

# Learning with wikis – three case studies of the use of wikis in university education

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**Abstract.** According to Tim Berners-Lee, wiki technology represents an instantiation of how the World Wide Web was planned to work: a platform that users can use both to retrieve content (read) and contribute content (write). Besides wiki technology, the read/write web is also realized through the use of a variety of other technologies (e.g. blogs, open source software support communities, portals for user content upload, mash-up sites, and so forth). Wiki technology lends itself to many uses. One of the main features of wiki technology is its support for collaborative editing of content. In this paper, we introduce briefly wiki technology, the pedagogical premises of the use of wiki in education, and present several cases of the use of wiki in university education context as support for collaborative writing and learning. We also present possibilities and potential problem situations when utilizing wiki-technology in educational settings, in particular related to the assessment of learning, the monitoring of student participation, and the need for communication support in the learning process.

## 1. Introduction

In the past few years, we have witnessed a fundamental change in how people get informed. The Internet has come to play a more and more important role and people have become more and more used to the use of the Internet for all purposes, not least information gathering, but lately also for information creation, using what people usually refer to as Web 2.0 technologies. However, many,

among others Tim Berners-Lee (see Richardson, 2006), argue that there is no such thing as Web 2.0. Namely, most things associated with Web 2.0 have been possible with the technology prior to wiki and other such new tools. Regardless of this, there is no question that we have in the last couple of years witnessed a fundamental change in how people utilize the Internet. Many people have ceased to be mere receivers of information and started contributing to the Internet by using e.g. discussion forums, blogs, chats and wikis. The common denominators of these tools are that they enable User Generated Content (UGC) in an easy manner and that they often are open to all. Hence, participation is unrestricted and democratic. These Web 2.0 components also generally rely on the users to monitor the content and behaviour of other users. A requirement for this is that there exists a large enough user mass, the so-called critical mass of users, and also that there are power users, or leaders.

As part of this change in Internet technologies, wiki is a tool that has gained acceptance among users. Most Internet users encounter Wikipedia when searching for information on the Internet. The success of Wikipedia as a source of information has been tremendous, despite that some critics have voiced their doubts about the validity of its content, especially in academic circles. Wikipedia is today the largest online encyclopedia – available in 253 languages. The English-language version contains more than 2,300,000 articles (Statistics collected on March 8, 2008, [http://meta.wikimedia.org/wiki/List\\_of\\_Wikipedias](http://meta.wikimedia.org/wiki/List_of_Wikipedias)). The success of Wikipedia (and wiki technology) has sprouted a series of similar sites, using wikis to foster participation and leverage the participative power of online users (e.g. Wikibooks, Wikitravel, and so forth). Wiki is also increasingly being taken into use in various learning contexts.

In this paper, we pay particular attention to the use of wiki in university education, especially as a tool for students to collaboratively contribute to a course assignment. The use of wiki as part of a course module raises many questions. First, the tool (or technology) should work smoothly and not be a hinder to student participation. Second, a sound pedagogical approach to learning using this type of technology should be deployed, and an appropriate assessment of the learning outcomes is required. Third, adequate support to the learners should be provided. Consequently, there are many research questions to address. The research questions that we strive at answering in this paper are: i) what characteristics are required from wiki technology to support learning, collaboration and assessment in university education?, ii) are any changes in the pedagogical approach and curriculum needed when including wiki technology in university education?, and (iii) what are the role of participation and communication support in the use of wiki technology.

The paper at hand discusses Wiki technology more closely, especially issues related to the use of wiki in university education. We draw on the state of the art in the field and three cases of the utilization of wiki in education we have been

involved in. In particular, we will take a close look at the issues of learning assessment, participation and communication support.

## 2. Method

The case study method will be used in this paper. Three case studies are presented: these case studies illustrate the use of wikis in the context of university education. Wikis were used in three courses in an Information Systems programme (2 introductory courses in IS, 1 intermediate course in IS). Students were divided in groups of the same size (about 15 students per group). The authors are aware that there is a possible bias in selecting IS courses, because IS students might be more inclined to use innovative ways of working; however, this bias is limited since the introductory courses in IS are targeted to all business and technology students (ie. the user population does not consist only of IS students).

The data used in this paper consist of qualitative and quantitative data. Qualitative data consist of evaluation of the wiki process by the responsible teachers (quality of edits, review of the use of communication tools...), and an evaluation of the work produced by the students using wikis with respect to learning outcomes. Quantitative data consist of wiki usage statistics (number of edits, frequency...); a questionnaire is mentioned in this study, but we do not report its results in this paper, since this questionnaire was used only in one of the three case studies. The results are analysed in the light of existing literature and knowledge about the use of wikis in learning environments.

## 3. Wiki state-of-the-art

### 3.1 Wiki: definition, characteristics and features

The word “wiki” is borrowed from Hawaiian. Some of the meanings associated with the word “wiki” in Hawaiian are “quick” and “informal”. Will Richardson (2006, p. 8) defines wiki as “a collaborative Web space where anyone can add content and anyone can edit content that has already been published”. The core properties of a wiki are: the ease of use, simple navigation and linking features, user involvement and democraticness. “Wiki is a lot about a collaboration space, albeit an unusual one because of its total freedom, ease and access of use, simple and uniform navigational conventions, and apparent lack of formal structure” (Leuf et al., 2001, p 16). Informality is at the core of the wiki concept: wiki sites invite users to freely and easily contribute to the content of a wiki. Users are on an equal basis and there are practically no barriers to start contributing to a wiki.

The fact that wiki is very easy to implement and understand, is probably a key to why wikis have become so popular. Previous attempts at creating technologies for collaboration have not been as successful. At the same time as technology has perhaps become easier to use, people have become more used to computers and the Internet so that virtual collaboration seems more natural than before.

### 3.2 Wiki selection issues

There are several dozens of wiki programs available on the Internet, but only a few of these can be seen as unique. According to Schwartz et al. (2004), common feature categories of wikis are: source code, wiki management, page formatting, access control, communications, support and advanced features.

According to Schwartz et al., there are several issues to consider when selecting a wiki for educational purposes:

- *cost*: open-source vs. proprietary, license fees, and related IT-support.
- *complexity*: availability of technical support (through online documentation, user and developer community support, hosted or to be downloaded/installed, plug-in, and sandbox).
- *control*: user registration (not) required, password-protection of specific content, user rights management, participants online, restore capabilities (history and version tracking).
- *clarity*: index/site map, interwiki formatting, back-linking, page hierarchy (navigation and structure), archiving, new page creation, page deletion, new content identification (compare), change notifications by e-mail.
- *common technical framework*: browser compatibility, cross-platform, internet and intranet installation, support of simultaneous edits, plain ASCII text storage.
- *features*: WYSISYG editing, HTML support, text editing (bold, italic...), image insertion, tables, lists, media insertion, hyperlinks, search, spell-check, emoticons, blogging, polling, RSS, link checking, drawing tools, equation editor, synchronous text messaging (IM).

Many of the features listed above - such as index/site map, page hierarchy, WYSIWYG editing, search - enhance the tool's usability, which is an important adoption factor.

Wiki is a tool among others, competing with other collaborative tools in the scope of learning. Collaborative tools can be classified according to two dimensions: (1) communication-oriented (e.g. discussion forums, e-mails); (2) document-oriented (e.g. content management systems, learning platforms). Depending on their implementation and features, wikis can be found midway between these two axes: some wikis might impose tight control (in terms of user rights management and document management), whereas some others may look unstructured and promote high interaction between participants (see Figure 1).

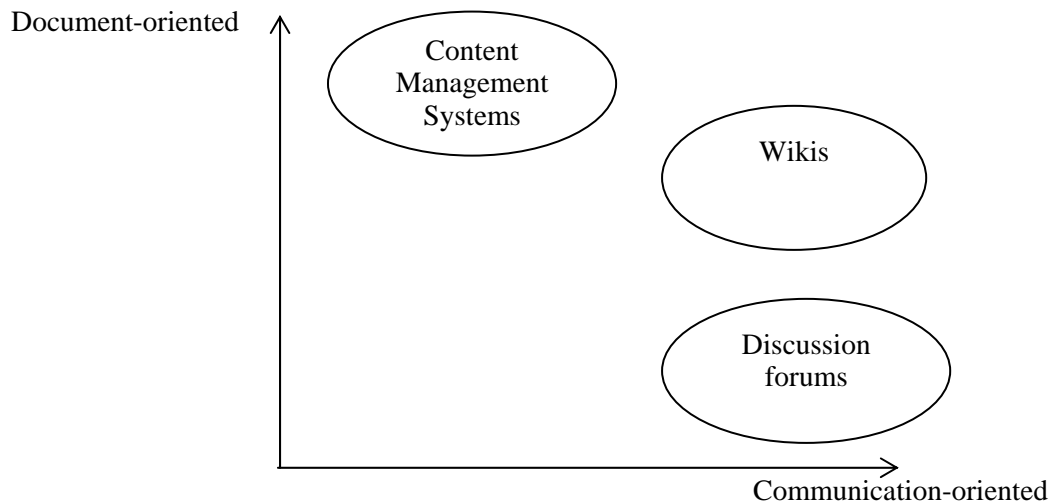


Figure 1. Communication and documentation orientation of collaborative technologies (adapted from Fuchs-Kittowski et al., 2004)

### 3.3 Related research - use of wikis in education and learning

There have been several attempts to use wiki in educational settings. An extensive coverage of the state-of-the-art of wikis in learning is beyond the scope of this paper but a good starting point can be found in the wiki page hosted by EduTech Wiki (Wiki, 2008). In this section, we will focus on the role of wikis in learning, the importance of assessment in collaborative learning, the issues of participation and control, and the role of communication in the “wiki process”.

#### Role of wiki in learning

Students regularly use wikis as a source of information, for example to get knowledge about a subject for an assignment. Probably the most commonly used wiki is Wikipedia. However, the use of wikis may cause problems connected to the trustworthiness of the information and the risk for plagiarism (Richardson, 2006, p. 63). Another problem is that wikis often have anonymous authors, making viable research work difficult. The trustworthiness of on-line sources, and especially wikis, have resulted in that many people regard them as inaccurate. However, it might be argued that they are no less trustworthy than other sources. Research indicates that contrary to a general belief wikis are quite trustworthy, although there certainly are examples of misrepresented facts, errors and deliberate lies in wikis, as can be the case in any source.

Chen et al. (2005) found that wikis help students in engineering reflect on what they have learned, meaning that wikis can be used as a tool to support knowledge synthesis or learning outcomes. Kim et al. (2006) report their use of a wiki to

support idea sharing in a problem solving process in computer programming methods. Wiki is also being used as a way to organize, structure and share information and knowledge resources across groups of students in the context of design project work (Grierson et al., 2004, Hon and Chun, 2004). Schaffert et al. (2006) identify several tasks where wikis can be used: cognitive apprenticeship, learning within communities of practice, project-based learning, collaborative story writing, and interdisciplinary and intercultural learning.

#### Assessment

Forte and Bruckman (2006) have studied the use of wikis to engage students in authentic collaborative writing activities. The use of wikis engages students in a learning opportunity, addressing the following features: personal (in terms of students' commitment to the learning task), real world (connected to reality outside the classroom), disciplinary (related to the subject matter to be dealt with), and assessment (self-assessment of one's own learning and of others). In the study conducted by Forte et al., the students edited essays and reviewed each other's work. The authors found out that a perceived online audience plays a role in helping students monitor the quality of writing.

#### Participation and control

Chong and Yamamoto (2006) investigated the use of wikis to support collaborative learning. Their results show that wikis, when supported with appropriate communication tools, foster active participation and high-quality debate among students. According to Richardson, wiki projects in schools have worked best when there have been less regulations of the wiki and the students have been able to manage the content on the wiki themselves. Richardson also believes it is a good idea for students to contribute to a widely accessible wiki, if for example the student has done some prior research on the topic in question (Richardson, 2006, pp. 64 - 65). The issue of control has been discussed by Wang and Turner (2004) in terms of *who* can edit *what* wiki artefact, and *when*. They identify situations where teachers may need to exert control on the wiki in order to prevent changes from other users. Participation, and especially the issue of free-riding, is discussed by Augar et al. (2004). In an open wiki environment, without much restrictions, participation is often bound to the contributors' interest, motivation and responsibility for their own learning. Augar et al. report on an experiment in which 42% of the surveyed participants joined the discussion on a weekly basis. Reinhold and Abawi (2006) suggest, based on their experience with wikis, that the participation level is often low and that the quality of articles depends almost exclusively on the students' motivation.

## Role of coordination

Viégas et al. (2007) studied the coordination features provided by Wikipedia. Their conclusion is that although Wikipedia seems to be uncoordinated and potentially a place where anarchy would prevail, the coordination features provided by Wikipedia actually promote group coordination, policy and processes and support “strategic planning of edits and enforcement of standard guidelines and conventions”. In their analysis of “Talk” pages, Viégas et al. identified 11 categories of posting to Talk pages. The researchers found out that “requests for coordination” accounted for more than a half of the contributions. Stvilia et al. (2005) in turn found that “Talk” pages in Wikipedia play a crucial role in letting users articulate quality issues in Wikipedia articles.

## 4. Constructivist learning and virtual collaboration

The three key characteristics of constructivist learning can be said to be problem orientation, room for individual learning strategies and situated collaboration. By problem orientation is meant that the learners take a genuine interest in the topic under study, and thus preferably start with their own questions. This is known as owning the problem. The problem should be a real-life problem or as close to a real-life problem as possible. Secondly, the facilitator is not supposed to control the learning materials and the work methods restrictively, which gives individual learners leeway for applying methods that they feel confident with and that suit their personal learning style. Thirdly, given the instructional preference for hands-on methods, links to a real-life problem or question, group work and the matching of individual strengths for attaining a common goal (i.e. project work), collaboration becomes perhaps the most important single factor in constructivist collaborative learning. Consequently, all forms of communicative and collaborative technologies are potentially valuable to communities of learning and teachers applying constructivist learning guidelines (Järvinen, 2001; Poikela and Nummenmaa, 2002; Engeström, 1987; Tétard and Patokorpi, 2005; Patokorpi et al., 2007).

Johnson and Johnson (1994) have done research on collaborative learning based on 875 case studies, showing that collaborative learning leads to better results, higher achievement and greater productivity than working alone. Learning, hence, can be enhanced by collaboration, either in real life or virtually. However, virtual collaboration is not as easily accomplished as real life collaboration, as noticed by Koufman-Frederick et al. (1999). Reasons for this are due to technology and peoples’ work methods and prejudices. Technology is less important than generally believed, while social matters provide the major challenges for successful virtual collaborative learning. Success factors for

collaborative learning include having a common purpose, a clear structure, and purposeful forums for dialogue and interaction (Mirijamdotter et al. 2006).

Enabling functional, virtual collaborative learning potentially improves and enriches learning. Gross Davis (1993) states that learners learn best when they are actively involved in the process. Learners working in groups learn better and are also more satisfied with the teaching. Learning should be applied in a context, in order to be perceived as having a meaning and in order to be learned better. Usually, collaboration in education takes place physically and technology is often used merely for informing, e.g. to disseminate the course materials to students, and not so much used for actual learning. Technology enhanced collaboration is usually done with the help of e-mail or discussion forums. Wiki is a viable and good additional means to collaboration that enables easy co-authoring of content. Other new media are the blog and the videoblog, which also can be used to support learning in several ways.

The traditional term for collaborative learning using technology is Computer-Supported Collaborative Learning, but it does not give justice to the possibilities offered by new technologies. Collaborative learning should not be restricted to computers alone but should be possible using any means found useful, depending on the situation where learning takes place. General potentials with improved collaboration include the utilization of collective intelligence of a group; enhancing the participants' ability to focus on their core-capabilities; better dissemination of information, possibly leading to the avoidance of double labour (Koufman-Frederick et al., 1999).

For learners, improved collaboration can mean enriched learning, when people come together to discuss a topic, especially when the participants have different backgrounds and can add to each other's knowledge. Another possibility is found in reflection through co-author summaries of what they have learned, e.g. using wiki-technology, where learners can discuss what they have learned, and possibly apply it in the form of stories. Furthermore, the skill of collaboration itself is important to learn as much in the everyday working life depends on collaboration and group work. Collaboration between teachers allows teachers to reflect on their teaching, develop curriculum, share resources, and receive help and advice (Koufman-Frederick et al. 1999). This enables the reuse of learning resources, too.

## 5. Cases of learning with wiki

During the period between spring 2007 – fall 2008, we conducted three experiments of using wikis for assignments in three courses in Information Systems at the Åbo Akademi University. The first two cases were in two separate instances of the basic course in Information Systems. The first one was held in the spring of 2007, where we used the wiki embedded in the learning platform

Moodle. The students were divided into five groups and were asked to create one wiki-page, each describing a particular technology. The second instance of the basic course in Information Systems was held in the fall of 2007. For the second wiki assignment the students were asked to create wiki-pages concerning IS-matters in the Swedish version of Wikipedia. The third case was conducted within the course of Managing the Digital Enterprise, held in the fall of 2007. For this case, a specialised variant of WikiMedia was installed on a server, and the students were asked to create one wiki-page regarding the topic of “business models for open source software”.

### 5.1 Case 1 – Using wikis to build a knowledge base in Moodle learning platform

The purpose of the assignment was to build a knowledge base about different business models that selected companies use, and how they use ICT to support their business models in their operations. Each student group chose a company and produced materials on how the company used ICT to support their respective business model. Students were given access to a wiki-tool in Moodle. The course participants were organized in 5 groups, with about 15 students per group. Each group was given the task of creating their own wiki about one company assigned to them. Each wiki included a start page created by the course teacher. The page could be changed or filled in by students with their own materials. Sub-pages could also be created.

The assignment was divided into three parts: the gathering of materials to the wiki, structuring the wiki, and finalizing the wiki. The students got access to instructions on what kind of materials is appropriate to use in the assignment and how to use the wiki. Students were also given access to a “test wiki” where they could experiment how wiki works and behaves upon editing. A discussion forum was created to support remote communication and interaction between students during the assignment.

The assignment lasted for a period of 4 weeks. During this time, the students had made between 70 to 190 contributions to each wiki. Figure 2 shows one of the wiki that was created by the students: the students have formatted the text, inserted pictures and created links to internal wiki pages and external web pages. The assignment was graded according to the following criteria: (i) points for the creation and update of wiki pages; (ii) review of the wiki pages; and (iii) links to external web pages. Both quality and quantity were taken into account. The students’ individual and collective input was taken into account in the final grade.

Communication played a significant role in the process of the assignment. It appeared that the groups that were most active in the wiki process were also communicating actively through the medium given to them (the discussion forum). The students were communicating with their peers when they made

changes to the wiki. Wikis appeared to be a remarkable tool for collaborative assignment writing. However, it appears that the particular version of the wiki that was used in this assignment lacked functionality, although it worked well technically.

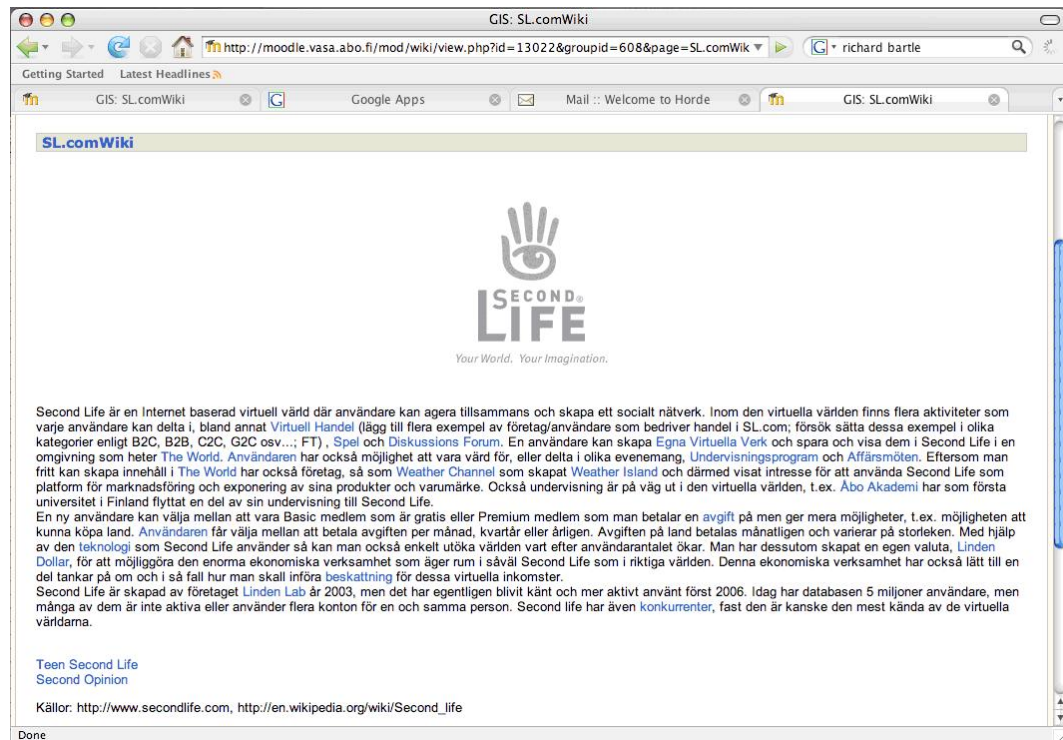


Figure 2. Example of a wiki knowledge base created by a group of students

## 5.2 Case 2 – Writing and learning with Wikipedia articles

The purpose of this assignment was to teach students to use wiki as a support tool for collaborative writing. The students were also expected to learn about “wikipedia-literacy”.

The course participants were divided into 5 groups (10 participants per group). Each group wrote a Wikipedia article about a chosen basic concept in information systems. The articles were written in the Swedish wikipedia (www.wikipedia.se). The course participants were given five weeks to complete the assignment. The concepts that the students wrote about were: (i) customer-relationship management (CRM); (ii) supply-chain management (SCM); (iii) enterprise resource planning (ERP); (iv) Management information systems; (v) IT-architecture and IT-infrastructure.

Assignment support and supervision was provided in the following manner. The students had access to two documents summarizing how to use Wikipedia

(how to get started, edit pages, etc.), and how the assignment would be graded. Two guidance sessions were organized by the course assistant.

Several pages were created by external contributors before the assignment started (for example, the figure below shows that the wikipedia page on “customer-relationship management” contained two short paragraphs explaining the concept). The students were invited to continue writing on the same page or to create a new one.



Figure 3. The Wikipedia page on “customer relationship management” (screenshot taken in October 2007)

The following evaluation of the pages was made:

<i>Topic</i>	<i>Page existed prior start of assignment</i>	<i>Number of edits</i>	<i>Word count</i>
Customer-relationship management (CRM) <a href="http://sv.wikipedia.org/wiki/CRM">http://sv.wikipedia.org/wiki/CRM</a>	Yes	25	460
Supply-chain management (SCM) <a href="http://sv.wikipedia.org/wiki/SCM">http://sv.wikipedia.org/wiki/SCM</a>	No	22	395
Enterprise resource planning (ERP) <a href="http://sv.wikipedia.org/wiki/Affärssystem">http://sv.wikipedia.org/wiki/Affärssystem</a>	Yes	23	585
Management information systems <a href="http://sv.wikipedia.org/wiki/Ledningsinformationssystem">http://sv.wikipedia.org/wiki/Ledningsinformationssystem</a>	Yes	12	360
IT- architecture och IT-infrastruktur <a href="http://sv.wikipedia.org/wiki/IT-arkitektur">http://sv.wikipedia.org/wiki/IT-arkitektur</a>	Yes	22	440

Table I. Number of edits and word count of wikipedia articles edited by students

In conclusion, we can observe that all groups performed more or less equally in terms of quantity. All groups edited their pages about 20-25 times during the same time period, and the articles' length (in terms of word count) were more or less the same. Within the Wikipedia community, it is commonly accepted that a good article's length includes at least 300 words ([http://en.wikipedia.org/wiki/Wikipedia:Words\\_per\\_article](http://en.wikipedia.org/wiki/Wikipedia:Words_per_article)). As it can be expected with large groups, each group was composed of so-called "leaders" and "free riders", ie. 2-3 participants made most of the article contributions ("leaders") whereas several others did contribute little or not at all to their respective group pages ("free riders").

The difficulty of grading Wikipedia articles resides in the fact that anyone can edit pages (even anonymous users) making it difficult to know individual contributors' inputs. The grading in this case took into account the group's input (quality of the article) and each participants' input. Principles used in grading were the following:

- each article gets "basic points" for reaching a certain quality level (max 10 points).
- each participant gets the same amount of "basic points", regardless of how much they have individually contributed to the article (5 points).
- participants who have contributed the most get extra points (15 points).

The assignment took place during a period of 5 weeks. During this time, the students wrote 5 articles in wikipedia.se. One has to notice that the writing of wikipedia articles is an on-going process. Although the assignment took place within a given time period, the articles keep being updated later on. For example, the course instructor visited the articles one month after the assignment ended and noticed that several articles were updated and enhanced by external contributors (for example, the ERP article was edited 9 times between Dec 9 2007 and Jan 7 2008). In other words, the students' input inspired other contributors to make additions and eventually correct the content of the articles.

### 5.3 Case 3 – Collaborative writing of a course paper with wiki

Managing the Digital Enterprise is an IS course given at the intermediate level in English and Swedish at the Åbo Akademi University, teaching out the basic concepts of electronic commerce. During the ten-week period in the course in autumn 2007, the students were given a group assignment each week. One week the assignment was to write a wiki article. There were 34 students from all over the world who had registered for the course. 20 of them participated in the wiki assignment, whereas the rest either dropped out or compensated by doing another assignment.

During a weekly classroom discussion the students were given the task of collectively writing an article on the topic “Business Models for Open Source Software”. The platform to be used was Skolwiki, which had been updated by the institution’s programmers so that the contribution by each student was easier to assess. The wiki technology was introduced and pieces of technical advice were given to get the writing started. The title of the article was written in the Skolwiki for the students but all the rest of the work was left for the students themselves.

Upon hearing that the students were supposed to write an article on their own, some students expressed their anxiety and wanted to get more precise guidelines and division of work from the teacher. The teacher, or rather the facilitator, explained that the students themselves have to divide the work among themselves as well as decide how long it should be, how to focus their topic, and so forth. Some students seemed pleased with the freedom given to them and commented that the right way to write a wiki is exactly to let it live and not constrain or control it from above. The only constraint or demands set to the students was that they should contribute to the article within a week. Seven students could not contribute within the deadline because of technical problems (e.g. they joined late and their browser could not handle the file which at that time was fairly large) or having missed the deadline due to some other assignment.

After the week had passed the Skolwiki contained an article of about 4.800 words

([https://www.nimtour.com/skolwiki/index.php/Business\\_models\\_for\\_open\\_source\\_software](https://www.nimtour.com/skolwiki/index.php/Business_models_for_open_source_software)). Skolwiki is designed to enable a more detailed study of the history of contributions. There were 190 contributions in all from 20 students so that the average number of contributions was 9. The wiki history shows also the identity of the contributor (by user name) as well as the time and the body of text which has been contributed. All students had contributed more than once but the length of the text contributed varied from several paragraphs to few sentences and grammatical corrections. Two so-called power users stand out. One started the activity immediately after the classroom discussion and defined the topic which was subsequently accepted by other students. A Forum was provided for the students for communication. The Forum, although it was at the students’ disposal all through the assignment, was used only in the beginning when deciding what angle one should take into the topic. From there on the discussion moved to the wiki platform. Some students commented the advance of the article by pointing out areas not yet covered or parts of the text needing revision. The other power user clearly adopted a role of monitoring the quality of the article as well as contributing decisively to the text itself. This sort of peer control was exercised by other students as well. For instance, one paragraph of the text was considered too close to a part in another article on the web, and recommended to be changed so that they would not collectively have to face the accusation of plagiarism.

The article in Skolwiki is the length of a regular conference or journal article. It is also of very high quality, considering that it was written within a week by 20 students taking part in an intermediate university course. Part of the success is probably due to the topic. It is not self-evident how one can apply business models to open source software, and there was only one article on the web which addressed exactly the same topic. Consequently, the topic was a real challenge and not just a case of copying what others had already said about it.

The assessment of the assignment was subjective. The Skolwiki enables one to count all contributions down to the number of words but the examiner decided to assess the overall contribution of each individual student in terms of the whole project. The scale of the evaluation was fail, satisfactory and good.

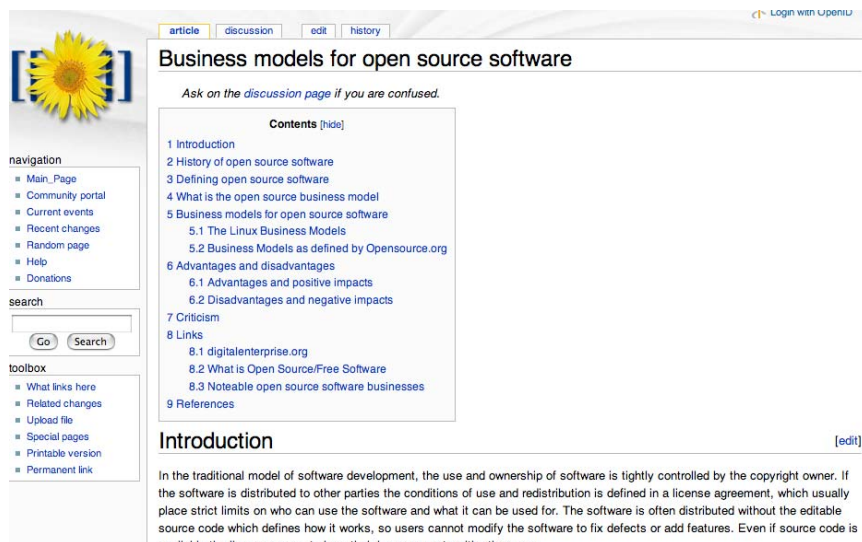


Figure 4. Screenshot of Skolwiki

## 6. Discussion

The cases we reported in the previous section indicate that wiki is a suitable tool for use in university education. There are certainly many pitfalls that one should avoid when using a wiki: we will discuss these pitfalls in some detail in this section.

Choosing the right wiki is essential. As mentioned in section 2, there are several dozens of wikis available, all with a different set of available features. From a teacher's point of view, it might be important to keep in mind that some wikis do not enable a proper follow-up of the contributors' edits, which in turn can be difficult if one wants to make a quantitative evaluation of the contributors' individual input. From a learner's point of view, usability issues might need to be

taken into consideration. In case 1, the wiki was difficult to use and did not enable the students to get a holistic view of the content of the wiki (a “site map” would have been needed). In the second case, a WYSIWYG text editor had to be added, since the Wiki syntax was too complex for some participants. We have also noticed how important it is to produce help material on how to use the wiki’s basic functions (or alternatively to run a tutorial).

Quality of learning is an essential issue, since it is the main outcome of the wiki process. As we could notice from all three cases, students can produce high quality results with wiki technology even in a very short time (e.g. case 3). Especially in case 3 it was evident from the students’ wiki platform discussion that knowing there is a real-world audience, which generally is the case when students edit a Wikipedia article, motivated students to do their best. Peer quality control kicked in early on and decisively contributed to the guidance of the wiki process. Although not all students assumed the role of a quality controller, even students with a more modest overall contribution commented and criticized parts of the ongoing work. The ability of learners themselves to set standards to their own work and assess the progress of their work can be seen as a valuable learning outcome in its own right. It also shows that wikis serve the constructivist pedagogical guidelines in the sense that the students are enabled to set their own goals as well as collectively take responsibility of both the learning process and outcome. For instance, the students were given free hands to retrieve information from any source they considered appropriate, which naturally led to a need to assess the reliability and usefulness of various information sources. It has to be pointed out here, however, that IS students are continuously given guidance in the analysis of information sources, and the IS courses in question are no exception. Wikis also supported the learning of how to work together, and thus are likely to improve the social skills needed in collaboration in the real world. One can also assume – and the students’ spontaneous feedback in the classroom support this assumption – that writing a wiki article was experienced as doing something real in the real world, as the result was out there in the cyberspace, accessible and visible to millions of people all over the world.

One issue related to the learning outcome is the issue of assessment. The learning outcomes have been examined in quantitative terms in section 4.2, which corroborates earlier findings indicating that quantitative criteria are up to a certain point applicable for evaluation purposes. Especially the number of edits gives a rough measure of a satisfactorily performed wiki assignment. From a teacher’s point of view, an assessment of students’ individual performance must in some cases be made. Evaluation of a group’s learning outcome can be done with several qualitative and quantitative criteria; other groups’ outputs can also be used as a point of comparison. Evaluation of individual performance is a bit trickier and a sensitive issue. Several wikis do not allow a proper statistical follow-up of edits and contributions, and even when a quantitative evaluation is

possible, there is a risk of it being of little value, since statistical data give little information about the quality of the output. Also, contributors can, if they want to, remain anonymous during the wiki process, making it even more difficult to identify the origins of the contributions. In case the assessment of individual learning outcomes is a priority, it might be wiser to use some other tool than wiki, as the control from above conflicts with the ethos of wiki peer collaboration. However, another solution comes to mind. We suggest that part of the evaluation should be made as a form of self-assessment or/and peer assessment. Students could be asked to evaluate their own contribution and evaluate how their peers performed. This could be done on an individual basis or in groups. Such an assessment would be in line with the nature of collaboration related to the use of wiki: *democratic* and *informal*:

- Democratic since each contributor could have his or her say about the quality of the work.
- It would be informal as the procedure would bypass the hierarchical control of most traditional education.

From the students' point of view, such an assessment would certainly be welcome: in a questionnaire sent to students, many respondents voiced their concerns about how individual contributions will be taken into consideration in the evaluation. This finding confirms similar observations made by Forte et al. (2006).

Participation is also an issue which we looked at very closely. Several studies report low participation level (Augar et al., 2004; Reinhold et al, 2006). In all of our three cases, we observed that there were two typical groups of users: "leaders" and "free-riders". *Leaders* are users who are (pro)active in the wiki process, communicate with the other group members and make decisions or influence how the wiki content should develop. Free-riders are less active, do not take initiatives and act when asked to (or reminded). In each group experiment, "leaders/power users" were about a third of the group and took a much more active role in the wiki process. It is possible that involving less active students in their own evaluation and their peers' will encourage them to participate.

The wiki process requires some basic level of communication and coordination. Depending on the increasing complexity of the task at hand, the need for communication and coordination might increase. Two wikis that were used in our experiments included communication support; in one of the cases, we created an external discussion forum and encouraged students to use it. In our cases, we noticed that groups which communicated more actively achieved better results, both in terms of quantity and quality. This result is confirmed by a study made by Stvilia et al. (2005).

As a concluding remark, the new digital media has expanded the potential of peer-to-peer collaboration throughout all society. People are not only consumers but also prosumers of information. In terms of education, this means that all sorts

of collaborative technologies are becoming readily available and should be integrated into the mainstream of the educational system.

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