PAELLA:

Personalized student Activation in Engineering-education: Leveraging Learning Analytics for an engaging blended learning course design

Progress Report R1:
The educational approach

Version 2.0:

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1. Introduction: the motivational problem in remote online learning

Blended learning, and its online components, play a crucial role in university teaching in the present and the future. The consequences of the Covid-19 transition only underline the vital role of online learning and blended learning will remain more prominent in the post-Covid period.

Unfortunately, online learning suffers from several barriers that make life for students more difficult. First, many motivating elements of traditional courses are missing. Students need to develop and maintain a regular schedule, motivate themselves, and persist in their learning activities. Therefore, students' self-regulation of their learning is much more relevant in online courses (Cho & Shen, 2013). Second, the distance between teacher and students is larger in online courses than in courses that incorporate regular face-to-face interaction (Rodríguez-Triana et al., 2017). Teachers are less aware of whether students are on track in meeting the course learning goals and of how they experience the teaching. This lack of insight makes it hard to adjust the teaching and quickly intervene when students fall behind in their learning progress. The PerActiLA project aims at helping university teachers to solve this issue.

A promising strategy to empower students consists of interventions that allow for more personalized or differentiated learning. These take into account students' personal deficiencies and difficulties and are expected to be much more effective than general interventions (van Eck et al., 2015). However, since the student-teacher ratio has increased during recent years at Dutch universities, the challenge of how to initiate more personalized learning has become more significant.

The basic idea

As a solution to this challenge, **we combine Learning Analytics with personalized instructional (mindset) interventions**. Learning Analytics-based data can be used to provide timely and differentiated feedback on a larger scale (Lim et al., 2021). Timely feedback and instructional mindset interventions are known to be effective instruments for stimulating students' self-regulation of learning (Burnette et al., 2013; Hattie & Timperley, 2007; Yeager & Dweck, 2012). Moreover, mindset interventions have been successfully scaled up in online settings (Paunesku et al., 2015). Still, they have not yet been applied online in Learning Management Systems (LMSs) in regular blended courses. We plan to apply these personalized mindset interventions via LMSs in three large Bachelor courses, leading to online modules that can be plugged into other courses after their content has been tailored to course-specific student needs.

During the 2010s, many Dutch universities introduced LMSs that automatically collect click-stream data that can potentially be relevant for better understanding the invisible learning processes of students. The recent Covid-19 transition intensified the application of LMSs at Dutch universities to an unprecedented level

- everybody taught and learned (often wholly) online. This creates an enormous source of information that now waits to be exploited for solving the issue of how to activate students' self-regulation of learning through personalized offers.

In the PerActiLA (Personalized Activation using Learning Analytics) project, we aim to develop and test a new learning design in three different Bachelor courses. We use click-stream data from the LMS within these courses to push forward *personalized feedback and formative testing* in the Bachelor program. For selected students with a backlog in their online learning, we offer appropriate *(Mindset) interventions* that stimulate students' self-regulation of learning. For this, we need to address the following challenges:

1. How can we utilize the LMS data to differentiate between students who are on track and those who lag behind in their learning processes? This question is going to be answered in Report 2 of the project.

2. How can we design and apply personalized interventions in LMSs that activate students and stimulate them to better self-regulate their learning? This question is going to be answered in Report 3 and Report 4 of the project.

3. How can we track students in such a way that students' privacy is guaranteed and that they do not feel threatened during online and blended learning? This question is going to be answered in the current Report 1.

In this version (version 2.0) of Report 1, we first describe the students' point of view on the use of Learning Analytics for the application of educational interventions (chapter 2, already available in version 1). Thereafter, we describe how students experienced and evaluated several videos that potentially could be used as a crucial element of the intervention. This leads to several suggestions for the design of the intervention from the point of view of the students (chapter 3).

Finally, we describe how we (the research team together with the course teachers) re-design(ed) the courses (chapter 4).

2. The point of view of the students at TU/e

At Eindhoven University of Technology, all students are acquainted with the use of Canvas as the LMS. The authors of this report established a Learning Analytics student panel, consisting of four students of the Bachelor program Psychology & Technology: each study year is represented and in addition the member of the student association who is responsible for educational issues.

Two members of the research team met regularly with the student panel to discuss the students' point of view on the use of Learning Analytics. (This will be continued in the year 2022 until the end of the project.)

In the first meeting, the researchers presented the basic ideas and goals of the project to the student panel, followed by an open discussion. A few weeks later, the four students in the panel received three documents that they were asked to read in preparation for a discussion with two members of the research team:

- Conijn, R., Snijders, C., Kleingeld, A., & Matzat, U. (2016). Predicting student performance from LMS data: A comparison of 17 blended courses using Moodle LMS. IEEE Transactions on Learning Technologies, 10(1), 17-29.

- Van den Bogaard, M. E. D., Drachsler, H., Duisterwinkel, H., Knobbout, J., Manderveld, J., & De Wit, M. (2016). Learning Analytics in education design: a guide. Surfnet publication.
- Eindhoven University of Technology (2019). Code of Conduct Learning Analytics for the BOOST program. October 2019.

The students met before this meeting to discuss these readings and to make a list of questions for the follow-up meetings. Students could raise and discuss any questions and concerns that they might have had. Furthermore, the researchers had a number of questions prepared that they discussed with the students. In the following, we provide a summary of these discussions.

Did you get an idea what LA entails?

Do you have questions about the documents?

- The students were curious to know what *type of interventions* would be part of the study. The researchers explained that it would be mindset interventions for specific groups of students (based on, for example, the estimated risk of failing the course) without the involvement of the teacher (or student advisor).

- *Choosing valid indicators.* Selecting appropriate measures for LA is not straightforward. For example, time spent on studying lecture slides may, at first sight, seem to be a suitable indicator. Still, it may difficult to understand

its meaning, for example, because a student may access lecture slides in Canvas, have them on the screen, but do something else during this time.

- *Use of grades (interim tests) in prediction.* In response to the article by Conijn et al. (2017), students were curious about the possibility of using not just click trail data but also interim test grades in deciding who should get an intervention. According to one of the researchers, this may be possible, if available on time, so that an intervention may in part be based on this grade. This would be acceptable for the students. Although it would be helpful to include more detailed feedback about the interim test (e.g., you made most errors on this topic), this won't be easy to realize.

What would be acceptable ways to use LA?

What would be unacceptable for you?

The students did not have general objections against the (massive) use of Canvas click data for the purpose of enhancing students' learning motivation. However, they had some qualifying comments on their generally positive attitude towards the use of Canvas data.

- *Communicating between a teacher and an individual student.* Here, the students distinguish between public and private messages. Use of public messages for LA is considered acceptable, an example being a conversation in a discussion forum or related to an announcement visible for all students and teachers involved in the course. Private messages are those exchanged through the Canvas mailbox. Although it is unclear if such messages are part of the course and are part of the data available for LA (the mailbox can be searched for messages pertaining to a specific course), the students find inclusion in the data for LA less acceptable. In addition, a lot of communication between teacher and student takes place via Outlook, which makes the data in Canvas incomplete anyway.

- *Communication between students in Canvas groups.* It is unclear if the group pages in Canvas are part of the available course data. Students find the inclusion of such pages in the data for LA less acceptable, but note that these Canvas groups are hardly ever used. Instead, student groups tend to create a WhatsApp group and exchange information there. So, any data retrieved from Canvas groups is likely to be incomplete.

- *International students.* Although the students in the panel – all domestic – see the advantages of receiving useful feedback and do not mind that this implies that all their click data will be collected and analyzed, they note that international students may have a different opinion. Given their national or cultural background, some international studies may be less trusting and may value their privacy higher.

(What) Would you like to learn about your own learning behavior via LA?

What would you like to know?

If you were selected for an intervention, would you want to know on what data this is based?

- *Personalized communication.* The students recommended that the interventions be communicated in a personalized way, i.e., addressing the student by name in e-mail communication and mentioning that the intervention is based on data obtained on the behavior in Canvas of that specific student. Otherwise, students are unlikely to read the e-mail and participate in the intervention.

- *Formative intervention.* The intervention should not just state that the student is at risk of failing the course and that their online behavior deviates from the average in the course. This increases the risk of students dropping out (also mentioned in the Surfnet paper). It should be motivating and encouraging, meaning that it also needs to include possible ways in which the student could change/improve their behavior to be successful in the course.

- *Clarity and no surprises.* When they enrolled for the study program (in Studielink), all students explicitly gave permission to use their data for formative purposes. Nevertheless, if interventions are not clearly communicated, this may make students anxious about who has access to this data.

- *Data the teacher has access to. The students consider sharing this individual data with teachers unacceptable*, as this may induce bias towards these students (consciously or subconsciously). To obtain insights into elements of the course that work and don't work, it can be helpful for teachers to have *access to aggregated data at the group level. This is acceptable for the students* (but probably not included in the current project).

- We discussed whether the intervention should include *information on the reason why a student was eligible for an intervention* (e.g., how they did on relevant indicators, compared to some standard or group mean). The key issue is that the communication should motivate the student to participate in the intervention, not lead to excuses why the intervention is unjustified, and especially not increase the risk of a student deciding to quit the course. In any case, the students consider important that it is made clear that it is not a general notification for all course participants and that not everybody will receive the intervention. The preference for receiving information on the reason for selection may be a personal one and differ among students. Some detail-oriented students may want to have as much supporting data as possible, whereas others may just want information on key problems. All in all, the

students lean toward avoiding feedback that emphasizes the amount of monitoring that is taking place.

- Related to the previous topic, the students do not think that deviations from the recommended time investment in a specific week represent feedback that is motivating for students, because on the one hand, some teachers do not base these numbers on actual workload and deadlines, and on the other hand, students do not use the same workload distribution across the course weeks (e.g., depending on the workload of other courses taken at the same time). Students would probably benefit most from a realistic schedule that clearly shows, for example, which weeks will have a higher workload.

- The students were not interested in specific insights about their own learning behavior. They have a general curiosity and an interest in a dashboard with some general indicators about their learning behavior. At the same time, they doubt whether such information in itself will be enough to change their behavior in the long run.

Preliminary Conclusions

The students who participated in the Psychology & Technology student panel are, by and large, optimistic about the potential value of the use of Canvas Learning Analytics under the pre-condition that it is used in specific ways:

- no use of some forms of textual data that contain personal communication,
- no sharing of the data about individual students with their teachers, and
- interventions that rely on Canvas data should be framed in an encouraging way.

This perspective of the P&T student panel is more positive/constructive than the perspective of several other Dutch students who have discussed the use of Learning Analytics in debates initiated by SURF[1]. Several factors may have caused this. The SURF debates were rather general, whereas our discussion with the students focused on one specific application of Learning Analytics that promises direct benefits for student learning. Furthermore, students at TU/e are engineering students who generally may have a more open-minded and constructive attitude towards the use of educational technologies than the average student. Also, TU/e developed a Code of Conduct for Learning Analytics. The University Council (Universiteitsraad) and its student members participated in the formulation of this

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[1] https://communities.surf.nl/artikel/terugblik-learning-analytics-een-studentenperspectief

Code which may have prevented a more distrusting attitude towards Learning Analytics.

We (the team of researchers of the project) will continue discussing with the students the use of Canvas Learning Analytics throughout the project. The preliminary feedback that we received is encouraging and offers some guidelines for using the Canvas data and the design of the interventions. We will update this report (Report 1) in line with the schedule announced in our proposal.

3. Student suggestions for the design of the interventions

The goal of the next discussions with the students was to identify desirable properties of a video on Fixed and Growth Mindset that can be offered to students taking a Psychology & Technology course, in order to contribute to a growth mindset. Mindset interventions are known to increase students' self-efficacy and engagement (Burnette et al., 2013) and work especially well for students who are typically less engaged (Pauneksu et al., 2015).

The videos were developed and pre-tested by P&T Bachelor students in several small-scale online experiments. Eight videos were deemed as potentially useful and their characteristics were discussed in more detail. Four of these videos were established mindset videos that were not tailored to P&T students and four videos were generated by ourselves and tailored to P&T students. In the discussions, we wanted to find out to what extent several characteristics of the video, such as whether the video had a peer student as an actor, whether it was made in a studio or at home, etc. , were relevant.

To prepare for the meeting, the three students in the panel (one earlier student dropped out) received a document containing links to eight videos on fixed and growth mindset and were asked to individually watch these and form an initial opinion on what are important elements and in which of the videos these elements are best used.

The videos are:

Video	Title	Duration	URL
YouTube video 1:	Better Than Yesterday	6:36	https://www.youtube.com/watch?v=EyIF5VUOJc0
YouTube video 2:	Growth Mindset vs. Fixed Mindset	5:30	https://www.youtube.com/watch?app=desktop&v=KUWn_TJTrnU
YouTube video 3:	Mike and Matty MD	6:15	https://www.youtube.com/watch?v=iuPwF75Oniw
YouTube video 4:	Fixed Mindset Vs. Growth Mindset	3:32	https://www.youtube.com/watch?v=Xv2ar6AKvGc
Student Video 1: Animated	Mindset theory & PT students	4:27	https://drive.google.com/file/d/1DnH8xT8BqFn9ptETpyNw2xSSgaRjGDo2/view?usp=sharing
Student Video 2: in-person		5:59	url not shared to maintain student privacy
Student Video 3: in-person		6:29	url not shared to maintain student privacy
Student Video 4: in-person		5:11	url not shared to maintain student privacy

At the start of the meeting, it was explained that a mindset video is merely a component of a broader online mindset intervention that will contain other information and assignments for students. The eight videos represent a range of possible videos with very different, and sometimes contrasting, characteristics.

The discussion was divided into two parts. First, the student panel members could provide any comments about which videos and elements of videos they considered appealing, motivating, and/or attractive (or not). Then, key aspects that came up were listed and discussed to reach conclusions.

This general discussion resulted in eight key aspects.

I. Visuals, animation, and background music

- It is essential for P&T students that visuals that are employed fit the narrative well and reinforce the message of the video. So, first have a good script of the story the video wants to tell and then carefully select images and animations that optimally support this story. The videos YT1 and YT2 have such a good connection between the narrative and the visuals. YT3 has a clear story but the visuals are cluttered and do not support the story well. Animated visuals are much more appealing than PowerPoint slides.
- Background music gives the video a more professional feel, as long as it's not intrusive. A good example is YT4.
- The student panel conclude that the videos SV2, SV3, and SV3 – in which students provide an in-person talk without visuals or background music – will not hold viewers' attention and should not be used in that form.

II. On-screen person or voice-over

- An on-screen narrator is not considered essential, especially if visuals/animations tell the story.
- It may be an option to have an on-screen narrator at the beginning for the introduction and at the end for the conclusion/summary.
- A good example of a voice-over combined with visuals is YT2.

III. Connection to P&T program/course

- The video should contain one or more practical examples that the (P&T) viewers can identify with, which they recognize as issues that they struggle with. These do not necessarily have to be specific to a course. Some videos present mainly general examples (e.g. about sports, such as the career of Michael Jordan in YT1). This should be avoided.
- Although it would probably be too cumbersome to create entirely course-specific videos, an option would be to have a general video in which a course-specific issue can be included (e.g. as a one-minute module).

- The example of the physics course used in SV1, SV2, and SV3 was not appreciated since it is not exclusively relevant for PT students.

IV. Professional versus do-it-yourself

- Do-it-yourself videos, as such, are not very appealing and professional videos are preferred. Some basic requirements, however, have to be fulfilled: good visuals/animations, use of a good camera and microphone. If these are not in order, the credibility of the message is compromised.

V. Expert versus peer

- It is not important to have a peer (e.g. P&T student) as the in-person narrator.
- Having a clear narrative, communicated sincerely, in a pleasant voice in good English is much more important. A good example is YT3.

VI. Scientific content

- All videos to some extent describe the work of Carol Dweck on mindset theory. The student panel feels that some theoretical background including a clear statement that the ideas are backed up by scientific research, should be provided, but it should be 'short but sweet' and not cause the video to be too long.

VII. Quality of English

- Preferably the video is narrated by a native-English speaker, who does not have a pronounced accent.
- If a native speaker is not available, narration could be provided by, for example, someone with very good English proficiency, perhaps with a slight (Dutch) accent.
- Good examples are YT2 and YT3. In contrast YT1 and the four student videos (none native-English speakers) are problematic.
- It is recommended to have (non-intrusive) subtitles to accommodate viewers who are less-proficient in English.

VIII. Duration of the video

- There is consensus among the student panel that the video should be less than six minutes, to hold the attention of the viewers (or to prevent that the video will not be watched at all!). Also, it does not seem feasible to tell the story in less than 4 minutes. Often, five minutes is a critical threshold.

IX. Other considerations

- The student panel expects that the fact that students are selected as in need of an intervention will already have a motivating/activating effect.

- Most videos focused on increased effort as the key mechanism through which a growth mindset affects success. Only YT4 includes the two other key mechanisms from the literature: a good strategy and seeking help. Later two aspects should be included in the video. With respect to seeking help, options could be included in the broader intervention (e.g., mentioning study advisors, asking students to write down names of fellow students they would approach for getting help).
- By giving examples of why a fixed mindset is 'bad' and a growth mindset is 'good', some of the videos run the risk of alienating viewers with a fixed mindset. This is reinforced by using a comparisons between those with a fixed and growth mindset. The focus should be on making changes in one's own mindset, and on emphasizing that it is no problem if the step is small or if there is no immediate success (actually, key to a growth mindset). The focus should be on improving rather than comparison with others (The title of YT1 – Better Than Yesterday' - fits well with this perspective).

We followed these suggestions, combined with general insights from earlier research on mindset interventions, to generate our tailored interventions (see report R4 for details on the design of the interventions). The interventions were to be applied in three different courses.

4. The Course (re-)design

We apply our Learning Analytics-based interventions in three courses of the Bachelor program Psychology & Technology (P&T) and discussed with the course teachers how to re-design the courses.

Course 1

Course 1 is a first year Bachelor course that was followed by about 200 students in the recent years. Most of them (about 80%) were P&T students and other students have chosen the course as an elective in their Bachelor program. Because of the pandemic restrictions, in the last academic year the course lectures were provided online via live streaming and combined with some other shorter recorded videos. Already the course version of the year 2020/21 offered many learning activities that required students to interact with the Canvas Learning Management System (LMS).

The online elements of the course that require interaction with the Canvas LMS comprise

- recorded videos,
- graded online quizzes and non-graded online quizzes (practice quizzes),
- a written group interim assignment,
- several individual interim assignments that were accompanied by peer-review activities of students,
- a discussion forum used for teachers' announcement,
- several discussion fora used for student questions and answers,
- and some articles and book chapters.

In the current academic year 2021/22, the course was given in the third quarter from April – July. Since the pandemic constraints were released in Q3, the course took place in a blended form with some on-campus lectures and meetings as well as several recorded videos. There was a final written exam in MC form that did not require interaction with Canvas. The main text book of the course had to be bought by the students and was not available via Canvas.

Since the course already covered many online elements and since we used the Canvas click stream data of the year 2020/21 for the preparation of the predictive models, no fundamental change in the course design was desirable nor needed. We therefore changed two elements: First, the use of graded online quizzes was intensified. The first graded online quiz took already place at the beginning of week 3 of the course. With this change, we wanted to make sure that enough Canvas data is available that allows for an early (=before the first treatment) discrimination between less and more engaged student. We expect that the former group of students would profit more from the interventions. The intervention treatment started in week 4. Second, we made sure that all video elements were embedded into the Canvas LMS. Earlier explorations of the Canvas clickstream

data revealed that clicks on videos that are available on Canvas but not embedded into the Canvas LMS (f.i., clicks within Canvas that start YouTube videos that are located on the YouTube servers) are not saved by the Canvas LMS. This would create a bias in the measurement of the use of the course videos. By embedding this videos within Canvas this bias is eliminated and more Canvas data is available.

The course started on April 25 with about 200 students. At week 6, 183 students participated in another graded online quiz and were still active in the course.

Course 2

Course 2 is a third year Bachelor course that was followed by about 130 students in the recent years. Most of them (about 90%) were P&T students and other students have chosen the course as an elective in their Bachelor program. Because of the pandemic restrictions, in the last academic year the course lectures were provided online via live streaming and combined with some other shorter recorded videos. Already the course version of the year 2020/21 offered many learning activities that required students to interact with the Canvas Learning Management System (LMS).

The online elements of the course that require interaction with the Canvas LMS comprise

- recorded videos,
- a large number of graded online quizzes,
- three written group interim assignments,
- a discussion forum used for teachers' announcement,
- several discussion fora used for student questions and answers,
- and many articles and book chapters.

In the next academic year 2022/23, the course will be given in the first quarter from September – November 2022. Just like in course 1, no fundamental change in the course design was desirable or needed but we will introduce two smaller changes. First, we will embed all video material that will be offered in the course in Canvas for the same reason as for course 1. Second, we will offer already in week 2 two graded online quizzes and one graded interim assignment. The grades of the interim assignment will be made available at the start of week 4, just before the start of the treatment through the intervention. This second change is motivated by our failure to identify unengaged students early and accurately in course 1 with the prepared models that make use of the Canvas clickstream data of the same course one year ago (see report R3 for more details). If we fail in course 2 in the same way then we need to identify students post-hoc. For this, we need as much discriminating data as early as possible, in any case before the first application of the intervention. As the first intervention is scheduled for the mid of

week 4, this design facilitates the early and accurate identification of unengaged students post-hoc.

The course will start on September 7. We currently (June 2022) do not yet know the exact number of students.

Course 3

Course 3 is a second year Bachelor course that will be offered in Q2 from mid-November 2022. In line with our schedule, we will plan the re-design of course 3 after the summer break.

We (the team of researchers of the project) will continue discussing with the teachers and students the use of Canvas Learning Analytics and the course re-design throughout the project. We will update this report (Report R1) in line with the schedule announced in our proposal.

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