Blending Classroom, Collaborative, and Individual Learning Using Backstage 2

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Abstract. Seminars are difficult and therefore often neglected classes in STEM education even though they greatly contribute to the students' scientific maturity. Seminars are a traditional educational format blending classroom, collaborative, and individual learning: Seminar participants are tasked to discover, understand, and convey a scientific or technical issue to the other seminar attendees in an essay and in an oral presentation engaging them into a fruitful discussion. Seminars are rightly considered a cornerstone of STEM education, yet they are often frustrating experiences for both learners and teachers due to insufficient supervision and practice. This article reports on using Backstage 2, a web platform that, by offering a virtual space and tools for a fruitful communication, bridges classroom, collaborative, and individual learning activities. The contribution of this article is threefold: First, a class format aimed at boosting collaboration in seminars, second, technological tools supporting collaboration among seminar attendees, and third, an evaluation of the approach demonstrating its effectiveness.

Keywords: Online Learning Environments, Blended Learning, Peer Review, Computer-supported Collaborative Learning.

1 Introduction

Seminars are essential components of the training in Science, Technology, Engineering, and Mathematics (STEM). During STEM seminars, students learn to discover, understand, and present scientific or technical issues beyond what is taught in other classes. A STEM seminar typically requires from an attendee the following: Selecting relevant literature on an issue, reading and understanding it, summarizing the essential aspects of the issue in a written overview, presenting the overview in a talk, and finally answering questions posed by seminar attendees and the teacher. Thus, seminars are a traditional educational format blending classroom, collaborative, and individual learning long before "blended learning" became fashionable. Collaboration is essential among other because answers can only be given if questions are posed.

Ideally and traditionally, the work for a seminar is both, closely supervised by teachers and collaborative in the sense that seminars attendees assist each other in most of the afore-mentioned phases. In practice, however, STEM teachers

hardly have the time to sufficiently supervise the attendees of their seminars and collaboration among seminar attendees is very limited if existing at all. The reasons for this unsatisfactory state of affairs are large numbers of seminar attendees, lack of locations where seminar attendees can work together on their own initiative, and disinterest among students and teachers alike for a type of class often considered to be "worth only a few credits".

STEM seminars also face a considerable educational obstacle: STEM education does not sufficiently prepare for the self-regulated learning seminars require. Since the concepts and techniques conveyed in most STEM classes are highly abstract and rather complex, STEM education favours lectures and tutorials giving little opportunity for self-regulated work.

STEM seminars nowadays face an additional obstacle: Even though they are focused at training communication skills, they still are mostly run without recent, if at all, communication technology. As a consequence, seminars are often perceived by STEM students as obligatory steps in their courses imposed by tradition and without much relation to real life and their future careers.

This state of affairs and the conviction that well-run seminars can greatly contribute to a good training of STEM students led us first to reconsider the formats of the seminars we give, second to reflect on what communication tools could help restore a good seminar practice among students, third conceive, implement, and deploy a tool, Backstage 2[1], and fourth to evaluate Backstage's impact on seminar attendees. This article reports on that endeavour and on the findings of an evaluation demonstrating the effectiveness of the technology-enhanced novel seminar format.

This article is structured as follows. Section 1 is this introduction. Section 2 is devoted to related work. Section 3 presents a teaching format for seminars fostering collaboration. Section 4 presents those functions of the platform Backstage 2 supporting the proposed teaching format for seminars. Section 5 describes an evaluation of the technology-enhanced seminar format and its findings. Section 6 concludes the article and gives perspectives for future work.

2 Related Work

The technology-enabled blending of classroom, collaborative, and individual learning in STEM seminars reported about in this article is a contribution to blended learning and relates to audience response systems, backchannels, collaborative annotation systems, and peer review in learning.

Blended Learning. Even though dated, the book [2] still is a good introduction to blended learning. Among other, the book discusses different definitions of blended learning with their main differentiator being what is being blended – for this article, both classroom learning and indvidual learning as well as different instructional methods are blended. The research literature on blended learning

[1] `https://backstage.pms.ifi.lmu.de:8080`

is too vast for being reviewed here. The article [9] is a recent overview of that research. The following publications have inspired or are related to the present article: The articles [8, 15, 13, 18] hint at the potential of various forms of blended learning and the articles [16, 1] address the design of blended learning educational formats.

Backchannels and Audience Response Systems. A Backchannel is "a secondary or background complement to an existing frontchannel" [22, p. 852]. Backchannels can be deployed during lectures, allowing students to "exchange questions, comments and thoughts on the subject matter synchronously to the lecturer's presentation" [14, p. 6]. Most backchannels designed for lectures [3, 7] provide audience response systems, which allow students to answer lecturers' questions during lectures and give immediate feedback about the classes' performance. The article [11] provides an overview of the research on ARSs.

Collaborative Annotation Systems. Using a collaborative annotation system (CAS), groups can collaborate on annotations for documents and their editing. The CAS PAMS 2.0 is discussed in [17]. That article stresses the positive response of students to the CAS and the positive impact on students' learning. The CAS MyNote is discussed in [4] where a positive response of its users is mentioned. CAS are enablers of peer review in learning.

Peer Review in Learning. Peer Review and peer assessment refer to the enrolment of students for providing feedback, in place of or in addition to the teacher's feedback, to their fellow students, their peers. A positive impact of peer review on both reviewers and reviewees has been demonstrated in various studies: Peer review has been for example shown to significantly improve the peer reviewers' own writing abilities [12]; an effect this article attributes to the reflection about one's own work triggered by doing peer review. This hypothesis is also made in [19] where a further explanation is hypothesised: The better learning of peer reviewers might result from the increased time they have to spend on the issue they learn.

The article [10] reports on students positively appreciating peer review because it makes them discover alternative solutions or answers and because they get more feedback and negatively because of their difficulties in discriminating between good and bad solutions or answers. According to the article [21], students see three main benefits in peer reviews: the chances "to compare different approaches", to "compare standard of work", and the "exchange of information and ideas" [21, p. 52].

3 A Novel STEM Seminar Format, its Promotion, and its Limitations

A participant in a STEM seminar is expected to select relevant literature on an issue, to read and understand it, to write an overview of the issue's core aspects,

to present that overview in a talk, and to answer the subsequent questions of the seminar attendees and of the teacher. In practice, however, many STEM seminars are far from this. Instead, they often consist of insufficiently prepared and poorly written overviews, talks hard to follow with low attendance. Collaboration among seminar attendees is minimal, if at all existing, and often limited to half-hearted questions that are given half-hearted answers. This often leads teachers to step in and to lecture on the presentation's issue, what in turn reduces the students' participation.

The didactic benefits of STEM seminars, as they are often run, are questionable. This unsatisfying state of affairs led us to reflect on how to revive the seminars we run for bachelor students in informatics.

First, peer review was introduced: In addition to the afore-mentioned activities, each participant has to deliver written reviews of the written overviews of two other seminar participants. A schedule is devised with deadlines for delivering a first draft of an overview, for delivering reviews, for discussing overviews and peer reviews in classroom sessions, and for finalizing overviews taking into account the reviewers' feedback. Thus, the novel seminar format blends synchronous classroom sessions and asynchronous homework. The grading of seminar attendees' work is based not only on their written overviews and talks but also on their reviews, what makes peer review an integral component of the work expected from seminar participants.

Second, we chose to promote the seminar format described above by introducing it with a subject that first, had never been offered before, second, makes peer review necessary, and third, appeals to a large number of students. Indeed, students are unlikely to accept additional work if they do not see the point of it. We chose job applications as subject, an issue of high interest to most students, often subject to different viewpoints and therefore good at triggering reflections and debates. Indeed, there is more than one way to write a good job application and "[p]eer assessment may prove especially valuable in cases in which structured and formal education is neither preferred nor even available" [5, p. 89].

In a Job Application Seminar, the literature to select is about writing applications (letters and curricula vitae) stressing the usages in different countries, the overviews are replaced by applications, and the talks by simulated job interviews. The peer review is extended to the interviews, that is, every seminar attendee has to play two roles at different times, that of a job applicant and that of a member in the selection committee.

The Job Application Seminar, in German "Bachelorseminar Bewerbungen", has been offered once a year since 2014. Since its first realisation, it has been very well received by students. At each of its realisations, all students engaged heavily in researching the issue and in discussing it with fellow attendees both outside and in the classroom. The role playing, both as applicant and as member in a selection committee, has always been popular among the seminar attendees who all performed it earnestly.

In spite of its success, the students' participation in the Job Application Seminar was not fully satisfying and the organisation load it imposed on teachers

was high. Students read only those applications they had to review and the reviews were very heterogeneous what made it difficult to work with them. The timely collecting and dispatching of the written material of the seminar attendees turned out to be a time-consuming and dull task for the teachers. We realized that technology could overcome both problems what led us to reflect on, and develop an appropriate technological support.

4 Towards Overcoming the Seminar Format's Limitations

In the seminar realisation of the summer term of 2017, we provided the seminar participants and the teachers a tool, Backstage 2, for collaborative content collection and creation to be used in collecting and discussing literature and for peer review. The relevant functionalities of Backstage 2, an education software developed by the authors built upon the foundation of the first version of Backstage [14], are briefly presented in the following.

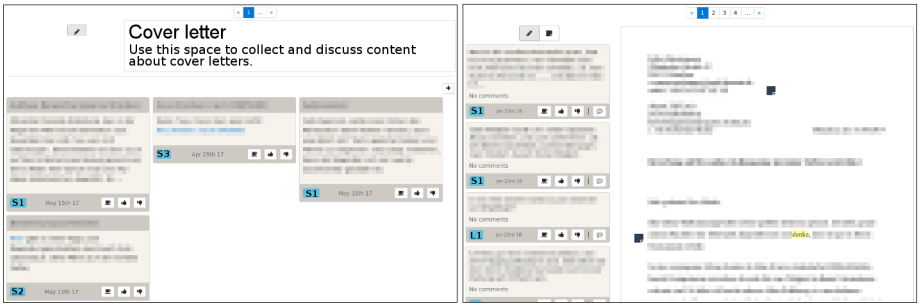

Fig. 1. Left: vertical stream of a unit (top) with four student contributions (bottom). Right: annotations (left) created for a peer review of an application page (right). The text was enlarged and translated from german

With Backstage 2, the documents of a course (like a seminar or a lecture) are stored in a folder called "course" that contains one or several "units". A unit consists of one or more pages of arbitrary media type. For the seminar,pages for the different parts of an application, such as *cover letter*, were created. Each set of pages is called a *horizontal stream*.

Every page can be annotated by every seminar participant as follows: A region is selected on the page and a textual comment referring to that region is created. Annotations can be seen by every seminar participant who can rate and comment it – see Fig. 1 for an example.

Every page has a *vertical stream* located below the page using which participants can attach additional documents referring to that page – see Fig. 1. Vertical stream documents can be seen and annotated by all attendees.

A couple of features of Backstage 2 are worth stressing. First, annotations are given a context in the form of the region of a page they refer. Second, the structure of a "course" including those of its "pages" that are given a vertical stream are specified by the teacher. These specifications act as scripts [6, 20] and care for homogeneous students' contributions what, in turn, helps their sharing. Collaborative content collection is enabled by the vertical stream, and peer review is done using both the vertical stream and annotations.

5 Evaluation and Findings

During the summer term of 2017, the Job Application Seminar has been held in its novel form using Backstage 2. 20 participants have attended the seminar. During the peer review, 317 annotations (average: 15.85) and 26 vertical stream documents (average: 1.3) were created. During the collaborative content collection, a total of 12 documents (average: 0.6) were created.

Method. A survey consisting of four parts was conducted during the final session of the seminar:

- Part 1 was a self-assessment of the student's activity on Backstage consisting of yes/no-questions.
- Part 2 was a questionnaire measuring the student's attitude towards using Backstage in the seminar consisting of five statements to be rated on a four-point Likert scale from *strongly agree* to *strongly disagree*.
- Part 3 was a questionnaire estimating which parts of the Job Application Seminar are perceived by the student as likely to have a positive impact on their future applications to be rated on the same scale as mentioned above.
- Part 4 consisted of two questions to be answered with free text.

Data on the user-created contributions, including vertical stream documents, annotations, and comments, was collected from Backstage.

Results. 17 (out of 20) participants attended the final session each of whom participated in the survey; 12 were male, 5 female. The answers of 3 participants, except for their free text answers, were discarded because they included contradictory answers. Part 1 shows that the majority of the participants used all of the functionality offered by Backstage. A detailed discussion of these results is out of the scope of this article.

The left image in Fig. 2 shows the results for Part 2; the right image the results for Part 3. Part 2 clearly shows a positive attitude towards to usage of Backstage 2. Part 3 shows that all parts of the course were perceived as positive even though at varying degrees.

All participants gave free text answers in Part 4 yielding 67 statements. A content analysis and categorization of these statements was performed by three human judges resulting in a Fleiss' kappa of 0.848. Most liked in the seminar and its use of Backstage were: access to other attendees' applications

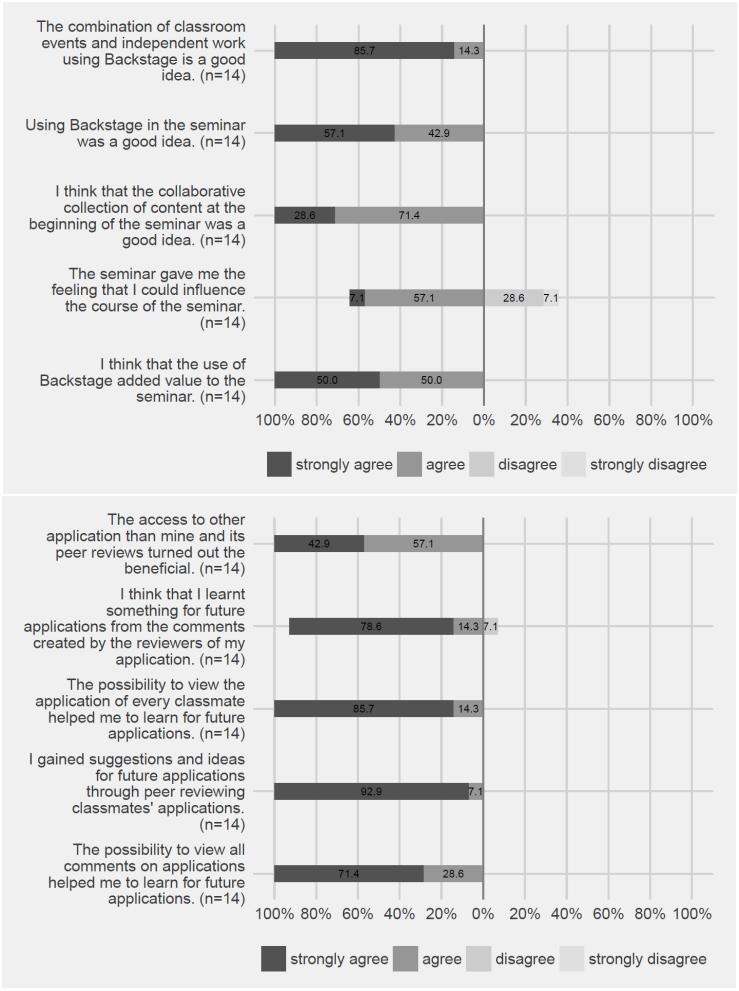

Fig. 2. Results of the Likert questionnaires on *Attitude towards the use of Backstage in the course* (top) and *Perceived value of parts of the course design* (bottom)

(6 statements), peer review (4 statements), and user-friendliness and usability (7 statements). Negatively perceived were: information overload and a lack of overview for annotations (4 statements).

Discussion The results indicate that Backstage 2 well supports the novel seminar format. The answers of Fig. 2 suggest that Backstage 2 had a significant impact on the acceptance of the novel seminar format – and of its increased workload for students. An evaluation comparing the reception of the novel seminar format with and without the technological support of Backstage is none the less outstanding and will be performed in the forthcoming months.

Only 6 students participated actively in collaboratively collecting 12 documents. Since the majority of the participants expressed positive appreciations of collaborative content collection, most of the students probably were passive consumers of their peers' submissions.

Compared with the previous summer term, the teachers felt that classroom sessions gained much from Backstage 2: Discussion felt more natural and advanced because students already had familiarized themselves with the applications and peer reviews. An assessment backed by the fact that many students mentioned the access to all applications and the peer reviews as beneficial.

6 Conclusion and Perspectives

Seminars in STEM teaching often face problems: insufficient supervision, limited collaboration among participants, and limited discussions. In this article, a novel seminar format for STEM teaching has been introduced that boosts active participation with peer review and collaborative content collection supported by the system Backstage 2.

The novel seminar format has been promoted with, and evaluated in a Job Application Seminar. An evaluation has shown a good reception of the seminar format and of its technological support.

Aspects of the seminar format are relevant for other courses like lectures and practicals too. Backstage 2 has been built for covering a wide array of teaching and learning scenarios in which it will be evaluated in the forthcoming months.

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