Wiki as a tool for Microbiology teaching, learning and assessment

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Abstract

Introduction: Evidence suggests that cooperative learning and peer-assessment fosters students' ability to work with others and may lead to better cognitive outcomes and higher achievement. This work aimed to assess the use of an online collaborative tool for the teaching/learning and assessment of Microbiology.

Materials and methods: A total of 144 students were grouped and assigned to create wiki entries as well as to peer review wikis created by colleagues (peer-assessment process) using the Wiki module from Moodle Virtual Learning Environment (MVLE). MVLE actions log was used for tracking students' activity.

Results: The number of student's actions within wiki did not present a strong correlation with wiki scores, so it should not be used as a heavy evaluation parameter. The amount of work developed between members of the same group differed significantly, suggesting that final scores should be attributed individually. When peer-assessment process was implemented, the number of editing actions increased, suggesting that the peer-assessment strategy encourages the development of a better work. The vast majority of students execute the work in the last 10% of the period assigned for task development, which can be counter-productive for a truly collaborative work.

Conclusions: Wiki revealed to be a useful tool for Microbiology teaching/learning and assessment, promoting collaborative work, promoting virtual mobility and facilitating the real-time monitoring of the students' work. This pedagogical project promoted also the involvement of students in their assessment process, encouraging their critical sense and quest for Excellency.

Introduction

Microbiology is the science that studies micro-organisms, and it is integrated in almost all curricula of Medical and Biological Sciences Programs, either at graduation or post-graduation levels. The Bachelor plus Master Degree in Dentistry (3 + 2 years) at Faculty of Dentistry of University of Porto (FMDUP) has two courses of Microbiology, named Microbiology I and II, integrated in the first and second semesters of the second year, respectively. These courses have only one teacher responsible for all the students, which are around 80 per semester. The Microbiology I course focuses on transmitting to students the importance of the microbial world; to provide students the knowledge about the microbial taxonomy, anatomy, physiology, metabolism and genetics as well as to skill students with the current laboratorial methods and techniques used in micro-organisms handling, isolation, characterisation, identification and study. With this purpose, students attend 1 h lecture and 2 h of practical classes weekly. Students' final scores are based upon theoretical evaluation (50%), assessed through a written exam, plus continuous evaluation (50%), assessed through laboratory reports, weekly quizzes and one semester assignment consisting on a contribution for a global wiki development.

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In addition to the traditional teaching/learning synchronous model, the teaching of Microbiology at FMDUP incorporated the use of Moodle Virtual Learning Environment (MVLE) within the course organisation (1). This approach of blended learning, with synchronous and asynchronous levels of education, revealed to be of great value for the teaching of dental students (2–5). This approach follows the Association for Dental Education in Europe's (ADEE) recommendations, which suggests that the student learning is probably best facilitated by the use of a combination of educational methods and tools that promote reflection, critical thinking and continued learning, for example the use of self- or peer assessment and portfolios (6).

MVLE provides the necessary tools to manage and make available multiple types of contents, assess learning through quizzes and offer very useful communication tools, such as forums. In addition to these more commonly used MVLE resources, a wiki activity was also used within the Microbiology I course.

Ward Cunningham developed the first wiki in 1995 with the name WikiWikiWeb (7). A wiki, one of the many Web 2.0 collaboration tools, allows several users to create, organise, edit and shape content in a collaborative and straightforward manner. In the MVLE, all changes to a wiki are tracked and recorded enabling strong editing and reversion capabilities. This function is useful within group projects when the group or an individual needs to refer to an earlier version. These features also provide for the necessary means to track and assess student's activity. In comparison with other Web 2.0 collaboration tools, Wikis present several advantages, such as easy editing, automatic linking of pages and a 'History' function (8). Evidence suggests that cooperative learning fosters students' ability to work with others and may lead to better cognitive outcomes and higher achievement (9–12). Wikis represent a shift in information technology tools by supporting collaboration and the intellectual sharing of ideas. Given that, with a wiki, learners can share information, resources and experiences, and work together as a group, the idea of implement the use this Web 2.0 collaboration tool in the teaching/learning process within Microbiology courses was embraced with high motivation by the teacher. With this project, it was expected to promote the creation of a learning community amongst students and to promote an active participation in the learning process.

In addition, other researchers developed a wiki-based peer review/evaluation system where students are called to participate in the evaluation process (13, 14). This approach of peer assessment allows students not only to get involved in their evaluation process but also, more important, to stimulate their critical sense and their quest for Excellency (13–15).

The main goal of this educational project was to assess the use of a wiki as an online collaborative tool for the teaching/learning and assessment of Microbiology.

Materials and methods

This study includes the data obtained from a pedagogical experience using a wiki in the course of Microbiology I of the Bachelor plus Master Degree in Dental Medicine at FMDUP. Data were gathered in two sequential academic years (year 1 and year 2), including a total of 144 students, 77 students per year. The students were assigned to develop contents for a global year wiki created within the MVLE (versions 1.8 and 1.9). The topics to be developed by the students consisted in species, genus or families of micro-organisms, microbiology laboratorial techniques or simple concepts in Microbiology. To guarantee similar level of difficulty between topics, the teacher made available a group of themes from where the students could choose. The students could also suggest different themes that should be validated by the teacher.

In each academic year, the students were grouped in teams of 4–6 elements. In year 1, each group of students had to create a wiki entry regarding a given topic. In year 2, the students had to create a wiki entry as well as to evaluate and review one wiki entry produced by other group of colleagues (peer-assessment process). The students were evaluated for the created wiki entries as well as for the review of colleagues' wiki entries and scored separately for each task from 0% to 100%. In year 1, the students had 8 weeks to create the wikis entries, whereas in year 2, the students had 4 weeks to create the wikis entries followed by 4 weeks to review colleagues' wikis.

Because of the wiki's free-nature regarding content creation, which can lead to a chaotic information organisation, it was decided to make available to students a template with predefined sections within each topic. The text to be developed should have a maximum of 1500 words, excluding tables, figures and references. During the review process, the students used a classification grid to minimise discrepancies in the evaluation criteria. This grid included the following topics: knowledge transmission, scientific quality, text comprehension, writing quality, references quality, plagiarism and text organisation. Further, to easily track changes carried out by the evaluating group, students should write in green and underline the added text and strikethrough marking in red the deleted parts.

The work performed by the students within the wiki was monitored accessing the individual action log reports of MVLE. Students' editing actions consisted in actions where students introduce changes in the wiki, whereas students' screening actions consisted in actions where students only visualise the wiki without introducing changes. To build the individual students and groups' activity profile, it was evaluated the number of screening and editing actions per student and an average of these actions were calculated per group of students; given that, different groups may be constituted by a different number of students. Also, for each group of students, it was determined the maximum (Max), the minimum (Min) and the median (Med) number of editing actions within group members and calculated the average of these values for all groups.

Data used for statistical analysis were the MVLE's actions log files. The statistical analysis was performed using Microsoft Excel and GraphPad Prism statistics software package (16). The continuous variables were described using average $\pm$ standard deviation (SD) and analysed by Student's *t*-test for unpaired comparisons or one-way ANOVA, when appropriated. The categorical variables were described through relative frequencies (%) and analysed by chi-squared test. Also, correlations between variables were evaluated by Pearson test using two-tailed *P*. In all comparisons, $P < 0.05$ was assumed to denote a significant difference.

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Results

In the year 1, the 77 students were divided in 18 groups, whereas in year 2, the 77 students were divided in 17 groups. A summary describing the assignment average final scores, the total number of editing and screening actions as well as the average of editing and screening actions per group is presented in Table 1 for both year 1 and year 2. The final score given by the teacher for the wiki creation did not differ between year 1 and year 2 or between wiki reviews within year 2 ($P > 0.05$, one-way ANOVA). However, the average number of screening actions per group regarding wiki creation was higher in year 2 in comparison with year 1 (Table 1, $P < 0.05$, Student's t-test).

Regarding the task wiki creation, the average number of screening and editing actions for each group of students correlated well using data from either year 1 (Pearson $r = 0.75$, $P < 0.001$) or year 2 (Pearson $r = 0.71$, $P < 0.01$). Figure 1 presents Pearson correlation between average number of screening and editing actions per group during wiki creation using data from both year 1 and year 2 (Pearson $r = 0.71$, $P < 0.001$). In addition, a low correlation was observed between the average editing actions per group and the final score given by the teacher for the assignment wiki creation in both year 1 and year 2 (Pearson $r = 0.43$, $P < 0.05$, Fig. 2).

To evaluate the individual contribution within a group of students, it was calculated the maximum, minimum and median number of editing actions within group members. A significant difference between maximum and minimum number of editing actions within group members was observed (Fig. 3, one-way ANOVA: $P < 0.0001$), evidencing the unbalanced students participation within a work group. In addition, the median values are closer to the minimum number of editing actions, revealed by the significant difference between the subtraction of maximum and median (Δ Max,Med, 13 ± 11) and the subtraction of median and minimum (Δ Med,Min, 6 ± 5) ($P < 0.01$, Student's t-test).

During the process of peer assessment (performed only in year 2), the results were similar to the process of wiki creation. A good correlation was observed between screening and editing actions (Pearson $r = 0.90$, $P < 0.0001$), but no correlation was observed between the final scores and the number of editing actions per group (Pearson $r = 0.22$, $P > 0.05$). Also, evidences of unbalance students' participation in work development were observed (minimum, median and maximum values for editing actions per students within a group: 1.65 ± 1.41, 5.21 ± 3.49, 12.59 ± 5.76, one-way ANOVA: $P < 0.0001$). Once again, the median values were closer to the minimum number of editing actions, revealed by the significant difference between Δ Max,Med and Δ Med, Min (7 ± 5 vs. 4 ± 3, $P < 0.05$, Student's t-test).

TABLE 1. Assignment scores, screening actions, the average number of screening actions per group, editing actions and the average number of editing actions per group within year 1 and year 2

	Year 1	Year 2	
	Wiki creation	Wiki creation	Wiki review
Assignment scores (in %)	83 ± 18	84 ± 8	90 ± 9
Total screening actions	2379	3027	1707
Average screening actions per group	132 ± 68	178 ± 60*	100 ±54
Total editing actions	851	926	513
Average editing actions per group	47 ± 23	54 ± 30	30 ± 17

*Significantly different from year 1, $P < 0.05$, Student's *t*-test.

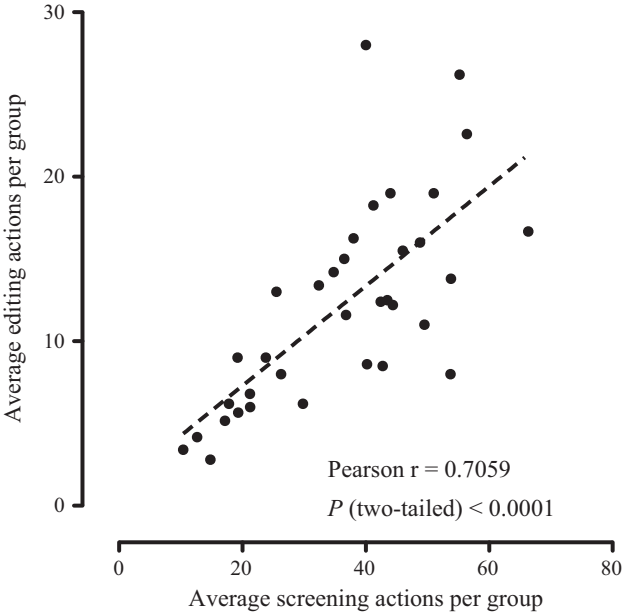

Fig. 1. Pearson correlation between average number of screening and editing actions per group during wiki creation in year 1 and year 2.

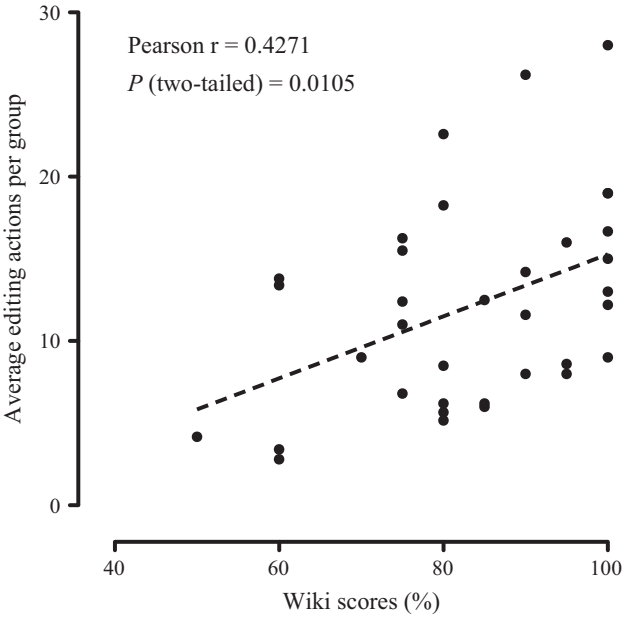

Fig. 2. Pearson correlation between number of editing actions per group and the scores given by the teacher for the wiki created by each group in year 1 and year 2.

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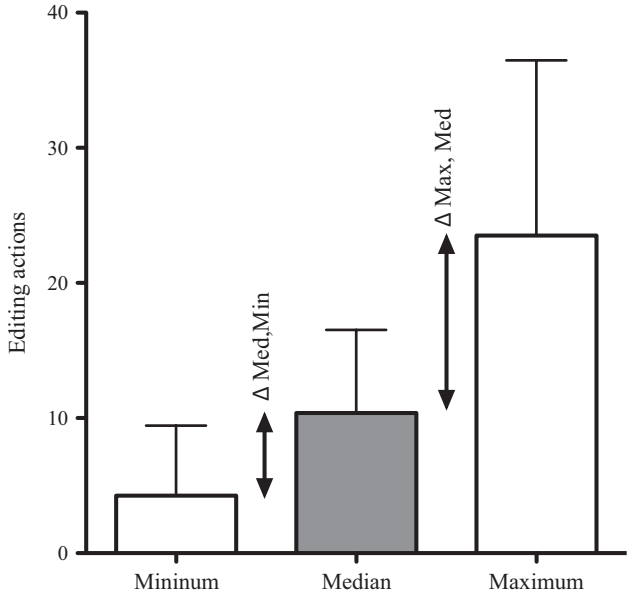

Fig. 3. Minimum (Min), median (Med) and maximum (Max) values for editing actions within group members during wiki creation. Bars represent means of 35 groups from year 1 and year 2 and error bars represent standard deviation. Δ Med,Min represent the subtraction between median and minimum editing actions within group members and Δ Max,Med represent the subtraction between the maximum and median editing actions within group members.

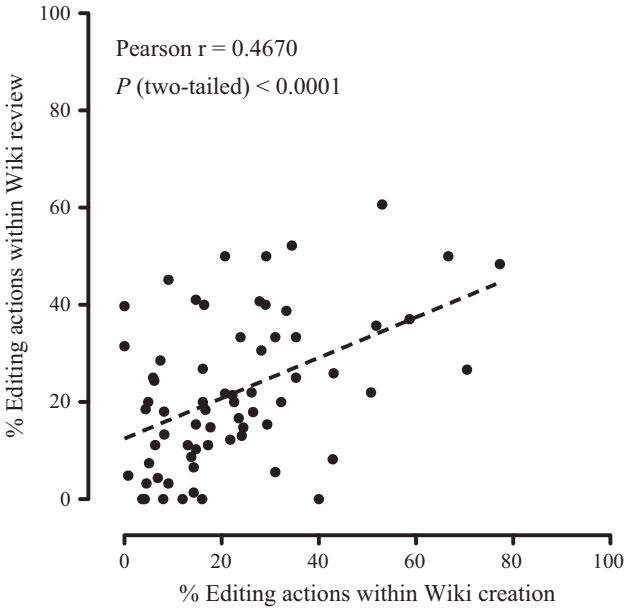

Fig. 4. Pearson correlation between the percentage of students' individual editing actions within each group during wiki creation and wiki review in year 2.

To understand the individual contribution of each student in the two different tasks given in year 2 (wiki creation and wiki review), it was evaluated the correlation between the percentage of students' individual editing actions within each group in wiki creation and wiki review (Fig. 4). The correlation value was not very strong, but attained statistical significance (Pearson $r = 0.47$, $P < 0.0001$).

The temporal development of the wiki assignments was also assessed. Figure 5 shows the distribution of editing actions throughout the period available for wiki creation within year 1 as well as wiki creation and review within year 2, respectively. In year 1, the students performed more than 50% of the total work in the last 4 days of the 8 weeks given for the assignment, and, in year 2, 50% of the total work was performed in the last 2 days of the 4 weeks given for wiki creations and in the last 3 days of the 4 weeks given for wiki review.

To understand the impact of the wiki project as a teaching and learning tool, it was compared the overall final course scores obtained by the students as well as the course approval rate between year 1 and year 2 and the academic year previous to the introduction of the wiki project (year 0). No differences were found regarding students' final course scores, but the approval rate increased significantly after Wiki implementation (Table 2, chi-squared test, year 0 vs. year 1: $P < 0.01$ and year 0 vs. year 2: $P < 0.05$).

Discussion

Different learners learn differently, and the use of diverse teaching and assessment strategies including media and technology is strongly recommended (6). Given that, online communication is here to stay (2), blended learning, which combines a face-to-face and an online teaching approach, allows greater flexibility in learning (4). E-technologies, such as blogs or wikis, make new demands on learning and provide new supports to learning, even as they dismantle some of the learning supports upon which education has depended in the past (3, 4, 11). Wikis, blogs or e-portfolios enable students to explore creative possibilities in presenting their work, but wikis also enable students to work collaboratively in a group in an online environment with access to peer learning opportunities.

The development of this pedagogical project using a wiki as a tool for Microbiology teaching, learning and assessment presented several advantages, namely: (i) the development of Microbiology contents specific for dental students, enhancing the comprehension and analysis of the field of study, (ii) the collaborative environment, promoting the teamwork, (iii) the peer assessment of the created content encouraging accuracy and promoting critical sense and (iv) the real-time monitoring of students' work.

The wiki topics developed by the students include themes of Microbiology I syllabus, which the student could understand and analyse well. This methodology had the goal of consolidate the acquired knowledge, integrating the synchronous and asynchronous components of the Microbiology I course.

From our and others teachers' experience, wikis associated with a specific course are of value as teaching, learning and assessment tool (9–12, 17, 18). In the present study, it was observed a greater commitment of students in the learning process as well as an increase in the approval rate in both academic years where wiki was used as a teaching/learning tool in comparison with the academic year previous to wiki implementation.

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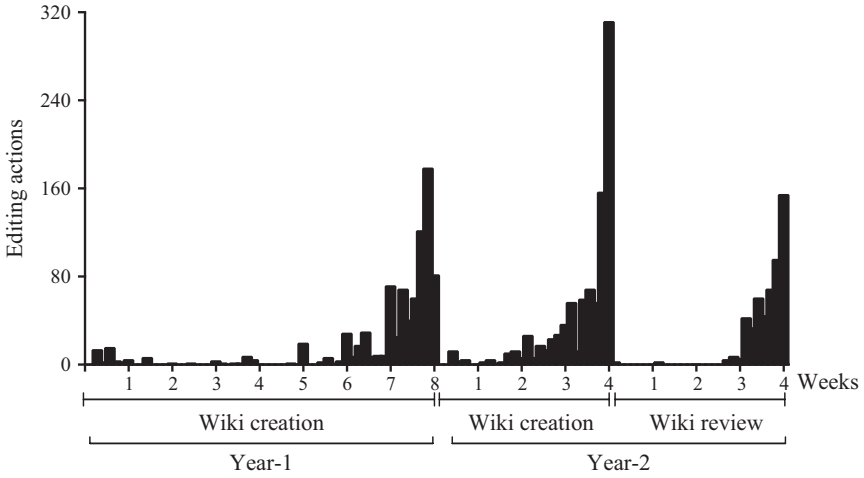

Fig. 5. Distribution of editing actions throughout the periods available for wiki creation (year 1) and wiki creation and review (year 2).

TABLE 2. Summary information on students' final outcome in Microbiology I course in the academic year previous to the introduction of the wiki project (year 0) as well as in year 1 and in year 2. It is presented the mean overall final scores obtained by the students (scale ranging from 0 to 20) as well as the course approval rate

	Year 0	Year 1	Year 2
Mean final score	13.83 ± 1.82	13.95 ± 1.93	14.04 ± 1.99
Approval rate (%)	78.3	95.5*	91.1*

*Significantly different from year 0, $P < 0.05$, chi-squared test.

Regarding student's work assessment, evaluating the real work of an individual student within a group can be hard (19, 20). MVLE, and particularly Wiki module, can represent a valuable tool to help on this difficult task. MVLE offers instruments for activities tracking, so, with these available actions reports of MVLE, a complementary and more automated assessment could be performed. With the results of the present work, it was possible to conclude that either editing or screening actions could assess the students work. However, actions reports may allow the assessment of the amount of work performed in a quantitative perspective but do not allow a qualitative assessment of these actions. Editing actions reports do not reflect if the change was a single comma or a complete paragraph. This is in agreement with the results obtained in the present study case, where the editing wiki actions did not correlate well with the wiki final scores. Thus, to really understand the work performed by students, a more informative actions report output could be interesting to be incorporated in the MVLE. For instance, showing the amount of changes such as number of characters, words and sentences differentiating between punctuation and letters. These enhancements could help on characterising more accurately the students' participation.

Small group work is an effectively and widely used teaching and learning approach in higher education, given that group work improves team skills, communication skills, critical reflection skills and self-directed learning skills – all of which combine into lifelong learning skills (21–23). In this non-individual teaching/learning strategy, commonly, the score attributed to the group's work is the same for all the group members (24). With the data obtained from the present study, it is possible to conclude that the work performed by the group is not evenly distributed by the group elements. This conclusion is a reflection of the great differences between the minimum and maximum number of editing actions of the students within a group. Also, when one looks to median values of the number of editing actions of the students within a group is possible to observe that is closer to the minimum number of editing actions, reflecting that within a group of four to six elements, probably one or two students developed the majority part of the work presented. In addition, it is showed that the amount of individual work within a group is similar in both creation and review phases, putting a side a possible work division strategy within group elements. These conclusions suggest that the student' score should be individually attributed, independently if the work was performed by a group of students. In fact, collaborative or cooperative learning is viewed as a means of learning, not assessment (25). Wiki module of MVLE offers excellent tools for tracking individual work within a group, and several methods are described for individual assessment of group members (25–27).

Most students executed the wiki assignment only in the last 10% of the days available for the task development, independently if they had 8 or 4 weeks for the task development. Procrastination at higher education has been growing for decades and is considered a serious problem today (28). The main reasons responsible for this behaviour may include fear of failure, task aversiveness and society distractors (28, 29). However, the reduced period of real work may not proportionate the ideal conditions of collaborative work. So, additional strategies to avoid procrastination of work amongst students should be employed.

In year 2, the teacher felt that the students were more worried about their outcomes, given that the colleagues would be evaluating their work (peer-assessment process). This concern was reflected in the enhanced number of screening actions regarding wiki creation in year 2 compared with year 1. As

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observed by others, the existence of a review/evaluation process by peers appears to promote the creation of a better wiki (14, 15). Consequently, it should be expected higher scores for wiki creation in year 2 in comparison with year 1. However, grades attribution is always a relative process within the group of students in a specific year and comparisons between different years may not be very accurate.

Another interesting point that should be stressed out was the parallel use by the students of the general discussion board forum within the MVLE. This discussion forum was frequently used for peer-to-peer troubleshooting. Students learn to work together, drawing on each other strengths and weaknesses. As previously mentioned by Schönwetter (4), student/student interactions and student/instructor interactions predict student success.

Despite MVLE wiki module high value as a tool for teaching and evaluation processes, MVLE wiki module is not applicable for an open and public wiki given its closed profile. And so, the wikis advantages as free and public sources of information are not applicable in this case.

Despite the huge gains of this educational project, the amount of work involved on correcting and evaluating wiki entries and wiki reviews by the teacher should not be underestimated as highlighted by others (30, 31).

Conclusion

From the analysis of the data resulting from this pedagogical project, it was possible to conclude that the students activity within wiki can be assessed either by screening or editing actions; the number of students' actions within wiki do not seem to have a strong correlation with the wiki scores, so it should not be used as a heavy evaluation parameter; the amount of work developed between students of the same group differed significantly, suggesting that the final score should be attributed individually and not to the group; in the approach of peer review, there was a greater number of editing actions, suggesting that the existence of this peer-assessment process seems to encourage the development of a better work; and the vast majority of the students executes the work in the last days of the period assigned for the task, which can be counter-productive for the truly collaborative work.

Wiki revealed to be a useful tool for Microbiology teaching, learning and assessment, promoting collaborative work and virtual mobility amongst all players in the learning process. The real-time tracking of students' activity provided by MLVE revealed to be an excellent tool for students' assessment and monitoring. Not only wikis but also e-learning platforms in general can provide additional teaching instruments that allow students to pursue more flexible and personalised learning paths. This pedagogical project promoted the engagement of students in their assessment process, encouraging their critical sense and quest for Excellency.

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