Cited as: Chu, S.K.W., Capio, C.M., van Aalst, J.C.W., and Cheng, E.W.L. (2017). Evaluating the use of a social media tool for collaborative group writing of secondary school students in Hong Kong. Computers & Education, 110(7), 170-180.

Evaluating the use of a social media tool for collaborative group writing among secondary school students in Hong Kong

Abstract

The rapid development of social media tools has increased interest in their pedagogical value. It has been suggested that social media tools such as wikis can promote online collaborative and interactive learning. This study investigated the value of wikis in supporting collaborative group writing quality among secondary school students in Hong Kong. Students from a local secondary school engaged in group writing projects using Pbworks, a popular wiki tool. Data were gathered from (1) the revision tracking history, (2) a questionnaire on the perceived pedagogical value of the wiki, and (3) group interviews with students. Findings showed that students who made more collaborative revisions on the wiki produced higher-quality writing output. In general, students reported a moderately positive attitude towards the pedagogical value of the wiki. The findings suggest that wikis promote collaborative writing, but teachers need to adopt pedagogical strategies that would equip students to use wikis.

Keywords

Social media, PBworks, Collaborative writing, Cooperative writing, Secondary education, Wikis

1. Introduction

There has been an upsurge in the use of social media tools for education purposes because they are believed to be user-friendly and convenient, and to promote online collaborative and interactive types of learning (Chu, 2008; Doering, Beach & O'Brien, 2007). These tools include blogs, wikis and RSS feeds (Alexander, 2006), which enable the sharing of articles, images, audio, and video (Hazari, North & Moreland, 2009). Moreover, they require relatively little technological knowledge to be used effectively (Désilets, Paquet & Vinson, 2005). Based on these desirable features, Barbara and Kerry (1994) predicted that technology would be a powerful tool to facilitate students' collaborative learning.

Cole (2009) identified wikis as appropriate and effective tools for collaborative content sharing and editing. Besides being content management systems, they also enable a group of users to share knowledge and encourage individuals to communicate, collaborate and interact via technology. The potential value of wikis can be summarized in three points. First, wikis facilitate students' expression of their views through a web platform and group discussions (Hazari et al., 2009). Second, students have more opportunities to be actively involved in group work, thus potentially improving their reading, writing, reflection, and collaborative learning skills (Leight, 2008). Third, wikis provide a flexible environment for teachers to cater to students with various learning preferences (Cole, 2009). It is through such processes that users may benefit from the development of collective or group intelligence (Doering et al., 2007; Hazari et al., 2009).

Central to the effectiveness of wikis is their potential to facilitate collaboration rather than cooperation. Collaboration involves the mutual engagement of participants in a well-integrated process of problem solving (Roschelle & Teasley, 1995), whereas cooperation occurs when tasks are divided up amongst a number of participants who perform them individually (Henri

& Rigault, 1996). Previous research has shown that students who work in groups perform better in writing than students who work individually, and that collaboration can improve the writing quality of students (Storch, 2005). Therefore, in the field of education, wikis are believed to help students complete collaborative projects and track their work progress, and enable teachers to monitor individual contributions to group work (Mak & Coniam, 2008).

Despite the positive indications, definitive evidence that collaboration in wiki environments contributes to improved writing output has yet to be established. Empirical support for the effectiveness of wikis has been provided by studies showing that wikis promote collaboration (e.g. Chu, 2008; Naismith, Lee & Pilkington, 2011; Chu, Siu, Liang, Capio & Wu, 2012; Du, Chu, Chan & He, 2016) and receive positive evaluations from students and teachers (e.g. Hazari et al., 2009; Woo, Chu, Ho & Li, 2011). However, an extensive review by Stoddart, Chan and Liu (2016) showed that the effectiveness of wikis depends on multiple factors, many of which have as of yet not been studied in detail. One question that has yet to be examined is whether collaboration is related to the quality of group writing on a wiki platform. Therefore, this present research investigates whether a direct positive association exists between the extent of collaboration and the quality of group writing on wiki.

1.1. Wiki as a learning tool

Social media tools are user-centered and support communication, information sharing, and collaboration. These tools allow online interactive exchange (Richardson, 2009) and promote media convergence, thereby encouraging individuals to build collectively on each other's intelligence (Doering et al., 2007). Social media enable knowledge to be "decentralized, accessible, and co-constructed by and among a broad base of users" (Greenhow, Robelia & Hughes, 2009, p. 247).

Popular social media tools include blogs, wikis, RSS feeds, social bookmarking, and Podcasts (Parmeswaran & Whinston, 2007; Richardson, 2009). The popularity of these social media tools depends on the extent to which they facilitate information sharing, and on their connectivity with other programs (e.g. word processors, video and/or image programs, etc.). As noted by Hazari et al. (2009, p. 188), "the underlying tenet of all these tools is the social networking aspect where a community of users is involved in a common goal." Wikis in particular allow users to create a hypertext and revise it by adding, deleting, or changing any part of it whenever and wherever they are as long as there is an Internet connection for digital devices (Cress & Kimmerle, 2008). They have been used for teaching at various levels of education, including primary and secondary schools, colleges and universities (e.g. Konieczny, 2007; Mak & Coniam, 2008; Naismith et al., 2011; Parker & Chao, 2007; Raman, Ryan & Olfman, 2005). Wikis are considered to be platforms where students may undertake their group work, and where learning is scaffolded by real-time posting of assignments, tracking work-in-progress, discussing and debating (Davis & Miyake 2004; Hazari et al., 2009; Jenkins, 2006). As such, wikis are considered appropriate for inquiry-based learning and the co-construction of knowledge (Yukawa, 2006).

Woo et al. (2011) studied the effectiveness of wikis based on three affordance categories: educational, social, and technological (Kirschner, Strijbos, Kreijns & Beers, 2004). The researchers found that wikis' key affordance was mainly social in that it provided an online platform for collaborative problem solving and peer critiquing. Woo et al. (2011) suggested that the potential benefits of using wikis include: (1) reduction of students' cognitive loads through the provision of functions such as spell checks; (2) creation of a pool of ideas by different students, thereby reducing their need for information search; (3) production of more

online written content that facilitates participation in discussion; and (4) facilitation of positive peer feedback inducing students' self-corrections.

1.2. Collaboration and cooperation

Collaboration is widely recognized as an effective means of promoting student learning (e.g. Judd, Kennedy & Cropper, 2010; Kolloffel, Eysink & De Jong, 2011). In this respect, the wiki is a virtual application that supports joint knowledge construction, as has been shown in empirical studies of collaborative writing activity (e.g. Trentin, 2009; Woo et al., 2011). However, the extent to which collaboration occurs has yet to be clarified. Engstrom and Jewett (2005) highlighted the pedagogical values of using wikis in classrooms and claimed that the collaborative nature of wikis has enabled students to perform better than have more orthodox ways of teaching and learning.

Group learning activities are usually clustered into two major types – "cooperation" and "collaboration" – whereby groups are composed of members who work for a specific task (Henri & Rigault, 1996). "Collaboration" refers to "a coordinated, synchronous activity that is the result of a continued attempt to construct and to maintain a shared conception of a problem" (Roschelle & Teasley, 1995, p. 70), while "cooperation" refers to "the division of work among individuals, with each and every participant being responsible for a particular part of the problem solving" (Naismith et al., 2011, p. 229).

Paulus (2005) highlighted three important aspects of collaborative writing. First, there is mutual respect for members' contributions. To achieve a common goal, members contribute their talents, life experiences, and perspectives equally and collectively, and these contributions are evaluated by peers. Second, group work is conducted through effective negotiation (Hathorn & Ingram, 2002). Even if group members respect one another's contributions, agreements cannot be reached without the process of negotiation (Dillenbourg, Baker, Blaye,

& O'Malley, 1996). Dillenbourg et al., 1996). Third, collaborative performance is enhanced through cycles of exploratory talks (Curtis & Lawson, 2001; Johnson & Johnson, 1996). According to Arvaja, Salovaara, Häkkinen and Sanna (2007), critical information is built through frequent talks that accumulate the outcomes of challenges, counter-challenges, and explanations with justifications and alternative hypotheses.

Collaboration appears to be valuable in facilitating student learning with the use of web-based technologies such as the wiki. A wiki setting creates an opportunity for students to engage in interactive activities, such as sharing and presenting ideas, joining in dialogues, monitoring the learning process, and making decisions (Hazari et al., 2009). However, researchers have suggested that real collaborative writing cannot be easily facilitated (Curtis & Lawson, 2001). The concept of collaboration itself needs to be sufficiently understood, and students need to be equipped with the skills and support to manage the technology and actualize its potential benefits (Stoddart et al., 2016). Therefore, in evaluating the use of wiki for collaborative writing, it is crucial to examine indicators of collaborative behavior and to look into whether students actually engage in meaningful dialogue within a context of mutual respect (Curtis & Lawson, 2001).

1.3. Study objectives

This current study explored the pedagogical value of wikis by adopting a combined qualitative and quantitative approach in examining indicators of collaborative writing. The study objective was to investigate the direct relationship of collaborative activities to the quality of a group writing output on wiki. We measured the extent to which students engaged in collaborative group writing in a wiki project, and whether this collaboration was associated with positive

learning outcomes. This research is situated in the context of Form 1 and 3[1] secondary school students, who engaged in group projects that utilized wiki technology (i.e. PBworks).

2. Research methods

Both qualitative and quantitative data were collected because such a mixed-method approach facilitates meaningful interpretations through triangulation (Creswell, 2003).

2.1. Participants

A total of 219 Hong Kong secondary school students from 6 classes (3 Form-1 classes; 3 Form-3 classes[2]) participated in this research in the academic year 2013-2014. Of these students, 108 were Form 1 students and 111 were Form 3 students. All participants responded to the questionnaire, while a subgroup (n = 118) participated in the group interviews.

2.2. Procedure

The classes participated in a five-month group project aimed at improving students' understanding of Hong Kong society through Liberal Studies (LS), one of the four core subjects[3] in Hong Kong secondary schools. Working in groups of 4 or 5, students chose a particular topic about Hong Kong society, gathered relevant information, and wrote a detailed report. The project involved the use of a wiki named Pbworks, an online, text-based communication and learning platform where students can share files and information, exchange ideas and comments, thereby co-constructing their writing output. Before commencement of the group project, students were provided with a step-by-step video guide produced by the research team on how to use PBworks for collaborative group writing. Throughout the project, the teachers[4] supported the collaborative activities. Because our aim was to observe the

[1] Form 1 and 3 correspond to Grades 7 and 9 in the K-12 education system.
[2] Form-1 and Form-3 are equivalent to year 7 and 9 in the K-12 system.
[3] Other core subjects include Chinese, English and Mathematics.
[4] Each class received instructions and advice on collaborative writing from their own, regular teacher.

naturally occurring number of collaborative activities on the Wiki, the teachers were not given any specific instructions other than to carry out their regular lesson plans.

2.3. *Measures*

2.3.1. Group writing quality

The quality of the group writing projects was judged by the secondary school teachers based on a marking rubric consisting of seven areas: scope of study, research methods, data analysis, conclusion, feasible suggestions, visual presentation and oral presentation. The students were graded from 0 to 5 (0 being poor, 5 being excellent) in each area.

2.3.2. Collaboration and Cooperation

In line with previous studies (e.g. Mak & Coniam, 2008; Woo et al., 2011), two independent raters counted the number of collaborative and cooperative types of revision based on the editing history of PBworks. The raters used an analytical framework based on the frameworks developed by Mak and Coniam (2008) and Cress and Kimmerle (2008) (see Table 1).

Mak and Coniam (2008) established four identifiers of group writing revisions: (1) adding ideas, (2) expanding ideas, (3) reorganizing ideas, and (4) correcting errors (e.g. spelling, grammar, and punctuation). These identifiers served to distinguish between different types of cooperative and collaborative behavior.

Furthermore, Cress and Kimmerle's (2008) systematic view of collaboration in wikis was used to distinguish between assimilation and accommodation types of collaboration. Cress and Kimmerle's (2008) view presents two dimensions of learning in wikis: social and cognitive. The social dimension distinguishes between internalization (i.e. transfer of information from the social environment to a students' cognitive system) and externalization (i.e. transfer of information from a students' cognitive system to the social environment). As internalization cannot be observed through PBworks, results of the current study concerned externalization

exclusively. The cognitive dimension distinguishes between assimilation (i.e. integration of new knowledge into an existing structure of knowledge) and accommodation (i.e. making changes to the existing structure of knowledge).

Taken together, the frameworks of Mak and Coniam (2008), and Cress and Kimmerle (2008) allowed us to distinguish between 3 levels of group writing:

Level 1: Cooperation-type external assimilation.

At this level, students work together with clear division of work among members. They contribute to the PBworks with the portion of work assigned to them, and would not add their writings (i.e. ideas and insights) to other members' contents or modify other members' work. No cooperation-type behavior was rated as accommodation as no changes to the structure of other group members' input are made.

Level 2: Collaboration-type external assimilation.

At this level, students add their scripts to any part of the group project, but would not rewrite others' contents.

Level 3: Collaboration-type external accommodation.

At this level, students freely insert their text into any part of the project, and modify not only their own work but that of others as well. This level is what Cress and Kimmerle (2008) referred to as the emergence of new knowledge that is desirable in the web environment to sustain the quality of group writing.

Table 1
Eight types of revision

Type of Revision	Activity Type	Learning Mode
1. Adding new ideas to self-content	Cooperation	Assimilation
2. Elaborating on self-existing ideas	Cooperation	Assimilation
3. Reorganizing self-existing ideas	Cooperation	Assimilation
4. Replacing and correcting self-existing ideas	Cooperation	Assimilation

5. Adding new ideas to contents of other group members	Collaboration	Assimilation
6. Elaborating on existing ideas of other group members	Collaboration	Accommodation
7. Reorganizing existing ideas of other group members	Collaboration	Accommodation
8. Replacing and correcting existing ideas of other group members	Collaboration	Accommodation

2.3.3. Questionnaire: Perceptions of pedagogical value

A questionnaire was used to examine students' perceptions of the pedagogical value of PBworks. Fifteen questions measured students' perceptions of the usefulness of PBworks according to five categories: (1) learning outcomes, (2) motivation, (3) group interaction, (4) ease of use of technology, and (5) knowledge management. Students gave ratings on a five-point Likert scale from "Strongly Disagree" (1) to "Strongly Agree" (5). The first four categories addressed factors believed to contribute to the pedagogical value of wikis (Hazari et al., 2009). The fifth category addressed the role of wikis in knowledge building (Bruns & Humphreys, 2005) because wikis are expected to facilitate knowledge management (Chu, 2008). The questionnaire was translated into Chinese by a native Cantonese-speaker who is also an English language instructor.

2.3.4. Group interviews.

Group interviews (17 groups of Form 1 students and 15 groups of Form 3 students) were conducted, in which students were asked to voice their positive as well as negative experiences with PBworks. Students were asked the following main points of inquiry: (1) whether PBworks was useful or not for group projects, (2) whether they encountered any unpleasantness when using PBworks, and (3) whether they preferred using PBworks or other tools such as MS Word or Powerpoint. As suggested by Cavana et al. (2001), a probing process was developed whereby students were first asked a set of primary questions. Then, interviewers asked secondary questions by paraphrasing the salient points from the interviewees' answers to the primary questions. This process moved on until a summary of points had been drafted for each

primary question. How far the interview progressed for a particular question was dependent on whether the points were deemed sufficient to address the interview objective. Each group interview lasted approximately 20 minutes. Interviews were audio-recorded and then transcribed into text files. Based on the interview transcripts, two independent raters counted the total number of positive, negative and neutral responses. Here, the terms positive, neutral and negative refer to the expressed attitude towards PBworks rather than the confirmation or negation of the question. For example, a student who mentioned not having perceived unpleasantness stemming from PBwork's functions provided a positive answer to the second question. Furthermore, the responses were used to construct a single, overall attitude per group, meaning that 2 neutral answers were treated as equivalent to 1 positive answer and 1 negative answer. Only when the number of positive answers was different from the number of negative answers was an overall positive or negative attitude assigned to the entire group.

2.4. Data analyses

All statistical analyses were performed using SPSS (Windows version 16.0).

Inter-rater agreement between the raters of revision type was determined using intra-class correlation. Good agreement was established, wherein the two raters displayed 82.1% agreement (Miles & Huberman, 1994). Furthermore, inter-rater agreement between the raters of the group interviews was determined using Cohen's Kappa. Overall agreement was fair to good (K = .66), and on the individual questions it ranged between fair and excellent (K_1 = .63, K_2 = .49, K_3 = .82) (Fleiss, 1981).

2.4.1. Collaboration and group writing quality

The best performing group and the worst performing group from each class – based on marks provided by the teachers – were selected for further analyses. As in some cases two groups shared identical scores, a total of 8 best-performing and 8 worst-performing group were

selected for analyses. The main dependent variable was the number of collaborative types of revisions. The quality of group writing (best vs. worst), academic level (Form 1 or Form 3) and learning mode (accommodation or assimilation) served as independent variables. Since the dependent variable was not measured on a continuous scale, vernacular statistical techniques, such as ANOVA or linear regression could not be used. Therefore, a Generalized Linear Mixed Model (GLMM) was used to determine the effects of group writing quality, form and learning mode on collaboration because a GLMM does not require assumptions such as normality or homogeneity of variances to be met and is thus a viable alternative. A GLMM consists of two major steps. First, a best-fitting model is selected that exclusively incorporates the independent variables that together produce the best prediction of the variation in the dependent variable. Independent variables were included in the best fitting model if they lowered Aikake's Information Criterion (AIC) by 2 points. For a full description of the models tested and their accompanying AIC values, see Appendix A. Second, only after the establishment of the best fitting model is statistical significance tested for. The effect of a variable can therefore turn out to be non-significant, even though it is included in the best-fitting model.

2.4.2. Questionnaire data

A one-sample Kolmogorov-Smirnov test showed that the questionnaire data were not normally distributed, so non-parametric tests were used for data analysis. Following Hazari et al. (2009), the correlations between the five latent categories were computed to verify whether the theoretical grounds of the study are empirically acceptable. Cronbach's alpha coefficient 0.7 or above was deemed acceptable (Nunnally & Bernstein, 1994; Thorndike & Thorndike-Christ, 2010).

2.4.3. Group interviews

Participants' responses to the pre-planned questions in the interviews were summarized using an *a priori* structure, which helped facilitate the process of analysis (Cavana et al., 2001). Students' answers to open questions in the semi-structured interviews and students' written comments were summarized through content analysis, which is a systematic approach to analyzing textual data or communication contents without a pre-determined structure (Creswell, 2003). To examine the overall attitudes displayed by the groups, one-sample Wilcoxon signed rank tests were performed based on the rated numbers of positive, neutral and negative group attitudes to each of the three interview questions.

3. Results

3.1. Number of collaborative revisions

Table 2 and Figure 1 summarize the number of revisions on PBworks that were recorded for each of the 16 groups. In total, 1070 revisions were counted. A substantial part (40%) of these revisions consisted of collaboration (N = 427), indicating that collaboration occurred during the group projects. For the Form 1 classes, 33% of the entries (52 out of 160) were classified as collaborative, while in the case of the Form 3 classes, collaboration occurred in 41% of the revisions (375 out of 910).

Table 2

2a Number of observed revisions made by 8 groups of F.1 students

Type of revision	Best performing groups				Worst performing groups			
Cooperation								
1. Adding new ideas to self-contents	2	4	3	3	8	0	3	1
2. Elaborating on self-existing ideas	1	0	0	7	15	0	3	0
3. Reorganizing self-existing ideas	3	0	0	2	7	0	4	1
4. Replacing and correcting self-existing ideas	6	12	4	6	9	1	0	3
Total per group	12	16	7	18	39	1	10	5
Cumulative total	**53**				**55**			
Collaboration								
5. Adding new ideas to contents of other group members	2	5	0	5	5	0	0	4
6. Elaborating on ideas of other group members	4	1	0	0	1	0	0	3
7. Reorganizing ideas of other group members	2	0	2	0	3	1	0	0
8. Replacing and correcting ideas of other group members	5	2	1	2	1	0	2	1
Total per group	13	8	3	7	10	1	2	8
Cumulative total	**31**				**21**			

2b Number of observed revisions made by 8 groups of F.3 students

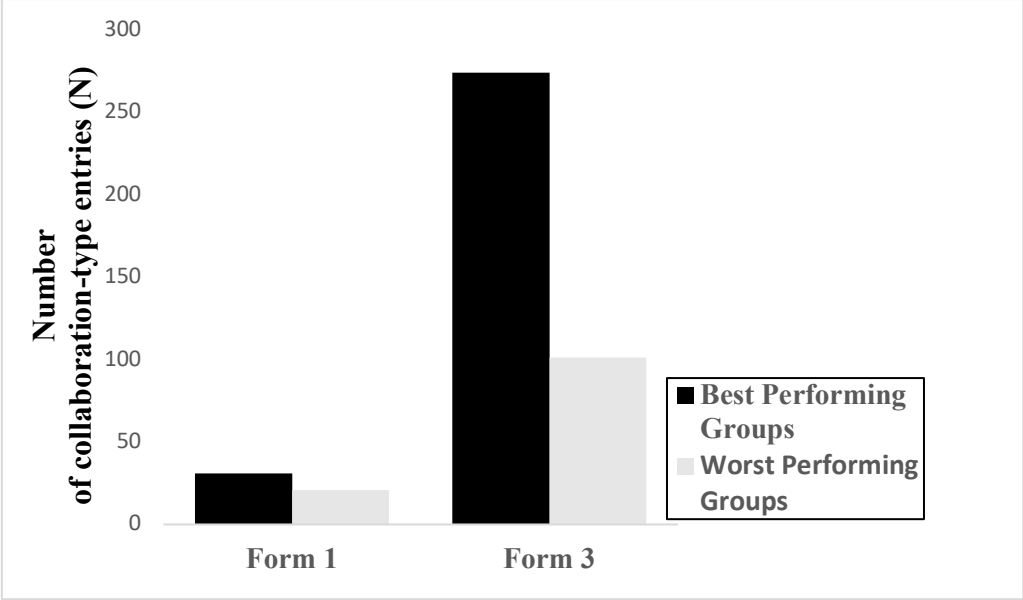
Type of revision	Best performing groups				Worst performing groups			
Cooperation	**3A**	**3A**	**3B**	**3C**	**3A**	**3A**	**3B**	**3C**
1. Adding new ideas to self-contents	21	10	15	32	11	3	11	14
2. Elaborating on self-existing ideas	19	4	12	26	8	4	27	6
3. Reorganizing self-existing ideas	28	13	5	25	6	1	8	3
4. Replacing and correcting self-existing ideas	23	31	25	87	15	6	20	16
Total per group	91	58	57	170	40	14	66	39
Cumulative total	**376**				**159**			
Collaboration								
5. Adding new ideas to contents of other group members	6	9	24	25	8	0	12	10
6. Elaborating on ideas of other group members	3	9	10	25	4	0	8	9
7. Reorganizing ideas of other group members	1	16	3	24	3	0	28	3
8. Replacing and correcting ideas of other group members	9	12	14	34	3	0	9	4
Total per group	19	46	51	108	18	0	57	26

Cumulative total	**274**	**101**

3.2. Number of collaborative revisions and group writing performance

The GLMM with the number of collaborative revisions as dependent variable indicated that the best-fitting model included the effects of group writing quality ($F(1, 60) = 9.53$, $p < .01$), form ($F(1, 60) = 34.28$, $p < .001$) and their interaction ($F(1, 60) = 6.88$, $p < .05$). High performing groups had significantly more collaboration entries ($M = 31.88$, $SD = 36.86$) than low performing groups ($M = 15.25$, $SD = 22.48$), ($t(62) = 2.18$, $p < .05$, *95% CI* = [.34 7.97]). Form 3 classes ($M = 40.63$, $SD = 36.83$) collaborated more than Form 1 classes ($M = 6.50$, $SD = 7.02$), ($t(62) = 5.15$, $p < .001$, *95% CI* = [5.21 11.84]). The interaction effect between group writing quality and form indicated that the effect of group writing quality was only significant for Form 3 students ($F(1, 30) = 8.63$, $p < .01$), and not for Form 1 students ($F(1, 30) = 1.25$, $p = .27$). In the Form 3 classes, high performing groups ($M = 56.00$, $SD = 38.86$) collaborated significantly more than their low performing counterparts ($M = 25.25$, $SD = 28.08$), ($t(30) = 2.57$, $p < .05$, *95% CI* = [1.57 13.81]). In the Form 1 classes, high performing groups ($M = 7.76$, $SD = 7.48$) also collaborated more than low performing groups ($M = 5.25$, $SD = 6.49$), but this difference was not statistically significant ($t(30) = 1.01$, $p = .32$, *95% CI* = [-.64 1.89]).

Fig. 1. Number of collaboration type entries.



3.3. Students' Perceptions of the Pedagogical value of the wiki

3.3.1. Findings from the questionnaire

As shown in Table 3, the five categories within the questionnaire had significant inter-item correlations. This, along with the Cronbach's alpha (.98) indicated good internal consistency.

Table 4 summarizes students' perceptions of the five categories of pedagogical value of wikis. On a 5-point Likert scale, mean responses were above 3.00 but below 3.50, implying that PBworks was perceived to be somewhat useful at best. There did not seem to be a difference in the perceptions of students from the different year levels (i.e. Form 1 and 3), except for the category of knowledge management. Form 3 students reported slightly more positive perceptions of the value of the wiki for knowledge management than Form 1 students. Nevertheless, the ratings did not go beyond the perception that PBworks was only somewhat useful.

3.3.2. Findings from the interview

A subsample of participants participated in group interviews (118 out of 219 students altogether). Table 5 summarizes the groups' attitudes towards the use of PBworks. It appears that PBworks' functionalities were perceived to have provided an effective means of facilitating group work. All the 30 groups interviewed reported a degree of positive regard for the functionalities of the online system. For example, Student D (Form-1, Class F, Group 6) said "it is convenient in the sense that we can post information on PBworks as soon as we find them. It saves time because we don't have to meet to discuss the project." Another student, Student A (Form 3, Class E, Group 6), remarked "PBworks can effectively help to put different parts of the project that had been done by different students together." Students suggested that the ability to work online together allowed them to revise work immediately and respond quickly to other group members. Students were also able to trace the group progress, and view and learn from the work of their group members.

Results of the Wilcoxon Signed Rank tests confirmed that students expressed mainly positive opinions regarding the use of PBworks. A majority of the groups expressed having found PBworks an overall useful tool ($Z = 4.27$, $p < .001$) and not having experienced unpleasantness using PBworks ($Z = 2.65$, $p < .001$). Groups appeared to be neutral in their preference for PBworks compared to other programs ($Z = .58$, $p = .56$).

Factors that motivated students to use the wiki were also mentioned during the interviews. Student B (Form 3, Class E, Group 2) identified that one motivating factor was that communications were made easier. The student noted, "I had to spend more time on taking phone calls or sending emails before, but now I can use PBworks as a platform, which makes communication more efficient." Group interaction appeared to have been promoted by the virtual environment, which allowed students to interact with each other any time. For example, Student D (Form 3, Class G, Group 2) said, "I think PBworks can help us to finish the group

project more easily because we can communicate online and don't need to go out to do a discussion." Another student, Student B (Form 1, Class E, Group 2), also noted, "We can find some information; we can upload it on PBworks. Other group members can see them and it can help us do the project." Essentially, the interview findings suggested that the students engaged in enhanced communication and interactions beyond school hours and premises.

Table 3

Inter-item correlations between categories of the pedagogical value of Pbworks

	M	*SD*	*1*	*2*	*3*	*4*	*5*
1. Learning outcomes	3.31	0.84	(0.83)				
2. Motivation	3.22	0.85	0.72**	(0.77)			
3. Group interaction	3.31	0.84	0.64**	0.58**	(0.74)		
4. Ease-of-use technology	3.37	0.84	0.56**	0.59**	0.47**	(0.74)	
5. Knowledge management	3.46	0.76	0.44**	0.45**	0.47**	0.42**	(0.76)

Note: M = mean; SD = standard deviation; numbers in bracket are alpha coefficients; ** $p < 0.01$; * $p < 0.05$.

Table 4

Students' perceptions of the pedagogical value of Pbworks

Category of pedagogical value	Form 1	Form 3	Overall	Mann-Whitney U test
1. Learning outcomes	3.33 (0.77)	3.30 (0.90)	3.31	0.856
2. Motivation	3.26 (0.81)	3.18 (0.89)	3.22	0.457
3. Group interaction	3.29 (0.85)	3.32 (0.83)	3.31	0.490
4. Ease-of-use technology	3.38 (0.90)	3.36 (0.78)	3.37	0.735
5. Knowledge management	3.41 (0.77)	3.52 (0.74)	3.46	0.042*

Note: Ratings are reported on a 5-point Likert scale where 5 represents the most positive perceived value for each category; * $p < 0.05$; numbers in parenthesis are standard deviation values.

Table 5

Group attitudes towards PBworks as displayed in the group interviews

Questions	Number of positive attitudes	Number of neutral attitudes	Number of negative attitudes	Statistics
1. Do you find PBworks helpful for your group project work?	26	1	3	$Z = 4.27$, $p < .001$
2. Have you ever experienced any unpleasantness stemming from PBwork's functions?	21	2	7	$Z = 2.65$, $p < .001$
3. Do you prefer PBworks over other tools such as MS Word or Powerpoint?	15	3	12	$Z = .58$, $p = .56$

Note a: The terms positive, neutral and negative refer to the displayed attitude towards PBworks, not the confirmation or negation of the question. For example, a student who mentions not having perceived unpleasantness stemming from PBwork's functions provides a positive answer to the second question.
Note b: One overall answer per group was counted, such that 2 neutral answers are equivalent to 1 positive and 1 negative answer.

Another motivating factor was the structure provided by PBworks as evident in the remarks of Student C (Form 3, Class E, Group 2): "PBworks provides a framework, which can help us do the project. I like the structure it designed." Despite being a relatively novel tool for students, the structure of PBworks appeared to be generally easy to use. Students felt that PBworks was convenient to use and edit in that they managed to add more information, review previous contents, and change the display easily. Student B (Form 1, Class E, Group 2) reported, "In PBworks, it is quite convenient for me to find the part I did, and the reference information can be uploaded on it." Nevertheless, some students also reported that some of the functions on PBworks are not quite user-friendly. Student C (Form 1, Class E, Group 2) mentioned, "when one group member is editing the content, it is inconvenient for other group members to edit at the same time. So it will cause some trouble." Another student, Student B (Form 1, Class E, Group 5) said, "I personally prefer MS Word, because it is more difficult to edit our work

on PBworks.[5] I cannot copy what I've written onto PBworks. I can only do the editing on PBworks."

Some support for the pedagogical value of PBworks in disseminating, sharing, and creating knowledge was also evident in the interview findings. Students reported knowledge sharing in particular as illustrated by Student A (Form-3, Class E, Group 1), who said, "PBworks provides a platform for us to share our ideas." Another student, Student A (Form 3, Class E, Group 2), also identified knowledge management as a benefit of using Pbworks saying, "PBworks can effectively help us put together different parts of the project done by different students." It appears that the ability to share and manage information online prevented repetition of information search processes.

4. Discussion

This study aimed to contribute to the evidence supporting the use of wikis as a learning tool in collaborative group writing projects, by investigating the extent to which Hong Kong secondary school students engaged in collaboration when working on a group project using Pbworks, an online wiki platform. Furthermore, the study examined whether there was a positive association between this collaboration and group work performance. The key findings are discussed in relation to the wider literature in the subsequent sections.

4.1. Collaboration and the quality of group writing

In line with previous studies (Chu, 2008; Chu et al., 2012), the present study found a positive association between collaboration and the quality of group writing. Kolloffel et al. (2011) proposed that collaboration has a positive effect on learning outcomes, and this appears

[5] Users can in fact copy texts from Microsoft Word to PBworks. Students may not be familiar with PBworks.

to have been the case in the current study. Altogether, the main results suggest that the wiki enhanced group writing performance by facilitating collaboration (as opposed to cooperation). Eight types of revisions were identified and analyzed from the wiki platform, and the findings show that student groups with higher writing performance were the ones who engaged in greater collaborative activities on the wiki. This suggests that a direct relationship between collaborative activities and output quality may exist in wiki-based group writing. Besides contributing to the growing evidence supporting wiki for collaborative writing, the novel methodology used in this current study for analyzing collaborative activities on the wiki is one that future studies may use.

Overall, the student groups who frequently revised their work on PBworks appeared to have engaged substantially in the eight types of revision. They not only added and modified their own work, but also reorganized and corrected others' work, thus appearing to have engaged in collaboration. In contrast, the groups who generated poor output quality hardly engaged in collaborative learning despite the collaborative functionalities offered by the wiki site. These findings suggest that the wiki could potentially support online collaborative writing. When students used the available collaborative functionalities, they were able to generate high quality output. However, some students did not appreciate the benefits of this type of learning method. This needs to be addressed by practical teaching strategies.

4.2. Practical Implications and Recommendations to teachers

Even though PBworks supported collaboration and enhanced the quality of group writing to a substantial degree, there appeared to be room for improvement. For example, not all groups showed high degrees of collaboration; one group even demonstrated no collaboration at all. Furthermore, results from the interviews and questionnaires indicated that students had only

moderately positive attitudes towards the pedagogical value of PBworks. This is not to say that the students showed negative attitudes. After all, the results showed a trend towards more positive than negative attitudes even though the interview questions specifically asked students to voice any negative experiences. Rather, the responses to the questionnaire and interview can be viewed as not overwhelmingly positive and therefore as having room for improvement. Given the positive role of the wiki in supporting collaboration and writing performance, a possible future improvement might be to remove any obstacles currently preventing some students from making more extensive use of wikis.

An important challenge appeared to be students' limitations in operating the technology. Some indicated finding PBworks difficult to operate, while others found it inconvenient. Indeed, in a recent review by Stoddart and colleagues (2016), it was recommended that collaborative wiki-based writing might be successfully facilitated if a teacher, who is an expert in using wiki, adequately introduced students to the technology. Teachers' own technology competency is deemed a prerequisite for supporting students who encounter difficulties in operating new technology. In line with Raman, Ryan and Olfman (2005), we therefore recommend that teachers try to maintain a sufficient level of technological literacy themselves.

Besides the teacher's expertise, Baylor and Ritchie (2002) also pointed out that the attitudes of teachers and school leaders influence students' use of technology. The beliefs and expectations of students are indirectly affected if their mentors demonstrate their openness to the use of online learning platforms. In the current study, some students worked on other platforms, such as MS Word, before uploading the end product despite the availability of technical support in using the online platform. This suggests that teachers may need to encourage students to use the technology that supports collaboration, not only cooperation (i.e.

as in the case of copying from MS Word). It may also be important for teachers to make explicit the potential advantages of collaboration over cooperation.

Pedagogical practices may need to be aimed at improving students' attitudes and competencies in using social media tools. The fact that Form 1 students showed significantly lower usage and less collaboration suggests that they might have found the wiki tool more challenging, and therefore needed greater support. It may be inferred that younger students in particular, are more likely to need such technological competency support than older ones.

4.3 Limitations and Future Research

A limitation of the current study is that the number, rather than the content, of collaborative entries was used as a measure of collaboration. Curtis and Lawson (2001), and Paulus (2005) suggested that effective collaboration requires a sense of equality, mutual respect, sharing of talents and life experiences, and a meaningful dialogue that involves a number of negotiation cycles. It seems reasonable to assume that these preconditions were met in this study as results showed that collaboration had a positive association with group writing quality. However, future research might consider further examining which specific components of collaboration contribute most to writing performance. It is also acknowledged that subjectivity with respect to the quality scores provided by the teachers may not be completely ruled out – although the school authorities maintain that marking was consistent. Future studies may consider using standardized marking rubrics.

Future research might also consider investigating how the use of wikis can best be supported. From the group interviews, it became apparent that students sometimes found it difficult to operate the wiki, and that interoperability with different programs might be improved. There

seem to be three possible ways to overcome these difficulties. First, the effectiveness of attempts to improve students' digital literacy might be investigated. Second, attempts to improve teachers' digital literacy might resolve some of the remaining issues. Third, the wiki environment itself might be adapted to suit students' needs better. Studies may investigate exactly what aspects of the wiki can be amended to remove obstacles to its use.

5. Conclusion

This study examined the use of a wiki to support collaboration in a secondary school group writing project. Based on triangulation of revision analysis, and questionnaire and interview data, it was found that the wiki supported group writing performance by promoting collaboration. This study therefore contributes to the evidence supporting the pedagogical value of wikis. Moreover, the direct relationship of collaboration and writing performance that exists on wiki as shown by this study, contributes to our understanding of how online technologies may have a place in teaching and learning. Finally, the study provides a novel methodology for evaluating collaboration based on revision analysis, which other researchers may use in future research.

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Appendix A – Details GLMM

The table below describes the AIC values of all models tested. The dependent variable was the number of collaborative revisions made by each group. In line with recommendations by Twisk (2006) a first model only included the main effect of the independent variable being studied – in this study that was writing quality. Subsequently, other variables and all possible interactions were added. Added variables (or interactions) were retained in the model if and only if they lowered AIC values by 2. If not, they were removed before the contribution of the next factor was tested for. Retained variables are highlighted using **bold** letters in the table below.

Independent variables	Aikake's Information Criterion
Writing quality	**436.97**
Academic level (Form 1 and Form 3)	**410.09**
Learning mode (Assimilation and Accomodation)	416.52
Writing quality x Academic level	**400.83**
Writing quality x Learning mode	412.67
Writing quality x Academic level x Learning mode	408.83