

## **PAELLA:**

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

**PerActiLA:**

**Personalized Student Activation through Learning Analytics-based insights about students' learning processes**

## **Progress Report R4: The Design of the interventions**

Version 1.0:

Eindhoven University of Technology

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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 it is expected that 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 more extensive in online classes than in classes 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 individual students' 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 in recent years at Dutch universities, the challenge of how to initiate more personalized learning has become more significant.

### **The basic idea**

As a possible 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). Both 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 interventions.

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's program. For selected students with a backlog in their online learning, we aim to 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 Report 1.

In this version (version 1.0) of Report R4, we describe how we developed the interventions, starting with the intervention of course 1 that was executed in May and June 2022. In later versions of this report, we will describe how we adjust the interventions for course 2 and course 3.

## 2. The design of intervention 1 (course 1)

### 2.1 Guidelines

Previous research offers some general guidelines for the design of the intervention. For instance, Campbell et al. (2021) and Yeager et al. (2019) showed that mindset intervention typically consists of two parts: 1. learning elements and 2. application exercises. We take these two *general* guidelines into account. In addition, and very importantly, research findings indicate that mindset interventions are more likely to have strong effects when they are *tailored* to the students' course-specific needs and experiences (Yeager & Walton, 2011).

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 (course 1 is a first-year major course in this program). Each study year is represented and in addition, the member of the student association who is responsible for educational issues is included in the student panel. We pre-tested several potential elements of mindset interventions and discussed the characteristics of the most promising elements (e.g., short videos) with the panel members to find out more about the students' needs and experiences. The discussions with the students are described in more detail in Report R1. They led to the following specific guidelines for our students.

- 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. Animated visuals are much more appealing than PowerPoint slides.
- 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.
- 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.
- 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).
- Do-it-yourself videos, as such, are not very appealing and professional videos are preferred.
- It is recommended to have (non-intrusive) subtitles to accommodate viewers who are less proficient in English.
- Most videos focused on increased effort as the key mechanism through which a growth mindset affects success. Only one of the sample videos includes the two other key mechanisms from the literature: a good strategy and seeking help. Later two aspects should be included in the video.
- 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, the key to a growth mindset). The focus should be on improving rather than comparing with others.

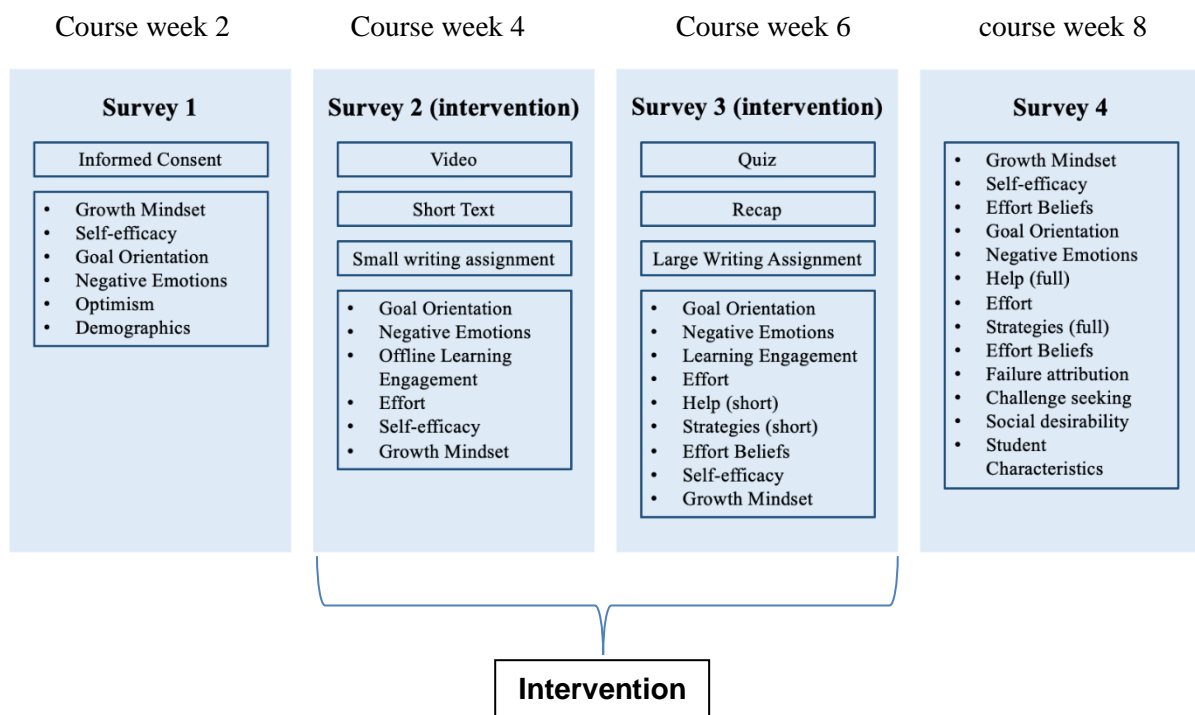
- Learning Analytics data and predictions should not be shared with the teacher.

Taking these suggestions into account, for course 1, we examined whether a mindset intervention that refers to the contents of this course would be engaging (and whether this effect would be stronger for students who were less engaged before the intervention).

## 2.2 Design of Intervention in course 1

Figure 1 provides an overview of the implementation of the intervention in course 1 that took place in quarter 3 of the academic year 2021/2022.

**Figure 1: Overview of the application of intervention**



The core intervention consists of two parts that were applied in course week 4 and week 6. Before and after the intervention, in course week 2 and week 8, pre- and post-measurements took place. More details of how we apply the intervention and its effects are described in Report R5. In the following, we describe the content of the intervention and its elements.

In line with the key literature (Campbell et al., 2021; Yeager et al., 2019) our mindset intervention consists of two different elements: 1. learning elements and

2. application exercises. We included both types of elements in each of the two parts of our intervention, as Figure 1 demonstrates.

### 2.2.1 The learning elements

The mindset intervention used in this study consisted of three learning elements: an explanation video, a short text, and quiz questions. Furthermore, a **short recap** of the most important insights that students learned in the first part, was offered in part 2 of the intervention.

In the **video**, a (former P&T Bachelor and current) Master's student explains the basic ideas of the concept of a growth mindset. Also, the video emphasizes the three main constructs through which a growth mindset can be expressed: putting in effort, asking for help, and using the right learning strategies. The video message was tailored specifically to the course with an example of a course student changing their mindset from fixed to growth, which we expect to be beneficial for effectiveness (similar to Yeager et al., 2019). The video was followed by a comprehension question to measure whether it was understood. The layout and message of the video were based on the findings of the panel discussion group with students, as described in section 2.1. The video was produced semi-professionally with the help of the TU/e video studio. The full 5:30 minute video can be found at the following url: <https://youtu.be/eT2EKAxUvmc>. The complete manuscript that was used in the video, as well as the comprehension question, can be found in Appendix A. Most parts of the video may be used for future mindset interventions at TU/e. However, as shown in Appendix A, there is one short course-specific part that needs to be produced anew for each separate course.

The **short text**, presented after the video in part 1 of the intervention, contains some practical tips on how to achieve a growth mindset (see Appendix B). Another learning element consists of a small selection of **quiz questions** that should help the participant remember what they learned in the video and short text. The quiz was offered at the beginning of part 2. This quiz uses a more active learning approach, contrary to the more passive video and text elements (see Appendix C). Thereafter, a **short recap** (shown in Appendix D) is presented.

### 2.2.2 The application exercises

The growth mindset condition included two writing exercises, as research found that writing assignments help participants internalize the message (Yeager et al., 2016a). In the first, **smaller, writing exercise** participants are asked to describe an example from their own life where they experienced the growth mindset in one to two sentences, reminding the participants that they are capable of having a growth mindset (Limeri et al., 2020). We presented the shorter writing exercise as the last element of the first part of the intervention. Details can be found in Appendix E. In the second, **larger writing exercise**, participants wrote a letter to future students following the course by answering two questions, similar to Hoang (2018) and Yeager et al. (2019). These questions included explaining growth and fixed mindsets in their own words, and writing down personal

experienced struggles and how to overcome these with a growth mindset. For each question, the participants had to write a few sentences. The letter deception (second writing exercise) was used because indirect framing was found to be more effective than direct framing, as students otherwise might feel pressured or controlled toward desired intervention outcomes. In addition, by describing how one could overcome struggles by using the growth mindset, participants mentally rehearsed the behavior associated with a growth mindset which may make it easier to behave similarly when they experienced struggles (Yeager et al., 2016a). The second writing exercise was offered as the last element of the second part of the intervention, as Figure 1 shows. The second writing exercise is presented in detail in Appendix F.

### **2.3 Outlook**

In the further development process of the interventions, we will tailor the video and other intervention elements to the content of course 2 and course 3. The application of the intervention(s) as well as the effects are going to be described in Report 5.

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## Appendix A: The manuscript of the video of course 1 intervention

{start TU/e logo & intro}

{here at the start for about 45 seconds a student narrator}

Stories about individuals who experience success in their study and life usually have one thing in common: these people have a growth mindset, a belief that much is possible *if* they have the right attitude and use the right strategies.

This may sound nice on paper, but I'm sure many of you are skeptical about this. So what if I told you that this view - if we present it slightly more nuanced - is actually supported by science? A number of studies have shown that how we choose to understand both challenges and failures has a great effect on our study success.

Hi, my name is XXX. I am a current HTI master's and former PT bachelor's student. Let me tell you more.

{end student narrator}

{start animation}

There are two types of mindsets we can cultivate: one that embraces problems as opportunities to learn and one that avoids them often out of fear to fail.

People who avoid problems and difficulties can be described as having a fixed mindset. Those who see problems as interesting challenges have a growth mindset.

People have a fixed mindset when they believe that basic qualities like intelligence or talents are fixed traits and that these traits are responsible for success. They think that these cannot be changed or improved upon.

With a growth mindset, people believe that new abilities can be developed through practice if we invest time and effort and use smart strategies. This view creates a love for learning that most great leaders and artists have in common. For them, life becomes an exciting journey with endless opportunities to figure out new things and advance.

Obviously, these two lines of thought are very different. At their core, the main difference is how each mindset interprets failure and effort. This view is what leads students to take certain actions when confronted with challenges.

Dr. Carol Dweck, the Stanford University professor who coined the term 'mindset', provided much scientific evidence in favor of this idea. To develop a growth mindset she advises leaders, teachers, and parents to celebrate trying: Teachers should applaud students if they studied hard. Parents should encourage their children to develop any new skill they are interested in.

Doing this will make them learn the skill of learning, which will also help them back in the classroom.

{start part dedicated to course 1}

{Example for PT students following course 1}

{here looped drawing that resembles Figure 2.1 of the course book}

Let's take an example. Peter, a first-year Psychology & Technology student, faces a difficult time when he reads about phrenology, neurons, soma, dendrites, and axons. Already in high school, he thought that he just was not good at biology. Peter thinks it's no use in trying it hard. He keeps postponing studying for the course and eventually just gives up. In the end, he fails the course.

{end part dedicated to course 1}

{here post-its with Peter, parents, coach, and fellow students}

Peter then talks to his parents and a study coach and also has discussions with fellow students about how one should study. The advice he receives makes him realize that experiencing failure and frustration is part of learning. So, he decides to change his approach to studying for this course. He started increasing his efforts to try and really understand neuro-cognitive ideas. Instead of quitting when failing, he maintains studying or asks fellow students for help until he understands what he needs to know.

He does a lot of extra work for those courses, realizing that investing effort is not an indicator of a lack of talent. Rather, putting in effort in learning is normal and indicates that he expands his limits of understanding. He may not be successful immediately but realizes that failure is a natural ingredient of learning.

{here three post-its of words: effort, strategy, help}

With a growth mindset you believe that no matter where you are now, you can always improve with effort, good learning strategies, and help. The effort involves dedicating time and energy to studying. Learning strategies are about finding and using ways that work for you to best master the knowledge and skills you have to obtain. Examples include making summaries, self-explanations, testing yourself, and many more. And don't be afraid to ask for feedback to learn from others, because you fear it may show others that you lack knowledge and skills. Actively seeking help from knowledgeable others speeds up your own learning. With a growth mindset, you realize that asking for help is not an indicator of a lack of talent.

{here six post-its with sentences}

As the late poet Samuel Beckett once said:

Ever tried.

Ever failed.

No matter.

Try again.

Fail again.

Fail better than yesterday.

{here student narrator}

In conclusion, whether we perceive challenges with a fixed or growth mindset affects our actions. The way we react to failure prevents or creates learning opportunities.

And that's the number one piece of information you should take away from this lesson. No matter where a person is now, they can always improve with effort, good strategies, and help.

Thank you for listening.

{end TU/e logo}

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Full video: <https://youtu.be/eT2EKAxUvmc>

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Comprehension question that was shown after the video:

Test your knowledge!

What are the accurate descriptions of the concept of growth and fixed mindset?

- Growth mindset: the belief that you can learn anything if you put in enough effort
- Fixed mindset: the belief that your basic qualities like intelligence cannot be changed or improved upon

- Growth mindset: the belief that your basic qualities like intelligence cannot be changed or improved upon  
Fixed mindset: the belief that you can learn anything if you put in enough effort

## **Appendix B: The short text of the first part of the course 1 intervention**

### 4 Tips to influence your Mindset

#### 1. Learn to recognize your fixed mindset/Be aware of your mindset

Everyone has that feeling when you are faced with a challenge: Can I do it? What if it doesn't work? And if it doesn't work out: You're not surprised, it was a risk, you think you have reached your limits, maybe you are disappointed in yourself, or angry. Or maybe you get mad at someone else.

#### 2. Remember you have a choice

How you perceive a challenge or setback and how you deal with criticism is your choice. Following the view of a fixed mindset, you think; that's not where my talent lies, or I can't do it. If you think with a growth mindset, you may think you need to find ways/strategies to do it and work harder for it.

#### 3. Replace your fixed mindset thought with a growth mindset thought

If fixed mindset thoughts come to mind when you are faced with a challenge, think of the growth mindset thought, for example:

- Are you sure you can do this? Maybe you don't have a talent for it. <-> I'm not sure if I can do it yet, but I can learn it if I put the time and energy into it.
- And if it doesn't work, am I a loser? <-> Most people are not immediately successful. It's about persevering and not giving up.
- This is not my fault but it's someone else's.<-> If I take responsibility for it, I can influence it and learn from it.

#### 4. Acting and making choices from a growth mindset

By becoming more and more aware of your choices and from which mindset you make them, it becomes more and more automatic: acting from a growth mindset. You are more open to learning and practice, you set higher goals, and you know it is your choice to act in this way. You will embrace challenges more and more. You become aware of what you can learn from the times you have failed. Learning and improving is more central than performance. It doesn't matter what you want to be successful at. You will benefit from that attitude for the rest of your life.

## **Appendix C: Quiz questions of part 2 of the course 1 intervention**

Test your knowledge!

Here are some questions for you to test your knowledge with regard to different mindsets. These are just for yourself so don't worry if you are not sure about the answers. Take ±7 minutes to answer them.

1. What are the accurate descriptions of the concepts of growth and fixed mindset?

- Growth mindset: the belief that you can learn anything if you put in enough effort
- Fixed mindset: the belief that your basic qualities like intelligence cannot be changed or improved upon
- Growth mindset: the belief that your basic qualities like intelligence cannot be changed or improved upon
- Fixed mindset: the belief that you can learn anything if you put in enough effort

2. Which mindset is more likely to avoid problems and challenges out of fear of failure?

- Growth mindset
- Fixed mindset

3. What are the three core elements of a growth mindset?

- Effort, help, and strategies
- Effort, help, and adaptability
- Help, strategies, and adaptability
- Effort, strategies, and adaptability



4. Which person's actions in the picture below are more in line with a growth mindset?

- Left person
- Right person



## Appendix D: Short recap of the most important insights of the first part of course 1 intervention

Recap! Here, you can read the most important points of the video from the training in the last session. If you experienced the questions on the previous page as difficult, you can find some more information here.

There are two types of mindsets we can cultivate: a growth and a fixed mindset. The former embraces problems as opportunities to learn while the latter avoids them often out of fear to fail. People have a fixed mindset when they believe that basic qualities like intelligence or talents cannot be changed and that these traits are responsible for success. With a growth mindset, people believe that new abilities can be developed through practice if they invest time and effort, use smart strategies, and ask for help.

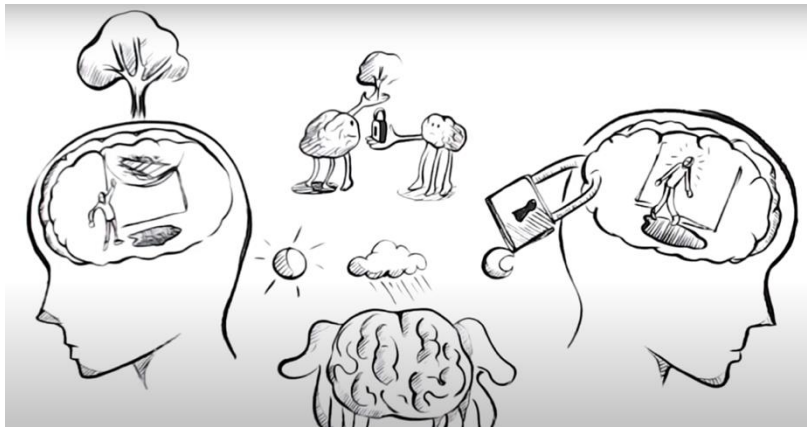


These two lines of thought are very different in the way they interpret failure and effort. This is what leads students to take certain actions when confronted with challenges.

To be able to change your mindset from fixed to growth, three important things to do are:

- Recognize your mindset
- Remember that you have a choice
- Replace fixed mindset thought with growth mindset thought

So don't forget, no matter where a person is now, they can always improve with effort, good strategies, and help.



## **Appendix E: Short writing exercise of part 1 of course 1 intervention**

Applying Mindset Theory to yourself, do you think you sometimes have a growth mindset? Please describe a short example in your life (if possible an example applied to this course) where you showed a growth mindset and achieved success because of it. What was typical of a growth mindset in your thoughts or behavior? Please use about 30-80 words.

## **Appendix F: Long(er) writing exercise of part 2 of course 1 intervention**

Your message to help future students

Here you will complete a short writing assignment. Please write a short letter to next year's students of the course *Brain, Body, and Behavior* by answering two questions in a few sentences each. We will use some of the best letters as inspiration for messages to next year's students.

1. Explain to a future BBB student in your own words what the concepts of growth and fixed mindset entail.
2. From your own experiences, write down what you struggled with during this course "here course title" and how a next-year student could use a growth mindset to overcome these struggles.