DigiEduHack Solution
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ATLAS: The Ambient Teacher-Learner Awareness Solution provides guidance in learner-centred lectures

ATLAS: Ambient Teacher-Learner Awareness Solution

ATLAS (Ambient Teacher-Learner Awareness Solution) is a digital tool that provides teachers with awareness information about their students' educational needs in online lectures by changing screen brightness indicating current lack of understanding, thus facilitating student-centred online teaching.

Team: ATLAS design crew (alias Iapetus)

Team members

Jule Krüger, Joana Böhm, Jana Hupe, Simon Maas, Lenka Schnaubert, Maribell Steiner, Suzana Vezjak, Jana Weniger, Yannick Wuttke, Elif Yilmaz

Members roles and background

The project was led by PhD student Jule Krüger in support of Dr. Lenka Schnaubert, who both work in the field of media-based knowledge construction at the University of Duisburg-Essen. Both researchers concentrate on Computer-Supported Collaborative and Individual Learning. While Jule Krüger has a special interest in Augmented Reality and Multimedia, Dr. Lenka Schnaubert focuses her research on Group Awareness, Metacognition and Self-Regulated Learning. The team members consisted of a group of students from the University of Duisburg-Essen, who attended this hackathon as part of a research project. All participants study Applied Cognitive and Media Sciences in the Master's programme. The students Elif Yilmaz, Jana Hupe, Jana Weniger and Maribell Steiner have completed a Bachelor of Science in the same field. Yannick Wuttke (B. Sc. Business Psychology), Simon Maas (B. Sc. Media and Business Psychology) and Joana Böhm (B. Sc. Work and Organisational Psychology) have a background in related fields of the study of applied cognition and media science. Finally, Suzana Vezjak (Dr. des in German as a foreign language), DAAD lecturer at the University of Economics in Bratislava (Slovakia) joined the team and showed us another very inspiring perspective on our ideas.

Our team worked collaboratively on the topic of “Awareness Tools in Digital Teaching”. To do this, we all met online at the start of the hackathon to initiate a brainstorming session and collected initial ideas and areas of interest. It has emerged that we are particularly interested in the aspects of communicating “understanding” and the “overall mood”. In order to work out these areas in more detail, we have divided ourselves into small groups. Yannick, Joana and Maribell have dealt with creating a small survey on the topic, which was then distributed to teachers. This was intended to create an initial empirical basis for the needs of teachers in digital teaching. Lenka, Jule, Suzana and Jana researched on the teacher side in their small group and thought about the interests of the teachers and how information can be presented to the teachers as effectively as possible. As a third small group, Elif, Simon and Jana got together and focused on the student side. They have researched and discussed about which information students could and would like to share and how this can be designed effectively. Then we came together again in the whole group and gathered our knowledge. Based on the results of the surveys in particular, we decided to focus on the topic of “understanding”, as this is the greatest concern for the teachers.

Contact details

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Solution Details

Solution description

The Ambient Teacher-Learner Awareness Solution (ATLAS) is a tool to support teachers in conducting student-centred teaching in their online lectures.

Relevance

Online and video lectures are a central part of higher education (Crook & Schofield, 2017), a trend that has been exasperated in the last year. During the covid-19 pandemic, universities globally had to switch to online formats on the fly and thus emergency remote-teaching (Reynolds & Chu, 2020). Good university teaching should go hand in hand with didactic principles such as individualization, active and social learning, as well as professional ability through competence orientation and student focus (cf. Riedel, Berthold, Dubrau, & Möbius, 2017). Student centred teaching as educational goal is therefore a main ingredient of educational curricula in schools and universities. However, the lack of visual and auditive cues and thus feedback during online lectures makes it harder for teachers to perceive their students‘ cognitive and motivational state and adapt their teaching activities to their students‘ needs. Especially in online lectures, which often involve larger groups of students and are not based on direct interaction, this may be an issue (Krüger, Vogel, & Schnaubert, in press).

Problem: limited communication channels

Research on communication and cooperation points out that habitual communication can be problematic if social cues are missing (e.g., Kiesler, Siegel & McGuire, 1984). While there may be positive as well as negative effects of reduced cues when it comes to collaboration between learners (see e.g., Bodemer, Gaiser, & Hesse, 2011), the lack of feedback during online lecturing may negatively affect grounding processes (e.g., Clark & Brennan, 1991) and thus adapting their speech

to the students (i.e., audience design, Clark & Murphy, 1982). As tailoring explanations to students needs is important for fostering student learning (e.g., Wittwer, Nückles, & Renkl, 2010), this may ultimately affect student comprehension and academic success, but may also make communication more effortful for teachers as especially monitoring student understanding or progress while providing explanations are assumed to be high-load situation in classrooms (e.g., Prieto, Sharma, & Dillenbourg, 2015). Thus, providing teachers with the necessary may severely enhance online teaching. But what information do they need?

Question: But what information do teachers need?

To not only assess teachers‘ needs theoretically, but also their perceived need for information, we conducted a short survey on 12./13.11.2020. The questionnaire consists of 8 questions, of which 5 questions focused on the background of the teachers' experience with distance learning and 3 questions on relevant variables in synchronous online lectures. It was distributed via Mattermost and within various universities via directly sending it to teaching staff in Germany, the UK, Slovenia and Slovakia. $N = 30$ university teachers filled out the survey.

All participants answered the question "How many years have you been working in an apprenticeship?". On average, the respondents have worked in an apprenticeship for 10.82 years, but the absolute values range from less than one year to 30 years. There were seven abstentions to the question "How many online lectures have you given". On average, the respondents gave 35.52 online lectures and seminars. The survey showed that 60% of the respondents in the digital semester offer asynchronous teaching formats (e.g. teaching video that can be viewed at any time). 86% of the respondents state that they offer synchronous teaching formats (e.g. live lectures).

We used top-down categorization mixed with bottom-up clustering, which resulted in the following nine topic-specific clusters: (1) *understanding*, (2) *picture*, (3) *social presence*, (4) *motivation*, (5) *prior knowledge*, (6) *profile variables*, (7) *attention*, (8) *reaction* and (9) *technical challenge*. The profile variables contain, among other things, information about the students' whereabouts or time zone. While the cluster social presence refers especially to the atmosphere and the relationship to the students, the picture-cluster includes visual contact with students by activating the camera function. In addition, the two clusters understanding and reaction were subdivided into further subject areas for more precise differentiation: The understanding-cluster differentiates between content understanding and speech rate. In the reaction-cluster, we differentiated between facial expressions, gestures and acoustic reaction.

The clustering shows most teachers to want on-the-fly information about their students‘ current understanding and their non-verbal and verbal spontaneous reactions. Additionally, this was the information teachers reported to lack most during online lectures. A summary of the results can be found in table.jpg.

We deduced from the results that teachers especially need information about students' understanding and their reactions with special focus on facial expressions. Some of the teachers quotes can be found in the following and in the appendix (picture1.jpg):

- „Can students follow my explanations? Quick feedback on this, if explanations cannot be followed.“ (*content-related-understanding-cluster*)
- „Feedback on understanding the content“ (*content-related-understanding-cluster*)
- „Motivating for me as a lecturer and influencing lectures are also personal information: visual (facial) reactions to lecture elements.“ (*mimic-reaction-cluster*)
- „Even small gestures can reveal a lot in the normal teaching routine. This is a new challenge in pure online teaching.“ (*gesture-reaction-cluster*)

- „So the eye contact and facial expressions are missing.“ (*mimic-reaction-cluster*)

A more detailed description of the clusters can be found in clusters.pdf.

Solution: Tool description

Based on this information, we focussed our efforts on providing teachers with on-time information about their students‘ current understanding of the topic. For this purpose, we designed an awareness tool-concept. Awareness tools are commonly used within computer-supported collaborative learning and are designed to provide a group of learners with relevant information about (more or less stable) characteristics of group members of the group (Bodemer & Dehler, 2011; Bodemer, Janssen & Schnaubert, 2018). Such tools process relevant information in three consecutive steps: they assess the information from the learners , they transform the information and then feed it back (Buder & Bodemer, 2008), each of these steps comes with specific challenges (Schnaubert, Harbarth, & Bodemer, 2020). By purposefully processing relevant information, awareness tools may provide benefits that surpass possibilities in face-to-face settings (Buder, 2011) and may thus even surpass on-site lecture design.

This tool is a stand-alone tool that may be installed on the teachers‘ and students‘ computers and may thus be used independent of the software that is used to run the lecture and also independent of commercial interest. Additionally, and in the spirit of open education and science, it is planned to be open source to be usable, adaptable and enhanceable by the wider community.

At the students end, the tool assesses understanding by asking students to press and keep pressed a button when they have difficulties following the lecture or have comprehension problems. The information will be pooled on a server that may send the summarized (non-individualizable information due to privacy issues) to the teachers‘ computer. At the teachers‘ side, the tool adjusts screen-brightness to provide teachers with summarized information about their classes cognitive status and needs using an ambient design.

Both ends will be explained in more detail below, a visual can be found in tool_design.pdf.

Student side

For the tool to provide the teacher with relevant information, i.e. on their current understanding, it has to collect the information from the students. This can be challenging as the data collection process should - ideally - disrupt the students’ learning processes as minimal as possible. Assessing cognitive information for awareness tools is especially challenging as cognitions are not readily observable (see Buder, 2011). In group awareness research, there is a vast range of tools assessing cognitive awareness information in a variety of ways (e.g., Schnaubert, Harbarth, & Bodemer, 2020). While there are approaches to assess such information unobtrusively (e.g., Erkens, Bodemer, & Hoppe, 2016), this requires analysing artefacts not available in online lectures where students are less active than in other teaching settings like seminars. Additionally, having learners control the information provided is assumed to foster acceptance of the tool (e.g., Engelmann, Dehler, Bodemer, & Buder, 2009; Schnaubert & Bodemer, 2019). This may be especially relevant in digital teaching settings, where privacy concerns and being graded for performance may be issues.

Thus, our tool solution needs to bridge the gap between having students control the information, but disrupting the learning process as little as possible. We decided to use an easily recognizable buttons to allow students to provide the tool - and thus the teacher - with information about their current understanding or rather lack of it. This button is labelled with a thought bubble and a question mark so the intention is easily recognizable. The image on the button serves as a metaphor,

so that the individual function can be seen and intuitively interpreted. It was important for us to keep semantic directness. The user goal must correspond with the meaning of the provided functionalities (see Hutchins, Hollan, & Norman, 1985). Additionally, the tool can be individually and saliently positioned and thus placed in accordance to students needs, thus possibly reducing the gap between goal and execution (see Gulf of Execution; Preim & Dachselt, 2010). By holding on to the question-button, the student can signalise, that they cannot follow the teacher, e.g., because of the speed or other comprehension issues. Through the use of the tool it is thus possible to alert the teacher about a lack of understanding or a need for repeating. Ideally this helps the teacher to adapt to students, thus supporting the students' understanding and academic achievement. In consequence, on the teacher's side this information is presented as change in the ambient design. By using this tool rather than directly communicating a need for revision, the inhibition threshold for students may be lower.

The awareness tool on the student side presents some opportunities in providing information for the teacher. While this should be as unobtrusively as possible for students, it also presents an opportunity to directly communicate an educational need.

Teacher side

To design the teachers' side of the tool, some requirements must be taken into consideration. First, like with all awareness tools the information portrayed must be instantly recognizable and easy to interpret (see Bodemer & Dehler, 2011). This is a central requirement as the teachers' main task is to teach and monitoring student understanding can bind additional mental resources (e.g., Prieto et al., 2015). Second, the information must be salient and integrated into the workspace of the teacher to be within the focus of attention to avoid split-attention issues and unnecessary search processes (see Ayres & Sweller, 2014). Third, ideally, the presentation should implicitly guide teachers to act upon the information in a useful manner (i.e., persuasive design; Fogg, 2009). Fourth, fostering the teachers' social presence may be an additional benefit of providing social cues (see Krüger et al., in press).

Based on these requirements, we developed a concept for representing information about the students' status to teachers. In the file tool_design.pdf a presentation can be found of what the tool looks like. With each student that presses the button to communicate that they have difficulties following the lecture, the teacher's screen becomes a little darker. When students release the button again, the teacher's screen becomes brighter again. The maximum brightness, when nobody presses the button, is determined by the teachers' ideal screen brightness and the screen becomes darker up to a certain baseline, so that information on the screen can still be seen.

As described by Krüger and colleagues (in press), ambient displays using illumination (like "Lantern", Alavi & Dillenbourg, 2012) may be suitable to meet the above requirements, especially because they require minimal user attention (Mankoff et al., 2003). We thus decided that the tool should display the information in an ambient way by screen brightness, so that it is integrated into the teachers' virtual desktop environment and can be perceived easily.

When the screen is darker, this means that more students are pressing the button to communicate that they have difficulties following the lecture or have comprehension issues. Teachers can intuitively interpret the darkness of their screen as an undesirable state based on available image schemas and metaphors (see Hurtienne, Klockner, Diefenbach, Nass, & Maier, 2015 on designing with image schemas). When students feel that their difficulties or comprehension issues are solved, and they can again follow the lecture, they stop pressing the button and the teachers' screen brightens up again. Because the maximum brightness of the screen can be personalized by the teachers as their ideal screen brightness, this can intuitively be interpreted as a desirable state. This

can persuade teachers to change their behaviour, as they would want to optimize the brightness of their screen, and would thus react to the students' feedback (see persuasive design, e.g., Fogg, 2009), for example by adapting explanations or speed. This fits in well with the German saying of "Mir geht ein Licht auf" (relates to enlightenment) and is thus intuitively interpretable.

The addition of information about the students from the real-world and a representation of this information integrated into the teachers' virtual environment, supports the connection between and integration of real world information and virtual presentation. On one hand, this helps to bridge the gap between the realities (which may be perceived as very isolated in an online learning setting), on the other hand it shows the potential that the combination of real and virtual information has. The research area of mixed reality, augmented reality and augmented virtuality (see Reality-Virtuality-Continuum, Milgram, Takemura, Utsumi, & Kishino, 1994) is suitable in relation to this combination.

An additional advantage of the tool is that just the fact that there is a reaction and thus a feedback of the students, may lead to a higher social presence, the "sense of being with another" (Biocca, Harms, & Burgoon, 2003, p. 456), in the teacher.

In sum, the information provided not only informs teachers about comprehension issues of students but can act as instant feedback about the success of their didactic measures to improve comprehension. Timely feedback is one of the most powerful educational methods (see e.g., Hattie & Timperley, 2007) and - viewing teachers as learners - may help teachers to form adequate lectures scripts.

Add-on: positive reactions

To provide teachers not only with information on comprehension issues, but to additionally give students the chance to give and teachers to receive positive feedback on the lecture (see reaction cluster), we decided to conceptualize an add-on that gives students the chance to compliment teachers' via a "thumps-up". With this function, students can directly communicate positive feedback by clicking on a "thumbs up-button". The "thumps" / reactions will be displayed on the fly per reaction (non-identifiable), using upwards floating thumps coming from a magic jar. This floating mechanism known from current social media sites like facebook and the jar enables teachers to move the jar to position it to their liking. While this information can be encouraging for teachers, it may also be distracting and thus teachers will be able to disable the display function altogether. While this is not the main feature of the tool, survey results suggested that indications of positive reactions are something to be desired by (some) teachers and thus, this feature will be integrated into the tool.

Reference list

See file "references.pdf"

Solution context

Awareness tools for digital teaching: supporting teachers during the student-centred, virtual lecture

Online and video lectures are a central part of higher education (Crook & Schofield, 2017), a trend that has been exasperated in the last year. During the covid-19 pandemic, universities globally had to switch to online formats on the fly and thus emergency remote-teaching (Reynolds & Chu, 2020). Student centred teaching as educational goal is a main ingredient of educational curricula in schools and universities. However, the lack of social cues and thus feedback during online lectures makes it harder for teachers to perceive their students' cognitive and motivational state and adapt their

teaching activities to their students' needs. Especially in online lectures, which often involve larger groups of students and are not based on direct interaction, this may be an issue (Krüger, Vogel, & Schnaubert, in press).

In the project, we thus conceptualized an awareness tool, which collects live information about students, processes it and presents it to teachers in an appropriate form during the digital lecture to enable student-centred teaching.

Solution target group

This solution directly benefits teachers in higher education while conducting online lectures. Thus, teachers are the target population and also the stakeholders of this innovation. By allowing teachers to focus their communication and adapt to students needs, this by proxy also benefits students' comprehension processes and academic success. While the idea originally stems from higher-education, this may also be transferred to schools and other forms of online communication settings (like scientific talks at conferences).

Solution impact

The solution is meant to impact both teachers and students in higher education. If the tool is successful and to allow for optimizing tool design is an empirical question best be answered by a mixture of psychological research within laboratory- and field settings. Laboratory settings may allow to test under very controlled conditions (high internal validity), if and how the student and teacher interface are adequate to support teaching and learning processes unobtrusively or if additional steps need to be taken to avoid disruption of learning or teaching. In field settings, acceptance of and satisfaction with the tool may be measured with higher external validity.

Solution tweet text

Lost in the digital world? ATLAS (Ambient Teacher-Learner Awareness Solution) guides student-centred teaching by providing teachers with awareness information in online lectures - connecting students and teachers!

Solution innovativeness

The tool is current and there is a strong need for tools and applications to support teachers in the current crisis and beyond. However , the tool not only meets current needs, but integrates innovative approaches that go beyond matching challenges. Thus, it is designed to enhance teaching and learning practices beyond crisis management. This solution builds on current learning sciences research mainly from psychology and connects various relevant research fields like research on education, communication, computer-supported collaborative learning, and technology-enhanced teaching and learning.

Apart from the strong psychological foundation, innovative aspects of tool design were given a high priority. The ambient design for the teacher blends psychological mechanisms allowing for high utility and usability. While empirical and experimental research still needs to be conducted to test and improve tool functioning, a student project is already underway to lay the foundation of a technical implementation and hopefully (depending on funding opportunities) larger scale development.

Solution transferability

The tool is applicable for usage in lectures in all domains in higher-education, although it may be especially useful for domains in which particularly complex content should be conveyed (e.g., physics, engineering) and comprehension problems may arise often. The tool would also be a welcomed aid in the field of foreign language learning, especially also in CLIL (content-and-integrated language learning) contexts, where comprehension difficulties are even more frequent and the inhibition threshold for feedback from the students is higher. It may also be especially helpful during lectures in which the comprehension of one topic depends on the comprehension of other topics and students are completely lost during the rest of the lecture when they lose the thread once.

While the idea originally stems from higher-education, this may also be transferred to schools and other forms of online communication settings (like scientific talks at conferences). In schools, the current increase in the number of online lessons is also creating the same obstacles for teachers. So it would be exciting to see if the tool can be used in schools as well to stimulate through ambient design and if the needs for teachers and students are comparable in primary education.

Solution sustainability

While currently we focussed our efforts on evidence- and theory-based tool design, a main part of the solution will be the technical implementation and thus, how data received from students is stored, aggregated, transferred and visualised on the teacher's screen. The bandwidth requirements for the end users are certainly lower than those for video submission. However, apart from technical solutions for the student- and teacher-side computers and considering differences in hardware and operating system, important issues about end-to-end communication, privacy issues and server access need to be considered.

Solution team work

Our team consists of students and university staff and thus, we are all concerned with digital teaching and/or learning. The idea for this project was thus mainly rooted in experiences from the current and last digital semesters. Supporting teachers was thus already a topic at the #Semesterhack, which some of the current group took part in earlier this year.

The idea to tackle the issue of lack of student-teacher awareness was then submitted by Jule Krüger in conjunction with Lenka Schnaubert, both of which have a background in educational psychology and Learning Sciences and work at the University of Duisburg-Essen. To approach this challenge, Jule Krüger initiated a student research project, which seven master students studying Applied Cognitive and Media Science at the University of Duisburg-Essen joined. These students are Joana Böhm, Jana Hupe, Simon Maas, Maribell Steiner, Jana Weniger, Yannick Wuttke and Elif Yilmaz, all of which have a degree in psychology or related fields and a high interest in fostering digital learning practices using their educational background. At the beginning and at the end of the Hackathon, the team was complemented by Suzana Vezjak from the University of Economics in Bratislava, where she works as a DAAD lecturer. She comes from the field of foreign languages, she researches knowledge communication in online discourses and has a particular interest in promoting high-quality teaching standards in Germany and abroad.

Our team quickly became acquainted and we started off with setting a game plane and developing ideas using a collaborative mind mapping tool. The first day we had long joint sessions in

BigBlueButton (video-conferencing) in which we collectively brainstormed ideas, discussed pros and cons and made strategic decisions together. We quickly set up a survey to get the first empirical data in before dawn. At the end of the first day, we had a first solution idea, a “need-to-do” list and a small set of data. Over night, especially Maribell and Yannick worked on analysing the qualitative data and were joined on the second day by Joana. At a kick-off meeting early on the second day, we made some needed final decisions and divided into groups with Maribell, Yannick and Joana mainly working on data analyses, Simon, Elif and Jana H. working mainly on the student perspective, and Jana W., Jule and Lenka on the teacher perspective. Suzana joined in working on the final document. In the end, we all contributed to the final submission.

Thus, our team worked mainly collaboratively, but also cooperatively by distributing some of the tasks while making important decisions as a team. The teamwork was very respectful and effective, which made this project not only possible, but also fun.

We will definitely keep working on this in the future - not only as part of the student research project, but as a team with a mission.