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COMPARING USER EXPERIENCES IN USING TWIKI & MEDIAWIKI TO FACILITATE COLLABORATIVE LEARNING

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This research seeks to determine the perceived effectiveness of using TWiki and MediaWiki in collaborative work and knowledge management; and to compare the use of TWiki and MediaWiki in terms of user experiences in the master's level of study at the University of Hong Kong. Through a multiple case study approach, the study adopted a mixed methods research design which used both quantitative and qualitative methods to analyze findings from specific user groups in two study programmes. In the study, both wiki platforms were regarded as suitable tools for group work co-construction, which were found to be effective in improving group collaboration and work quality. Wikis were also viewed as enabling tools for knowledge management. MediaWiki was rated more favorably than TWiki, especially in the ease of use and enjoyment experienced. The paper should be of interest to educators who may want to explore wiki as a platform to enhance students' collaborative group work.

1. Introduction

Rote learning, which focuses on the direct transmission of knowledge from teachers to students using a traditional didactic approach, is the prevalent norm in education in many countries (Jang, 2007). However, research has shown that this teaching method in which students passively absorb what the teacher explains is not effective (van Aalst et al., 2007) and it does not prepare students for productive lives in the workforce and society (Ravitz, 2008). Constructivism argues that active learning is not just about listening to and mirroring a correct view, but that it involves a student participating in and interacting with the real world and surrounding environment (Wilson & Lowry, 2000). In the past two decades, constructivism has gradually changed curriculum focus from exam-based to inquiry project-based learning (PBL) (Chu, 2009), an instructional method that encourages resolving authentic, real life problems (van Rooij, 2009). PBL has been

identified as a learning method that helps students in developing a better understanding of the selected subject matters (Thomas, 2000). In PBL, students engage in the application of knowledge, social interaction and collaboration to solve complex problems (van Rooij, 2009). Thus, collaborative learning has been widely recognized as an approach to encourage active, authentic, student-centered learning (Knowles & Hennequin, 2004).

Technological systems are important elements in PBL to manage different information sources generated in PBL scenarios (Pape et al., 2002). Web-based applications such as wikis have been used in PBL scenarios in higher education (Molyneaux & Brumley, 2007). Wikis' powerful information sharing and straightforward collaboration features make them particularly well suited for promoting cooperative learning environments (Schaffert, Bischof, et al., 2006). The different features and functionalities of various wikis themselves can influence the effectiveness of the learning experience (Bower et al. 2006), because subtle differences in technology can impact the social educational environment (Gunawardena & McIsaac 2004). It is therefore important to identify the wiki applications that offer positive user experiences and the wiki features that facilitate effective collaboration. While technical comparisons of different wikis are available (e.g., Tonkin 2005), there is a dearth of research on empirical comparisons of wiki use in higher education (Elgort et al., 2008). This research contributes to the literature by comparing the use of two comprehensive and popular wikis – TWiki and MediaWiki - in postgraduate students' group project work at the University of Hong Kong. The main research objectives are: 1) To determine the perceived effectiveness of using TWiki and MediaWiki in collaborative work and knowledge management; and 2) To compare the use of TWiki and MediaWiki in terms of user experiences.

2. Literature Review

2.1 From Rote Learning to Inquiry Project-Based Learning

Rote Learning remains to be the norm of today's classrooms in many countries (Harada & Yoshina, 2004). Ausubel (1963) defined rote learning as "arbitrary, verbatim, non-substantive incorporation of new ideas into cognitive structure; information does enter cognitive structure, but with no specific relevance to existing concept/propositional frameworks". A distinct disadvantage of rote learning is that students fail to notice associations between the material being learned and previous knowledge (Cakir, 2008).

Constructivism, on the other hand, emphasizes individual learners' role in constructing meaning, instead of a mechanical transmission of content from teacher to student (Duffy & Cunningham, 1996). It has been commonly regarded as a shift in paradigm in education psychology, in which knowledge is not "mechanically acquired, but actively constructed within the constraints and offerings of the learning environment" (Liu & Mathews, 2005). Learners "are required to examine thinking and learning processes; collect, record, and analyze data; formulate and test hypotheses; reflect on previous understand; and construct their own meaning" (Crotty, 1994). This approach

engage learners so that knowledge constructed are usable in new and different situations (Jonassen et al., 1995). This learning theory has impacted curriculums worldwide across different levels and has led to a gradual shift from exam-based to project-based learning (Chu et al., 2008). **Project-based learning** allows students to deal with problems in order to master facts and key concepts in the subject matter, rather than learning and acquiring concepts in a rote fashion (Norman & Schmidt, 1992). PBL is one of the instructional methods that encourages learners to resolve authentic, real life problems (van Rooij 2009). Different from other school projects, PBL involves students in “a constructive investigation that involves inquiry, knowledge building, and resolution” (Thomas, 2000). It has been identified as a learning method that helps students in having better understanding of the selected subject matters (Thomas, 2000). Research has shown that PBL is used often as a central element of academic reform (Ravitz, 2008).

2.2 Knowledge Construction and Sharing

Knowledge Construction is often viewed as a form of collaborative activity that leads to the shared understanding of concepts (Lipponen, 2002). Effectiveness of knowledge construction is affected by factors such as student interactions and tools they use for communication (Veerman & Veldhuis-Diermanse, 2001). Hmelo-Silver, Duncan and Chinn argue that inquiry-based learning approaches like PBL “promote the construction of knowledge we recognize as learning” by involving learners in the “practices and conceptualizations of the discipline” with appropriate scaffolding (2007, p105). **Knowledge sharing** provides a link between the level of the individual knowledge users, where knowledge resides, and the level of the community, where knowledge attains its value (Hendriks, 1999). Recent research has illustrated that teaching and learning in a higher education setting can be enhanced using Knowledge Management (KM) (McCarthy, 2006). Scardamalia and Bereiter (2006) explained that “the main uses of knowledge” in education “are in the creation of further knowledge.” They suggested that the main value of considering students as members of a knowledge building community is to give “rise to and speed the development of yet newer knowledge” (2006, p5). Nonaka and Takeuchi’s (1995) work on the SECI model for knowledge creation laid the foundation for many of the research on KM in Education (e.g. Edge, 2005). They explained that knowledge creation is a spiraling process of interactions between explicit and tacit knowledge and they called the interaction of these two forms of knowledge the four-stage knowledge conversion process: socialization, externalization, combination, and internalization (1995).

2.3 Wiki in Education

Web-based environments have become important forums for joint problem-solving, knowledge building and sharing (Nevgi, et, al., 2006), which enable learners to practice,

collaborate, reflect critically, negotiate, and build consensus similar to face-to-face learning environments (Liaw, et al., 2008). Scholars foresee the benefits of using collaborative web-based tools to promote learning within the constructivist approach (Richardson, 1998). Recent developments in the use of web technologies in project-based learning led to exploration of the use of wikis in project work and management (Molyneaux & Brumley, 2007). Past research have explored the use of wiki in education in four main areas: 1) rationale for using wikis, 2) collaborative learning and writing using wikis, 3) knowledge building and management using wikis, and 4) sharing and structuring of information (Chu, 2008; Coyle, 2007; De Pedro et al., 2006; Engstrom & Jewett, 2005; Lio et al., 2005).

TWiki, an enterprise wiki tool that can be used as a project development space or a knowledge base (Chu, 2008), has been considered as a collaborative tool for development of educational papers and technical projects (Raygan & Green, 2002). A recent study by Chu (2008) reported that undergraduates perceived a general improvement in their quality of work through better collaboration on TWiki. *MediaWiki*, on the other hand, gained its reputation and popularity as the software used by Wikipedia. Augar, Raitman, and Zhou (2004) have successfully used MediaWiki to enhance social interaction in an icebreaker assignment in Deakin University. Bruns and Humphreys (2005) adopted MediaWiki for developing an encyclopedia in an undergraduate new media technologies course, which broadened the contributor base and raised some academic interest to have classes collaborate on MediaWiki (e.g. Foley & Chang, 2006).

2.4 Research Gap

Research shows that the characteristics of wiki support group collaboration while different wiki applications with different features/functions may have impact on learning experience. However, comparisons on learning experience in collaboration, knowledge sharing and creation activities with different wikis as well as word processing tools in higher education are rare. With the aim of contributing to the empirical evidence on using different wikis for collaboration, this study explored and compared the use of two comprehensive wikis – TWiki and MediaWiki in the master's level of study at the University of Hong Kong.

3. Research Method

This study used a multiple case study approach (Yin, 1994). It also adopted a mixed methods research design which used both quantitative and qualitative methods to provide analysis to the student groups below.

Research participants included 21 postgraduate students of Master of Science in Library and Information Management (MScLIM), who were enrolled in the Information Behavior (IB) course, and 16 postgraduate students for the Master of Science in Information Technology in Education (MScITE), who were enrolled in the course on

Designing Shared Virtual Environments for Learning (DSVEL). All students were part-time students with full-time employment. For the IB course, the collaborative group project consisted of a small study on the information behaviour of a specific user group. The research report was co-constructed using TWiki. The work consisted of submission in four phases: (1) research proposal with relevant literature, (2) draft of the study design, (3) preliminary results, and (4) final report that includes discussion of previous studies in the area of interest. Students enrolled in DSVEL were required to use MediaWiki on a regular basis during the course to communicate and collaborate with other students on the subject, and used the tool to complete a major project at the end of course.

3.1 Research Questions

This study aimed to address the following questions: 1) What are some of the similarities and differences in user experiences when using TWiki and MediaWiki? 2) What are some of the perceived effectiveness of using the two wikis for collaborative learning? 3) How effective is wiki as a knowledge management tool to enable knowledge creation and sharing? 4) What positive/negative values are perceived by the students when Wiki is compared with popular word processing tools in collaborative learning?

3.2 TWiki and MediaWiki platform

The lecturer designed wiki templates for the students' projects which could be modified by students according to their needs. The TWiki workspace consists of three parts, namely "Progress," "Discussion," and "Report." The MediaWiki platform consists of both "Progress" and "Discussion". "Progress" is a page created for students to write their draft reports, whereas the "Report" page is for the finalized reports. Students are free to discuss any issues relating to their projects on the "Discussion" page. The templates for "Progress" and "Report" are initially identical; students then modify them in accordance with the design of their group project (Figure 1 & 2).

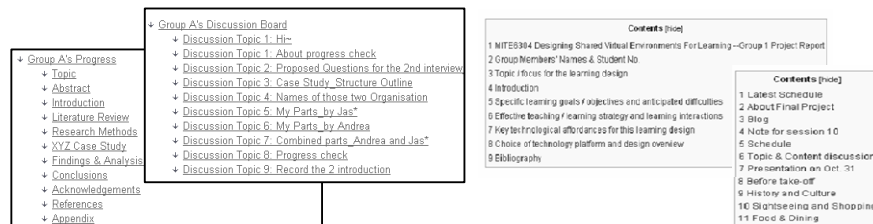


Fig. 1 (left) TWiki & Fig. 2 (right) MediaWiki templates for "group progress"/"group discussion" respectively

3.5 Evaluation and Data Analysis

To evaluate the individual collaborative contributions, the log data of both TWiki and MediaWiki were retrieved through the wiki websites upon completion of the courses.

Questionnaires were conducted to examine participants' perceptions on the effectiveness of wiki tools in collaborative work and knowledge management. Such factors were examined in the questionnaire including closed-ended questions that used a 5-point scale, and a few open-ended questions to explore the participants' opinions further. The perceptions of TWiki users and MediaWiki users were compared to examine differences.

The data were analyzed using SPSS (windows version 16.0). For each survey question requiring ratings, one-sample Kolmogorov-Smirnov test and histogram were used to test the normality of students' ratings. Since the results showed that the normality of data was questionable ($p < 0.05$ in Kolmogorov-Smirnov test and skewed histograms), non-parametric tests were used. Ratings in the survey questions were compared between students using TWiki and those using MediaWiki with the Mann-Whitney test. Alpha level was set at $p < 0.05$ for all statistical tests. For the open-ended questions, comments with similar meaning were grouped together and analyzed using NVivo version 7.0. External audit was done to verify the accuracy of the interpretations by having two research assistants perform the coding independently, and through discussion, come up with a consensus on the themes (Creswell, 2008).

4. Findings and Analysis

4.1 Perceived effectiveness of using TWiki and MediaWiki

The perceived effectiveness of TWiki and MediaWiki in the collaborative group projects was examined in terms of collaborative activities, group work quality, ease of use, enjoyment and suitability for the task. Table 1 summarizes the responses of both groups of students and statistical comparisons of two groups.

Table 1 Students' perceived effectiveness of TWiki and MediaWiki for collaborative group project

Effectiveness Component	TWiki	MediaWiki	Results from Mann-Whitney test: p-value
	Mean; Standard Deviation (N = 20)	Mean; Standard Deviation (N = 16)	
Improved collaborative activities ^a	3.23; 1.057	3.63; 0.806	0.328
Improved quality of group report ^a	3.23; 1.129	3.20; 0.775	0.710
Ease to use ^b	3.00; 1.076	3.75; 0.931	0.050 [#]
Enjoyment ^a	2.90; 1.021	3.63; 0.957	0.036*
Suitability ^a	3.60; 0.805	3.94; 0.772	0.147

Note:

^aRespondents answered according to a 5-point Likert-type scale, with 1 as "not at all" and 5 as "very much so".

^bRespondents answered according to a 5-point Likert-type scale, with 1 as "very difficult" and 5 as "very easy".

* $p < 0.05$: statistical significance/ [#] $p = 0.05$: close to the confidence level of statistical significance

The results indicate that ratings are all above the middle of the scale. No significant differences were found between TWiki and MediaWiki users in terms of collaborative activities and group work quality, indicating that both groups of users perceived the use of wiki tools to be effective in facilitating collaborative group project. The highest ratings were observed for the item on the suitability of TWiki (M=3.60) and MediaWiki (M=3.94) for the task, indicating that students found both wikis to be suitable for group project work. One student commented that wiki improved their work efficiency and learning atmosphere, because “amendments can be made easily” and “discussion is no longer restrained by time and place” (MScLIM 1). Most students perceived wiki’s history tracking function as a key feature that contributes to its suitability for group collaboration, for they could use it to check the working progress and retrieve older versions of entry.

All students found it relatively easy to use wiki tools in their group projects. MediaWiki was perceived as easier to use (M=3.75) compared to TWiki (M=3.00). They also perceived MediaWiki as more enjoyable (M=3.62) compared to TWiki (M=2.90). One student (MScITE2) even mentioned MediaWiki released her from the formatting problem that she encountered when using the word processor. On the other hand, one TWiki user (MScLIM3) pointed out that doing formatting work in TWiki was time-consuming, while another student (MScLIM19) noted the difficulties with posting materials on TWiki. It appears that there is much room for TWiki to improve in terms of providing an interface that will increase users’ enjoyment.

Among the first four items examined, TWiki was perceived to be a good tool for improving collaborative activities and group work quality, but it received the lowest ratings in users’ enjoyment. MediaWiki, on the other hand, seems to have an advantage in improving collaborative activities, while it is found to be easy and exciting to use. However, users have doubts about its impacts on improving group project quality. Overall, MediaWiki received higher ratings than TWiki in terms of suitability, which indicated that the students regarded the ease of use and user-friendly interface of MediaWiki to be quite important for its qualification as a suitable collaboration tool.

4.2 TWiki and MediaWiki as tools for Knowledge Management

Students rated TWiki and MediaWiki as an enabling tool for knowledge management using a 5-point scale. Two aspects of knowledge management were examined: knowledge creation and knowledge sharing. TWiki and MediaWiki were rated positively for both aspects of knowledge management with ratings ranging from 3.5 to 4.3 (Fig 3). In this study, it appears that users perceive wiki tools to be useful in enhancing their abilities for knowledge management activities. MediaWiki received higher ratings than TWiki on both aspects, although the result is not statistical significant ($p > 0.05$).

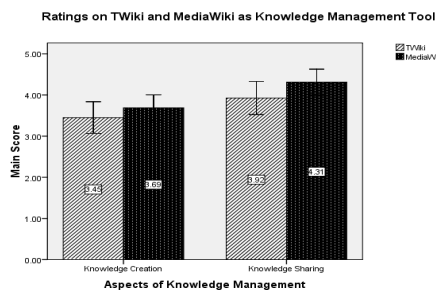


Fig 3 Ratings on the use of MediaWiki for knowledge management: Note: Respondents were answering according to a 5-point scale, with 1 as “not at all” and 5 as “very much so”

Comparing students’ ratings on knowledge creation and knowledge sharing, both groups of users gave significantly lower ratings to the potential for these technologies to enable knowledge creation ($p < 0.001$ for TWiki, and $p = 0.009$ for MediaWiki). This indicates that from the students’ perspective, wikis could work more effectively in providing a platform for knowledge sharing, rather than for knowledge creation. As researchers pointed out, wikis were most useful as tools to manage and update existing knowledge, but they were of limited use in collaboratively creating new knowledge (Raman et al. 2005). Nevertheless, interviews showed that both wiki platforms are still viewed to be useful for both KM aspects. One TWiki user (MScLIM 1) noted that TWiki allows for effective communication which assists the interaction among group members and results in the improvement of one’s work. The availability of different groups’ work also facilitates brainstorming and knowledge sharing. One MediaWiki user (MScITE 8) mentioned “MediaWiki is a constructivist learning tool that provides a good platform for students to construct knowledge and share freely”.

4.3 TWiki and MediaWiki as a tool in future course design

The study examined if TWiki or MediaWiki were recommended by participants for students’ group project work in the future. 20 TWiki users and 16 MediaWiki users responded (Fig 4). For TWiki users, 65% (13 out of 20) preferred using TWiki in future course design, among which one student (MScLIM 10) suggested using TWiki and the word processor jointly as “the editing functions of TWiki are not powerful”. 20% (4 out of 20) of participants considered using TWiki depending on whether enough training is provided (MScLIM 8, 12 & 16) and on the students’ familiarity with the tool (MScLIM 7 & 16). 15% (3 out of 20) expressed their concerns about using TWiki because of the difficulties in using (MScLIM 1 & 3) and the time needed to learn the new tool (MScLIM 6). When asked whether they recommended using MediaWiki for KM course group project, 15 out of 16 respondents expressed their preference for MediaWiki answering great certainty, such as “of course”, “for sure”.

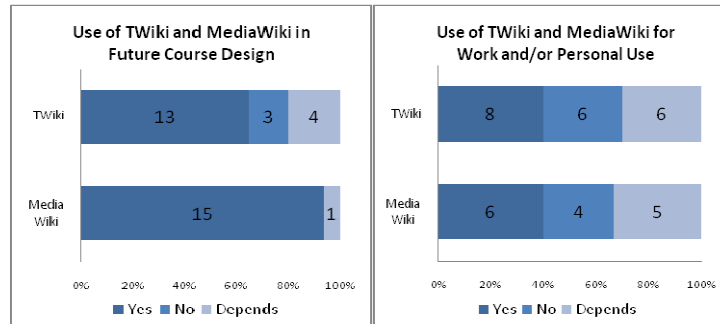


Fig. 4 (left) Responses on using TWiki and MediaWiki in future course design: Note: Fig. 4 (left) data were collected from 20 TWiki users and 16 MediaWiki users to the question: “Suppose you are the lecturer of the IB (KM) course, will you continue to use TWiki (MediaWiki) for students’ group project in the future?”

Fig. 5 (right) Responses on using TWiki and MediaWiki for work and/or personal use: Note: Fig 5 (right) data were collected from 20 TWiki users and 15 MediaWiki users to the question: “Do you think you may continue to use wiki for work and/or for personal reasons in the future?”

4.4 TWiki and MediaWiki as a tool for personal use

The study also examined if TWiki and MediaWiki were perceived by participants as something useful beyond the group projects. 20 TWiki users and 15 MediaWiki users responded on the possibility of adopting wiki software for future work and/or personal use (Fig 5). For TWiki users, 40% (8 out of 20) would continue to use TWiki in the future, among which 3 of them would only use it for work but not for personal purposes. 30% (6 out of 20) believed that the use of TWiki in the future depends on other factors such as their group members’ IT knowledge and job nature. The remaining 30% (6 out of 20) believed that they would not use TWiki in the future, as students complained (MScLIM 3) that the interface was “totally not user-friendly” and students were not familiar with the platform (MScLIM 7). Some users remarked that (MScLIM 1, 2 & 9) TWiki was not widely used in the work place and it would be difficult to encourage group members to use TWiki. For MediaWiki users, 40% (6 out of 20) would continue to use MediaWiki in the future, while 33% (5 out of 15) believed that the use of MediaWiki in the future depends on job nature and group size. As students (MscITE 7 & 11) pointed out, MediaWiki was more suitable for small group projects but might not suit the needs of large groups due to the multiple-input problem. The remaining 27% (4 out of 15) thought that they would not use MediaWiki due to the high level of IT skills required for setup and maintenance.

It is important to highlight that students’ responses may depend on the IT skills they possess. This echoes with observations in earlier research that new users of wikis need significant support on technical aspects of its use (Foley & Chang, 2006). Guidance and

interface design would have relevant implications on the development of wiki platforms for collaborative learning.

4.5 Comparison of TWiki and MediaWiki with the word processor

The use of the word processor is predominant in personal and collaborative work across all school level. Students, especially part-time students with full-time employment, are familiar with the word processor as a tool for creating documents. Students' responses to the open-ended question in the survey were analyzed regarding their opinions on TWiki, MediaWiki and the word processor for creating a group report.

It appears that more positive comments were given for the use of wiki software. The ability for collaboration, knowledge sharing and communication among group members seem to be the important points. For example, 50% of the users of TWiki agreed that it facilitated collaborative group work and knowledge sharing, while 40% agreed that it facilitated group communication. 69% of MediaWiki users said that it facilitated collaborative group work while 63% said that it facilitated knowledge sharing. Students commented that wiki allowed for more interaction among group members. The word processor functioned well for individual work, but it did not offer efficient facilitation for group projects. As for the negative aspect, the respondents identified the difficulty in formatting and unfamiliarity with wiki tools as key problems they faced with the online platforms, as students are used to processing their work with a word processor.

MediaWiki generally received more positive comments and less negative comments than TWiki in terms of the response percentage, which is consistent with the quantitative analysis presented above. MediaWiki seems to be more suitable for group collaboration and it is easier to use than TWiki. Some students even mentioned that MediaWiki is easier to use than the word processor. However, several MediaWiki users mentioned technical problems they met such as losing entries when doing multiple inputs, which was why many students considered MediaWiki as optimal only when the group size was small. Insufficient guidance hindered the efficient usage of MediaWiki because students were unfamiliar with the new software. They also met difficulties in maintaining their pages.

5. Limitations

The sample size of this study (21 TWiki/16 MediaWiki users) is comparatively small. In addition, differences in perceived effectiveness and user experiences of TWiki and MediaWiki cannot be solely attributed to wikis' different features. Course nature and students' background, although relatively comparable in this study, may still affect the study outcome. Furthermore, the use of questionnaires alone for the perceived effects of MediaWiki may be considered subjective to some extent.

6. Conclusion and Implications

The study set out to examine and compare the perceived effectiveness and user experiences of TWiki and MediaWiki in facilitating postgraduate group projects. Both wiki platforms were regarded as suitable tools for group work co-construction, which were found to be effective in improving collaboration within group and improving the quality of work. Wikis were also viewed as enabling tools for knowledge management.

MediaWiki was rated more favorably than TWiki, especially in the ease of use and enjoyment experienced. Part-time postgraduate students, having limited time to learn the technical aspects of online tools, seemed to consider the user-friendly interface as a key criterion for a wiki to be qualified as a suitable collaboration platform. The majority in both groups indicated that wiki is effective for knowledge sharing and recommended incorporating wiki into future course design. MediaWiki received stronger support than TWiki. However, students in both groups showed hesitation in applying wiki for future work and personal use, because they perceived the IT skills needed as a major obstacle.

Table 2 Comments given by TWiki / MediaWiki users about wiki software and the word processor

	Wiki Tool	Word Processor
Positive Comments	Comment (Response Number) [Response Percentage]	
TWiki	<ul style="list-style-type: none"> Facilitating collaborative group work (10) [50%] Facilitating knowledge sharing (10) [50%] Facilitating group communication (8) [40%] Keeping track of others' working progress (7) [35%] Working anywhere at any time (7) [35%] Keeping track of different versions (6) [30%] Referring to and learning from other groups (6) [30%] 	<ul style="list-style-type: none"> Higher familiarity (6) [30%] Working individually according to one's own schedule (1) [5%] Allowing easier facilitation of work (1) [5%] High security of documents (1) [5%] Same functions (1) [5%] User-friendly interface (1) [5%]
MediaWiki	<ul style="list-style-type: none"> Facilitating collaborative group work (11) [69%] Facilitating knowledge sharing (10) [63%] Referring to and learning from others (7) [44%] Facilitating group communication (5) [31%] Easy to use (5) [31%] Working anywhere at any time (5) [31%] Keeping track of different versions (5) [31%] Encouraging participation (4) [25%] Keeping track of others' working progress (2) [13%] 	<ul style="list-style-type: none"> Higher familiarity (2) [13%] User-friendly interface (1) [6%] Easy to print (1) [6%]
Negative Comments	Comments (Response Number) [Response Percentage]	
TWiki	<ul style="list-style-type: none"> Difficulty in formatting (13) [65%] Technical problems, e.g. server problem (7) [35%] Unfamiliar to use (5) [25%] Time consuming to learn editing tools (4) [20%] Insufficient training provided (3) [15%] Difficulty in using (3) [15%] Insufficient functions compared to alternatives (2) [10%] Not user-friendly (2) [10%] 	<ul style="list-style-type: none"> Overdependence on sending documents by emails (4) [20%] Difficult to identify others' contribution (3) [15%] Only allows individual work (1) [5%] Cannot compare with older version (1) [5%]
MediaWiki	<ul style="list-style-type: none"> Unfamiliar to use (5) [31%] Server and network problems (4) [25%] Difficult in using (3) [19%] Insufficient guidance provided (2) [13%] Require login (2) [13%] Multiple inputs problem (2) [13%] Low security of documents (2) [13%] 	<ul style="list-style-type: none"> Only allow individual work (6) [38%] Overdependence on sending documents by emails (2) [13%] Difficulty in formatting (1) [6%] Time consuming to combine work (1) [6%]

Note: Responses collected from 20 TWiki users and 16 MediaWiki users to the question: "When preparing a report for a group project in the past, you would in general use a word processor, e.g. Ms Word. How would you compare the two ways of creating a group report?"

The results of this study show that wiki has a promising potential for building a group collaboration and knowledge construction platform in PBL. Simplifying the formatting options and making the interface more user-friendly are needed in order to enable a smoother users' experience of these tools. Sufficient guidance and instruction from teachers are also important to facilitate students' collaboration on wikis and encourage their willingness to collaborate online.

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