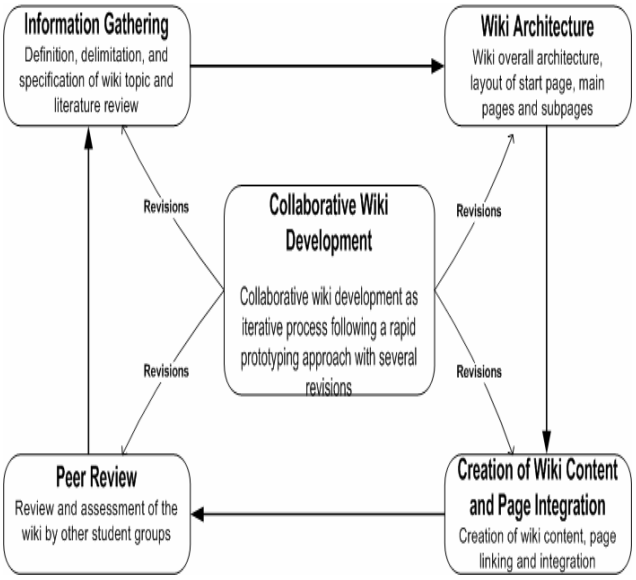


Fig. 1Co-writing approach to Wikis with four major phases

A. Information Gathering

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.

B. Wiki Architecture

This activity is concerned with the wiki overall architecture, which is usually hierarchical with the top as the start page. The wiki is divided into main pages that have one or more subpages. 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.

C. Creation of Wiki Content and Page Integration

The project members develop individually the various parts of the wiki that are assigned to them, and in this manner create a wiki applicationusing a "top-down" procedure. The project members are advised to proceed step by step to develop 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 keywords 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. Keywords need to be discussed within the group.

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 linked to their own pages. This activity fosters a better understanding of the

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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 designed. 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 of 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 2 shows how project members (student 1, 2, 3, and 4) work collaboratively to transform a initial document consisting of pages associated with each member of the group to a collective text, resulting from the transformation of the text from an hierarchical organization to a network structure.

Once the network architecture is created, wiki development continues with page assessment and integration. This activity 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. The activity consists of checking whether the wiki meets the requirements for content, linking, and quality of information. Students may suggest improvements of the respective pages, as well as the way the pages will be integrated into a comprehensive wiki. This phase 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.

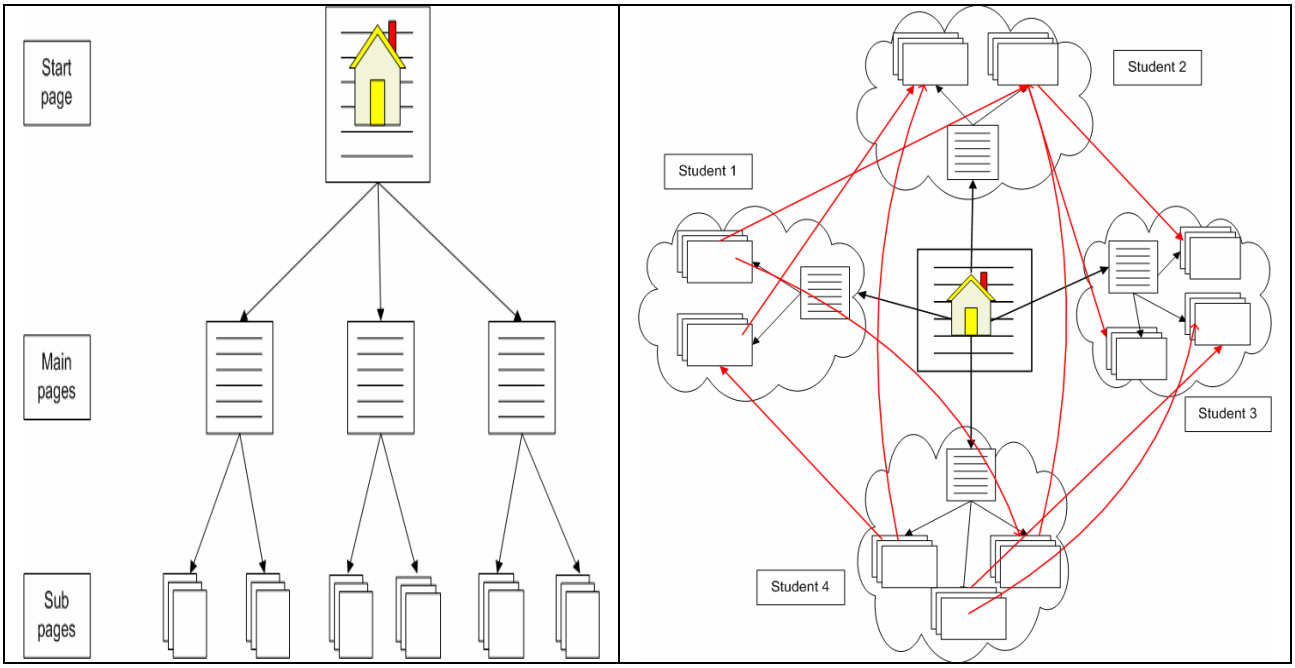


Fig. 2 Transformation of a wiki from a hierarchical organization to a network structure

D. Peer Review

Wiki development should foster collaboration and interaction between the project groups. To achieve this, the wiki applications need to undergo a peer review assessment process. Students are asked to review the wiki applications that other groups have developed. They are recommended to 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 are asked to use the group discussion function of the wiki tool to review the respective wiki applications.

V. CASE STUDY

This work uses a case study to examine the pedagogical benefits and limitations of the co-writing approach to wikis. The study is situated in higher education. The units of study are students' wiki applications that were developed using the co-writing approach and the MediaWiki tool as a software platform [20].

Participants were students taking the course in Web 2.0 technologies. Data from the case study came from students involved in three different wiki applications associated with collaborative writing projects. The students were instructed to use the co-writing approach to develop their wikis.

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The subjects of the wikis were chosen by the students themselves in collaboration with the teacher. The objectives, topics, and situations, in which the wikis were developed, are associated with the following subjects: (a) Information technologies and learning in secondary education; (b) Data security and privacy for young computer users; and (c) Food and health issues and the link between them for all categories of people.

The wikis were developed by three teams of students, using the co-writing approach, in collaboration with the university teacher, who provided academic supervision, on the one hand, and fellow students, who provided peer review, on the other hand. Collaboration and peer review occurred by means of the discussion forum associated with the wiki tool, but also by other communication channels. Students were required to meet a number of deadlines.

To investigate the pedagogical value of the co-writing approach to wikis, mixed methods and their triangulation were used to collect qualitative data:

- Self-evaluation and peer review to assess the students' perceptions of collaborative writing.
- Project supervision and informal discussions with the students over the duration of the projects.
- Analysis of students' final project reports.
- Analysis of the wiki final products and previous versions (prototypes) of the wikis associated with thewritingsthat the students performed gradually using rapid prototyping.
- Analysis of students' discussion protocols in the respective wikis.

Students' experiences with the co-writing approach were evaluated byinformal discussions, project supervision,and analysis of the final project reports.

Students' perceptions of collaborative writing were assessed by self-evaluation and peerreview. Students self-evaluated their own wiki as a team. The goal of peer-review is to assess whether others' wikissupport collaborative writing.Students were asked to review the wikis that other groups have developed, and suggest constructive comments and improvements of the wikis. Peer-review was carried out individually by each student. The results of self-evaluation and peerreview were analyzed and interpreted qualitatively. Both self-evaluation and peer review used four open-ended questions:

a) Do you think that wikis foster collaborative writing?
b) What do you think about the degree of collaboration?
c) Do you like to interact with the material that other students posted in the wiki?
d) Do you think that the discussion forum of the MediaWikitool provides support for collaboration?

Finally, the evaluation of students' writings was done on the basis of the wiki final products and previous versions of the wikis (prototypes). In this regard, it important to mention that the MediaWiki tool is particularly useful to support data analysis because it kept track of the students' writings and other contributions to the wikis made by each member of the groups and between the groups. The analysis of the data, which are automatically produced by the MediaWiki tool, will reveal whether or not they support the students' subjective perceptions of collaborative writing and students' experiences with the co-writing approach.

VI. FINDINGS

The findings describe the students' experiences with the co-writing development approach to wikis and their perceptions of collaborative writing after eight weeks of project work. A global and critical analysis of students' collaborative writingand group discussions is undertaken as well.

A. Students' Experiences with the Co-Writing Approach

During the development process, the student groups were supposed to create a number of wiki prototypes associated with collective texts that need to be gradually improved collaboratively. The groups had four deadlines, one for each important prototype during the development process.

The data collected by informal discussions, project supervision and final 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 prefer 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 student groups were confronted with the task of finding reliable information about the content of the wikis in the information gathering phase.
- Also the question of size and content of the start page, main pages, and sub pages created inconsistencies that needed to be resolved through revisions of the wiki architecture.
- Difficulties to specify the key words (concepts) that need to be used to link clusters of pages.
- Integration of pages did not follow a systematic procedure resulting in inconsistencies, typographical errors, graphical representations, cross referencing and navigation errors.
- Peer review was mostly positive, with the exception of some critical issues, 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.

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- The development process was very demanding in terms of efforts and time.

As a result, the wikis were rather of average quality from the content point of view. They lacked graphics elements, illustrations, and background colors that could have made the wiki 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 wikis 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 wiki products were mainly composed of texts, tables, and some images. Finally, the storage of temporal versions of the wiki applications through the history function was challenging when the applications scaled up.

Despite these difficulties, students pointed out that the wikis 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 cannot always cover the entire knowledge level of the users.

B. Students' Perceptions of Collaborative Writing

An analysis of students' perceptions of collaborative writing based oneansof four open-ended questions associated with self-evaluation and peer review indicate that most students characterized collaborationas a meaningful activity that supports group discussion, information sharing, and interaction with the material that other students posted in the wiki. However, most students believed that wiki-based collaborative writing needs to be supported by other means of communicationin order to foster genuine collaboration.

In addition, most students believed that the degree of 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 forum is too poor when used as a collaborative forum. The student'sname and contribution date should come up automatically"*.

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 wiki discussion forum is not the ideal arena through which to promote genuine collaboration. Rather, collaboration is more beneficial when the tool is combined with face-to-face communication, and eventually supplemented with email, FaceBook and other Web 2.0 technologies. This indicates that the wiki tool was not used alone as the only communication channel between students. This is in line with the data collected by means of students' discussion protocols, which indicate thatmost contributions to discussions were related to editing, formatting, and technical aspects of the wiki tool, rather than critically discussing the wiki content.As a consequence, most students believed that the combination of synchronous and asynchronous forms of communication is more beneficial to collaboration than wiki-based discussions alone. Finally, students agreed that working in a group is more beneficial to the learning process than working alone.

C. Global Analysis of Students' Collaborative Writing

Contrary to the students' subjective perceptions of collaborative writing, a global and objective analysis of the wiki final products and previous versions of the wikis (prototypes) once the wikis were delivered shows a very different picture of collaborative writing. Indeed, a careful analysis of the students' writings based on the final wiki products and 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 globally in line with the students' experiences with co-writing approach.

In addition, the students' contributions were not evenly distributed among members of the same project groups. The degree to which students contributed to the wiki tasks also varied considerably. Looking at the types of activities that the students performed, the following categories can be distinguished: add content, delete content, format content, and modify content that other students have created. Most activities were related tothe three first categories. Few activities were associated with "modify content". Group members mostly worked on individual sections of the wiki. 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.

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It is, indeed, important 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*" [21, pp. 190], cited in [22]. 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*" [23, pp. 464-465], cited in [16].

It is clear from the definition above that students' contributions fall under "cooperation" rather than "collaboration". One reason for the poor quality of collaboration writing is the students' lack of collaborative skills and experience with collaborative writing. 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", unless students possess collaborative, reading, and writing skills [22].

Another reason is the lack of motivation to use wiki in a collaborative manner. Indeed, the data collected by self-evaluation and peer review 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.

As a result, while the findings show that the students have the potential to be motivated by the wiki topics, their contributions to collaborative writing indicate a low level of engagement, shortcuts in information analysis, heavy use of information found on Wikipedia and Internet, poor writing and integration strategies, insufficient systematic testing, and lack of deadline awareness.

VII. PEDAGOGICAL IMPLICATIONS

Despite using a disciplined approach to wikis that was intended to support collaborative writing, the students experienced several problems with the approach, mostly because they lacked pre-requisite knowledge, skills, and co-writing strategies. Indeed, the findings indicate that the students encountered difficulties throughout all the development phases of the collaborative writing approach. 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.

As a result, it appears that the "wiki way" of collaboration does not work by itself for many reasons[10]. Firstly, Notari [24] 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, the time needed to monitor and assess the students' contributions and content may be a real challenge for any teacher [25].

Secondly, true collaboration is also dependent on the students' critical perceptions of wiki affordances and constraints, which can restrict the students to express themselves naturally to avoid conflict and critical reflections with peers [26]. Moreover, true collaborative writing may be a real challenge for many students as it is cognitively demanding in terms of 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 [27]. Otherwise, students tend to accumulate informationabout the wiki topic as the history function of the wiki clearly shows.

This work agrees with [28] that 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 socio-constructivist learning epistemology associated with wikis, which promotes participation and collaboration. The socio-constructivist learning epistemology [29] and related theories, such as communities of practices [30], 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 were confronted with are to a large extent determined by the academic practices and associated learning epistemology in which the students are involved, which do not involve a high level of collaboration with fellow students. Basically, existing pedagogical practices in higher education still rely on the behaviorist learning epistemology. These practices are incompatible with the underlying epistemology of wiki technologies, which entail that collaboration and active participation became indispensable for learning.

As collaboration, critical reflection 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 to supportcollaboration cannot be realized without a shift from instructor-delivered teaching to student-facilitated and wiki-based learning where group discussion, acquisition of higher-order thinking skills, critical awareness, and collaborative writing play an important role. According to Lamb [31], true constructive learning requires educators 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. Despite technological weaknesses,

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it is possible for teachers to use wiki technology to guide students design advanced wiki applications that stimulate collaborative writing. This, in turn, requires that teachers possess sufficient collaborative writing skills as well. Unfortunately, this is not always the case. As Cole [6] 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.

The co-writing approach presented in this paper will not work fully unless the 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. A socio-constructivist epistemology that fosters collaboration would increase the likelihood of successful involvement with wikis and collaborative writing. 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.

VIII. LIMITATIONS

The findings cannot be generalized because ofthe small sample size. Beyond the generalization issue, the second limitation are the instruments used to judge the pedagogical value of collaborative writing, in particular self-evaluation and 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 many students without training and teacher guidance. It may be necessary to refine these instruments 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 [32]. 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.

IV. CONCLUSIONS AND FUTURE WORK

Despite the limitations, the wiki projects were pivotal for both the instructor and the students, revealing the challenges of creating wiki-based applications from the ground on the basis of a co-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 can never be easy or straightforward. Clearly, a number of technological, pedagogical, and cultural issues need to be addressed to promote wikis as collaborative learning tools.

Future work will focus on the refinement of the co-writing development approach to wiki. 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 pedagogical models associated with the 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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