TOOL-SUPPORTED ASSESSMENT OF WIKI-BASED ASSIGNMENTS

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Abstract: Integrating wiki-based activities into education encourages development of students' competencies that are important for their future professional life. As wikis support social learning and interaction, when working with them students learn to cooperate, plan and organize collaborative tasks, create concepts, express ideas, etc. Many teachers recognize undeniable benefits of a wiki in learning and try to involve it in their teaching. Since wikis were developed for collaborative work but not for use in education, they typically do not include proper tools for tracking and assessing the students' activities, which makes the evaluation difficult for the teacher. In this paper we present a tracking and assessment tool, which we have proposed and developed and report on our experience with evaluation of wiki-based assignments using this tool as well. Since the evaluation of wiki-based assignments is a nontrivial problem not only from the technical point of view but also from the point of methodology, the assessment methodology is also discussed here.

1 INTRODUCTION

One of the most important competencies which our students will need in their future professions is the ability to collaborate during problem solving. Unfortunately there is only a limited number of courses offered at our faculty where teamwork is exercised and students work on projects in groups. The majority of courses relies strictly on individual assignments and hence the students are not trained in collaboration well. In order to improve this status we have reached toward wikis, and integrated wiki-based assignments into multiple courses.

Wikis were developed as a tool for collaborative creation and sharing of Web documents. This technology provides users with the possibility of publishing documents (called wiki pages) on the Web, which can then be accessed by other Web users who are able to read but also revise these documents. New pages can also be added and existing pages can be removed if considered useful by any of the users. Hence wiki pages are typically an outcome of multi-author collaboration. In extreme cases, such as some popular Wikipedia pages, there can be hundreds of coauthors contributing to a single wiki page.

Apart from being inherently collaborative, wikis are easy to use and excessive knowledge of Web technologies is not required for users to participate. In order to manage the collaborative activity, they offer special tools such as revision history tracking and comparison that greatly support the collaborative effort.

Applications of wikis in the educational process help to develop basic skills such as technical and creative writing, working with external sources, and of course language skills (Neumann and Hood, 2009; Rick and Guzdial, 2006; de Paiva Franco, 2008). In addition to these basic skills, the collaborative nature of wikis reinforces social learning (i.e., organization of knowledge in the form that is suitable and understandable by other members of the community), and helps to develop some more advanced skills such as cooperation, organization and planning of the collaborative tasks, but also communication skills, critical and analytical thinking, and the ability to express one's ideas clearly (Ruth and Houghton, 2009; Popescu, 2010). As mentioned in several studies (Rick and Guzdial, 2006; de Paiva Franco, 2008; Ruth and Houghton, 2009) using this tool stimulates community building, students' active participation in learning and responsibility of students for their own learning as well as for one another's learning.

While there is a number of apparent advantages that clearly motivate applications of wikis in educa-

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tion, and there is a body of literature that supports this approach, it is not completely clear from this literature how exactly a wiki should be applied and how students' interaction with it should be assessed. In this respect, the most powerful and useful aspect of wikis – their collaborative nature – quickly becomes the most problematic one. It shows that students are not accustomed to collaborative tasks very well, they need excessive motivation and guidance. Students should be continually involved with the wiki, which requires periodical involvement of the teacher as well. Finally, even if most wikis provide basic activity tracking tools, the collaborative activity carried out by a group of students over longer periods of time breaks down into an increased number of rather heterogeneous revisions which are difficult to track and evaluate from the didactic point of view. Hence suitable assessment methodologies remain largely an open issue.

In our approximately four years experience with wikis we run into many of these problems and were forced to tackle them. In order to get a better overview of students' activity we have designed and developed a special activity tracking tool that enables to organize students but also wiki pages related to the course into groups and allows the teacher to filter out the group activity within any given time frame. To keep track on students' fulfillment of the task, their revisions can be graded with evaluation points of multiple types from which overall evaluation can be computed. Statistical summaries and visualization of the activity and results are available as well. Our tool is freely available for download and reuse.

In addition our experience forced us to seek answers also for many of the methodological issues. Even if our conclusion in this respect may not be unequivocal and universal, the lack of research reports on this problem encourages us to share them with the community. We believe that they can provide useful insight for other seeking to integrate this useful tool into their curricula.

In the following section we describe wikis and their uses in education. Then our attention turns toward evaluation of students' activity, the basic activity tracking tools available in wikis and the functionality that is missing. In Section 3 we concentrate on methodological issues. Then in Section 4 we describe the tool that we have developed and its use. Discussion on related work and final conclusions follow.

2 WIKIS IN EDUCATION

There are many ways how wiki can be used in the educational process as documented in numerous studies (Schwartz et al., 2003; Gobbo and Lanzarone, 2006; Juan Ramon Prez Prez, 2006; Neumann and Hood, 2009; IT User Services, 2008; Popescu, 2010). Among the most interesting we find:

Collaborative Study Materials. In case of newly created courses or courses in quickly developing areas and topics, a wiki based collaborative text book with active collaboration from the side of students may be useful. Collaborative lecture notes or annotations written by students may be used even for well established courses. The information in the wiki textbook or lecture notes is up to date and the students' output provides valuable feedback to the lecturer.

Collaborative Report. In the assignments which require a report on the results (e.g., experiments, data analysis, etc.) students can communicate the results of their previous work and collaboratively write the report using wiki.

Creating a Library. In several courses it may be useful to create a reference library of topics and resources related to the course (e.g., a collection of algorithmic problems and their various solutions). A slightly modified perspective is to use wiki as host-environment to collect and share resources of various kinds such as papers, images, audio and video files, external links, etc., which can be uploaded, shared, annotated and discussed.

Project Diary. A group of students working on a team project assignment may use wiki as a common space where they record the project goals, their progress, schedule, and other project related issues.

Reciprocal Correcting of Essays. In the assignments requiring to write an essay, the essays can be uploaded into a wiki and then students may be asked to review the essays written by their classmates, check and correct the grammar, typos, sentence structures, etc.

Besides the benefits mentioned in the previous section, integrating wiki into teaching brings many other advantages. As it follows from recent comparative studies (Rick and Guzdial, 2006) student performance can improve measurably after adapting curriculum to this new tool, however the success is probably related to the culture and discipline in the classroom as well as the subject of study. Another studies showed higher students' involvement (Neumann and Hood, 2009) and acquiring significant skills in self directed learning (Ruth and Houghton, 2009) when using wiki in higher education. According to (Mikeor, 2011) using wiki in education can help students to build greater relations between new and old

knowledge by allowing student-created structure for the information and ideas. It also stimulates discussion and meta-cognition, different conceptualization of the same content, develops creativity and writing skills in students, etc. Monitoring of wiki discussions by teacher can help to determine the areas or topics of the course that are problematic for students. Also the development of interpersonal and communication skills, especially consensus-building and compromise, as well as teamwork skills we consider to be very important benefit of employing wiki into education.

As we already outlined in the introduction, one of the main reasons that hinders more widespread use of wikis in education is the problem of evaluation of students activity with a wiki. This evaluation is needed and should be continual or at least repetitive in several stages during the course in order to increase students engagement with the tool.

When a teacher is to evaluate a contribution of a particular student, she is confronted with a large number of revisions – the actions that have been performed – the students have carried out on a set of documents that are part of the assignment. These revisions are typically presented as a long list and have to be reviewed in detail because of their heterogeneous nature (e.g., some added new content, some edited existing content, some were improvements, some were corrections of typos and grammar, etc.).

A typical and probably the most popular example of wiki software is MediaWiki[1]. It offers two basic tools that can be very helpful to the teachers:

Revision History. Edits are stored in the database and can be listed and reviewed. The user may retrieve the history per each document, per particular user, or for all documents contained in the wiki. Timestamps are available, so the teacher is able to figure out the frequency and regularity of edits. Each version can be reviewed and any version can be restored if needed.

Version Comparison. This tool is integrated into revision history. It shows two selected versions side by side and visualizes the difference. This tool is essential for evaluation which would otherwise be nearly impossible.

The intended use of these tools is in tracking the basic activity of a large number of often anonymous contributors, identification of abuse and vandalism, etc. This is not to say that the tools are not useful to the teacher, they indeed are. However, their functionality is only very basic in order to support the task of student assessment which becomes difficult especially with larger groups of students or with labor intensive assignments. For such tasks, more comprehensive and specifically directed tools are needed. From our experience we were able to identify the following functionality that is needed to support the assessment task and it is currently lacking or not satisfactory in most of the readily available wiki softwares:

User Groups: wiki is rarely deployed for one single course. Typically a wiki is reused for multiple courses and also for multiple runs of same courses in consecutive years. Very often also students of one course are divided into several groups each working on a separate assignment or its version as collaboration in excessive groups becomes increasingly difficult. It is handy if the teacher is able to associate documents of interest with each group.

Filters & Search: teachers need to be able to filter out revisions of a particular set of documents, user, or user group. Sometimes it is handy to add or remove students/documents from the filter. It is also necessary to be able to filter out revisions in any given time frame. For instance, MediaWiki offers only most recent revisions with different windows the largest being last 500 revisions in last 30 days. As typical course runs in a semester spanning multiple months this is clearly unsatisfactory.

Evaluation Records: while wiki may offer some basic revision metrics such as number of edits and number of bytes changed in a revision, for a thorough assessment of student's activity one needs to assign some kind of evaluation score to the revisions. Evaluating a revision, teacher needs to take to account not only the amount of text edited or removed, but must be able to assess also the quality of the revision: is it addition a new content, modification of existing content, major error correction, or just grammar and typos correction? It may be desirable to assign a different weight or score to multiple quality categories for each revision.

Statistics & Visualization: a comprehensive assessment supporting tools should provide statistics and charts for analysis and visualization of both: the revision metrics provided by the wiki software and the evaluation points assigned by revisions by the teacher. It should be able to spot the most active students, the most frequent types of edits, the relation between the time period and activity of

[1]MediaWiki is a free software provided by the WikiMedia foundation. It is used by the foundation's projects such as Wikipedia and many others. It can be obtained from: http://www.mediawiki.org

students, etc. It would be also very desirable to be able to compare students and student groups.

In Section 5 we review a number of various tools which extend the basic functionality of MediaWiki with the aim of enhanced activity tracking. As we did not find any of these tools satisfactory for our needs we decided to design and develop our own activity tracking tool, which we describe in Section 4.

Another important problem is that even with different supporting tools, to our best knowledge, there is no methodology for wiki-based assignments assessment. We elaborate on this in the next section.

3 ASSESSMENT METHODOLOGY

Evaluation of wiki-based assignments is a non-trivial task even for an experienced teacher. It is difficult in general to evaluate the products of students' collaborative work and in addition a wiki offers to students many diverse ways how to contribute and hence typically a combination of multiple evaluation criteria need to be applied.

Before we get to the details, let us take a slightly broader perspective on wiki-based assignments. In the first place, attention needs to be given to formulating the assignments properly. Vaguely or too generally formulated assignments, (e.g., "contribute to the wiki with an article related to the topic of the course" and providing a list of topics) should be avoided. Such an assignment would most probably work fine with individual tasks, such as essay or blog article writing. In case of wiki-based assignments most probably one of the aims is also to exercise collaboration – this may not be obvious to the students however. Therefore students need further instructions and explanations how much of collaboration is expected, how should it be executed and coordinated.

It can be very handy to provide such instructions in the form of separate howtos and guides, that can reside in the very same wiki that will be used by the students as separate wiki pages. This way they are accessible to the students and can be shared by multiple assignments and even courses if applicable (in most cases the organization of the work will be very similar for different assignments). To some extent these instruction should outline also some details on how the assignment will be evaluated. For instance, we typically include a "How to get points" section which explains that certain amount of collaborative activities is needed to gain the full score, examples of such activities, and a warning that just adding new content will not be satisfactory.

One advantage of wikis is that students' contributions, even partial, become immediately visible to the teacher revision by revision. The teacher may thus supervise and provide guidance if necessary. In collaborative assignments an increased amount of guidance is needed. Teachers thus become actively involved with their students, they continually provide feedback and discussion. Wikis are very well suited for this purpose. In MediaWiki, for instance, each page and each user as well have a dedicated discussion page. The teacher can immediately use these pages to deliver feedback, and students themselves should be encouraged to use discussion pages to cooperate their contribution. In addition, in large wiki projects such as Wikipedia, so called *message box templates* have become a standard to indicate if there is some problem on a wiki page. These templates can be easily adopted for didactic goals, and we encourage their use especially by the teachers to deliver more targeted feedback to the students. An example of such a message box that we employ is shown in Figure 1.

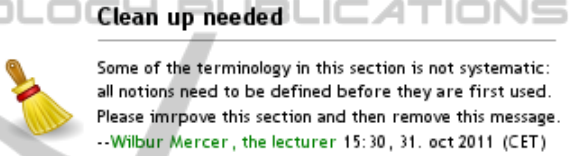


Figure 1: Example of a message box.

Most typical didactic message boxes that we employ ask for correcting errors, adding clarifications and further explanations, reorganizing text, etc. Such message boxes, once created, can be reused between assignments and courses. While in most cases the teacher adds the message box describing some problem when needed, and consecutively some of the students would resolve the problem and remove the message box (which the message box itself suggests), also the students should be able add message boxes and suggest some improvements to their colleagues if they find it useful.

Collaborative projects with number of participants typically only yields meaningful results if executed over a reasonable period of time. For most applications in higher education this can ideally match with the overall length of the course. Minimal time span for such assignments depends on the difficulty and size of expected results and the size of the team. On the other hand, our experience suggests that at least 4–5 weeks will be typically required in order to grasp the assignment and wiki basics, to establish effective collaboration, and to produce first meaningful results.

This kind of assignments also requires that the students participate continually and coordinate their contribution with the others. Students must work as

a team and their results will depend on other team members. Our experience shows that for this reason these assignments cannot be completely voluntary, and should somehow be part of the course assessment. For instance, in order to get high grading students need to collect a certain amount of evaluation points through the wiki-based assignment. In order to encourage continual involvement and team work we suggest that the following aspects of their work should be evaluated:

- quantity of contribution,
- quality of contribution,
- periodicity of contribution,
- amount of coordination with colleagues.

As students require feedback, the evaluation should be provided periodically. Our experience shows that one method to achieve a reasonable trade off between quantity and periodicity is to split the assignment time into multiple intervals which are evaluated separately. Approximate amount of content added or revised during one period is described to the students and the maximum number of evaluation points per period is set. Students are hence required to split their contribution between the periods and immediately receive feedback. The periods themselves may be weekly, biweekly, monthly, or so. We have achieved the best results with weekly evaluation, however it certainly puts increased workload on the teacher. Monthly periods seem already to be too long, as students then tended to leave all work to the last couple of days and decrease in cooperation activities was observable.

The evaluation points awarded for each revision will depend on the revision quantity (amount of added or revised content), the quality of added content or of the improvement, and collaboration activity. However a revision on a wiki page may be contributive in many different ways, hence we suggest to distinguish between multiple types of evaluation points respective to different evaluation criteria. These criteria are probably best defined by each teacher, however we suggest criteria as follows:

New Content (n): respective to the amount of new content was added.

Modifying Content (m): for significant improvement in the content.

Grammar/Editing (g): improving grammar, language and structure of the existing content.

Topicality (t): a coefficient (0-1) indicates whether the content is on topic.

Cooperation (c): use of descriptive comments, discussion with other users, planning of new content, etc.

The overall score (s) for each revision is then computed by a suitable equation, for instance:

$$s := t \times (n+m) + g + c \,, \tag{1}$$

but certainly other equations may be applied, depending on the needs of particular teacher and particular assignment. For instance, the topicality coefficient t may be applied to grammar and cooperation values as well, or even more complex equations with weighted sums of the score types may be handy.

Total score is then calculated as sum of totals for each revision. Structuring the score into different types is not only helpful in order to evaluate each revision properly but may as well provide interesting statistical summary of student's activities over longer periods of time. From the sums in the score types (average in case of the coefficient t) the teacher can obtain interesting insights on overall students' interaction with the wiki and their dominant types of activities.

Another important aspect is the size of students' groups that should participate on one wiki-based assignment. Clearly, certain minimal amount of students is required to achieve effective team work. On the other hand, if the group is too large, some students may complain that there is too little space for them to contribute, as everything what has to be done is done already. Also unnecessary competition may arise between the students as everyone wants to get the best (or easiest) share of evaluation points which degrades team work as well. Therefore large groups of students should be divided and each group should be given an independent assignment. It is hard to estimate an exact maximal size of a group, it largely depends on the size of the assignment, especially on how broad is the topic. Our experience shows that groups of twenty and more students are already quite difficult to manage.

Finally we would like to consider also the issues related to copyright and intellectual property law. Although our university implements strict sanctions for copyright infringement and plagiarism, our experience shows that a number of undergraduate students but not uncommonly master students as well are quite ignorant in the copyright issues. We share the opinion that students should be educated in these issues in the first place and this education must come during the courses as well. Creative assignments such as collaboration on wiki documents are well suited for this purpose. We have achieved interesting results by implementing small penalization into the course evaluation system (e.g., evaluation points are not awarded

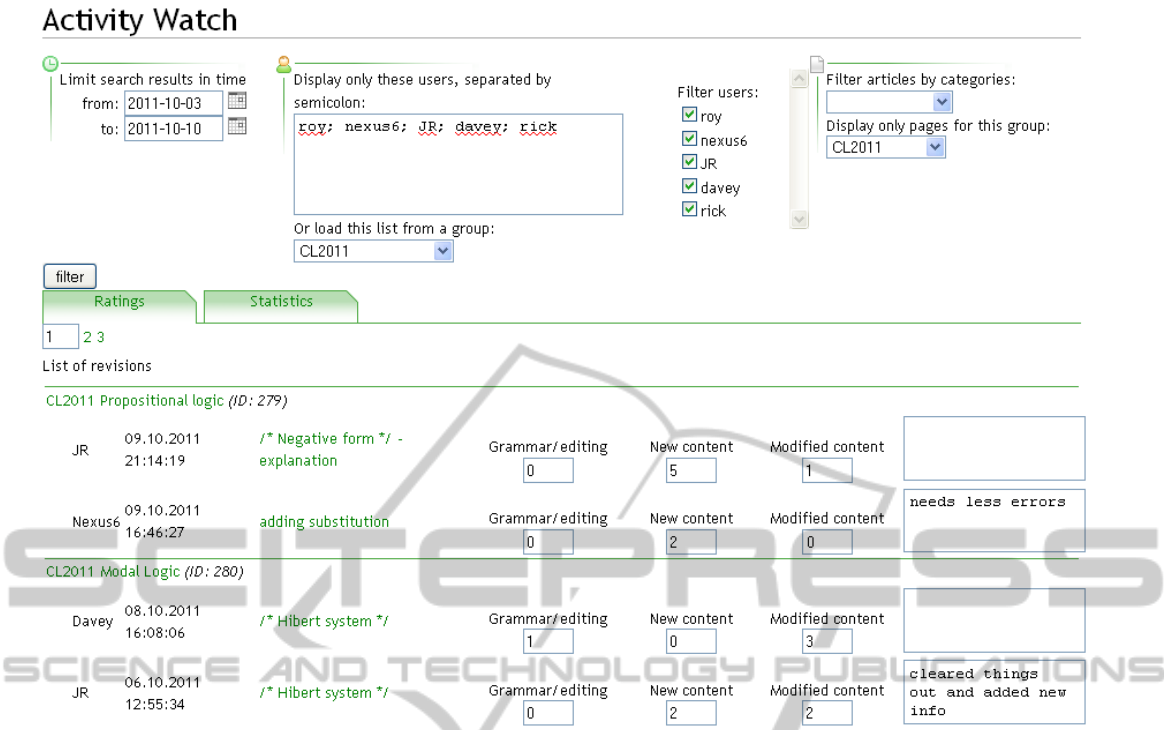


Figure 2: List of revisions for specified group of users.

for the given evaluation period if part of the content was reused without permission of the author, or even a small amount of points may be subtracted). Such rules of course need to be formally implemented in the evaluation methodology and the students need to be acknowledged about them at the beginning. The main goal here is to rise awareness of the copyright issues, as in most cases the problem is that students are not aware of how information from external sources should be processed and credited properly. Providing students with extensive guides and howtos on this topic is extremely helpful.

4 ASSESSMENT TOOL FOR MEDIAWIKI

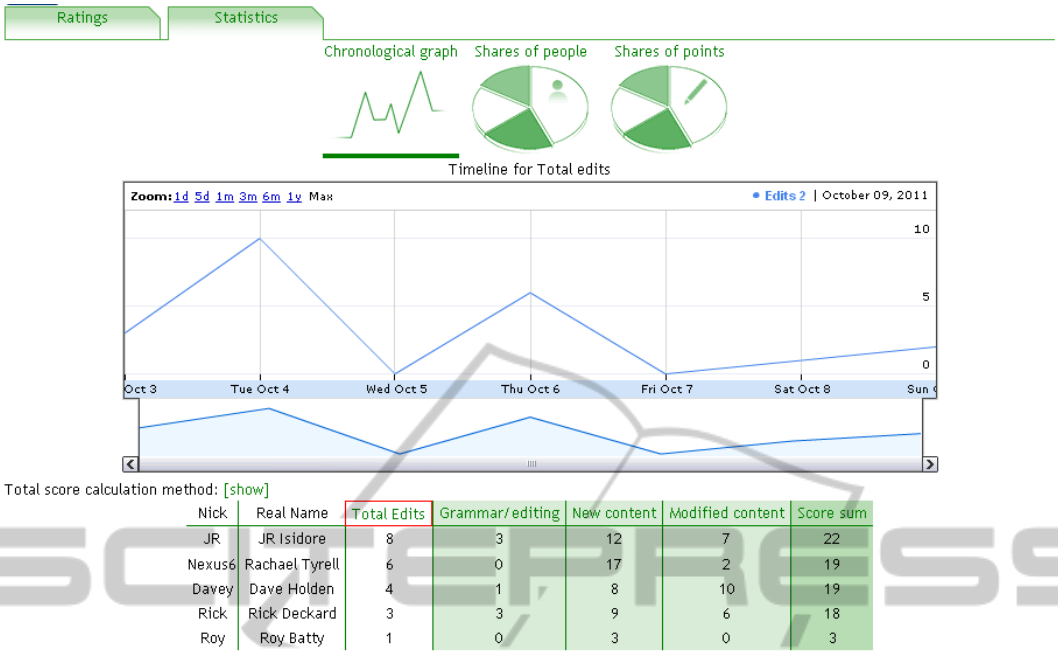
In Section 5 we review a number of various WikiMedia plugins and other tools that were created or can be used with the aim of improving the activity tracking task in the wiki. Unfortunately, we did not find any existing tool that would support the assessment task appropriately as we explained in the previous sections. Therefore we designed and developed our own tool (Janajev, 2011). It is called `TrackingBundle` and it is freely available[2] as a MediaWiki extension.

Once the extension is installed into a running MediaWiki it creates three new special pages: `TrackingBundle`, `AssignUserGroups`, and `ActivityWatch`. The first page provides global configuration options, the second page serves for administration of user groups, and the third one contains the tracking interface itself.

Let us have a closer look on the functionality supported by the extension. On the `AssignUserGroups` page the teacher is able to create groups for tracking and evaluation. Users can be added to each group, one user may possibly belong to multiple groups. Users in the group are split into ordinary members (students) and leaders (teachers). This is handy when there are more than one teacher responsible for a course. Group leaders can add or remove members, and assign or cancel the leader role to any member. Apart from users the leaders can also assign specific pages of interest to their group. Hence the group serves as a collection of users *and* documents associated with a particular course, assignment, team of students, etc.

Once user groups are configured the activity is tracked on the `ActivityWatch` page. This page is split into two tabs: `Ratings` and `Statistics`. An important part of this page is the filtering interface common to both of the tabs, with help of which the teacher can easily find relevant revisions in between

[2]The TrackingBundle extension for MediaWiki is available from the WikiMedia extension matrix: http://www.mediawiki.org/wiki/Extension:TrackingBundle.



Nick	Real Name	Total Edits	Grammar/editing	New content	Modified content	Score sum
JR	JR Isidore	8	3	12	7	22
Nexus6	Rachael Tyrell	6	0	17	2	19
Davey	Dave Holden	4	1	8	10	19
Rick	Rick Deckard	3	3	9	6	18
Roy	Roy Batty	1	0	3	0	3

Figure 3: Chronological graph with the score overview table.

the large number of revisions done by many users of the wiki (Fig. 2). The filtering is enabled along three different axes: first, revisions carried out by a selected set of users which can be loaded from a user group but users can be also dynamically added or removed from the filter; revisions done on a set of documents associated with a group or a wiki category; and third, revisions carried out within a specific window of time. All filters can be combined according to teacher's needs.

The `Ratings` tab lists all revisions that meet the filtering criteria in the chronological order (Fig. 2). For each revision its author, revision time, revision summary, and link to the revision itself (showing the difference w.r.t. the previous version) is displayed. Additionally, each revision can be rated in terms of evaluation points that can be assigned on this page as well. As we explained above, there are different aspects to be rated for each revision, hence the teacher may assign evaluation points of multiple types. These types and their relation to total score can be configured on the `TrackingBundle` page; the three predefined types are `new content`, `modified content`, and `grammar/editing`. A comment explaining the evaluation may be added as well, so the student is able to find out the reason why she was assessed that way.

The `Statistics` tab provides a score overview of all students showing the totals for each score type and the grand total as well as total number of edits in a summary table (Fig. 3). These results are also respective the current settings, and so the teacher may review and compare students' activity and results during selected periods of time or for selected documents only.

The total score (s) can be computed in multiple ways, which is also configured by the teacher on the `TrackingBundle` page. The preconfigured options include simple sum of points from different score types, weighted sum of points, and a special predefined contribution score formula that was originally introduced in the `ContributionScores` plug-in as described in Section 5:

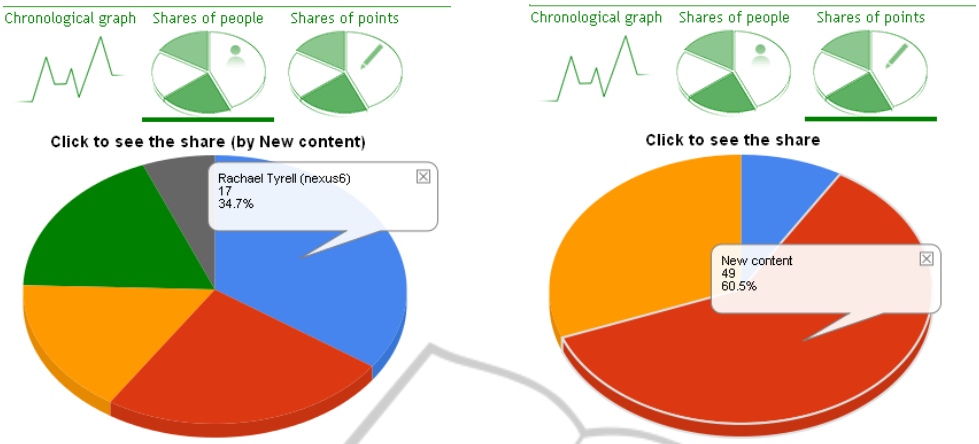
$$s := upe + 2 \times \sqrt{(e - upe)} \qquad (2)$$

In this formula, the basis of the score is formed by the number of unique pages edited (upe). This is increased by bonus score gained from total number of revisions (e) decreased by the number of unique pages edited. This way if someone did only one change per page, she gets no bonus score. In the case of more revisions per page a bonus score is assigned. In order not to overweight the base score value with the bonus score, the difference ($e - upe$) is square rooted and multiplied by a constant.

The teacher may also define her own evaluation formula consisting of regular mathematical expressions and variables corresponding to the respective score types.

Finally, the `Statistics` tab offers also three different ways of visualization of students' activity and score:

Chronological Graph: a line graph visualizing the activity of the students within the time frame set



(a) (b)

Figure 4: Ratios of evaluation points (a) earned by different students; (b) for particular score types.

by the current filter. The value which is visualized can be selected by clicking on the column in the score overview table (Fig. 3);

Shares of People: a pie chart displaying ratio of points earned by different students (Fig. 4 (a)). Also for this graph the score type to be visualized can be selected from the score overview table;

Shares of Points: a pie chart visualizing the ratio of evaluation points for particular score types in all watched revisions (Fig. 4 (b)).

As we can see one of the main design goals of the tool was flexibility. Partly due to the fact that there is no unified methodology that would allow to evaluate wiki-based assignments in one particular way. Also, great flexibility of filtering is needed due to the large number of revisions that students can possibly generate during one course. Powerful visualization tools may also be very helpful to tackle this task.

In Section 6 we share some of our experience with wiki-based assignments and with their evaluation using this tool.

5 RELATED WORK

Several plug-ins supporting evaluation in wiki were developed and are available as extensions stored on official MediaWiki extension matrix (Mediawiki, 2011). Some of them are purely cosmetic extensions, e.g., `TransformChanges`, which transforms the default `Recent Changes` extension from a list of revisions into a table. But there are also extensions trying to visualize data from wiki databaze in other than standard way with the aim to acquire information about revisions more effectively.

Most of them offer the list of users who contributed to the wiki and sort them by the amount of their revisions. The difference among the particular plug-ins is that some of them (e.g., the plug-in `Contributors`) list the contributors of a specific wiki page, while others (e.g., the plug-in `SpecialUserScore`) gather statistics about revisions from all the pages on the whole wiki or revisions related to a particular user (e.g., `CountEdits`).

One of the similar but more complex tools – `ContributionScores` – not only lists the contributions from the last 30 days according to some filter but offers also the possibility to calculate the evaluation score using the formula (2).

There are also plug-ins in MediaWiki focused on revision activities of a specified user. For example the extension `EditCount` lists all pages edited and for every page it shows the number and the percentage share of revisions done by a selected user.

Since these extensions use the number of revisions as the main measure of the user's contribution to the wiki, we do not find them satisfactory for our purposes. The number of revisions does not reflect the substantial factors of contribution, such as the amount of the text added and, more importantly, its quality, so this information could be misleading. Also the statistics information could give only the evidence of who is active with the wiki in general but it is not helpful in evaluating of the contributions related to a specific course. All the above mentioned plug-ins are insufficient also for other reasons. They mostly do not offer the opportunity to set the time period, create groups of students or groups of pages to be monitored, they do not allow to set the roles (teacher/student) or define teacher's own criteria and evaluation rules.

As one of the most inspiring MediaWiki extensions we consider `Annotation`. This tool tries to

interactively visualize which parts of a single page have been edited by which user. Different colors are used to highlight parts of the page edited by different users. When hovering over a highlighted area, detailed changes respective to this revision are visualized. Unfortunately this helpful and interesting project was never finished.

Assessment extensions of DokuWiki (other popular Wiki type) were also reported. One of them, `EdDokuWiki` (Popescu and Manafu, 2011) tracks students activities, enables teacher and also peer evaluation and allows to use various assessment criteria.

Independent from the MediaWiki and DokuWiki projects, the `ClassroomWiki` system developed at the University of Nebraska-Lincoln (Khandaker and Soh, 2010), offers an environment in which students work collaboratively on wiki-based assignments. Based on the set of pedagogy theories explaining collaborative learning, the authors implemented the tool with tracking, modelling and group formation capabilities. The system offers a mechanism for dynamic creation of heterogeneous student groups, which has been showed to improve the collaborative learning outcomes (Roberts and McInnerney, 2007). This tool offers the roles of teachers and students with different rights. Teachers are provided with an interface to create assignments for specific student groups and afterwards to review the revisions made by students and assess them. On the other hand, the dedicated students interface is similar to an ordinary wiki, enriched by forums, where they can discuss their contributions. The `ClassroomWiki` seems to be a powerful tool considerably improving the collaborative learning skills of students. We found many of its features useful and inspiring also for the development of our own tool and methodology.

6 CONCLUSIONS

Wiki as one of the educational tools encouraging the constructivist approach to knowledge acquisition (Heafner and Friedman, 2008; Parker and Chao, 2007) brings many benefits which we find important in modern teaching and learning. Moreover, it helps students to develop skills that are substantial not only for their learning but also for their future professional life, e.g., teamwork, conceptualization, communication skills etc.

For that reason we started to use this tool in our courses more than three years ago. Various types of wiki-based assignments were gradually integrated into several courses in different study programs.

One of the first courses where wiki was employed was the master course of Computational Logic. Since this course is a new element of the study programs, there is a lack of study materials for it. Therefore the main wiki-based assignment for students was collaborative writing of lecture notes.

Other courses (e.g., Algorithms and data structures for the bachelor students of Applied informatics or Principles of databases in the master program for future teachers of informatics) use wiki for creating additional materials related to various course topics.

As the aims of these two approaches of integrating wiki into education are different, the ways how to include wiki-based assignments into course and also how to evaluate them differ as well. In the case of preparing lecture notes the assignment was compulsory, students' contributions were evaluated weekly, so that the students received feedback almost immediately. This method brings strong motivation for the students to work continuously and periodically.

Creating of additional materials is an optional assignment and it is awarded some extra points. We first tried to employ this type of assignments in the database course and the evaluation was carried out at the end of the course, so the students had all the semester to work on them. This approach did not work properly, because the students were not motivated enough to contribute regularly. Most of them started to publish their contributions in the last few days of the semester and that way one of the main aims of these assignments – collaborative work – was impossible to accomplish. For this reason, when we consecutively applied this optional type of assignments in the course on algorithms, the evaluation was adjusted: the wiki contributions were evaluated monthly and per every month a maximal amount of evaluating points which could be assigned to individual student was specified. This helped partially but we were not fully satisfied as only about 13 % of the total number of students contributed to the wiki.

However, the evaluation of students' contributions was difficult task in all these cases. The problems related to the students' activity tracking and assessment served us as a motivation to develop the tool introduced in one of the previous sections. Subsequently, this tool was used in assessing some runs of the courses mentioned above.

Considering the small number of students contributing to the optional assignments and rather low level of their cooperation we used this tool with three predefined types of evaluation criteria: `new content`, `modified content`, and `grammar/editing`. The total score was counted as a weighted sum of evaluation points, as described in Section 4. Although in this case when wiki pages created by the small group of students were evaluated, the assessment tool was a useful aid because the number of revisions evaluated

at once was quite large.

As regards the compulsory assignments where the number of contributing students was relatively large and students were forced to cooperate, we added two new evaluating criteria (`topicality` and `cooperation`) to the three criteria mentioned above. The overall score was calculated according to the formula (1). While evaluating these contributions we ran up against the problem of large number of revisions with not too significant changes, e.g., minor spelling corrections or format changes, that needed to be checked one by one.

This problem and also our first experience with the tool inspired us to the proposal of several minor or major improvements. One of the most needed improvements is grouping multiple revisions of the same user as one revision. This could avoid checking long lists of small revisions without significant changes one by one. In addition, an improved visualisation of changes made by individual users on a single wiki page in a fashion similar to the `Annotation` plug-in described in Section 5 would be very helpful. Another interesting feature would be some kind of originality check that would enable marking of suspected parts of students' contributions and searching for excessively similar content.

In this paper we focused on issues related to assessment of students' contributions in the wiki. We have analysed the teachers needs related to this kind of tasks. Based on this analysis we have proposed a methodology for application of wiki-based assignments in higher education and designed and implemented a tool for students' activity tracking and supporting the assessment process which we have also described here. In the future we would like to implement some improvements of this tool and further investigate on the evaluation of the wiki-based assignments. In our opinion, the assessment tool introduced above is already now a handy aid for teachers which can help them to overcome increased workload related to evaluation of students' wiki contributions and facilitate this task.

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