Many institutions state student peer review in their learning outcomes; students should know how to provide proper feedback to a product from one of their peers, but they should also how to incorporate feedback from their peers. Students peer review is very important to increase students’ academic attitude and their learning process. The question is, how should this be achieved?. We did a small literature search and we did some research with first year Biomedical Sciences students during courses where academic skills were taught; for over three years we tried several peer review methods, every time a few aspects were changed and the peer review process and the students evaluations were examined. Evaluation showed that adding a peer review assignment to an assignment on academic skills creates a high learning efficiency, increased intrinsic motivation and a critical attitude. Moreover, it didn't cost a lot of time and effort for the lecturer. However, the setup of the peer review process should carefully be considered. Students have to learn how to provide proper feedback, and the lecturer should provide guiding questions. Also, it seems better if students review more than one paper, to achieve feeling with the process, and to receive feedback from multiple perspectives. It could also be beneficial to let students grade the peer review they receive, but this seems not necessary for a proper peer review process. Altogether peer review is easy to implement and has many advantages for the intrinsic motivation and critical attitude of students.

1 INTRODUCTION

Many educational institutions claim in their learning objectives that students should be critical and able to give and receive feedback. Also, providing detailed feedback to students work costs instructors a lot of time. Students reviewing their peers writing could be a perfect method to solve these problems. Peer review is defined as (formative) feedback, provided by the students. Usually this feedback is available prior to the final product, consequently students can use the feedback they receive to improve their work [1]. This peer review process has shown to improve students' work [2]. Chittum and Bryant (2014) even claim that involving (graduate) students in the peer review process will create a bridge toward gaining independence as scholars [3].

Secondly, peer review can be used as a tool to improve the intrinsic motivation of students. Intrinsic motivation can be improved by strengthening the three factors: competence, autonomy and relatedness as identified by Deci and Ryan (1985) in the self-determination theory (SDT) [4]. Competence relates to the basic need to feel able to accomplish the task at hand and to be supported in the form of positive and constructive feedback. Autonomy is strengthened by giving control and responsibility to the student. In being able to directly (and positively) impact the quality of the end product. Finally relatedness is the need to be part of a safe and supportive group. When all three of these factors are supported the student will move towards a more intrinsically motivated learning style [5] [6]. Peer review as an educational tool can potentially increase all three of these factors when implemented correctly.

To investigate whether 18-year old students can become independent scholars, we implemented the peer review process in the first year of the Bachelor’s degree program Biomedical Sciences at the Vrije Universiteit in Amsterdam. To implement this successfully, we asked ourselves a few questions: 1) Should this process take place in a controlled offline setting at the university, or can the assignment be created online and anonymous (using specified peer review software)? 2) How often should students write peer reviews; how many papers at once? 3) Should guiding questions be provided? 4) Should this process be graded, and if so by by students or teachers? 5) Can this process stimulate the intrinsic motivation of students, i.e., will they peer review each other’s work, even when it is not mandatory?
2 METHODOLOGY

We tried several peer review methods in three successive academic years: 2014-2015, 2015-2016 and 2016-2017. All students were First-year students at the Vrije Universiteit Amsterdam, the Netherlands, studying in the Biomedical Sciences Bachelors programme. Most of the students were just graduated from high school, and were around 18 years old. All students participated in this project. The average number of students per year was +/- 100, in total 300 students participated.

The project took place at the VU Amsterdam, under the supervision of three teachers, who teach, mentor and support the students during their first year. During this year, students write several scientific reports according to the scientific writing method. All reports are examined with rubrics which provide criteria and rating scales for final evaluation. They were all graded according to the same criteria throughout the year, to keep the criteria transparent for students.

The process of the peer review assignment was divided in three separate assignments. First, the students are writing (a draft version) of a paper. Second, the students are providing feedback to the work of their peer(s). Finally, students re-write a final version of their paper on which they receive feedback (formative or summative) from the teacher. The three assignments all have three dates: the start date, the due date and the feedback-release date. See figure 1 for an overview of the assignments and the dates.

![Figure 1. The process of the Peer Review Assignment.](image)

2.1 Peer review in a controlled face-2-face setting

In the first course of the academic year, the students got an introduction into Biomedical Sciences. They learned about ethics, methodology, possible career options and scientific writing. During the course, the students individually performed a small literature review on a biomedical subject of interest. The writing process of the literature review was guided per subsection (research question, introduction, middle part, discussion) and peer review was conducted at three stages on different parts of a literature review (introduction, middle part, discussion).

In small groups (around 15 students), students learned how to give and receive feedback. It was explained that proper feedback consists of three parts: observation, interpretation and evaluation. The students practiced in a controlled setting, under supervision of their teacher. To get familiar with the feedback process, they first practiced with examples from daily life. After this exercises, they provided feedback at the writing reports of their peers. The feedback was provided in groups of 2 students, while the student who wrote the report was sitting opposite of them. This set-up facilitated direct communication between the peer reviewers and the author of the report to clarify any questions. In 2014, the students did not receive any extra instructions for the peer review process besides the
theory on feedback. In 2015, the students received the same rubrics, which were used to grade their final work. In 2016, guiding questions for the peer review process were provided. These questions were based on the rubrics, which were used to grade their final work. For example, when the rubric indicated that the title should be a clear sentence, with the necessary keywords, the guiding questions about the title were: 1) Is the title a clear sentence? If not; what is wrong? and 2) Write down what you think the keywords of this paper are. Are they all in the title? In all cases, a teacher was present in the classroom and available for questions. The dates were set as noted in the table below (see table 1). See Figure 1 for the meaning of the dates.

Table 1.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Date 1</th>
<th>Date 2</th>
<th>Date 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing paper</td>
<td>Day 0</td>
<td>Day 14</td>
<td>Day 14</td>
</tr>
<tr>
<td>Peer reviewing</td>
<td>Day 14</td>
<td>Day 14</td>
<td>Day 14</td>
</tr>
<tr>
<td>Re-writing paper (revision)</td>
<td>Day 14</td>
<td>Day 21</td>
<td>Day 28</td>
</tr>
</tbody>
</table>

2.2 Voluntarily peer review with guiding questions

In the second period of the first year, students follow a course on Biochemistry, in which they had to write in pairs a scientific report about their research project. The final report counted for 25% of the final grade. The students could voluntarily participate in a peer review process about their report. If they would like to participate, the draft version of their report should be handed in seven days prior to the deadline of their final report. They received a report of another student to review, together with guiding questions. This process was conducted via an online peer review tool (PeerMark) and was therefore anonymous. The dates were set as noted in the table below (see table 2). See Figure 1 for the meaning of the dates.

Table 2.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Date 1</th>
<th>Date 2</th>
<th>Date 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing paper</td>
<td>Day 1</td>
<td>Day 30</td>
<td>Day 31</td>
</tr>
<tr>
<td>Peer reviewing</td>
<td>Day 31</td>
<td>Day 34</td>
<td>Day 34</td>
</tr>
<tr>
<td>Re-writing paper (revision)</td>
<td>Day 34</td>
<td>Day 41</td>
<td>Day 55</td>
</tr>
</tbody>
</table>

2.3 Mandatory peer review with grades

In the fifth period of their first year, the students followed a course in statistics. Besides a written exam, the students performed an individual research project in which they collected data on something in daily life. They performed statistical tests on their data and wrote a short scientific report about their experiment. The procedure was similar to the procedure of the Biochemistry-course in the second period, except that they reviewed two papers and that is was mandatory. They received a grade for their written peer feedback given by the student who received the feedback, which counted for 10% towards the final grade. The dates were set as noted in the table below (see table 3). See Figure 1 for the meaning of the dates.

Table 3.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Date 1</th>
<th>Date 2</th>
<th>Date 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing paper</td>
<td>Day 1</td>
<td>Day 30</td>
<td>Day 31</td>
</tr>
<tr>
<td>Peer reviewing</td>
<td>Day 31</td>
<td>Day 37</td>
<td>Day 37</td>
</tr>
<tr>
<td>Re-writing paper (revision)</td>
<td>Day 37</td>
<td>Day 44</td>
<td>Day 58</td>
</tr>
</tbody>
</table>
3 RESULTS

3.1 Should this process take place in a controlled offline setting at the university, or can the assignment be created online and anonymous (using specified peer review software)?

Previous research used peer review in an undergraduate essay assignment for students, taking large second-year courses in life sciences and biology in which a web-based online peer review (OPR) and a face-to-face peer review (FPR) was compared [7]. They could not conclude that one is better than the other, but they did find that students provided more honest feedback in the OPR format. The students reported that they thought the peer review assignments was useful, regardless of the format (OPR or FPR).

In our experience, it was very useful to let students practice with peer review in a controlled offline setting. This creates a safe and positive environment in which students feel more at ease which improves relatedness within the group. They could ask questions to the teacher (if they had questions about the assignment) and they could ask questions to the writer of the paper (if they had questions about the paper). As a teacher you can also more easily monitor the type of feedback given and stimulate a more positive and constructive feedback style which in turn improves the competence. However, the disadvantages were is that it costs a lot of time and students had to come to the university, since the peer review sessions were arranged in groups of 25, two hours per group.

We conducted a peer review by making use of an online environment twice, during the biochemistry and the statistics course. Compared to the offline face-to-face peer review, the advantages were that students could work from home at any time and it took the teacher just a few minutes to set the dates in the peer review software right. For the online peer review, the teachers did not receive any questions (by email) about the assignment and everyone completed the assignment in time.

3.2 How often should students write peer reviews; how many papers at once?

Lundstrom et al. investigated which is more beneficial to improve writing: giving or receiving peer feedback. The "givers" reviewed anonymous papers, but received no peer feedback, while the "receivers" received feedback but did not review other students' writing. They found that the “givers” made more progress in their own writing than the “receivers”, which indicates that giving feedback is more effective than receiving feedback. Still, the “receivers” also made some progress. The more papers they reviewed, the more progress the students made [8].

This indicates that students should do as many reviews as possible. In our experience, students improved more when they provided feedback to more than one paper. However, the writing of reviews takes a lot of time. Students reported that it took them about one to two hours to read the paper and provide feedback.

3.3 Should guiding questions be provided?

In 2015, one of the first empirical studies analysed the use of instructional rubrics in peer review [9]. They found that a rubric with guiding questions provided more guidance and less summation and problem detection than a similar control rubric without guiding questions. This indicates that a guided rubrics provides more useful feedforward comments, instead of feedback. The students indicated that both rubrics were equally useful.

Constructive and positive feedback leads to a higher feeling of competence according to the SDT [4]. If the provided questions are openly formulated (for example: “write in your own words…” instead of “What is wrong with…”), the receiver of the feedback can decide for himself if the message is clear. The receiver of the feedback has to decide for himself if there should be adjustments in his paper in response to the feedback, which increases the feeling of autonomy. Furthermore, it has been shown that the combined improvement of competence and autonomy has the strongest effect on the intrinsic motivation [4].

In our experience, students perceived the peer review assignment without guiding questions as a “find the mistake” assignment. They were focussing on errors like misspellings instead of reviewing the content and the structure of the paper of their peers. On the contrary, the guiding questions work towards the final assessment criteria. In this way, students know what to focus on when giving peer feedback.
Some reactions from the students:

- “This student looked really good at my writing and noticed some very good improvements.”
- “I can improve my report thanks to this peer review.”
- “Even though I didn’t wrote my whole report, the reviewer made some really good suggestions for the parts I still have to write.”
- “Very good constructive feedback!”
- “The reviewer made some good suggestions, but some of the suggestions are incorrect.”

From these reactions it appears that students appreciated the feedback they received. Furthermore, they did not copy the suggestions blindly, but they were still critical (see last comment).

3.4 Should student grade the feedback they receive?

Some research is done about students who grade work of their peers. A Meta-analysis from Deci, Koestner & Ryan concludes that all forms of rewards, for example grading, undermine intrinsic motivation [10]. But for more extrinsically motivated students a grade might provide a boost to the quality of the feedback they provide.

We let the students grade the feedback they received on their statistics report (mandatory peer review with grade). Because every student wrote two peer reviews, all students also received two grades; the average grade counted for 10% towards their final grade of the course.

Because all students were familiar to each other, we expected students to be kind to each other and give high grades. However, as shown in figure 2, the grades were quite normally distributed. The students who graded their feedback (n=176) gave grades between 0 and 10.

Figure 2. This figure shows the distribution of the grades which the students administered for the peer review they received.

3.5 Can this process stimulate the intrinsic motivation of students so they will peer review each other’s work, even when it is not mandatory?

In the second period, students follow a course about Biochemistry, in which they had to write a scientific report about their research. The students could voluntarily participate in a peer review process about their report.

Possibly, because the students still don’t know each other very well, the relatedness is not very strong [10]. This could lead to a lower intrinsic motivation. But, even though it was not mandatory, 52% of all
students handed in their draft version and wrote a review on their peers work, despite that there was a limited amount of time (4 days) to write the feedback and an exam was scheduled in the same week.

After this peer review assignment, which was (digitally) arranged by the teachers, that year we did not arrange any voluntarily peer review sessions for those students. Still, students report they liked the peer review process and asked peers to look at their work, even though it was not arranged by the teachers.

4 CONCLUSIONS

To increase intrinsic motivation, the competence, autonomy and relatedness should be increased [10]. All these aspects seem to be positively stimulated in a peer review assignment when conducted properly. By creating an open, positive and constructive atmosphere, relatedness is increased. By providing constructive and positive guiding questions the feeling of competence is increased. Finally the autonomy is increased if the student can decide for himself what he will do with the feedback and if the peer feedback is provided before the final assignment, which will be graded by the teacher. Also by making the purpose and the (learning) objective of the assignment explicit, the sense of internalization increases, which can further increase the autonomy.

From our experiences, it seems that a peer review assignment in a controlled face-to-face setting is a good start for students to get familiar with the peer review process and giving and receiving feedback. Once students are familiar with the process, online peer review assignments are a good way to let students provide feedback to their peers work. Furthermore, to ensure the feedback is useful, it is recommended to provide guiding questions, which are in line with the criteria that are used to grade the students’ final work. Supplemental to the peer review assignments, the reviews could be graded by students. Grading and deadlines could lead to less intrinsic motivation; but this is one way to give students feedback on their work. Moreover, it is not always desirable to give the full responsibility of the process to the students, especially when this method is being implemented. In this way, the teacher still has some control over the learning process of the students.

Concluding, it seems that first year bachelor students find peer review assignments useful. They take the assignment seriously. The received feedback is not copied blindly, but is critically evaluated and incorporated. Even when the peer review is not mandatory, or when it is not arranged by the teacher, the students review their peers’ work. This suggests that the students appreciate the benefits of peer reviewing. Although peer review is not used often with first year students, we think it can be of great value and it should be used more, also in the first year of study. It is hard to measure if peer review really improves the intrinsic motivation, but under the right conditions, peer review could really be beneficial for the intrinsic motivation of students.

ACKNOWLEDGEMENTS

We would like to thank the students for their commitment and the course coordinators for their cooperation.

REFERENCES


