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Wikipedia as a teaching tool for technological pedagogical content knowledge (TPCK) development in pre-service history teacher education

Ibrahim Hakki Öztürk

Çanakkale Onsekiz Mart University, Turkey. E-mail: ibra.ozturk@gmail.com. Tel: +905059151237. Fax: +902862180524.

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This paper seeks to explore a web-based teaching activity designed for technological pedagogical content knowledge (TPCK) development in pre-service history teacher education in Turkey. The study is conducted by action research methodology. Using a project-based learning (PBL) approach, the designed activity aims to provide the necessary background knowledge to support student-teachers for their use of the wikis as a teaching tool in history education. The results show that the PBL activity engaging student-teachers as authors in Wikipedia reveals as an effective and motivating tool for initiating them to web authoring. Wikipedia authoring activity has been also fairly influential in terms of improving the student-teachers' historical knowledge. However, the acquisitions reported by participants do not display the same effectiveness in terms of the proper measures to be taken in order to improve an efficiency model. The results support the idea arguing that an effective TPCK development in pre-service teacher education requires systematic engagement of student-teachers in rich teaching experiences within the real teaching contexts.

Key words: Wikipedia, teacher education, history teaching, technological pedagogical content knowledge (TPCK), project-based learning, Turkey.

INTRODUCTION

Related literature shows that despite the rapid dissemination of Information and communication technology (ICT) equipments in the schools, the integration of the ICT-based methods and materials in teachers' practices encounters great difficulties (Haydn, 2001; Sanchez and Salinas, 2008; Hofer and Swan, 2006). Recent approaches focusing on the concept of technological pedagogical content knowledge (TPCK) offer a useful theoretical framework for the researchers and educators for a better understanding of the issue of technology integration in teaching practices.

The concept of TPCK was modelled on Shulman's (1987) notion of pedagogical content knowledge (PCK). As "the distinctive bodies of knowledge for teaching", PCK "represents the blending of content and pedagogy into an understanding of how particular topics, problems or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented

for instruction" (Shulman, 1987:4). In 2000's, the researchers included the technology dimension to Shulman's conceptualization. Although different terms were used to nominate this new conception as "PCK of educational technology" or "ICT-related PCK", the concept of TPCK is largely accepted in literature.

TPCK represents the knowledge that teachers need for an effective and successful integration of technology in their teaching practices. Content knowledge (CK) is knowledge about the subject matter that is to be taught in a specific teaching field as history or mathematic. Pedagogical knowledge (PK) is knowledge about the teaching methods, processes and practices. Technology knowledge (TK) involves the knowledge related to technologies using in teaching and learning activities.

TPCK approach argues that, for the technology integration in their teaching practices, the teachers must have a kind of knowledge which could incorporate at the

same time CK, PK and TK. According to Mishra and Koehler (2006: 1028-1029):

"Technological pedagogical content knowledge (TPCK) is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology). [...] This knowledge would not typically be held by technologically proficient subject matter experts, or by technologists who know little of the subject or of pedagogy, or by teachers who know little of that subject or about technology. [...] Productive technology integration in teaching needs to consider all three issues not in isolation, but rather within the complex relationships in the system defined by the three key elements."

As Walsh (2008: 4) notes, "information technology is of no value in itself or by itself". To develop an ICT-based teaching, the inherent features of each discipline (teaching contents, specific pedagogical methods, established practices, etc.) should be considered. However, Harris et al. (2009) state that most of the existing technology integration approaches and policies organize their efforts mainly based on the technological affordances and constraints rather than those relative to subject contents, pedagogical issues and teaching contexts. They do not consider disciplinary knowledge differences and the pedagogical strategies varying by content and context.

The technology integration in teaching activities is a very complex and multi-dimensional phenomenon. Although the technologic knowledge is very important, effective teaching with technology requires essentially an effective interweaving of the knowledge and affordances in different areas (content, pedagogy and technology) and constraints relative to educational context. TPCK defines a body of knowledge that results from connections and interactions among technologies, curriculum content, and specific pedagogical approaches for effective discipline-based teaching with educational technologies (Angeli and Valanides, 2009; Harris et al., 2009).

TPCK approach requires radical changes in the established practices and approaches for the ICT integration in the field of teacher education. In pre-service teacher education programs, the courses and activities for technologic skills acquisition are organized usually in isolation from disciplinary content and pedagogic issues, thereby focusing merely on technologic skills (Chai et al., 2010). The content of education organized this way fails to provide the necessary knowledge and skills for the teachers so that they could effectively use technology in their applications. As Mishra and Koehler (2006: 1033) note, "merely knowing how to use technology is not the same as knowing how to teach with it". The approaches and practices that would properly integrate skills and knowledge in relation to different fields including content, pedagogy and technology should be developed in the teacher education programs. Doering et al. (2009) argue

that teacher education programs must bring the areas of technology, pedagogy, and content knowledge together, as one knowledge base, rather than separating knowledge related to three areas. According to Koehler and Mishra (2005: 148), in teacher education, "it is necessary to teach technology in contexts that honor the rich connections between technology, the subject-matter (content) and the means of teaching it (the pedagogy)."

TPCK development by project-based learning (PBL)

In recent decades, the new approaches and initiatives in the field of education including constructivist theory have led to the emergence of new teaching methods. The project-based learning (PBL) attracts a great deal of attention as one of these methods in the educational researches and practices. Thomas (2000:1) defines PBL as "a model that organizes learning around projects" that are "complex tasks, based on challenging questions or problems, that involve students in design, problemsolving, decision making, or investigative activities". PBL is a student-centered approach in which learners control the learning process and this "affords students the possibility and the motive to work their way to the solution in their own idiosyncratic way" (Helle et al., 2006: 292).

In relevant literature, the benefits and advantages of PBL for an effective and successful process of learning are often emphasized. PBL encourages student's inventiveness, initiative. self-directiveness, and independence in learning activities (Donnelly and Fitzmaurice, 2005). In a PBL setting, students investigate and seek resolutions to problems; hence they acquire a better understanding of the key principles and concepts of the disciplines (Blumenfeld et al., 1991). Compared to the traditional methods. PBL is much more effective in the improvement of students' skills (Kolmos, 2008). According to Thomas (2000: 37), "there is ample evidence that PBL is an effective method for teaching complex processes and procedures such as planning, communicating, problem solving, and decision making".

It appears that the widespread use of computer technologies in the education has been beneficial and useful in terms of the implementation of PBL projects. The technical opportunities provided by the ICT offer students to carry out their projects and realize their products (Blumenfeld et al., 1991). Technology facilitates access to knowledge and sources. The Internet has particularly introduced a radical change. The Internet facilities are also important considering that it serves a venue for the students to share their projects with large masses (Papastergiou, 2005).

Despite its potential to improve learning process, relevant researches show that most of teachers rarely use PBL in their teaching activities (Barron et al., 1998). The primary reason for this state of reluctance appears to be its complexity and complicated structure for using in

comparison to the conventional methods. With respect to students, PBL requires considerable effort, motivation, persistence and ability to organize their own work plans. Likewise, teachers should have extensive knowledge, student-oriented methods and adequate capacity on different PBL strategies and activities in respect to the project subjects in order to better support and direct the students during the project period (Blumenfeld et al., 1991). Therefore, success of PBL heavily depends upon the competence of the teachers, the support provided for them to design PBL environment and the quality of the teacher education on this matter.

PBL should be integrated into the teacher education since this method is an effective professional training method. The works of teaching models on TPCK development in the literature are mostly based on PBL or similar approaches. Koehler and Mishra (2005), Mishra and Koehler (2006) and Koehler et al. (2007) propose "learning technology by design" approach for TPCK development in teacher education. According to this approach, in the learning-technology-by-design, students learn by acting as practitioners, rather than merely learning the practice through overt lecturing and traditional teaching. They propose different types of activities including online course design, making movies and redesigning educational web sites that involve "authentic and engaging ill-structured problems that reflect the complexity of the real world" (Mishra and Koehler, 2006: 1035). In many other studies, the researchers use the activities based on PBL or similar design task models for the TPCK development in teacher education (Angeli and Valanides, 2009; Doering et al., 2009; Özgün-Koca et al., 2010; So and Kim, 2009).

Wiki works as a web-based PBL activity

Web-based learning has become in recent years an effective and widespread teaching strategy in history education like other teaching disciplines (Doğan and Dinç, 2007; Hillis ve Munro, 2005; Matta, 2002; Yang, 2009). However, the use of the Internet by students in history classes does not always improve historical and critical thinking. The most important problem is the reliance of the students on copy-past practices without spending much time and effort for actual and proper learning (Haydn, 2003; Walsh, 2008). Therefore, effective use of web opportunities depends upon the designation of the proper teaching activities.

One of the best ways for effective use of the Internet in teaching activities is web authoring. The web authoring activities that transform the students from web users to the web creators seem to be proper to merge technology skills with the knowledge and skills of the discipline. It has been observed that in the field of history teaching, the web content creation applications encourage students to do research on historical subjects and generate knowledge, contribute to the emergence of a productive learning process and improve effectively the ICT skills (Matta, 2002; Yang, 2009).

Wikis are web tools offering suitable conditions for web authoring studies and works. A wiki is a multi-user web site where all users can add content and edit the content of the others (Downing et al., 2009). The most distinctive feature of the wikis is its construction by multiple users in an interactive and collaborative process. Ruth and Houghton (2009: 148) stress that the "wiki epistemology" displays five significant aspects:

a) "Collaboration – individuals acting together to develop shared knowledge;

b) Construction/co-construction – individuals acting together to produce knowledge and their products (in flux);

c) Different ways of learning – individuals acting together as equals – sometimes an expert, sometimes a novice, rather than in competition;

d) The authority of 'the' expert is undermined; and

e) A different philosophical underpinning which is more oriented towards constructionism".

From an educational perspective, Parker and Chao (2007: 57) define a wiki as "a web communication and collaboration tool that can be used to engage students in learning with others within a collaborative environment". Researches confirm that the wikis can be used in both secondary education level (Lamb and Johnson, 2009; Nordin and Klobas, 2009) and higher education level (Mindel and Verma, 2006; Workman, 2008).

In terms of PBL effectiveness, one of the greatest advantages that the wikis offer is that its use is technically fairly easy (Duffy and Bruns, 2006; Gooding, 2008). According to Deters et al. (2010:123), "because of their simple features, wikis can be appropriate for students and teachers at all levels".

Wiki studies provide a collaborative learning environment for the students. In a wiki activity, the knowledge is collectively generated with the participation of different wiki members in the content production process. From this perspective, the wiki activities constitute an interesting tool for enhancing studentcentered and social constructivist learning environments (Farmer, 2006; Nordin and Klobas, 2009).

Wikipedia, under review in this study, is the most popular wiki site on the web. In the English version, Wikipedia is defined as "a free, web-based, collaborative, multilingual encyclopedia" (Wikipedia, 2011). Launched in 2001, Wikipedia has become the largest and most popular encyclopedic knowledge source in web.

Some teachers and educators complain about the negative effect of the Wikipedia for the student studies (Darren and Smoot, 2009). The students prefer copying methods instead of intensive and extensive research by use of the Wikipedia since it provides easy access to a

huge number of subjects. As stressed earlier, this is a general downside of the Internet over student research projects. However, students may be transformed from passive users to active producers by reliance on PBL activities. In other words, students can serve as Wikipedia writers rather than Wikipedia users. A number of studies confirm that web authoring activities performed through Wikipedia website motivates students (Darren and Smoot, 2009; Konieczny, 2007; Nix, 2010).

Purpose of the study

This study seeks to analyze the use of the wikis as an effective web-based teaching tool for technology integration in pre-service teacher education. The web-based PBL activity (Wikipedia workshop) used in the study aims to develop student-teachers' knowledge and skills about wiki authoring that is an emergent history teaching method in secondary education. Wikipedia workshop is designed here as a learning activity that could combine pedagogical, technological and content knowledge, in line with TPCK approach. It seeks to ensure that student-teachers acquire the necessary knowledge and skills on a web-based PBL strategy that they could use in their own teaching applications in the schools.

As an action research, this study aims, on the one hand, to test the efficiency of the designed activity and to improve it. Therefore, the research holds some practical and pragmatic goals towards improvement of the teacher education practices. On the other hand, investigating the process of the TPCK development in the context of a web-based PBL activity in pre-service teacher education, the study also seeks to make contributions to emergent literature on this field.

The research questions are following:

1) How Wikipedia workshop contributes to improvement of the student-teachers' skills (in term of the content knowledge, the pedagogical knowledge, the technological knowledge and TPCK).

2) What are the difficulties that the student-teachers encounter in Wikipedia workshop?

3) What are the factors that influence the student-teachers' motivation in Wikipedia workshop?

METHODOLOGY

Action research model

Greenwood and Levin (2007: 3) define action research as "social research carried out by a team that encompasses a professional action researcher and the members of an organization, community, or network ("stakeholders") who are seeking to improve the participants' situation". Action research explicitly seeks to make the social situations better than they were before; and this is basically



Figure 1. Action research cycle.

what distinguishes it from other research approaches (Norton, 2009). Action researches are designed as circular phases. Different circular models are used in the action researches in the literature. There are basically four phases in the circular model: Planning, acting, observing and reflecting (Costello, 2007; McNiff and Whitehead, 2002; Cunningham, 2008) (Figure 1).

An action research starts with the identification of an issue or a situation that needs to be improved and developed (Costello, 2007; McNiff and Whitehead, 2002). Some (Cunningham, 2008) start the action research with the process of reflecting. In fact, at the planning and reflecting beginning, are intertwined. А comprehensive reflection is needed for the identification of a problem and planning an action. The phase to follow is the implementation of the planned action. The objective of the action is to observe a change and improvement. This could be a change toward improvement in education-related structures and issues or a change in the professional competencies of the participants. The third phase involves observation of the impacts of the changes and improvements. The phase to follow is a comprehensive review of the action along with its impacts. This is a phase for transition to the next cycle. The success, impact and flaws of the planned action as well as the state of the issue after the action are reviewed in details to draft the action. The action is planned again based on the reflections and the cycle keeps going.

Action research is a research strategy widely used in education. Action research offers a very suitable framework to ensure professional development of the teachers and of the trial of new educational model and activities. In teacher education, action research lets teachers and teacher educators to have the opportunity to research on their own teaching practices and to improve them (Altrichter et al., 2000; Henning et al., 2009).

Participants

The study was performed in the pre-service history teacher education program at the Faculty of Education in Çanakkale Onsekiz Mart University (Turkey). It was performed in the context of the Modern European History course offered in the 3rd year in history teacher education program. In Turkey, the pre-service education of secondary school teachers is provided in a five-year long education in the faculty of education in the universities. During

Categories	Frequency
My knowledge on content generation over the Internet has improved	17
My knowledge on history and historical research has improved	13
I have become more confident on knowledge generation and sharing over the Internet	6
I have learned new methods that I can use in history teaching	5
Others	2
I have not acquired anything	5

Table 1. Student-teachers' acquisitions out of the Wikipedia workshop according to their responses.

five-year long education, the student-teachers receive both disciplinary education in history and pedagogical formation.

Twenty seven student-teachers (14 female, 13 male) taking the Modern European History course in the history teacher education program in Çanakkale Onsekiz Mart University participated in this action research. PBL activity, subject matter of the research, has been designed as an obligatory part of the course that would have an impact over the overall grade of the students. The participants had no prior experience on web authoring except social media such as Facebook.

Research procedures

The study has followed the action research model encompassing the phases of planning, acting, observing and reflecting as outlined earlier. The researcher served as the supervisor of PBL activity and worked together with the students during the entire research process.

The student-teachers were asked to create an article on the European history by utilizing the Turkish version of Wikipedia; the assigned article was to be at least 3500 words with visual documents. The themes were picked by the student-teachers under the guidance by the researcher. Some of the picked themes required addition of new articles in Wikipedia whereas some others required the enhancement of existing articles. Whether they would work as teams was left to the preference of the student-teachers. Ten students preferred working as pairs whereas 17 students preferred to serve as single authors for their articles.

The researcher and the student-teachers worked together in the ICT laboratory three hours in a week during the period of four weeks. Before the first group work, the subject matters were identified. The students were asked to find relevant sources and documents. In the first week of the group work, the researcher taught how to prepare content for Wikipedia. He also provided extensive information on the web-based methods in history teaching and how the wikis are used in this teaching process. During the first week work, the student-teachers have taken the first steps to write content for Wikipedia by using short applications. During the weeks following, the student works were assessed; the technical problems they encountered were discussed and they were given advice to improve the historical content. They were also asked to make progress by studying outside the classroom.

The majority of the student-teachers have completed their works after the four-week period. The rest of the students were allowed to complete their works within two weeks. In the aftermath, the student-teachers were asked to give their views on the work; the responses were analyzed. Whole of the research process lasted one and half month.

Data collection and analysis

The qualitative approach was adopted in the collection and

analyses of the data. The data was collected by structured interview method. The responses of the participants were received in written forms, including open-ended questions, upon the completion of the PBL activities.

The data analysis was performed by content analysis method (Berg, 2001; Yildirim and Şimşek, 2004). Three main dimensions were identified for the content analysis: (1) the acquisitions of the student-teachers; (2) the difficulties they had; and (3) the factors affecting their motivation.

The corpuses of the data collected were separately analyzed in term of the three identified dimensions. The themes expressed by the student-teachers for each dimension was taken as a unit of analysis. After a general review of the data, the categories were constituted for each of the three dimensions. The categories and the frequencies of the responses are showed in tables. The themes referred to by only one student-teacher are classified in the category others. The analysis includes also the examples from student-teachers' responses.

FINDINGS AND DISCUSSION

Student-teachers' acquisitions

In their responses to interview questions, 22 out of the 27 student-teachers refer to the individual acquisitions out of the Wikipedia workshop. In return, 5 students note that they did not acquire anything significant or at all in this study (Table 1).

In terms of web authoring (technological knowledge), most of the students find the Wikipedia workshop effective and successful. The following observation by a student-teacher reflects the view of the majority of the participants:

"This has been a pretty productive study for me. I have produced a webpage for the first time. I have learned a lot of things about computers. This is new and I believe this will be of great help for me."

In addition, some student-teachers note that the Wikipedia study enhances their ability of knowledge generation and their confidence over sharing this knowledge. For instance, a participant makes the following statement:

"This work has inspired me on webpage creation. I have not done such a thing over the Internet. It was not as hard as I used to think."

In general, it is also observed that the student-teachers

have positive views on the content (history knowledge) acquisitions. Compared to a traditional history research, the students find Wikipedia study more productive and illustrative. They stress that in this study, they are able to have access to more sources, work harder for the synthesis of the information and that their skills and knowledge have improved. There are two primary reasons for this improvement: first, authoring for a public webpage is far more motivating than traditional homework assignments. It is observed that this encourages the students to work harder. A participant states this:

"What distinguishes this work from the other assignments is that it will be published in an open source. This enabled us to do more extensive research on this matter and pay greater attention to the authoring process."

Secondly, it is observed that creating an original text and respecting authoring rules in Wikipedia forces the student-teachers to work harder. For example:

"This work was far more challenging than the previous assignments. In doing this assignment, I have reviewed a lot of books, and collected extensive details on the subject. I have worked hard to observe the proper citation rules, comply with the property rights and achieve a reliable synthesis. It was tough; but it was illustrative than the others."

One of the unexpected results of the research was that only a few student-teachers made note of the pedagogical acquisitions of the Wikipedia work. As noted earlier, the Wikipedia study was presented to studentteachers as an example of the web-based PBL activities that could be used in the history teaching. However, it becomes apparent that the majority did not notice this pedagogical dimension, or that they did not pay much attention to it even if they became aware of it.

As the aforementioned examples show, there is visible interaction between the technological dimension (authoring in Wikipedia) and content dimension (doing research, writing a history text, improvement of historical knowledge). However, statements by the studentteachers do not display a similar correlation in terms of pedagogical dimension. The pedagogical acquisitions are expressed in general terms without being related to the other fields and any emphasis upon concrete experiences. For example:

"This workshop was important, because we learned how we can use Internet in schools."

In light of these results, what could we say about TPCK development in student-teachers? The literature stresses that TPCK is a separate knowledge independent of the interactions between different knowledge areas. According to Angeli and Valanides (2009), TPCK is a distinct "unique body of knowledge" and separate from the types of knowledge that constitute it. It is constructed from the interaction of its knowledge bases, but the mere development of one or more of its knowledge bases does not mean its development. Harris et al. (2009:401) state that

TPCK is different from knowledge of its individual components, and "it arises instead from multiple interactions among content, pedagogical, technological, and contextual knowledge." According to the research findings, the participants refer to significant acquisitions in terms of technological and content knowledge; however, they also imply that its pedagogical side remains poor and that there are no interactions between these three knowledge areas that would constitute a new knowledge area.

Angeli and Valanides (2009: 158 and 166)) offer a fairly useful framework for understanding of this result. They argue that teachers' TPCK development requires learning activities highly situated within the context of classroom and teaching:

"ICT-TPCK is a body of knowledge that grows continuously with systematic engagement in rich teaching experiences. This means that any program or instructional design model that aims at the development of ICT-TPCK must consider teachers' knowledge and classroom experiences. [...] Teachers must be trained in powerful learning environments where teaching is situated in real and authentic tasks, and in ways where teachers themselves constitute a part of a larger learning and professional community for the purpose of exchanging perspectives, resolving dilemmas, and confronting uncertainty in transforming classroom practice."

In this study, PBL activity performed with the studentteachers has been designed as a teaching activity that could be applied in elementary and secondary education level. The activity has been applied in the context of the teacher education at university environment. The studentteachers did not perform the relevant Wikipedia work within the context of real classroom and students. In the end, their perceptions on the pedagogical dimension of the activity did not improve; and probably they failed to develop the necessary TPCK knowledge required to implement this activity in the classroom environment.

Would this mean that these activities are irrelevant and useless for TPCK development in the student-teachers? Our answer is "quite possibly no". The results of this study show that reliance on such works alone would not ensure TPCK development. However, this does not necessarily mean that these learning activities are completely useless and dysfunctional. In pre-service education, these activities may serve as a stage of preparation for the teaching applications that the studentteachers would hold in the classroom environment. Considering the activity practiced in this study, it will be fair to argue that it is almost impossible for the studentteachers to experience this activity in the real teaching context without acquiring the necessary fundamentals relevant to Wikipedia work. Therefore, without a real classroom environment, the works performed in teacher training context alone may become a part of TPCK development process. However, for a productive TPCK development process, these works should be supported by

Categories	Frequency
I had difficulties because other users of Wikipedia erased my additions	16
I had difficulties because I did not have the required ICT skills	8
It took a lot of time	7
Others	4

Table 2. Difficulties during the Wikipedia workshop according to student-teachers' responses.

and combined with other works of real classroom and teaching context.

When it comes to the student-teachers stating that they have acquired nothing out of these works, it is observed that some difficulties they had to face played a key role in their final judgments. Some student-teachers (two) had such a conclusion because of lack of necessary computer skills whereas three others were frustrated and disappointed by the deletion of their contribution and addition to the content by other users. For instance:

"I do not think I have acquired anything. I had difficulty because I did not have much skill for computers use. It took a lot of time and still I cannot do anything properly. Perhaps I would not be able to perform this assignment if it is repeated once more."

"Unfortunately, I have not seen anything positive in this work. I cannot say I acquired anything out of it. I worked hard, rewrote my part; yet the part I added was deleted. The only thing I got out of this has been anger and distress."

Difficulties encountered by student-teachers

As the student-teachers participating in this study did have to have any web authoring experiences, particular attention was paid to make sure that the activity used did not involve advanced level of technical applications. One of the reasons for the selection of Wikipedia study is because it is easy to implement wiki technology.

Regarding technological knowledge and skills, studentteachers have encountered some problems during the early stage of the work. However, after a process of practicing, most of the students have learned the fundamental Wikipedia applications. A participant states this:

"I do not think this work is pretty hard. It was just a little difficult because it was my first time to do such a work. And I overcame this problem after learning the fundamentals."

The problems reported by the students expressing difficulties with respect to lack of computer skills mostly include singular issues as add visual content or make proper citation. Only three student-teachers stated that they had general difficulty because of lack of computer skills. In the end, it may be concluded that the wiki works can be taken as a useful start for the teachers with no prior experience on web authoring.

The most significant difficulty and challenge that the student-teachers had, relates to the collaboration and coordination with other users. More than half of the students noted that they had difficulties because other users deleted the content they added and that they had to redo what they had done before. The changes made by other users were mostly made in the form of page removal, instead of revision or improvement (Table 2).

The primary reasons for the deletion of the contents include improper citations or forms of plagiarisms. At the beginning of the study, the students were told to comply with the citation rules; however, despite this initial warning, most participants did not pay much attention to this issue at the beginning. But they changed their attitude after having difficulties to integrate their content to the Wikipedia. Therefore, these challenges have been regarded as a positive outcome that compelled the participants to generate high quality content.

However, the students' tendency to prepare contents consistent with the property rules after the initial deletions did not always address the problem. This has been the case particularly in regards to the existing articles. In many cases, despite that the student-teachers authored high quality content for the existing entries, the previous versions were reinstalled. This created a sense of frustration; lack of motivation, disappointment and indignation among the student-teachers encountered this problem. A participant expresses his view on the matter as follows:

"The other Wikipedia authors do not accept out additions for some reasons. Frankly, I did my part over and over again; but they just did not accept it. Besides, I did not understand that on what basis they did so. This discouraged me from doing my assignment."

Another problem that the students reported is that the assignment took a lot of time. The students note that the Wikipedia study requires a great amount of time compared to other assignments. The fact that they had to work longer hours during the research and knowledge generation phases and then implementing their output to Wikipedia required a lot of time is the primary reason for this situation. Table 3. The motivating features of the Wikipedia workshop for the student-teachers.

Categories	Frequency
Sharing their product with others	14
Being an author in a popular encyclopedia	6
Working with computers	4
Other	3

Motivational issues

The research findings show that the student-teachers find the Wikipedia authoring workshop more interesting and motivating than the conventional assignments. It is observed that they are particularly motivated by the dissemination of their own content through the Internet environment; this creates a sense of satisfaction and pride for the student-teachers.

The student-teachers discuss this issue from two general angles. Above all they underline that it is pretty nice to share their contents and produces with the others and to help others by this generation of knowledge. A student-teacher makes the following statement on the matter:

"It is pretty nice to share information in web environment. What we do in other assignments stays with us. We were unable to share that with other people. But others are able to benefit from our products in Wikipedia."

It is also a matter of pride and satisfaction to serve as an author in a popular encyclopedia like Wikipedia. It is observed that the student-teachers were motivated by this. For example:

"Frankly, it gives me real pride and satisfaction to write for an encyclopedia that is used by millions. I have an entry in this encyclopedia."

Excepting the issues specific to Wikipedia authoring, the ICT-based workshop does not seem as interesting or motivating by vast majority of the student-teachers. Only a small number of student-teachers note that the ICT-based workshop is less boring and more interesting than the classical works (Table 3).

The factors that discourage the students from taking up Wikipedia works include incidents relevant to the difficulties encountered during the workshop. As reviewed above, the deletion of their content by other users negatively affects the student-teachers.

Conclusions

Action research appears to be a very effective and functional method for the assessment and improvement

of the teaching activities and models designed for TPCK development. The research findings show the weaknesses of the practiced teaching activity and serve as guidance for the researchers for its improvement.

The Wikipedia authoring, designed as a PBL activity, has been fairly influential in terms of improving the student- teachers' technological and content knowledge. The results demonstrate that the Wikipedia work has provided a very motivating working environment for the student-teachers. It becomes evident that such an activity is pretty consistent for the student-teachers with limited technological skills to initiate web authoring.

However, the acquisitions reported by participants do not display the same effectiveness in terms of the pedagogical knowledge. Likewise, it has also been observed that the student-teachers do not maintain connections between three types of knowledge (technology, pedagogy and content). Therefore, it may be argued that this activity fails short in TPCK development. This result supports the idea arguing that an effective TPCK development in pre-service teacher education requires systematic engagement of student-teachers in rich teaching experiences within the real teaching contexts (Angeli and Valanides, 2009).

The research findings refer to a number of points that should be considered for the improvement of the webbased PBL activity. Above all, it is crucial to integrate to the model used the activities that could ensure to the student-teachers to perform practices in real teaching environments. The consecutive series of activities can be planned for this. The first set of activity can involve activities that could be held to improve the fundamental skills in respect to the Wiki works, whereas the second can feature activities that could be performed with the participation of in-service teachers and secondary students in school context. This requires a long-lasting, systematic and intense learning process.

The wikis are very proper tool for creating collaborative learning environment. However in this study, despite some positive findings, the relation of the participants with other users has been mostly confrontational. Although Wikipedia provide the possibility of interactions among the users, the student-teachers abstained from maintaining contact with the other users and generate common knowledge. In the future works, the studentteachers should be directed more properly for collaborative study with the other users. To this end, it will be beneficial to extend the study to a longer period of time.

The students were encouraged to work in groups in the study; however, they were not obliged to do so. It was observed that the students working in isolation from others had greater difficulties than those who worked in groups. Therefore, it can be concluded that it will be useful to design the endeavor as a group activity rather than individual work.

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