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Towards an Inquiry-Based Language Learning: Can a Wiki Help?

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Abstract

Wiki use may help EFL instructors to create an effective learning environment for inquiry-based language teaching and learning. The purpose of this study was to investigate the effects of wikis on the EFL learners' IBL process. Forty-nine EFL students participated in the study while they conducted research projects in English. The Non-wiki group (n=25) received traditional inquiry instruction and the Wiki group (n=24) received wiki-mediated instruction during their IBL process. Data were collected through surveys at the stages of pre-search, exploration, and completion of the IBL activity. The instruments sought to measure differences in knowledge accumulation, as well as the challenges students encountered during their inquiry process. The results revealed that the use of wikis can provide support to (a) help students go beyond information accumulation and regurgitation of facts and move toward generating more integrated and synthesized knowledge representations and (b) address the challenges of traditional IBL including planning the tasks, organizing multiple resources, managing the inquiry process, and coordinating the final product. According to the results of the survey, wikis can constitute a dynamic forum that keeps students engaged in staging the sequences of structured inquiry process and improve ability to perform inquiry-based tasks in an efficient manner.

Keywords: EFL, inquiry-based learning, language learning, wiki

1. Introduction

Over the decades, educators have been committed to finding a way to make language learning more meaningful and transferable to various situations out of a specific context and help learners to acquire more productive and interactive language skills as well as develop their intercultural understanding. The notion of inquiry-based learning (IBL) has been around in both theory and practice of this long-term desire (Lim, 2004). Many researchers such as Dewey, Massialas, Fenton, Griffin, Metcalf, Bruner, Suchman and Beyer have been addressed and defined IBL from a variety of perspectives (Lim, 2004; Looi, 1998). Some connect IBL with the development of scientific approach and emphasize promoting self-directed learning and higher-order thinking skills. Others stress the learner's active involvement with hands-on experience as a way of implementing IBL.

In this study, the researcher defines IBL as a carefully planned instructional approach in which inquiry functions as a main vehicle to guide students learn about inquiry and learn through inquiry. In this approach, students build deep knowledge and understanding of a topic and gradually develop higher-order thinking and self-directed learning skills. The inquiry process induces learners to contemplate problems in preparation for the investigation ahead, conduct self-directed investigations, gather pertinent evidence, and finally prepare to share what they have learned with the others in their learning community and lead towards independent learning. At this point, students share the process of learning with each other that addresses the learning needs. Such knowledge-sharing is a community process of construction and they begin to understand the meaning of their investigation. Students' development occurs in a sequence of stages, which is the most important characteristic of IBL and has been considered beneficial in augmenting meaningful learning (Brown & Campione, 1994; Collins, Brown, & Holum, 1991; Lim, 2004; Linn & Hsi, 2000; Slotta, 2002; White & Frederickson, 1998).

While there are many ways to implement IBL, the attention of educational researchers and organizations has been drawn to the successful use of web-based IBL. Many researchers point out the potential of integrating technology and recommend using technology to augment inquiry (Barab & Luehmann, 2003; Edelson, Gordin, & Pea, 1999;

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Hakverdi-Can & Sonmez, 2012; Kim, Hannafin, & Bryan, 2007). However, web-based IBL should be designed properly to assist learners in inquiry, including some kinds of inquiry tools, components, and mechanisms to facilitate inquiry. It should also have its own visual representation as a main vehicle for the inquiry process. Moreover, self-directed learning and learner-centered approach should be encouraged in a web-based IBL environment (Lim, 2004).

There are many critical issues to be considered when one tries to implement web-based IBL for language learning. Such a study may help clarify some entangled and unsolved issues surrounding various types of technology supported IBL. Ultimately, it is hoped that such a study may shed some light in providing a theoretical and a pedagogical foundation for the premise that active participation of information seeking and knowledge assimilating processes, two of the key principles of IBL, are supported in many ways by a well-designed IBL on the web. Moreover, through web-based IBL, EFL teachers can create and represent modifiable representations of ongoing stages of inquiry to guide students to develop appropriate thinking and research skills. In this way, EFL students learn on their own to possess substantial linguistic knowledge which makes learning most effective and permanent.

The following research questions guided this study:

1. Is there any difference on EFL students' inquiry-based learning process in terms of gaining content knowledge?
2. What were the major difficulties of traditional inquiry-based language learning and wiki-mediated inquiry-based language learning?

2. Background

2.1 Inquiry-based Language Learning

Inquiry-based learning is a recent manifestation that provides the students with an earning environment in which they are at the center of their learning to improve the understanding of science content and practices (Edelson et al., 1999). According to Shih, Chuang, and Hwang (2010), inquiry-based learning is a concept which encourages teachers to allow learners to get in touch with authentic situations and to explore and solve problems that are analogs to real life. Students who study content through engaging, hands-on exploration can make more connections between what they learn in the classroom and what they experience in the outside world and develop higher level thinking skills.

Learning takes place through a sequence of stages and students become actively involved in social interactions as well as higher level thinking. Price (2001) stated that students develop a deeper understanding of the subject and "learn how to learn" in inquiries which is a combination of acting and reflecting on the experience and its consequences. Colburn (2000) described inquiry as "the creation of a classroom where students are engaged in essentially open-ended, student-centered, and hands-on activities." Online IBL enlarges learning experience as an active individual process by increasing their involvement and responsibility for their own learning (Lim, 2004). Like Lim, Creedy's research and writing (Creedy, Horsfall, & Hand, 1992) confirm that inquiry-based learning is intended to emphasize hands-on learning as opposed to authoritarian methods in teaching, encourage people to be active learners rather than passive receivers of information.

Kim (2015a) explores the learning experience of three different English proficiency-level groups of English language learners (ELLs) within the framework of Kuhlthau's Information Search Process (ISP). The finding indicates that ELL students showed significant increases in their topical knowledge and estimate of interest and knowledge as they progressed in the inquiry project. In this respect, IBL plays a very important role in language teaching and learning. Studies indicate that inquiry processes provide the context and opportunity for language learners to use academic language and increase their achievement not only in reading and writing but also in their content knowledge (Amaral, Garrison, & Klentschy, 2002; Stoddart, Pinal, Latzke, & Canaday, 2002). The content knowledge does not need to be academic; it can cover any topic, theme, or any issue of interest or importance to the learners.

Through the process of feeling curious about a topic, asking questions, and seeking answers, language learners can clarify their understanding of the content and develop their language skills simultaneously. Specifically, learners gain implicit knowledge by processing target-language input without consciously giving attention to acquiring the forms and structures of the language (Hulstijn, 2005). For language learners, understanding the content is an effective motivation when the content is interesting or of some value to the learners (Genesee, 1994). In this way, students learn on their own to possess substantial linguistic knowledge which makes learning most effective and permanent.

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2.2 Challenges for Inquiry-based Language Learning

Although IBL approach offers compelling opportunities for language learning, it is not used so much because there are challenges and difficulties in the process of implementation, for example, teachers' lack of proficiency and confidence in implementing instructional technologies within inquiry learning environments (Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004). Lim (2004) argued that in a complex and ill-structured IBL environment, instructors face a lot of difficulties and challenges to deal with in the course of designing inquiry experiences for learners. It is also time-consuming; teachers might not be able to spend a considerable time on IBL learning environment design and development and adjust to new forms of tasks and activities (Hakverdi-Can & Sonmez, 2012). If students are not sufficiently motivated, they either fail to participate in inquiry activities or they participate in them in a disengaged manner that does not support meaningful learning (Edelson et al., 1999).

Students might misunderstand the goals of every phase of the IBL process and lack to utilize appropriate strategies to complete IBL tasks. Without clear guidance and intervention throughout the process, students often approach the process as a simple collecting and presenting task by copying and pasting from single source (Kuhlthau, 2010). The lack of English proficiency made the EFL students have difficulties in understanding found information and summarizing the content (Kim & Todd, 2008). Moreover, students may not have the ability to achieve the ultimate goal of open-ended inquiry which requires planning and coordination of activity and the management of resources and final products (Edelson et al., 1999).

2.3 Incorporating Web-based IBL with Language Learning

While there are many ways to implement IBL, the attention of educational researchers and organizations has been drawn to the successful use of web-based IBL. Many researchers point out the potential of integrating technology and recommend using technology to augment inquiry (Barab & Luehmann, 2003; Edelson et al., 1999; Hakverdi-Can & Sonmez, 2012; Kim et al., 2007). The benefits of integrating technology into inquiry learning environments include providing resources for inquiry which are free for anyone with Internet access to use (Dennen & Bonk, 1999), giving students the opportunity of experiencing scientific modeling (Chang, Quintana, & Krajcik, 2010), and utilizing asynchronous conferencing systems and hypermedia to collaborate and inquire more efficiently (Lim, 2004).

As researchers (Dennen & Bonk, 1999; Lim, 2004; Lim, Plucker, & Bichelmeyer, 2003; Pierce, 2003) suggest, students who use these approaches to facilitate inquiry receive better support in record keeping, reflective writing, collaborative brainstorming, web pages designing, search skills developing, and perform self-directed inquiry through remote access to many types of resources.

In the past decade, researchers have carried out the issue of designing a well-structured IBL on the web in a variety of educational fields in both informal and formal settings such as WISE (web-based inquiry science environment) (https://wise.berkeley.edu/), Inquiry Page (http://www.inquiry.uiuc.edu/), WebQuest (http://edweb.sdsu.edu/WebQuest/), and Learning to Teach with Technology Studio (LTTS) (http://ltts.org). IBL is not just a model for learning and various approaches such as structured inquiry, guided inquiry, open inquiry and learning cycles can be used in an IBL activity to assist the students in facing and solving a problem and the search for realistic and strategic solutions (Creedy et al., 1992; Lim, 2004).

While the aforementioned representative cases provide an Internet-based platform for students to work collaboratively on an inquiry project and revealed the benefits of training students to master certain structural or systematic knowledge or skills, the use of web-based IBL for language learning is seldom reported. Currently, the knowledge base for IBL is not firmly established in foreign language settings. However, a relatively recent view of language learning has focused on how student-centered, activity-based learning approaches can be applied in a foreign language class (Martinez, 2003; Schwarzer & Luke, 2001).

The implementation of online IBL for the EFL class can change teacher's and student's role. Teachers guide students through a sequence of inquiry stages to build deep knowledge and deep understanding of a topic and different cultural aspects and gradually students' linguistic skills improve (Arauz, 2013). Online IBL empower EFL students learn through all of their senses in different ways so they can be in control of their own learning. Consequently, reading, listening, viewing, and observing are joined with writing, speaking, visualizing, performing, and producing to encompass a holistic experience of learning (Kuhlthau, Maniotes, & Caspari, 2007).

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Through integrating technology and IBL into the curriculum, a well-designed IBL on the web may be a solution to the challenges and limitations of IBL approach. In this proposed study, the researcher seeks to explore if Wikis can be utilized as an instructional medium allows students to capture, reconcile, and transfer knowledge in an efficient manner as it has the potential to eliminate the barriers in implementing IBL environments. Therefore, the purpose of this study is thus to foster the process of wiki-mediated inquiry-based language learning.

Wikis, as one of the Web 2.0 social networking tools, have been increasingly integrated into second language (L2) instruction to promote teaching and learning (Lee, 2010). In the field of second language (L2) learning, wikis have been mainly used for collaborative learning (Parker & Chao, 2007) and knowledge construction (Cole, 2009). Lund (2008) argues that wikis hold transformational potential and offer a collective approach to language development and production. When students use an inquiry based approach to searching, central to composing wikis focuses on engaging learners in the process of constructing their knowledge of a topic in a multidimensional way and transform founding information into personal knowledge.

In order to accomplish an inquiry-based task, students need to develop the ability to use prior knowledge to recognize the value of new information, assimilate it, and apply it to create new knowledge and capabilities. The use of wikis at this point provides EFL learners with cognitive tools and procedural guidance to fulfil their inquiry and enables maximization of storing, transforming, and transporting knowledge throughout the organization.

3. Method

The research sought to measure students' learning in multidimensional ways including growth of knowledge of their content topic and major difficulties during the inquiry process. A combination of qualitative and quantitative methods were used to examine and measure the students' learning. The data were collected at three stages of the students' inquiry process: at the pre-search of the research task, midway during the task, and at the completion of the task. Data were collected through survey instrument which captured responses to open-ended questions as well as categorical responses.

3.1 Participants

The participants were 49 college students in Taiwan in two sophomore English classes taught by the teacher-researcher. Both the Wiki group (n=24) and the Non-wiki group (n=25) were similar in terms of age (ranging from 18 to 21) and English proficiency level (intermediate). Of the 49 students, 38 were female and 11 were male. The participants were majoring in English and had been studying English as a foreign language for at least 9 years.

3.2 Facilitation Plan of Web-based Inquiry Learning Activity

Inquiry-based language learning emphasizes students' understanding concepts in which students are motivated to engage in self-regulated learning activities supported by the teacher-researcher. In order to help students to engage in the inquiry-based learning while acquiring the foreign language, a facilitation plan adapted from Kuhlthau's model (1997) was used in this study. Kuhlthau's model (1997) of inquiry-based information search process (ISP) is more relevant today than notions of an invariant curriculum or conventional modes of English language instruction.

The inquiry-based ISP can not only provide a systematic intervention to guide students in the inquiry process, but also build a more comprehensive picture of how to measure student learning through using found information. Research shows that ELL students became significantly more relieved and satisfied and less frustrated and confused as they progressed in the inquiry project using Kuhlthau's Information Search Process as a theoretical framework (Kim, 2015b).

The inquiry activities extended over a period of six weeks. With reference to the work of Kuhlthau (2010), a facilitation plan of web-based inquiry learning activities was designed to foster students' learning for both Wiki and Non-wiki groups (see Table 1).

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Table 1. Facilitation plan of Web-based inquiry learning activity

Steps of inquiry	Task
1. Pre-search	Investigating a general topic and conducting preliminary searches through the internet.
2. Topic selection	Selecting a specific focus for the project.
3. Exploration	exploring and gathering related reference information through the internet (multiformat information is encouraged)
4. Formulation	Forming a personal perspective of the information encountered
5. Collection	Gathering information that defines and supports the focus formed in the prior stage
6. Completion	Turning in the final project (multimedia expression is encouraged)

3.3 Design of the Learning Activities

When a facilitation plan of web-based inquiry learning activities is used as a framework for developing and guiding inquiry, students need a well-structured platform to independently explore complex problems, to learn from their peers, and to reflect on their experiences. With a well-structured platform, students move away from simply collecting information and putting it together; rather, they are engaged and guided in a thinking process from the first step of Pre-search to the later stages of Collection and Completion.

In order to amplify the opportunities for researchers to make inquiry-based language learning effective and successful, a WIKI Website (Google site) was created and used in this study. WIKI is one of the Web 2.0 social networking tools. WIKI has been increasingly integrated into second language (L2) instruction to promote teaching and learning (Lee, 2010). In the field of second language L2 learning, wikis have been mainly used for collaborative learning (Garza & Hern, 2006) and knowledge construction (Cole, 2009), as well as hold transformational potential and offer a collective approach to language development and production (Lund, 2008) (see Figure 1)

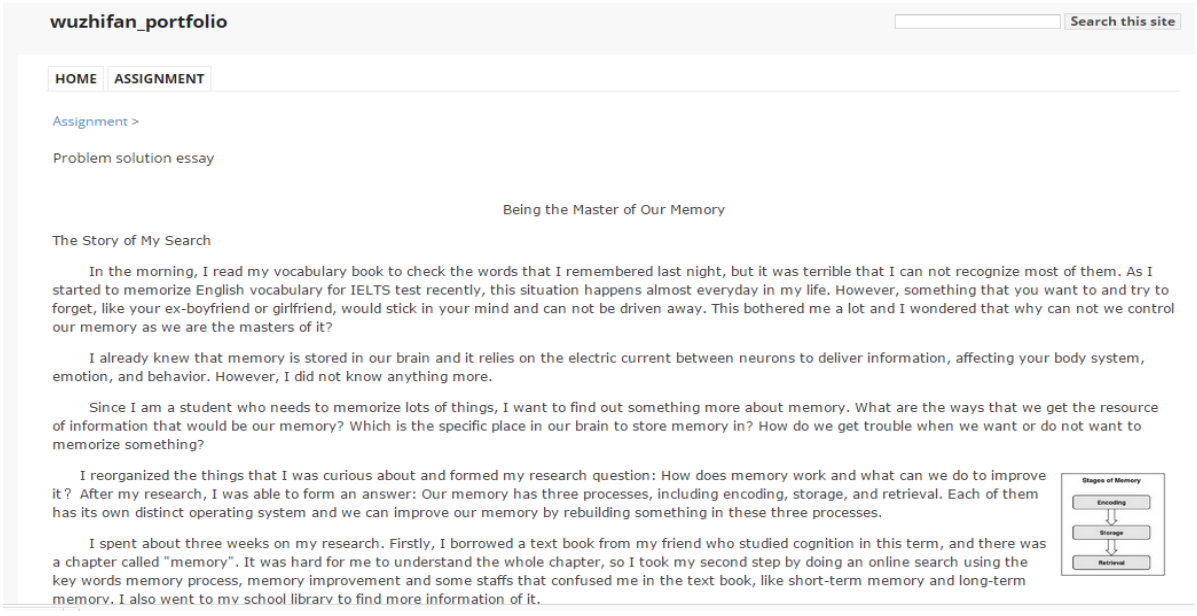

Figure 1. Screen capture from WIKI Website (Google site).

The activity used in this study was the same for both groups. During the inquiry process, students in both groups were free and encouraged to seek and engage with a diverse range of sources to explore topics and build background

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knowledge. The participants in the Wiki group recorded their online inquiry learning process using Wiki (Google sites) which were employed to serve as virtual platforms where the students can post their progress of each step and share their inquiry data. That is, the support of wiki makes their thinking visible and their thoughts can be externalized. For participants in the Non-wiki group, approaches to source logs recording and places to publish their final project were also prescribed. They need to turn in their final work and relevance reference as a Word file.

In order to accomplish the task, students need to develop the ability to use prior knowledge to recognize the value of new information, assimilate it, and apply it to create new knowledge and capabilities. The use of the Wiki at this point enables maximization of storing, transforming, and transporting knowledge throughout the organization. Moreover, online IBL allows students to capture, reconcile, and transfer knowledge in an efficient manner and thus eliminates the challenge of understanding and planning tasks, coordination of activity, and the management of resources.

3.4 Procedures

During the instruction session, the participants in the Wiki and Non-wiki groups met separately with the teacher-researcher. The instruction sessions were held in a computer lab where the students had access to computer terminals and could follow along with the teacher-researcher. In the first 60-minute session, the teacher-researcher prepared a PowerPoint presentation and a one-page handout that covers the steps of facilitation plan of IBL activities for both groups. In the second 60-minute session, both groups were instructed on doing practice searching for their research topics followed the steps of inquiry. The teacher-researcher served as a facilitator through the inquiry process.

Students in the Wiki group need to create their own wiki using Google sites and practice using main functions of the wiki. They were taught to organize their project into six stages of inquiry and post the links of their own Google sites to the class wiki which was developed by the teacher-researcher. In this way, the Wiki group had the chance to share their idea with their peers during the inquiry process. One of the advantages of using a wiki was that it offered a well-structured learning environment to facilitate students at different stages of inquiry. Without this kind of preparation, students could easily encounter the challenge of understanding the learning tasks. The wiki site provided students with a space not only to pursue topics of interest but also to add video, audio, and graphics to support various pieces of information found. For participants in the Non-wiki group, they recorded their inquiry learning process and organized their project into six stages of inquiry using Word software.

3.5 Instrument

This study investigates the role of wiki played in Taiwanese college EFL students' IBL process. Data were collected through a survey instrument. For the purpose of measuring changes in implicit knowledge, the survey instrument which adapted from the Student Learning through Inquiry Measure (SLIM) toolkit (Todd, Kuhlthau & Heinstrom, 2005) were used at three stages (Pre-search, formulation, and completion) of the inquiry assignment.

The survey instrument consisted of the following questions:

1. Write the title that best describes your research project at this time.

2. Take some time to think about your research topic. Now write down what you know about this topic.

3. How much do you know about this topic? Check (√) one box that best matches how much you know: Nothing, Not much, Some, Quite a bit, and A great deal.

4. What do you find difficult to do? Please list as many things as you like.

Additional questions regarding the participants' background information at Pre-search stage were:

1. What is your gender?

2. What is your age?

3. How many years have you been learning English?

4. Findings

4.1 Estimate of Knowledge

The students were asked to estimate how much they knew about their topic through a five-point scale, and these estimates are shown in Table 2.

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Table 2. Personal estimate of knowledge by group

How much do you know about this topic?	Pre-search		Formulation		Completion	
	Non-wiki Group	Wiki Group	Non-wiki Group	Wiki Group	Non-wiki Group	Wiki Group
Nothing	2(8%)	2(8.3%)	1(4%)	0(0%)	0(0%)	0(0%)
Not Much	10(40%)	9(37.5%)	4(16%)	5(20.8%)	1(4%)	1(4.2%)
Some	9(36%)	10(41.7%)	8(32%)	7(29.2%)	3(12%)	2(8.3%)
Quite a bit	3(12%)	2(8.3%)	10(40%)	10(41.7%)	10(40%)	11(45.8%)
A great deal	1(4%)	1(4.2%)	2(8%)	2(8.3%)	11(44%)	10(41.7%)
Average (SD)	2.64(9.52)	2.62(9.24)	3.32(0.99)	3.38(0.92)	4.24(0.83)	4.25(0.79)

The results showed that the students in both Wiki (n=24) and Non-wiki (n=25) groups recorded that their knowledge of their topic grew as they progressed through their inquiry. In the stage of pre-search, the majority of students reported their estimate knowledge as not much or some (Wiki group: 79.2%; Non-wiki: 76%). In the stage of formulation, the majority of students estimate their knowledge as some or quite a bit (Wiki group: 70.9%; Non-wiki: 72%). In the stage of completion, the majority of students estimate their knowledge as quite a bit or a great deal (Wiki group: 87.5%; Non-wiki: 88%).

The Non-wiki group increased their estimate knowledge scores from the pre-search mean score 2.64 to the formulation mean score 3.32 and from the formulation mean score 3.32 to the completion mean score 4.24. In the Wiki group, the pre-search mean 2.62 to the formulation mean score 3.38 and to the completion mean score 4.25 was observed. The results of paired sample t-test showed that there were significant differences between their estimate knowledge between:

pre-search and formulation $t(23) = -8.31$, $p < 0.00$ (Wiki Group);

formulation and completion $t(23) = -7.99$, $p < 0.00$) (Wiki Group);

pre-search and formulation $t(24) = -7.14$, $p < 0.00$ (Non-wiki Group); and

formulation and completion $t(24) = -11.9$, $p < 0.00$) (Non-wiki Group).

These findings indicated that both traditional inquiry instruction and wiki-mediated inquiry instruction had positively affected EFL students' online inquiry-based learning in terms of knowledge growth. With regard to estimate knowledge scores between the Wiki and Non-wiki groups, no statistically significant difference was observed. An Independent-samples t-test (Table 3) shows that there was no significant difference in the students' estimates of knowledge between two groups in the stages of pre-search ($t(47)=0.056$, $p=0.956$), formulation ($t(47)=-2.01$, $p=0.842$), and completion $t(47)=-0.43$, $p=0.956$).

One possible explanation of this result could relate to the fact that all the participant students received the same instruction on basic components of inquiry process. While the traditional inquiry instruction and wiki-mediated inquiry instruction did not differ very much in terms of these basic components, they didn't show differences in their estimate of knowledge.

Table 3. Independent-Samples t-Test results for estimate of knowledge by stage

Stage	T	Df	Sig.
Pre-search	0.056	47	0.956
Formulation	-2.01	47	0.842
Completion	-0.43	47	0.966

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4.2 The Amount of Content Knowledge

Data were collected through the survey question "Take some time to think about your research topic. Now write down what you know about this topic." Students were required to do this free writing protocol from memory without reference to any sources or notes at each of the three stages of data collection. As a representation of their content knowledge, the ideas that they wrote down should be in some connected way rather than as single words or phrases. What they wrote could be in the form of facts, opinions, ideas, attitudes, reactions, and emotions; it could also repeat what they have stated earlier or could be changes to what they knew previously.

Regardless of grammatical errors and statement accuracy, the number of the students' relational statements about their topics was counted and was analyzed according to the categories developed by Graesser and Clark (1985). In this study, content knowledge will be collected through the survey question "Take some time to think about your research topic. Now write down what you know about this topic." The output of this free writing protocol will be regarded as a representation of students' relational statements about their topics (content knowledge) at each of the three stages. The number of statements will be counted and coded according to the categories developed by Graesser and Clark (Graesser & Clark, 1985; Todd, 2006). These categories are statements that focus on (a) facts, (b) explanations and results, and (c) synthesis. The coding framework is shown below with examples (Table 4).

Table 4. The coding framework of content knowledge

Statement Type		Definition and example
Facts	Properties	statements describing characteristics *Ex: The colour of Valentine's day is red;*
	Manner	statements describing processes, styles, actions *Ex: People drive aggressively in USA.*
	Set membership	statements about class inclusion *Ex: Michelangelo created works such as statue of David, Cistine Chapel and the famous Pieta.*
Explanations and results	Reason	statements of explanations of how and why *Ex: The wall was constructed to block invaders; This was because of the air pollution.*
	Outcome	statements providing end result *Ex: (People eat too much) As a result, people got very sick.*
	Causality	statements showing some event causally leads to another *Ex: Acid rain causes many fish to die.*
Synthesis		statements showing predictive relations, inference, implied meaning or statements presenting personal position, viewpoint, or value judgment. *Ex: That's not right; I do not believe that; I now realize that it is not as easy as you think living in a castle.*

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Table 5 shows the average number of statements at each stage of data collection by group. The number of statements recorded at each stage for Wiki and Non-wiki groups showed that the students' knowledge of their topics progressively increased. In the stage of pre-search, the students in both groups represented their knowledge of the topic predominantly by factual statements and substantially increased the number as they progressed from pre-search to formulation and from formulation to completion stage.

Table 5. Descriptive statistics of statement scores by group

	Pre-search		Formulation		Completion	
	Wiki	Non-wiki	Wiki	Non-wiki	Wiki	Non-wiki
Facts	3.88	3.47	5.43	6.47	7.62	9.49
Explanation and result	1.63	1.73	2.42	1.67	3.18	1.62
Synthesis	1.25	1.34	1.98	1.26	2.37	1.25
Total	6.76	6.54	9.83	9.40	13.17	12.36

The data also showed that there was no significant difference between the overall number of statements of Wiki and Non-wiki groups throughout the stages:

Pre-search $t(47)=0.273$, $p=0.786$;

Formulation $t(47)=-4.48$, $p=0.656$; and

Completion $t(47)=0.791$, $p=0.433$.

However, a distinctive difference on the capability of knowledge accumulation and integration was shown between the Wiki and Non-wiki groups. Although students in both groups presented progressive improvement in the number of statements which represent their amount of knowledge throughout the inquiry stages, only Wiki group added more explanations and results and synthesis statements while Non-wiki group appeared to be oriented to simply gathering facts and knowing a set of facts.

The results showed that the average number of factual statements of the Wiki group was lower than the Non-wiki group in the stage of formulation (Non-wiki: 6.47; Wiki: 5.43) and completion (Non-wiki: 9.49; Wiki: 7.62). The results also showed that the Wiki group used increasingly more explanation and synthesis statements to represent their knowledge while the Non-wiki group showed a slight decrease in explanation and synthesis statements. That is, the Wiki group presented their knowledge with a more synthesized way through the stages of formulation and completion while the Non-wiki group remained on adding facts into thematic format. It can be explained that the lack of technology support may result in the limitation of storing, creating, and transferring knowledge and therefore the development of knowledge accumulation and integration remained on a descriptive level.

The creation of new knowledge from the application of existing knowledge requires concerted effort and a high degree of experience in recognizing and capturing (Gold, Malhotra, & Segars, 2001). The use of a wiki can engage students to capture, reconcile, and transfer knowledge in an efficient manner. In a traditional English classroom, students do not have the chance to develop the habits and skills of planning, searching, and organizing which are critical for inquiry learning. As the students built knowledge without the support of a wiki, the capability of the knowledge accumulation and integration was mainly based on an individual's ability to find, list, and sort a bunch of superficial statements at each stage of the research process. Consequently, Non-wiki group did not continue to add explanations and results statements and even to a lesser extent to synthesis statements.

An example is shown in the following student's statements about the 2011 Tōhoku earthquake and tsunami. Pre-search stage: I know that it was a powerful quake. And the tsunami destroyed the Northern Japan. Exploration stage: After the powerful earthquake and tsunami, thousands of homes and roads were destroyed. People buried in the rubble. Trains and buses were not running and power and cell phones were down. Completion stage: It was a triple disaster — earth, water, and nuclear. The magnitude of the quake was 9.0. The duration of strong shaking from the quake was up to 5 minutes. Thousands of people were died, missing, or injured. There were nuclear power plant concerns after the tsunami waves hit the Fukushima Nuclear Power Plant. Two years later, numerous people are still homeless, living

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in residential camps. Right now, researchers are investing in understanding its tsunami history and developing new alarm models to prevent the disaster.

A more abstract and synthesized level of knowledge construction takes place when students develop the ability to use prior knowledge to recognize the value of new information, assimilate it, and apply it to create new knowledge and capabilities. In this aspect, the use of a wiki enables maximization of storing, transforming, and transporting knowledge throughout the inquiry process. This is illustrated by the following student's statements about playing guitar:

Pre-search stage: Guitar is a music instrument. It is fun to play.

Formulation stage: First of all, a guitar tuner is needed to tune a guitar unless you can tune by ear. Second, you need to learn to read guitar tabs. Lastly, you need to learn finger placement.

Completion stage: Guitar is fun to play and you don't have to be a musician to be a good guitar player. However, it takes desire and effort to learn and to maintain your skills once you learn.

Rather than just gathering facts at each stage, a significant ability of manipulating found information was identified in Wiki group's work. In the pre-search stage, their works showed with sets of facts statements. However, in the stage of formulation, they started to organize information into more coherent structure and added more explanations statements. In the last stage, the number of explanations statements constantly increased, as well as developed synthesizing statements into their works. Consequently, the average number of statements in their representations reduced which reflected students' ability to interpret multiple resources of information to establish personal conclusions.

4.3 Difficulties Encountered in Wiki and Non-wiki Group

4.3.1 Pre-search Stage

The pre-search stage involved planning what to do and how to do it. The data showed that at this stage, the main difficulty for Non-wiki (72%) and Wiki (75%) groups was determining an appropriate topic to research. Below showed some comments made by the participants:

1. I am worried that I cannot come up with an interesting topic.

2. I am worried if the topic that I choose would be easy to search information.

3. It is difficult in topic selection so I need more inspiration from the teacher or classmates.

4. The most difficult thing is to select a special and interesting topic to research. Selecting a familiar theme would be too boring.

Even though they found a topic related to their interests, they still felt unsure if it was doable due to the lack of English proficiency (Non-wiki: 52%; Wiki: 50%). As one student stated:

5. It's difficult for me to search information that I am really interested in English, so I decided to do an easier, general, and common topic instead.

Another most frequently reported difficulty only from the Non-wiki group was understanding the goals of each step of inquiry based learning (84%). Below are some comments made by the participants in the Non-wiki group.

6. It is difficult to understand the steps and proceed with my project.

7. The steps of the project confused me.

However, only 25% of the participants from the Wiki group reported that they had difficulty in the aspect of how to approach each step. As one student stated:

8. Sometimes I am not sure if I have a correct concept of my own process so I would check other classmates' wiki site.

Comment 8 revealed that although the assignment had been set up as an isolated work to be accomplished independently, participants in the Wiki group used collaborating as a natural strategy as they moving through the stages of the process.

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4.3.2 Formulation Stage

A common difficulty for both groups was reading and understanding the materials caused by the lack of English proficiency (Non-wiki: 52%; Wiki: 54%). This difficulty also hindered the students in summarizing and analyzing the content as they interacted with the information. Below showed some comments made by the participants:

Although I have a direction of research, I still need to narrow my search because it is too hard for me to read so much information I found.

It took me too much time to read articles and pick up useful information.

Some articles were hard to understand and summarize, so I had to read them several times.

One difficulty that mainly reported from the Non-wiki group was organizing and managing multiple resources through extended investigation (68%). Without paying attention to record every piece of information they found on the internet, the students fount that it was difficult in organizing sources into logical groups and felt overwhelmed by the many aspects related to the topic. As one student stated:

It's hard to save all the articles in an organized way. It's not easy to find an article when I need it.

It's hard to decide when to stop gathering information.

The conflicting information made me frustrated.

I am not sure if I had enough information or if they are the right kind.

4.3.3 Completion Stage

The results showed that over 72% of the participants in the Non-wiki group found it difficult to coordinate the final product, which is 34.5 percent greater than those in the Wiki group (37.5%). Participants compensated for difficulties in this stage by either selecting easier articles or locating single resource. Below are some comments made by the participants:

The information that I found is interesting, but I don't know where to cram it into my article.

I am not sure what information I should keep and what information I should get rid of.

I tried to make sense of the information coming out of my research process, but it seems that the information doesn't relate to and support the topic I've chosen.

There is too much information to organize; I don't know how to combine all of them.

In sum, the results of survey revealed that even though the inquiry project provides students with freedom of topic selection within their ability and of their interest, they encountered challenge in choosing possible topics. Students in the Non-wiki group also had difficulties in getting an idea of the process and think about how to approach each step. Without fully understanding the extensive process that an inquiry involves, some students in the Non-wiki group might choose to focus quickly on the end product. That is, they may miss some of the important research steps and start to write the final paper without enough understanding of the topic. Consequently, there is a gap between what students had intended to search and the results of gathered information were larger among participants in the Non-wiki group than those in the Wiki group.

The survey results also revealed that as students gathering specific information, refining their focus, and intentionally looking for a main point to their findings in an analytical and organized way with the support of a wiki, relationships between the different sources emerge very obviously from the materials and thus students can easily form them into a whole concept. In contrast, some students in the Non-wiki group didn't organize found information during their research and thus noticed a more heavy weighting to one aspect of the topic than others at the end information searching stage. They struggled to break down the information and bring together the parts into a sensible whole. Some students simply summarized the articles individually and did not show any synthesized knowledge from the diverse perspectives. They felt frustrated trying out different organization patterns and didn't step back to construct their final project in a big picture view.

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5. Discussion

Does the use of wiki as a supplementary tool affect EFL students' inquiry-based learning experience? The study collected data by tracking how Wiki and Non-wiki groups build knowledge of a topic through the inquiry-based learning and surveying their perceived challenges. The results revealed that inquiry-based learning instructions alone do not necessarily lead to productive induction and deep personal learning.

Although EFL students in both groups perceived that they knew more about their topics and the number of statements they recalled increased as they progressed through the task. Many students in the Non-wiki group seemed however to be oriented to only gathering information to their knowledge base. They tend to present their knowledge using factual statements accumulating strategy. On the contrary, more students in the Wiki group tried to go beyond information accumulation and regurgitation of facts and move toward generating more integrated and synthesized knowledge representations.

These findings point to the importance of Kuhlthau's formulation stage of the inquiry-based learning process. This stage involves interpreting information and creating a new understanding which echoes a central concept in Bruner's (1986) work. Bruner argued that an interpretive task should go beyond the information given and engage in information manipulating and transforming. This calls for a need for carefully chosen technology tools to keep students engaged by making connections between information in various sources and integrating knowledge into rich and complex representations as opposed to a superficial one, which is one of the significant benefits of wikis illustrated by this study.

As we returned to the goal of facilitating extended inquiry with wikis, we felt it was necessary to examine and understand if the use of wikis can address the challenges of inquiry process. While the participants expressed the problematic situations they encountered during the open-ended inquiry activity, some challenges were similar and some were different between the Wiki and the Non-wiki groups. Students in both groups perceived that they had a problem determining an appropriate topic to research at the stage of pre-search. Furthermore, poor English proficiency can limit the learning outcome due to the need for extensive reading of found information and summarizing and analyzing the content.

However, a number of challenges were raised mainly from the students in the Non-wiki group. They were confused about understanding the goals of each step of inquiry-based learning. They also complained that it was not easy to remember what they had done and what they had left to do from day to day during the inquiry activity and made coordination of the final product a struggle. This once again calls for the need to provide technology support such as wikis for staging the sequences of structured inquiry process, maintaining an accurate record, and managing the final products.

Inability to perform inquiry-based tasks effectively reveals that many students do not develop the habits and skills of planning, searching, maintaining, and communicating that are critical for conducting and learning from inquiry due to the fact that those skills are not necessary to be successful at traditional school practices. Thus, students in language courses would be more likely to engage in inquiry learning if wikis were integrated into course content as students went through a series of inquiry stages. The use of wikis in current study serves not only a knowledge construction and organization tool but also an information management and integration tool.

6. Conclusion

While this research did not examine the factors that might influence the specific stages of inquiry learning process nor did track the strategies in dealing with the problems that students perceived during the inquiry process, exploring how these variations affect the incorporation of wikis and inquiry-based language learning is a fruitful line of further research. Whether other factors such as prior knowledge of topic, computer literacy, and learner personality have a significant effect on the inquiry process. What are the thinking process and strategies used by EFL learners in the wiki-mediated inquiry setting? In addition, given the focus on standards based education, can the results of knowledge construction from current research related to other standardized test such as TOEIC and represents a higher level of intellectual quality? These are questions that continue to challenge the school education arena.

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