LONG PAPER

Utilizing Wiki-Systems in higher education classes:
a chance for universal access?

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Abstract Wikis are a website technology for mass col-
laborative authoring. Today, wikis are increasingly used for
educational purposes. Basically, the most important asset of
wikis is free and easy access for end users: everybody can
contribute, comment and edit—following the principles of
Universal access. Consequently, wikis are ideally suited for
collaborative learning and a number of studies reported a
great success of wikis in terms of active participation, col-
laboration, and a rapidly growing content. However, the
wikis success in education was often linked either to direct
incentives or even pressure. This paper strongly argues that
this contradicts the original intentions of wikis and, fur-
thermore, weakens the psycho-pedagogical impact. A study
is presented which focuses on investigating the success of
wikis in higher education, when students are *neither
enforced to contribute nor directly rewarded similar to the
principles of Wikipedia.* Amazingly, the results show that,
in total, none of the $N = 287$ students created new articles
or edited existing ones during a whole semester. It is
concluded that the use of Wiki-Systems in educational
settings is much more complicated, and it needs more time
to develop a kind of "give-and-take" generation.

> Íve heard some argue that such a process (Wikipedia)
> should produce nothing better than graffiti; but
> somehow it works. Philip Evans, senior vice president
> of Boston Consulting Group

1 Introduction

Although the term Universal access has various definitions,
the basic idea behind this term is access to information by
everybody [38]. Therefore, it can be argued that the basic
ideas of Wiki-Systems exactly follow the main idea of
universal access. When viewing the possibilities of Wiki-
Systems, a very high congruence can be found with aspects
of the universal access concept, and in particular the pos-
sibility of obtaining, creating and maintaining a wide pool
of information resources and interpersonal communication
facilities, thereby enhancing the learning experience of
students at universities worldwide [31]. Since an essential
part of the Information Society is the opportunity to learn,
Wiki-Systems are ideal to promote these goals [37].
However, due to the fact that the acceptability of the
emerging Information Society by all citizens ultimately
depends on its accessibility, usability and reliability, the
focus on issues in human–computer interaction (HCI) plays

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a crucial role [36]. Additionally, the reliability of the contents is of vital importance when used by students at university. There are a lot of arguments that wikis can support Universal access.

The concept of *wikis* was introduced by Bo Leuf and Ward Cunningham in 1995 [25]. The term wiki was derived from *wikiwiki*, which is the Hawaiian word for quick. A wiki system is an online platform which allows each and every user to create articles and also to edit, revise, extend, or link existing articles. The original aim was to develop an easy-to-use knowledge management system enabling effective and efficient online collaboration. Wiki systems therefore provide mark-up languages, which are based on simplified HTML elements, basically reducing it to the very basic tags, or they provide editors to simplify creating online contents [13, 39]. Consequently, even novices can easily contribute to the online community without being required to have a high level of computer skills. Finally, wikis are online applications and, therefore, they do not require specific local software or operating system.

The first implementation of the wiki principle was *wikiwikiweb* (http://www.c2.com/cgi/wiki) by Ward Cunningham in 1995. Further implementations were *CoWeb* by Mark Guzidal in 1999 [15] and *Nupedia* in 2000. Nupedia followed a rather traditional approach to establish an online encyclopaedia; authors were experts and articles were reviewed in a seven-step editorial process. Due to a lack of participants and the extensive review process, Nupedia failed in the end. Nupedia's successor was *Wikipedia* (http://www.wikipedia.org) which was established in 2001 by Jimmy Wales. It fully incorporated the described principles of openness and freedom and today it is the most successful wiki system. However, current technologies fail to address the challenges that informal, human authored content presents, and, according to Souzis (2005) [35], technology must be easy to use for both developers and end users.

While the principles of freedom are promising from the perspectives of collaborative work and collaborative learning, the occasional irresponsibility of users is a severe disadvantage. First, even if wikis use simplified mark-up languages, a certain level of computer skill is still required, and WYSIWYG editors are implemented sparsely. Second, freedom and openness makes wikis vulnerable to destructive activities and vandalism. Third, in many wikis, an organizing structure is lacking and, thus, navigating in the system and retrieving specific information is often difficult. Denning, Horning, Parnas, and Weinstein [11] outlined further risks of wikis. (1) *Accuracy*: which of the information is accurate and which is not. (2) *Uncertain expertise*: some contributors exceed their expertise and supply speculations or incorrect information, consequently it is difficult to determine how qualified an article's contributors are; the revision histories often identify them by pseudonyms or variable IP-addresses of universities, making it difficult to check credentials and sources. (3) *Volatility*: contributions and corrections may be negated by future contributors. Volatility also creates a conundrum for citations, therefore backups are regularly made by those who are responsible for the system. (4) *Coverage*: voluntary contributions largely represent the interests and knowledge of a self-selected set of contributors. Usually, they are not part of a careful plan to organize human knowledge. (5) *Sources*: many articles do not cite independent sources. Few articles contain citations to works which are non-digitized, thus not accessible via the internet.

Due to Wikipedia's great success and despite the possible risks, the capabilities of the wiki principle were quickly discovered for educational purposes and technology-enhanced learning, to communicate, collaborate, or contribute to a common pool of knowledge.

Generally, characteristics of technology-enhanced learning are interactivity and the well-known expression A^3 (anytime, anywhere, anybody). Wikis highly support these characteristics. Learners may contribute to a common pool of knowledge and become actively engaged in interactive, collaborative work, either interacting with content (active or passive), with instructors (computer-mediated communication), or with other learners (collaborative learning). This degree of freedom and the possibilities of interaction and active contribution are considered to be important factors for successful learning [7, 26]. While higher education still focuses on the individual acquisition of knowledge, there is an increasing demand for graduates who are able to cooperatively develop new knowledge and to solve problems [5, 22]. It must be emphasized that the problem with using wikis, especially in publication of practical procedures is that, an original can be edited by any end user, which can lead to incorrect and sometimes potentially unsafe information [8, 14]. Moreover, wikis serve the psycho-pedagogical ideas of constructivist approaches to learning [6], where learners should create instead of absorbing knowledge [33]. One factor which is crucial in that respect is the possibility of incidental learning [17, 19]. Current learning theories emphasize the importance of situational nature and also social processes within learning [15]. Wikis also enable collaborative work on one subject where ideas and content is developed commonly, fostering the acquisition of knowledge and social interactions [34]. Working in peer groups, furthermore, increases the interest for a subject [24] and peer-review processes, which occur when students access, review, and edit each others contributions, foster meta-cognition and reflexivity [21]. Exactly these abilities are considered to be crucial for being successful in our modern knowledge and information society [2].

Previous research has demonstrated that wikis can be successfully applied in education, for example [1, 5, 9, 16, 30, 28]. For example, Kim et al. [20] applied a Wiki in order to learn a programming method and reported the advantage of wikis in fostering learners ability of algorithm thinking through processing of sharing ideas and collaborating on a work with learners, they also found that wikis improved learners' thinking power.

However, success was often limited to the active or passive use of systems, and not linked to success in terms of learning performance (e.g., grades or comparable measures of achievement). Often reports are technically enthusiastic and there is a lack of hard facts and quantitative measures. Additionally, in many studies active contributions of students were motivated, fostered, or moderated by direct incentives provided by teachers (e.g., grades for participation). Another frequent form of "enforcing" participation was an assignment of responsibility for articles to individual students [16, 27]. O'Neill [27] reported, for example, that without incentives and assignment of responsibilities, "everyone expects someone else to do it". However, such enforced use contradicts the original aims and intentions of a wiki and it may decrease its power. An active, voluntary participation is important from the perspective of psycho-pedagogical considerations. Pressure, for example, reduces students motivation to create and construct knowledge and, moreover, it weakens mutual exchange and meta-cognitive processes such as reflecting on ones own contributions and those of others. In such cases, the potential of wikis might be reduced to being "just a tool to collect information"—without any added value.

The question arises whether the principle of wikis, including the original intentions of freedom, can contribute to (collaborative) learning in higher education. Existing research on wikis (and similar knowledge management systems) so far sparsely investigated whether and which students voluntarily and actively made use of the possibilities of a wiki to jointly collect and develop a resource of knowledge related to a given subject.

2 Background of the study

DeMarco and Lister [10] observed that, "the major problems of our work (and learning) are not so much technological as sociological in nature". Generally, many of these sociological and psychological issues can be grouped into three categories [23]: *Communication*—how should information be presented and feedback provided to others? *Cohesion*—how do people interact comfortably with others, especially if they rarely or never meet in person? *Collaboration*—how can a plan be efficiently developed and executed effectively? From an educational perspective, it is important for students to experience these issues and to learn how to address them. This can be subsumed under the term self-directed learning. Although self-directed learning is not a clearly defined concept, it is essential for enhancing higher education [3, 4]. Moreover, learning must be viewed as a cognitive, active, constructive and collaborative concept [18, 32, 41].

The aim of the current study was to investigate the acceptance and success of a wiki utilized for higher education classes to support collaborative learning and the collaborative creation of a source of contents related to a subject, measured by the rate of active contributions. A further aim was to investigate factors which influence the rate of participation. In contrast to a number of previous studies, pressure by the teacher to foster participation, as well as direct incentives, were avoided. Instead, it was attempted to integrate indirect incentives by allowing students to use the jointly collected knowledge in the written exams. In this way, students were provided with the possibility to make use of collaboratively created knowledge and, thus, to reduce individual efforts for preparing for the written exam. The project was conducted at the University of Technology Graz, Austria, and the University of Applied Science FH Joanneum Graz, Austria.

2.1 BauWiki

The TWiki system was used for the study. This system is freely available (http://www.twiki.org) and it is one of the largest and most powerful systems among the approximately 200 wiki species. A further reason for choosing TWiki was its ability to be adopted for devices other than the personal computer. In consideration of the growing market of mobile devices and the growing integration of technology-enhanced learning solution for such devices, making the content of wikis also accessible for mobile devices such as PDAs or mobile phones is an important aim.

TWiki is based on cgi-bin scripts developed in PERL (Practical Extraction and Report Language), a general-purpose programming language that has its biggest strength in the area of string and data processing. It provides access to C library functions for fine-grained control of files, processes, and network sockets, while, at the same time, handling the onerous details of low-level memory management and offering powerful built-in data structures [12, 29]. Additionally, the decision of using the TWiki system was driven by the numerous available plug-ins to insert formulas (e.g., in LaTe(code), tables, animations and java applets.

2.2 Case study 1

Case study 1 was conducted simultaneously at the University of Technology Graz and the University of Applied Science FH Joanneum Graz. BauWiki was devised to serve learning and collaboration in the course of the module *structural concrete*, which is a major module in the master program of *civil engineering* and is held at both universities. All students have to pass this module for their master degree. Students were supposed to use the wiki to collect knowledge during a whole semester.

2.2.1 Participants

In total, 152 students participated in the module at both universities. Due to a limited response rate for questionnaires, the data of 77 students were analysed. Eight of the students were female and 69 male. The youngest student was aged 21, the oldest 36.

2.2.2 Material and methods

BauWiki served as technological backbone to collect knowledge in area of structural concrete. Due to the fact that the native language of the system is English, the pages were translated to German. To ensure that the system works smoothly, a pilot study was conducted with two students, both studying civil engineering in the seventh semester. Although neither student had used a wiki system before, both students were able to create and edit articles in BauWiki within 30 min, using only the help pages of the system.

At the beginning of the semester, the lecturer held an introduction to BauWiki for approximately 60 min, explaining its intentions and functions. Additionally, questionnaires were distributed to gather information such as, pior knowledge about structural concrete, use of wikis in general, and teamwork for learning. As a basic motivation, students were allowed to use the wiki's content in the written exam. To provide an initial basis of contents, 30 articles were created and published together with blank ones (to suggest a structure) on the wiki. The students were supposed to use the wiki during the semester voluntarily. At the end of the semester, a questionnaire was distributed asking for the general use of BauWiki. Additionally, semi-standardized interviews were conducted with some of the students.

2.2.3 Results and discussion

Case study 1 yielded quiet amazing results. During the semester, none of 152 students actively created a new article or edited an existing one. Additionally, also passive participation (i.e., accessing existing articles) was moderate. During the semester, the available articles were accessed in total 184 times. From the 77 analysed questionnaires, 61% of students reported to have accessed BauWiki at least once during the semester for learning or retrieving information and, 39% of students reported that they did not use the provided articles at all. Based on the questionnaires and semi-standardized interviews at the end of the semester, the major reasons for not using BauWiki can be attributed to motivational aspects and a cost-benefit trade-off. Figure 2 shows the most frequently reported reasons. Summarizing, 38% of students reported technical difficulties as major reasons for not using BauWiki, and 57% reported reasons related to a lack of motivation. Based on these results, it can be concluded that collaboratively collecting information about the subject and the refinement of contents per se could not sufficiently motivate students to actively contribute to the wiki, even if students were allowed to use these articles for the written exams. This finding is remarkable, since it contradicts the enthusiastic "success stories" of using wikis in educational contexts as yielded by previous studies.

2.3 Case study 2

The second case study was conducted at the University of Technology Graz during the module *Informatik II*, where students learn the programming language Visual Basic for Applications (VBA). Again, students were supposed to use the wiki to collect knowledge during a whole semester. Due to the results of case study 1, the study's setup was altered as described below.

2.3.1 Participants

In total, 135 students participated in the module Informatik II. The module is one of the first ones during the whole study of civil engineering. Due to a limited response rate for questionnaires, the data of 88 students were analysed. Nine of the students were female and 66 male. The youngest student was 19, the oldest 24.

2.3.2 Material and methods

As in study 1, BauWiki served as a technological backbone to collect data during the semester. At the beginning of the semester, the lecturer held an introduction to BauWiki for approximately 60 min, explaining its intentions and functions. Additionally, questionnaires were distributed to

Fig. 1 Screenshot of BauWiki
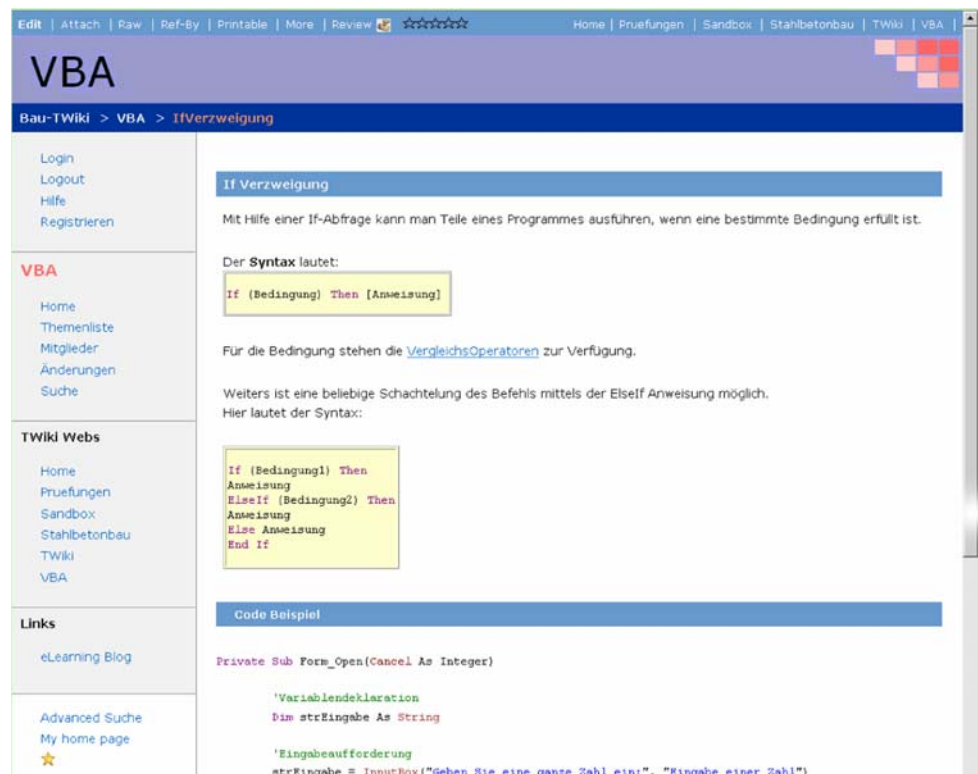
gather information such as prior experience in using wikis in general. Again, as a basic motivation students were allowed to use the wiki's content in the written exam. Since 38% of students in study 1 reported technical difficulties (see Figs. 1, 2), as a tutorial, students were required to write a first article about a predefined topic in groups of two at the beginning of the semester. The topics were related to the content of the module, for instance "describe the if-statement and give a good example". A tutor was present to support students with problems encountered. As in study 1, the students were supposed to use the wiki during the semester on a voluntary basis. To increase

indirect incentives of contributing to the wiki, the use of the wiki was not only allowed in the written exam but also in the exercises during the semester. To measure students subjective opinion about the articles, a review plug-in was implemented which allowed rating the quality of an accessed article on a scale from 1 to 5. At the end of the semester, a questionnaire was distributed asking for the usability, the usage, and the idea of using BauWiki in class in general. Additionally, semi-standardized interviews were conducted with some of the students.
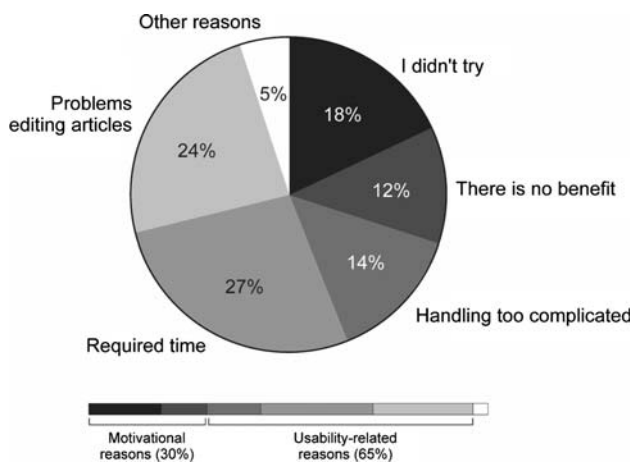
2.3.3 Results and discussion

Case study 2 yielded results equivalent to study 1. Apart from the articles created for training purposes at the beginning of the semester, none of the students edited or created an article in the course of the semester. The percentage of students who passively accessed articles of the Wiki was, in contrast to study 1, significantly higher. In total, 256 articles were accessed during the semester. The analysis of 88 questionnaires revealed that 95% of students accessed an article at least once during the semester, and 5% reported that they never accessed articles. A remarkable finding is that the access rate significantly decreased in the learning phase for the exam. For this phase, only 62% of students reported to have accessed articles of the wiki, and 38% reported to never have accessed an article. This is

Fig. 2 Reasons for not actively contributing to BauWiki in study 1

a critical finding, since it suggests that students do not consider the articles as an appropriate basis for preparing for an exam—even if students were allowed to use these articles. At the same time, this might be a possible reason for the decrease of passive participation. Students might have thought that it would not be necessary to learn or view material that can be retrieved during the exam.

Further analyses concerned the ease-to-use of the wiki and the quality of the articles. The results are summarized in Fig. 3. The data yielded that the average rating of the usability was 1.70 (SD = 0.83) on a scale from 1 to 5, where 1 was the best rating and 5 the worst. In this respect, the relationship between prior knowledge about wikis and their use and the estimated time to get familiar with such system was also analysed. A Spearman–Rho correlation yielded $r = 0.44$, which is significant on the 1% level. This remarkable finding means that the more experience a student had with wikis, the higher was the estimated time to become familiar with a new wiki system. The average quality judgment of the articles was 2.63 (SD = 0.78) on a scale from 1 to 5, where 1 was the best rating and 5 the worst, and finally the judgment of the general usefulness of wikis for collaborative learning was 1.67 (SD = 0.67). Summarizing, some indications emerged of a general lack of usability of wikis, because more experienced students were more pessimistic in their estimations on the time required to get familiar with BauWiki. Still, most students were optimistic about using wikis in education, although the quality-ratings of BauWiki's articles were below average.

As in study 1, the students were asked why they did not use BauWiki actively. For analyses, students where divided in two groups, students who never used BauWiki and students who used the BauWiki in a passive way. Figure 4 shows the results of the group that never used the wiki after the initial creation of a sample article (what is also the reason why the arguments "didn't try" and "problems
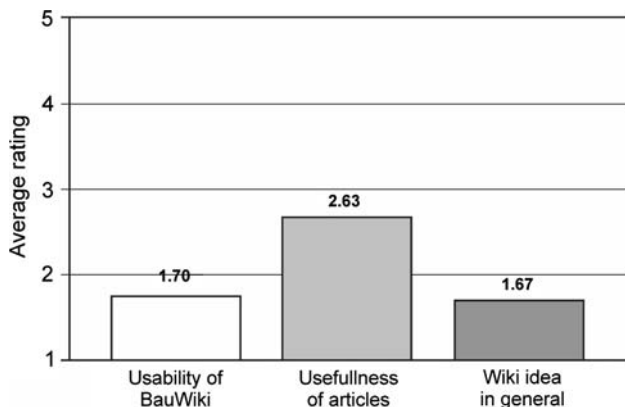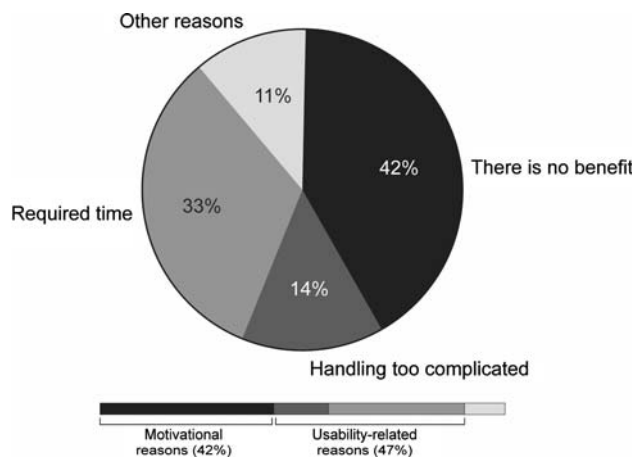

Fig. 4 Reasons for not actively contributing to BauWiki in study 2

editing articles" have been omitted). Despite the initial tutorial, 47% of students reported reasons related to lack of usability (i.e., too complicated handling and too much time required). Comparable to study 1, 42% of the students reported a lack of motivation to use the wiki. The interesting point of these results is that although students had an introduction to BauWiki and, additionally, a tutorial where they created an article together with a tutor, the use of BauWiki appeared to be too demanding to justify the estimated benefits.

Figure 5 shows the results for students who passively used BauWiki. Compared to the non-users, 34% of students reported usability-related problems (i.e., inappropriate search functions and too complicated handling). Additionally, 50% of students reported problems with the quality of the articles (i.e., incorrect or incomplete articles and articles written by non-experts). In summary, these results emphasize the argument that the demanding use of BauWiki does not justify the benefits, especially when
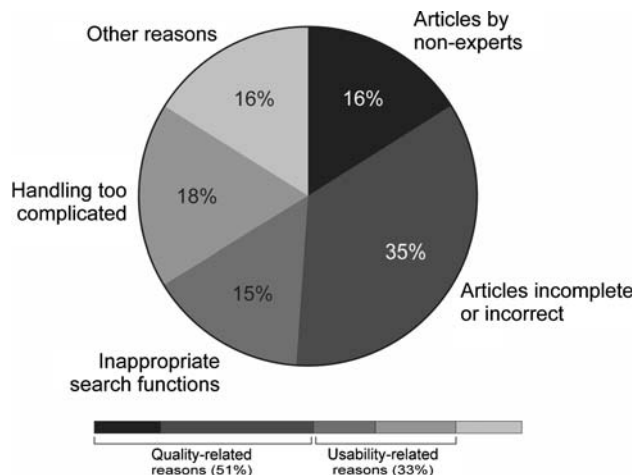

Fig. 3 Qualitative analysis of the usability of the wiki and the quality of its articles

Fig. 5 Main problems regarding using a wiki system in higher education

articles are not considered to be a high-quality source of content.

3 General discussion

Both case studies conducted in the current framework yielded quiet remarkable results. Summarizing, the attempt to utilize a wiki system to support learning and collaboration in two higher education classes clearly failed. In both experiments it was found that none of the 152 students in study 1 and none of the 135 students in study 2 actively contributed (either by adding or by editing articles) to the collaborative collection of knowledge in BauWiki. Moreover, the rate of passive participation (i.e., viewing existing wiki articles) was rather low in study 1, and moderate in study 2.

These findings are in contrast to a number of previous studies regarding wikis, which most often enthusiastically revealed a great success of wikis utilized for education [1, 5], [9, 16, 30]. On the other hand, the current findings are in accordance with usage statistics of Wikipedia, which yielded that only 2.5% of Wikipedia users actively contribute to the development and refinement of contents (http://de.wiki pedia.org/wiki/Wikipedia#Wissenschaftliche_Analyse). Also teachers who tried to utilize wikis in classes reported similar experiences [27].

The most distinct difference between the current study and previous research reporting successful applications of wikis is that direct incentives and any kind of pressure to "enforce" active contributions were avoided. This freedom is more in accordance with the original intentions of wikis, which aimed at voluntarily involving people to contribute to a common pool of knowledge. Although direct incentives and pressure significantly increase the rate of active participation, it limits students engagement to a certain class and to a certain amount of time (e.g., a semester). Moreover, due to a lack of intrinsic motivation and engagement, it might decrease constructivist processes of creating knowledge and also meta-cognitive processes, such as reflecting about one's own and others work.

A major question for future research is which factors, besides direct incentives and pressure, evoke an active and voluntary contribution to a wiki. In the first instance, a crucial factor is a critical mass of users. As mentioned, only 2.5% of Wikipedia users actively contribute to the development of contents. This clearly indicates that even in the most successful wiki system only a very small number of users are willing to spend time and make efforts to provide knowledge for other users. However, the number of users cannot be the only reason for the current results. Despite the comparably large sample sizes of both experiments, a participation rate of 0% was found. In a universal system like Wikipedia, there might be reasons such as the

awareness to contribute to an outlasting and global project and the related social rewards. On a small scale, however, such benefits are difficult to realize and, on the other hand, in an educational setting it is not desirable that only a minority of a class contributes to such system. It is argued that two major interrelated factors must be increasingly considered by future research: usability of wikis and motivational aspects.

Usability of a system is a crucial factor for its success. In relation to wikis, usability is an often unattended factor. This view is supported by the sparse amount of literature in this area. The importance of usability, however, is emphasized by the 65% of students in study 1 reporting technical difficulties (e.g., too complicated handling) as a reason for not actively contributing. In study 2, students were required to practise the creation of articles and, consequently, it was assumed that students are able to create or edit articles, at least from a technical perspective. However, despite the training, 47% of students reported usability related reasons for not actively participating. This is a clear indicator of the importance of increasingly addressing these factors.

A second reason for the lack of participation revealed by the present studies is very low intrinsic motivation at small-scale wikis. This is emphasized by the 30% of students of study 1 and 42% of study 2, who reported reasons which are directly related to a lack of motivation. Wikis limited to classes cannot evoke the feeling of contributing to a large and enduring endeavor, what might be a major motivational component. A further aspect might be that students are too similar in terms of interests, prior knowledge, or class-related learning progress [7]. In addition, a comparably small community (i.e., peers in the classes including the teacher) is based on arguably different psycho-sociological settings than that participating in a much larger and more anonymous online community. For example, on a small scale, contributing students probably take face-to-face criticism from personally known peers and the teacher.

Finally, study 2 pointed out that one of the main problems is the "trust in the content". From the learners point of view, it is very hard to decide in the beginning whether the article is right or not. The confrontation with learning material, which has not been prepared by a typical lecturer means a new way in the learning process. To use the power of nonexpert people to trust content which were developed just in time and to verify learning documents are basics toward self-directed learning.

In the end it must be mentioned that pressure to write articles is necessary till now. The often-called "give-and-take" culture is currently not typical of a student group within a university. The learning behavior, the not available user content and the "I-will-survive" culture maybe the crucial factors that have to be changed. These

motivational problems are, of course, not exclusive to the educational use of wikis. They concern all sorts of activities, which are expected (for example by teachers) on a voluntary basis. Consequently, future research and developments must address clever and neat motivation strategies applied to making wikis a success. Besides the idea of "barter my work for your work", also more direct incentives must be provided. Examples might be, providing different user categories (e.g., normal user and super user) or to replace other class-related and obligatory activities with contributions to the wiki. Motivation psychology [40] offers here a broad spectrum of guidelines to motivate students. On the other hand, it must be clear that, at least on the desirable voluntary and free basis, not all students can be sufficiently motivated.

In conclusion, the present studies did not confirm the often enthusiastic expectations on wikis and their possibilities to contribute to self-directed, exploratory, and collaborative learning. However, wikis can be a sensible addition in an educational context if usability and motivational aspects are considered. The conjunction of both factors is particularly important, because the easier a wiki is to use, the less motivation is required to use it and to contribute to it.

Because these problems are not technological in nature but rather sociological and psychological [10], future research must increasingly address socio-motivational and psychological aspects of wikis. Only by revealing the factors influencing intrinsic motivation of voluntarily participation in wikis, the original idea of wikis can be successfully utilized for educational purposes and their visionary idea can provide improvements of learning and collaboration.

In the end it must be pointed out that wikis may have a great potential for Universal access, but it is necessary to consider that the driving force of a successful wiki is "user-generated content". The aim of the future must be to ensure that user will spend their time in editing and contributing, and maybe it will be necessary to wait for the growing "give-and-take-generation".

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