

IS WIKI A GOOD TOOL FACILITATING TEAM COLLABORATION IN UNDERGRADUATE EDUCATION?

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Abstract

As one of the most popular Web 2.0 applications, the wiki has been widely acknowledged to be capable of promoting team collaboration. However the literature on adopting wiki in educational contexts has generated inconsistent results in performance consequences. The present study depicted a picture of how undergraduate students employed the wiki and explored whether the wiki usage could indeed promote team collaboration. Using an exploratory case study with multiple data sources, our results showed that using the wiki might transit a better evaluation of collaboration effectiveness by the students, though the actual performance seemed to be another independent issue. While some capabilities of the wiki were believed to promote collaboration, students' positive attitude toward the wiki was still limited due to several reasons. Findings were discussed and implications on how educators may reap the beneficial consequences of wiki use were suggested.

Keywords: the wiki, team collaboration, use, shaping behaviors.

1 INTRODUCTION

The advance of modern information and communication technologies enable more and more people to gain higher effectiveness and efficiency in not only social interaction but also collaborative task accomplishment. Business organizations as well as educational institutions have widely been engaged in the use of Web 2.0 technologies to facilitate collaboration, among which the wiki is one of the bright stars. Named after wikiwiki (“fast” in Hawaiian), the wiki is a web application with a set of linked web pages that is commonly used to support open source knowledge co-creation and sharing (Wagner 2004; Elgort et al. 2008; Bhatti et al. 2011). Wikipedia is one of the most notable applications of wiki technology utilizing the wisdom of crowd in public domain (Zhang et al. 2013).

In recent years, the wiki has gradually been adopted in educational practices for collaborative learning, at class or group levels (Putnik et al. 2011). Due to its low requirement on users’ technological knowledge (Zorko 2009; Wheeler et al. 2008; Elgort et al. 2008), the wiki can be employed in all levels of educational contexts, including primary schools (Ben-Zvi 2007). Prior research shows that students prefer to learn with the help of modern technologies like the wiki (Mirk et al. 2010). In the educational settings, good team collaboration has been found to be able to help students to learn better (Putnik et al. 2011) and enhance their academic achievement, personal development and learning satisfaction (Elgort et al. 2008). Although the literature widely suggests that wikis tend to promote team collaboration (Zorko 2009; Ben-Zvi 2007), the results of different studies are rather mixed, including positive (e.g. Minocha & Thomas 2007; Zhang et al. 2013), negative (e.g. Elgort et al. 2008) and insignificant conclusions (e.g. Mirk et al. 2010).

Shaping, a particular behavior in the context of wiki use, is defined as integrating, rewriting and reorganizing others’ work without adding any new information (Yates et al. 2009; Majchrzak et al. 2013). Research shows that information shared on wikis is likely to be messy and less useful if without necessary integration (Yates et al. 2009; Wu et al. 2010). Shaping behavior is considered as crucial as adding, and the shaper role has been one of the success factors of team collaboration (Majchrzak et al. 2006). The more efforts spent on shaping an article, the higher the quality of the final product (Kane 2011). Unfortunately shaping behavior has received relatively less attention, even rare in education and learning fields. Whether the shaping behavior represents majority of collaborative activities and whether it positively impacts collaborative learning are questions unresolved. The missing piece in a wiki strategy has largely prohibited the full exploitation of wiki technologies in education.

Adopting case study methodology, this study is designed to bring out the broader details of using wikis to facilitate team collaboration from the viewpoint of university students by using multiple sources of data. The main objective of the current research is two-folded. One, we aim to find out whether using the wiki can promote students’ team collaboration through knowledge sharing, co-creation and shaping behaviors. Two, we would like to explore how student teams employ the wiki technology, thus shedding a light on designing effective tactics of leveraging the advantages of wikis in educational contexts.

2 THEORETICAL BACKGROUND

2.1 Advantages and disadvantages of using the wiki in educational settings

As a typical Web 2.0 application, the wiki allows users to be editors and contributors instead of just readers or consumers of websites and contents. The word “wiki” is sometimes interpreted as “What I Know Is”, reflecting that the wiki has the function of knowledge contribution, storage and exchange (Ben-Zvi 2007).

Educational institutions and organizations nowadays enthusiastically respond to the wiki applications because of the advantages summarized below. Wiki is appealing, firstly, because of the convenience it brings to students. All authorized users can create, modify and delete the wiki pages easily (Shih et al.

2008). It can provide a common platform for the students working on the same project so that the communication with team members can be supported (Bhatti et al. 2011). By utilizing the wiki's commenting and discussion features, students can give suggestions and comments to peers without the support of other communication channels (Judd et al. 2010). In addition, wikis would keep a record of all the editing history including every version of the document, the corresponding author, the comments indicating the main reason of this edit and what major changes have been made, which can enable convenient version management (Shih et al. 2008) as well as the teachers' understanding of students participation.

Secondly, students can obtain higher efficiency in team collaboration with the help of wikis. The construction, access and modification of wiki pages can be done almost instantly (Shih et al. 2008). Team members can get access to the learning materials on wikis anywhere any time (Kinsey & Carrozzino 2011; Raman 2006), thus realize more efficient information and knowledge sharing (Zorko 2009; Elgort et al. 2008; Neo 2004). The only "latest version" format of wikis also ensures that the progress documents viewed by all the team members are exactly the same, so as to avoid excessive meetings, telephone calls and emails, and multiple version management (Kinsey & Carrozzino 2011; Bhatti et al. 2011).

Third, as a tool that allows users to edit the content of websites, the wiki has remarkably low requirements for technical expertise. Contemporary undergraduates don't need to know any programming language or install any software before being able to edit a wiki webpage (Zorko 2009; Wheeler et al. 2008; Elgort et al. 2008). Therefore, it allows students with different levels of technical expertise to use (Deters et al. 2010).

Fourth, the asynchronous nature of user communication in wikis has the potential of facilitating reflective learning. Students don't have to give an answer immediately as in face-to-face meetings, which let them have more time to consider carefully and reflectively before replying (Zorko 2009; Elgort et al. 2008; Arnold & Ducate 2006). Students could also post their "half-baked ideas" on wikis to discuss with peer classmates and get timely advices (Ben-Zvi 2007). This asynchronous feature makes the wiki a helpful and constructive platform for the temperamentally shy students.

Finally, all the above four features collectively enable the wiki an ideal tool for team collaboration in educational context. Compared with face-to-face meetings that usually are dominated by a few extraverted students (Bhatti et al. 2011), the wiki allows "quiet" students to participate more in the collaboration process (Elgort et al. 2008; Mirk et al. 2010; Biuk-Aghai et al. 2008), thus is more likely to promote equal contribution and reduce free riding among student groups (Prokpfieva 2013). In the research by Minocha and Thomas (2007), three quarters of the students involved in the group writing assignment said that the wiki was able to promote collaboration. A recent study statistically verifies that use of wikis can trigger a higher level of cognitive elaboration of team members when they process diversified information and knowledge shared within the team, which promotes knowledge integration at team level and further improve a team's collaboration quality (Zhang et al. 2013).

Although the wiki has been deemed to have great potentials in promoting team collaboration, researchers also raised some problems and shortcomings of the wiki that may preclude the fulfillment of its promising values. For example, given the easy-to-use feature of the wiki, still some people find it hard to adapt and use at the beginning. It takes time and sufficient training for students to master it, therefore detailed instruction is preferred (Kinsey & Carrozzino 2011; Raman 2006). Even with the existence of training, technical problems may still occur during the using process (Zorko 2009).

Second, it is generally reported that students are lack of enthusiasm of using wikis. In an attempt of wiki implementation by 287 students, none had created new pages or had edited existing ones over an entire semester (Ebner et al. 2008). The reason is believed to be the fact that students were neither provided with any form of enforcement to contribute on wikis nor rewarded for their contribution, as a simple imitation of the "Wikipedia-way" in the educational setting. Although the wiki has the function of recording edit history, it is very laborious and uninformative to parse the records and difficult for teachers to understand

how much each student had contributed to the final knowledge product, say, a report (Ebner et al. 2008). Therefore, this function may be less useful than expected and may reduce students' motivation to use.

Third, using the wiki does not mean that the students would definitely work as a team (Elgort et al. 2008; Raman et al. 2005). On one hand, problems like unequal contribution would still occur (Arnold et al. 2009). On the other hand, some students have the habit of pasting their finished products on wiki, a one-off use instead (Zorko 2009). Some researchers even conclude that the wiki is not useful for creating new knowledge (Elgort et al. 2008; Raman et al. 2005) since students generally use wikis to share information but less to discuss and exchange ideas, which may lead to surface thinking (Elgort et al. 2008). Moreover, most students tend to use the wiki right before the submission deadline, actually leaving insufficient time for deep team collaboration (Judd et al. 2010). Furthermore, students typically work on their own assigned parts rather than edit iteratively on peers' parts due to the conventional prudence in the eastern culture. The conflict between individual assessment and expected collaborative behavior in some pedagogical design could be another issue (Forte & Bruckman 2007).

Lastly, students might perceive the use of Web 2.0 tools like the wiki as nonacademic (Elgort et al. 2008). Therefore, it is suggested to let students be aware of the academic nature of their wiki use and consequently be serious in collaboration on wikis (Cann et al. 2006).

2.2 Media Synchronicity Theory

The above reviewed advantages of the wiki suggest that media synchronicity theory and its five dimensions of media capabilities a suitable theoretical lens guiding our study. The capabilities of media were firstly documented by the Media Richness Theory (MRT), which argues that media differ in richness, i.e., the ability to process many different amounts of and types of information that changes understanding within a time period (Daft & Lengel 1986). Based on MRT, Dennis et al. (2008) proposed the Media Synchronicity Theory (MST) and further identified five capabilities of media (transmission velocity, parallelism, symbol sets, rehearsability, and reprocessability) that may affect information transmission and processing. Transmission velocity is the speed at which a medium can transmit a message to recipients. Media high in transmission velocity enable messages to reach recipients as soon as they are sent, thereby allowing fast responses (Dennis et al. 2008). Parallelism is the number of concurrent transmissions that can effectively take place over the medium. High-parallelism media allow simultaneous sending and receipt of messages to and from multiple parties (multidirectional communication and multiparty transmissions) and increase the number of concurrent conversations (Dennis et al. 2008). Symbol sets are the number of ways in which a medium can support to encode information for communication. Media that are low in symbol sets are considered to be low in social presence. Low social presence may reduce satisfaction of the communication and interactivity, limiting the sharing of knowledge and experience among colleagues. Rehearsability is the extent to which senders can rehearse and fine tune messages before sending. Media that support rehearsability allow messages to be better crafted and reasoned (Maruping & Agarwal 2004), therefore ensure the intended meanings are expressed precisely (Dennis et al. 2008). Reprocessability is the extent to which participants can reexamine or reprocess previously sent content either within the communication event or at a later time. Media that support rehearsability allow recipients to spend more time on decoding messages by revisiting prior messages for better understanding and additional consideration, as well as provide a memory that can remind participants on their early discussion contents and help new participants to understand past activities (Dennis et al. 2008). Despite the generally understood capabilities of media, no empirical research has been conducted, to our best knowledge, to really measure a specific ICT medium's capabilities, let alone explore the impacts of media capabilities on user perception, behavior as well as team collaboration outcomes.

2.3 Team Collaboration

Collaboration and cooperation sometimes are used interchangeably. Cooperation generally refers to simply dividing the task into several parts with each of the team members being responsible for one of them and combining the individual results at last. Collaboration, however, goes further than that: it involves a coordinated attempt to develop and solve a problem together within a team for common goal and overall benefit (Prokofieva 2013; Judd et al. 2010). Collaboration requires communication and coordination, recently being tightly linked with the technology advancement (Alavi 1994; Choi et al. 2010; Kanawattanachai & Yoo 2007). When computer-supported collaborative learning tools are believed to be able to facilitate team communication and collaboration, the evidences in the field are not always positive (See Kreijns et al. 2003 for more review). Whether and how the wiki in particular would be a good tool facilitating team collaboration in undergraduate education has not been fully investigated yet.

3 METHODS

3.1 Case study method

Case study is suitable for focusing on a few issues that are fundamental to understanding the system being examined. We adopted exploratory case study method as it is “appropriate to any problem about which little is known” (Churchill 1995). Moreover, data collected through case study could provide more opportunities of obtaining evidence from different sources (Gross, Giancquinta, & Bernstein 1971). Two sources of data were employed in the case study. One was coding the records of collaboration processes of all the students on the wiki website where the group members shared information on their project, discussed how to move forward the project and wrote the project report collaboratively. The analysis of archival data recorded by wikis was done in a naturalistic research setting where researchers observed participants in their own environment to know about their behaviors (Miller 1977). Naturalistic observations are much easier to carry out nowadays since the Internet can help identify the behaviors involved in group collaboration processes (Birnbaum 2004). In the present study, students’ activities automatically recorded by the wiki site were utilized to analyze and assess the collaboration process and the students’ behaviors (Trentin 2008). The other data collection approach was a survey questionnaire completed by all the students after they submitted the project report (i.e., the final deliverable of the team collaboration) via the wiki. Using multiple sources of data would support the triangulation which consequently enhances the validity of processes and accuracy of the findings (Yin 1994).

3.2 Case scenario, participants and team collaboration task

The present study was carried out in a typical semester of the academic year 2013-2014 in one of the major universities in Hong Kong. Totally 90 undergraduate business students from a core IS subject were involved. The age of the participating students ranged from 18 to 22, with an average of 19.8. The students were from 15 self-formed teams, each containing 4 to 7 members. All the students had access to the Internet during the semester.

The students were asked to complete a case study on management information systems. The case study included two deliverables counted as a part of the course assessment: a class presentation and a final written report. Students were instructed to use the wiki as a collaborative platform to prepare for and complete the two tasks in groups. They were reminded from time to time that all team collaboration processes were encouraged to be performed on wikis, from the initial discussion on the whole design of their project, division of the task among team members, to information collection and the collective writing in an iterative manner, so that the teacher would be able to observe the project progress and provide timely feedback if there is a need. In response to Judd et al.’s (2010) suggestion that the use of the wiki should be associated with incentives such as formal assessment, the students were told at the

beginning that their individual performance on the wiki would be taken into account in assessing their participation in this subject (i.e., equal to 10% of overall course assessment).

The specific wiki platform used in this study was Wikispaces, a free version for educational institutions. It was introduced to the students at the beginning of the semester, specifically, in the second week. User training and demonstration was given in class to help the students register accounts, create a wiki for each group, and invite the teacher to join all teams' wikis. Besides these, each student was given a detailed user guide of Wikispaces for reference.

3.3 Data obtained and analysis technique

Objective data were collected from wiki records in three dimensions: pages and files, discussions and comments, and shaping behaviors. Using the predefined coding scheme described below, two authors and a third researcher coded the objective data separately. We followed the steps for content coding by Oh et al. (2013) to ensure the inter-coder reliability. Cleaned objective data and self-reported data collected through survey questionnaire were input into SPSS for statistical analysis later on.

Data regarding pages and files included (1) the number of valid pages created, (2) total number of edits in valid pages, (3) total number of discussion entries in wiki pages, and (4) total number of files uploaded and their types (i.e., pictures, relevant information in PDF format, etc.). "Valid pages" refer to those that contained meaningful words for forming a team and initiating the project, instead of "testing" or the home page created by the system automatically.

We coded the discussion messages of each team in terms of (1) the total number of messages, (2) total number of message threads (e.g., the series of messages initiating conversations or replying to the initial message), and (3) total number of message threads being replied. Messages sent by the teacher were excluded from the coding. All the messages were classified into 9 categories: information sharing, question, greeting, testing, management, compliment, discussion, casual chat and comment. Examples of messages for each category were presented in the Appendix A.

4 of the 15 groups either did not use the wiki to write their case study reports as required, or only one student from the group did. As a result, shaping behavior data of 11 groups were generated, including the number of shapers in each group, the frequency as well as the scope of shaping activities. Specific data on wiki use and shaping behavior is presented in Section 4.

A survey questionnaire was designed to further collect the students' feedback on usage experiences and their opinions on using the wiki for team collaboration. It included 4 sections. The first section was about the students' perceptions on the capabilities of the wiki with regard to facilitating team collaboration. We adopted the measures of five media capabilities (Dennis et al. 2008) developed by Chan et al. (2014) to ask the respondents to rate their perceptions on efficiency (e.g. Wiki allows me to get timely feedback from others), communication parallelism (e.g. Wiki allows me to manage multiple conversations at the same time), reprocessability (e.g. Wiki allows me to reexamine and reprocess the messages after the transmission), rehearsability (e.g. Wiki allows me to carefully edit my message before sending), and communication symbol set (e.g. Wiki provides me a set of symbols I need for effective communication) of the wiki. Following Chan et al. (2014), we also measured perceived administrative coordination (e.g. Using the wiki our team communicated well administrative issues), information sharing (e.g. We share with each other any new information and knowledge on the wiki) and satisfaction with team members (e.g. I am satisfied with working in this team). All questions were measured in 5-point Likert scales, ranging from 1 (strongly disagree) to 5 (strongly agree).

The second section was about the students' user experiences when using wikis for team collaboration, such as their perceived technical barriers (e.g. I have enough time to get familiar with the wiki for project collaboration) (Ractham & Firpo 2011; Roblyer et al. 2010) and perceived collaboration effectiveness (e.g. Wiki allows our project collaboration to function effectively) (Borden & Perkins 1999). Following

the literature, the questions in this section were measured in 7-point Likert scales, from 1 (strongly disagree) to 7 (strongly agree).

The third section of the questionnaire asked the students if they had adopted other means of team collaboration besides the wiki platform. Total numbers and time spent in hours on varied communication media (e.g., face-to-face meetings, emails, telephone calls, instant messengers and any other) were collected. In the final section, two open-ended questions were used to allow students to elaborate the problems or difficulties they had encountered in using the wiki and their suggestions or comments for future improvement in the use of the wiki for team collaboration. Basic information about respondents such as age, major, self-evaluated level of using the wiki and their academic performance in terms of accumulated GPA at the time of survey was collected as control variables. Among the 90 students involved in the present research, 83 returned completed questionnaire.

4 FINDINGS AND ANALYSIS

First of all, we witnessed students' positive participation in wiki usage in general. The sampled teams created 5.1 pages on average, with 4.5 of them being valid. The number of edits in valid pages per group was 36.1. On average 9.7 files were uploaded by each team, with a maximum of 22 and a minimum of 0. The files were mainly some information related to their case studies, PowerPoint files for their presentations, and Word version of pieces of reports generated by different members.

11 teams used the message tool of Wikispaces. Totally 184 messages were sent, with an average of 11.9 messages per team. Altogether 15.2% of the messages sent were discussions or comments. Over one third (39.1%) of the messages were sharing information related to own team's project topic. Administrative coordination accounted for the second biggest category (22.8% of the messages). See Table 1 for details.

	Category	NO. of messages	Percentage
1	Information	72	39.1%
2	Administrative coordination	42	22.8%
3	Discussion	24	13.0%
4	Greets	20	10.9%
5	Casual_chat	9	4.9%
6	Questions	6	3.3%
7	Compliments	6	3.3%
8	Comment	4	2.2%
9	Testing	1	0.5%
Total		184	100%

Table 1. *Statistics of discussion messages in categories*

These 184 messages were rooted in 84 discussion threads, out of which only 34 were replied. Interestingly, 4 teams had their discussion edits (16 times in total) inserted on wiki pages, rather than in the discussion board function. Those discussion messages on wiki pages were generally much longer and reflected deeper thinking than those taking place in the discussion board. See an example screen snapshot in Appendix B.

Second, shaping behaviors however were rather limited. Among the 11 teams that collaboratively composed their reports on the wiki, we observed 38 shaping activities from 21 shapers. Shapers from 8 teams shaped the whole report, while the reports of the other 3 groups were only partly shaped. Although the student teams had demonstrated varied levels of shaping activities, nearly all of them were focused on changing some words or correcting grammar mistakes, with few major changes such as integrating of information and reorganizing of paragraphs.

Third, to our surprise, although more than one quarter (27.7%) of the students agreed that the wiki helped their team collaboration, none of any type of wiki usage behaviors, in terms of total number, actually correlated with collaboration performance significantly. We only found that reported level of administrative coordination and the number of shapers in a team was positively associated (correlation = 0.527, $p < .10$).

Four, technical barrier seemed to be a severe challenge in the attempt of performing team collaboration in wikis. In our study, given the fact that 37.3% of the students agreed that they had enough time to get familiar with the wiki for team collaboration, 42 students, among 83 (representing 50.6% of the sample), stated they felt difficult in using the wiki. Most of the complaints from the students were regarding the difficulties or challenges they encountered in using the wiki, for example, “*I feel difficult to manage the editing on wiki*” and “*The wiki is not user-friendly at all.*” 12 students suggested the teacher provide more technical support. This paradoxically came with the condition of half students (50.6%) believing they were at the intermediate level of expertise in using the wiki.

Finally, it turned to be obvious that instant communication was strongly preferred by students in the process of team collaboration. Although up to two-fifth (38.5%) of students agreed or strongly agreed that the wiki helped them communicate with multiple parties concurrently, 83.1% respondents did not agree that the wiki allowed them to get timely feedback from others. The young Internet generation seemed to be more used to using instant communication tools like WhatsApp, therefore, they may not feel comfortable with the asynchronous communication supported by wikis. Some students commented that “*the wiki should offer a smartphone application to enable instant communication and notify users about the changes on wikis in real time.*” Or, “*it could be better if I can receive instant notification of new edits, like in Facebook Messenger.*” To echo with the preference for instant communication, the student groups reported that face-to-face meeting and instant messenger were the dominant tools supporting their within-team communication and collaborative learning. On average, all teams held 3.5 face-to-face meetings (5.9 hours totally), and spent roughly similar time (5.7 hours) in communicating through instant messengers. Details of other means of communication are shown in Table 2. Moreover, the instant messenger use in terms of total time spent was found to have a highly positive correlation with the quality of team collaboration (the rated marks of project report, correlation = 0.555, $p < .10$).

Means of communication	Minimum	Maximum	Mean	Std. Deviation
Face-to-face meeting times	1.0	6.0	3.46	.97
Face-to-face meeting time (in hour)	1.0	15.0	5.90	3.60
Instant messenger times	.0	1000.0	117.46	298.38
Instant messenger time (in hour)	.0	30.0	5.71	5.08
Email frequency	.0	20.0	3.14	4.60
Email actual time (in hour)	.0	4.0	.48	.77
Telephone frequency	.0	20.0	.90	2.77
Telephone time (in hour)	.0	4.0	.28	.73

Table 2. *Details of using other communication media for team collaboration*

5 DISCUSSION AND IMPLICATIONS

5.1 Is the wiki an effective tool for facilitating team collaboration?

It is a subtle question without simple answer of Yes or No. Different from the commonly held optimistic expectation, our data analysis revealed, surprisingly, neither the general wiki use behaviors nor the shaping activities in particular directly contributed to team collaboration performance (i.e., the quality of generated wiki-based project report). The usage of discussions and comments functions in this study was not satisfactory either. It seemed that the students did not use the message tool very often; instead they

used it to share information and manage administrative issues mainly, consistent with the literature (Elgort et al. 2008; Engstrom & Jewett 2005).

Although objectively we didn't find evidence of beneficial consequences of using wikis on wiki content quality, students responded positively on the capabilities of the wiki (specifically, high efficiency in transmission and supporting concurrent communication with multiple users). Both transmission velocity and parallelism capabilities of the wiki were significantly correlated with perceived collaboration effectiveness (0.724 and 0.845 respectively, $p < .05$, $p < .01$) reported by the students. Moreover, the parallelism capability of the wiki had significant correlation with the information sharing among team members (correlation = 0.908, $p < .01$), while information sharing and collaboration effectiveness were highly correlated (correlation = 0.943, $p < .01$). These suggest that, from psychological aspect, using wikis may foster the perceived collaboration effectiveness of students, and this positive effect might be achieved through enhanced information sharing.

5.2 How to maximize the positive impact of using the wiki

Our results provide four major implications to educational professionals. First and most importantly, the results of the present study show that lower perceived technological barrier may increase the level of perceived convenience (correlation = 0.915, $p < .01$) and collaboration effectiveness (correlation = 0.894, $p < .01$). Therefore, it might be better if the students can receive more hand-by-hand instructions on how to use wikis during the class time. More than a simple training or demonstration session, an ice-breaking exercise may deserve a bit more time so that students would be able to try the wiki and get familiar with using it in a relaxing manner. In addition, close monitoring of students progress on the wiki and providing constant technical support proactively would be preferred along the whole process of teamwork.

In addition, the young millennium generations are enthusiastic users of instant messengers like WhatsApp and WeChat. This has also been described by prior literature as well as evidenced by the results of our study. Compared with the average 11.9 messages sent on the wiki within each team, 117.5 instant messages were sent out on average. Therefore the students used instant communication tools quite frequently for performing team project. Our findings echoed with the literature (Majchrzakh et al. 2006) that using the wiki only for communication would be likely to have negative impacts on collaboration results as other channels could help throughout the process. Interestingly, in the present study, we noticed that the higher level of instant messenger usage, the more convenient the users perceived when using the wiki (correlation = 0.528, $p < .10$). It points out the necessity of an integrated approach in using Web 2.0 tools in contemporary education. In practice, the only notification channel of the wiki updates is email. However, most students don't check their emails as frequently as logging on Facebook, not to mention the "always-on" status in WhatsApp or WeChat. Therefore, the asynchronous communication supported by the wiki might be insufficient in the educational scenarios nowadays. Base on this result, teachers may consider encouraging student teams to establish an instant communication platform, for example on WhatsApp, WeChat, or Facebook messenger. Either a student or the system can send an instant message to all team members whenever he or she wants to get peers' attention immediately on new ideas or changes he or she has made on the wiki, which would be likely to ensure a compact progress of team collaboration without much time-lag on any individual member's side. For those who feel disrupted by instant notifications, they can simply turn off the notification function, so students could still choose to have either synchronous or asynchronous communication.

Previous research found that teams with better collaborative performances tend to have fewer but longer discussion threads where opinions of each member were given full consideration (Oliveira et al. 2011). However, the rate of reply to the initial messages in present study was somewhat low. We postulate that the inability of the wiki to provide instant notifications might have also caused the unfavorable user attitude toward wiki-based discussion. If a student did not enable the email notification function, the only way for him or her to learn about others' messages was to log in the wiki group page to check, from time to time. When the messages were unbeknown or the time lags between the messages and the replies were

too long, peer members were unlikely (or less motivated) to reply. In this study, an interesting phenomenon we noticed is that the discussions taking place on wiki pages were generally longer in length and deeper in depth than those messages initiated in discussion forum. A possible reason is that when discussing academic reports, students needed to show all the relevant information and explain their ideas as clearly as possible. However, separate discussion forum are normally perceived as an outlet for short and quick exchange of ideas. Besides, typing a lengthy thread in discussion forum seems to be wasteful when the users still need to input relevant content in corresponding wiki page(s) later on. Therefore, having discussions on wiki pages rather than in the separate discussion forum might be viable. Of course the eligibility of this option will be dependent on other factors such as the teacher's preference, team size (possibly manageable when a team has a small number of members), and so on.

Finally, leadership in the wiki use is an aspect that has largely been overlooked in prior literature. If the essence of the wiki is to promote the spirit of free knowledge contribution, as in the Wikipedia, the role of a strong leader may not be significant. However, we found that the existence of leadership in using wiki in a team did have positive relationship with students' satisfaction with their team members (correlation = 0.556, $p < .10$). Although the presence of leaders in wiki teams may not be as explicit as in ordinary project teams, they may still play an important role in coordinating the team activities, such as summarizing the ideas posted by different members, finalizing the task division and organizing face-to-face meetings when there was a need. The result that groups with more effective administrative coordination had more shapers (correlation = 0.527, $p < .10$) also implied the significance of team coordination, one of the key responsibilities of team leader. These findings suggest that an effective leader in using wikis is likely to promote the whole team to optimize the use of available resources in their wikis and achieve the team goal in a more efficient manner. Consequently, the members would be more satisfied with working in this team.

6 LIMITATIONS

In present study, although students were suggested to write their reports on the wiki, the final submission still requested both softcopy via e-submission in the Blackboard system and one hardcopy, which implied that students needed to transform the wiki-based report into a Word files eventually. The technical barriers most students reported in this study may imply that the students felt difficult to use the wiki platform for the entire circle of project. Finally, they were probably less motivated to write on wikis, as the teacher didn't formally allocate a specific weight on the wiki participation in the written course assessment document. An oral statement that wiki-based activities would be considered in assessing individual participation sounded vague and probably insignificant to students. All these might be the reasons of inactive engagement in wikis by students.

Second, due to the nature of explorative case study, we didn't propose a theoretical model associated with some hypotheses. All the qualitative results and quantitative analyses presented were descriptive, unable to verify any causal relationship. Future studies are welcome to develop rigorous method to empirically test the potential cause-effect links of the variables explored in this study.

Third, the current study was conducted in a Hong Kong university. Therefore, the generalizability of its findings to other educational scenarios is subject to the awareness of cultural effect. The phenomenon that most shaping activities were focused on changing words or correcting grammar mistakes may be attributed to the national culture, i.e., the Eastern people are believed to be more prudent on commenting on others' work, and they would rather correct the obvious mistakes than make major changes even though the major shaping behavior can make the co-created knowledge better in quality. However, prior study on Western people arrived at the same conclusion that "people tend not to edit others' work to avoid publicly criticizing others' work" (Arazy et al. 2013). Therefore the cultural influence may not be a big concern.

Besides, closeness and openness among group members are also suggested to be factors predicting the shaping behaviors (Forte & Bruckman 2007). In teams where members are closer and more open to each other, they would have lower concern for annoying their teammates or making them embarrassed. Consequently, the shaping activities would be expected to happen more frequently and in more depth. Therefore, socialization activities such as team-blog and icebreaking activities are probably helpful in stimulating shaping behaviors in the wiki usage (Minocha & Thomas 2007). However, the current study didn't take these factors into consideration, thus missed the chance of ruling out alternative explanations.

Finally, most undergraduate students generally had face-to-face meetings with each other on campus frequently, in which they might have completed most of the collaboration needed. So the collaboration processes and behaviors on the wiki platform might not be a full picture.

7 CONTRIBUTIONS AND CONCLUSIONS

The present study reported a case study of adopting the wiki in promoting team collaboration in the context of IS education and learning. It depicted a relatively clear picture of how student teams would use the wiki to perform a collaborative task and why or why not did so. The shaping behaviors observed in the present study are quite encouraging, which sheds a light on the preliminary understanding of shaping behaviors in educational contexts. It is among the first trials that examine both objective behavioral data and the students' subjective data. Consequently, our findings for the first time reveal the distinct impacts of wiki use on collaboration outcome in objective scale and subjective sense. Meanwhile, it calls the attention of educators that some problems are yet to be improved. When we are moving toward an era of online collaboration and blended learning, the wiki technology has great potential in promoting team collaboration but challenges co-exist with opportunities.

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APPENDIX A.

Examples of student messages and their categorizations:

Example messages	Category
http://www.aabri.com/manuscripts/10478.pdf This article talks about some updated systems (JetBlue's activities system).	Information sharing
Dear all, I have combined all of your versions together and made some polish.	Administrative coordination
I think there is no need to analyze the market as our focus of the project is the system of the company.	Discussion
Hi ^^	Greets
Have fun.	Casual_chat
We only need to use the information that provided to us? Do we need to find extra information related?	Question
Nice!	Compliments
Here is too much like a tv program show's mc xd. Maybe we shd say: working in the farm, do you ever realize how Zynga utilize Business Intelligence to earn more money from the farmer?	Comment
This is Angelina testing~	Testing

APPENDIX B.

Screen snapshots of one team's students discussing on one of their wiki page (comparison of version 3 and 4, texts highlighted in green meant the newly added contents by one member).

[nobody uses this name](#) > Home JoyHe | My Wikis | Help | Sign Out

☆ Let's do something for real!

[Edit](#) [0](#) [6](#) ...

Comparing [12131391d](#) Mar 26, 2014 12:18 pm to [Ryan_Runyuan_LI](#) Mar 26, 2014 2:15 pm
[View WikiText](#) [Review Changes](#)

<OK! Welcome everyone, this is the discussion forum for us to talk about our inspirations after reading the case. I have to say this is a confusing case. So we must put more weight on it!

With difficulty, I would say it is also an interesting one. I'm even considering make some actions or drama relating to this topic.

Problems identified:

1. Hard to attract customers. Why? You will never go to hospital, do surgery and buy expensive medicine until you are badly ill. Same with this case. This company is like a hospital for company. So how to promote his company?
We may also need to present the original promotion methods that have ethical concerns, so that we can illustrate the dilemma, the solution we are going to propose should also eliminate the such concerns.
2. Not attractive to talents. You will never be willing to work in India, are you? If you got one offer in Hong Kong, one in a small village in Guangdong, which one will you choose. So how to attract talents? Michael>

solution to problem 1:

As a general promotion method, we may use the previous successful defense example of the company to promote, I mean, examples that by using our security solution, the penetrations are successfully defended;
As for those big entities who have no awareness of cyber security, we may send a promotion team to them to present them the possible results of being hacked, and show them some possible ways to intrude only with their permission.
We may also cooperate directly with the system provider of those entities instead of persuading the entities to accept us. For example, A uses the e-infrastructure provided and maintained by B, then we can try to incorporate with B to make our security solution a customized part of the system provided by B instead of trying to sale a separate security solution to A.

solution to problem 2:

As talents will flue to big company anyway, why not use this as company's chips to attractive? By showing how many ppl can find nice jobs after employment in our company, what kind of career development we currently have, etc. Just personal idea. Gorden>
(Gorden...I think in this way we are no longer a company providing security solutions, but a training company...)

Except identifying and solving problems (as the outline provided by Micheal), we may also talk some background and explain some terminology in both presentation and report. So besides thinking about enriching the content above, I think the following part also need our contribution.

3. Background (including data, charts, famous real world case about cyber security)
4. Terminology
Custom perspective
(the case says "Big datasets demanded a custom perspective and a novel approach, and hence provide open opportunities for both the attackers

Wiki Home
Recent Changes
Pages and Files +
Members
All Pages
Actually wiki is user friendly
Case
introduction and background
Let's do something for real!
promotion
promotion revised
test 1
Work Allocation 3.29

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