Abstract

This paper investigates how the key promises of digitalization, namely the ability of delivering individual and even personalized services at the cost of mass services, can be leveraged in the area of higher education.

Thinking about modern didactic concepts including blended learning and inverted classroom scenarios leads us to solutions where each student is provided with personalized content, divided in self-learning-sessions for the knowledge transfer and onsite sessions to deepen the knowledge. Continuous online tests show us the individual learning progress of each student so that software with suitable algorithms is able to create tailored offers for the single students. We will still see teachers in the lecture halls and seminar rooms, but their role will completely change from the traditional lecturer to a coach instead. Moreover, this approach will ultimately lead to a culture where we are considering students as our clients and as unique persons with different needs and learning abilities to be addressed.

Keywords: Digitalization, individualisation, blended learning, inverted classroom, heterogeneousness.

1 INTRODUCTION

Digitalization has evolved as one of the megatrends that drives businesses in almost all areas and also affects our society in general.

The task of universities is to empower young people to actively shape this change. Obviously, digitalization can contribute much to improving teaching performance too. However, practice shows that universities are having a hard time anchoring this topic in teaching sustainably and often do not have a clear strategy for its implementation.

According to recently published studies [1], the vast majority of German universities do have the required technical equipment but are lacking a digitalization-based learning and teaching culture as well as the coordination and transparency of digitalization projects that so far have mostly been isolated and based on the intrinsic motivation of a few single lecturers.

The reason is that digitalization is not yet considered as a key solution to the challenges arising from the growing and increasingly diverse and heterogeneous group of students. One of the major challenges we are confronted with in modern classrooms is the question of how to guarantee each student receives the individual support that she or he needs in order to successfully complete the study. Thus, digitalization is not just another task to be mastered, but it needs to be regarded as the key for the design of successful learning processes and the key question is no longer about whether or not digital instruments, media and processes will enter the classroom at all but simply how to do it right!
2 METHODOLOGY

At the beginning, we examined the change of the structure of students (e.g. in terms of age, number, education attainment) and the typical learning and communication behaviour of the students especially in contrast to the group of the people they are confronted with in higher education institutions.

Then it was necessary to find and to evaluate suitable strategies and didactic concepts that lead to more individualisation by integrating digitalization. One of the most important criterion was the simplicity of implementation, because it’s essential to consider that you will have to deal with two camps: digital advocates and analogue sceptics.

In the end, we developed the 5E – Model, a process how to design a course using these elements in a blended learning scenario.

3 RESULTS

3.1 Change of key-figures regarding First-Year-Students in Germany

In the period from 2000 to 2017 the quota of First-Year-Students in Germany rose almost 70 percent.

![Figure 1. Quota of First-Year-Students in Germany [2]](image)

The absolute number of First-Year-Students increased in this time from 314.956 to 511.724.

![Figure 2. Absolute number of First-Year-Students in Germany [2]](image)

That clarifies that the universities are confronted with significantly more students that need to be cared for in order to study successfully.
The students are becoming younger when entering the universities. Furthermore, the generations Y and Z often grew up with so-called “hovering parents”. That means it is customary that they are provided with strong support (sometimes too much) reflecting their individual needs.

The percentage of First-Year-Students with a General University Entrance Qualification has declined whereas the quota of students with other entrance qualifications has increased. The consequence is that the universities and particularly the universities for applied sciences are confronted with increasing heterogenous groups of students in relation to the existing knowledge. That has amongst other things a deep impact on the math-classes, but other classes are affected as well.

We can also see that the quota of students with a foreign university entrance qualification has increased significantly over the last years. The positive impacts in terms of an intercultural exchange faces the challenge of language barriers in classes that are only available in German. It is often difficult for these students to follow the curriculum without individual support.
### 3.2 Learning and communication behaviour

#### 3.2.1 Overview of traditional learning paradigms

#### Table 1. Comparison of three major learning theories [3]

<table>
<thead>
<tr>
<th><strong>Category</strong></th>
<th><strong>Behaviourism</strong></th>
<th><strong>Cognitivism</strong></th>
<th><strong>Constructivism</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key Concepts</strong></td>
<td>Behaviourism is a theory of animal and human learning that only focuses on objectively observable behaviours and discounts mental activities. Behaviour theorists define learning as nothing more than the acquisition of new behaviour.</td>
<td>Cognitivism focuses on the “brain”. How humans process and store information was very important in the process of learning. It follows the Three-Stage Information Processing Model – input first enters a sensory register, then is processed in short-term memory, and then is transferred to long-term memory for storage and retrieval.</td>
<td>Constructivism focuses on how learners construct their own meaning. They ask questions, develop answers and interact and interpret the environment. Doing these things, they incorporate new knowledge with prior knowledge to create new meanings.</td>
</tr>
<tr>
<td><strong>Role of the teacher</strong></td>
<td>Instructor designs the learning environment. Instructor shapes child’s behavior by positive/negative reinforcement. Teacher presents the information and then students demonstrate that they understand the material. Students are assessed primarily through test.</td>
<td>Instructor manages problem solving &amp; structured search activities, especially with group learning strategies. Instructor provides opportunities for students to connect new information to schema.</td>
<td>Educators focus on making connections between facts and fostering new understanding in students. Instructors tailor their teaching strategies to student responses and encourage students to analyse, interpret and predict information. Teachers also rely heavily on open-ended questions and promote extensive dialogue among students. Constructivism calls for the elimination of a standardized curriculum. Instead, it’s customized to the students’ prior knowledge. Also, it emphasizes hands-on problem solving.</td>
</tr>
</tbody>
</table>
Role of the student

The student is passive from within, becoming active on external stimuli and reacts.

Learners process, store and retrieve information for later use - creating associations and creating a knowledge set useful for living. They use the information processing approach to transfer and assimilate new information.

Learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge, social interactions & motivation affect the construction.

Criticism

The problem-solving ability does not matter, but only the playback of information. The student is pushed into passivity.

The learning path and especially the result already exists. Although the student can reach the "right" result in his own way, what is "right" is already defined and in this sense, what is "wrong" too.

Students may be overwhelmed with the "freedom" and not able to manage this way of learning. Teachers however are often not educated for and familiar with this learning theory.

New forms of collaborative work and student-oriented learning require students to assume more responsibility for the learning process but also provide opportunities to help shape teaching.

Although blended learning scenarios might fit better to the cognitivism- and constructivism-theory, you can't say that these are of higher quality than Behaviourism.

What we need to learn is that not all classes or topics can be conducted in the same way and that each student has to be regarded as an individual that gets along better with one or the other method.

3.2.2 Changing communication behaviour

In 2009 only 49 % of the target group were using books, but 80 % already said that they are using the internet. It can be assumed that this proportion has shifted to the benefit of the internet until now.

Figure 4. Media use in the age group of 18-29 year olds 2009 in Germany in percent [2]
Young people (e.g. students) communicate mainly via messenger services while older persons (e.g. professors) still prefer mail or phone.

Figure 6. Daily use of communication media in minutes 2016 in Germany [2]

That illustrates the challenge facing digital immigrants in dealing with digital natives.

### 3.3 Teaching behaviour

![Survey on the use of digital media at universities in Germany 2016](image)

Traditional forms of teaching still dominate. That shows we are still in the phase to enrich the teaching with digitalized elements and do not really integrate them seamlessly [4].

Digitalization is not yet considered as a key solution to the challenges arising from the growing and increasingly diverse and heterogeneous group of students. One of the major challenges we are confronted with in modern classrooms is the question of how to guarantee each student receives the individual support that she or he needs in order to successfully complete their studies. Thus, digitalization is not just another task to be mastered, but it needs to be regarded as the key for the design of successful learning processes and the key question is no longer about whether or not digital instruments, media and processes will enter the classroom at all but simply how to do it right!

The simple use of tools is only an alibi reflex but not the right answer to this question. Publishing lecture slides as a PDF document or a video-captured lecture e.g. on a Learning Management System (LMS) delivers no real added value by itself. It’s just another way to provide information without any customization to the individual requirements of each student. They are still treated as an anonymous mass without any differentiation as regards individual capabilities, learning speed etc.

Understanding the key value of digitalization as the opportunity to assess the different learning situation and progress of each student and to provide an individual and personalized learning path including selected media and automated feedback, this - on the other hand - will result in a real qualitative improvement of the learning process.

The utilization of digital teaching and learning resources aids higher education institutions in providing support to an increasingly diverse student body at the various stages of their academic career. Digital teaching and learning resources allow non-traditional students easier access to higher education, because they are more flexible regarding individual needs and wishes of students, different lifestyles,
educational backgrounds and approach to academic study. Not only professionals but also students with family responsibilities and persons with disabilities can complete a more flexible (with respect to time and location) program of study through digital teaching and learning scenarios. This also applies to students from abroad, in particular from developing countries and from crisis regions, who, through flexible enrolment and digital resources, are supported during the preparation and implementation of their study program.

The development of teaching and learning methods through online based resources stimulates, motivates and enables individualized learning experiences, which could not be replicated in the classroom on this scale. Practical and/or research-related collaborations can be developed via digital platforms which enable students to cooperate on specific projects through virtual guest lectures, panel discussions, Q&A sessions, jointly produced materials and much more [5].

3.4 Some suitable and easy to implement didactic concepts and elements

3.4.1 Inverted classroom model

The inverted classroom model includes that the knowledge transfer is placed outside the classroom and the onsite sessions are used to deepen the knowledge [6]. This model can be combined with competence oriented teaching according to Bloom’s taxonomy ([7];[8]). This also supports the “Shift from teaching to learning” ([9];[10]).

3.4.2 Audience Feedback and Quizzing with Interactive Response Systems (IRS)

IRSs facilitate interaction between faculty members and students on an on-going basis by allowing instructors to ask multiple-choice, true/false and numerical questions during class and then analyse and display the student responses in real time.

As an increasing number of systems are web-based and – following the “Bring-Your-Own-Device” (BYOD) principle – designed for the use of smartphones to submit feedback, they can help teachers to understand whether students have learned the topic taught by them or not at low costs. Reports show that the students who learn using interactive voting systems understand the subject much more quickly - which, of course, may also result from the different, more active, learning style in general. However, it has also been observed that the use of interactive voting systems in a team competition setup helps students in improving awareness, social and communication skills as well as information preservation and thus contributes to a better teaching performance [11].

3.4.3 Game Based Learning (GBL) / Competition Based Learning (CBL)

GBL combined with multimodality can be a catalyst for energy and motivation especially for students in the digital natives’ generation.

The constructionist approach with a combination of problem-based learning, game construction and multimodality might also be a way to increase pass rates in programming courses at university level [12].

In addition to the fact that this way of learning was considered to be interesting by the students, it turned out that, overall, learning outcomes were better in the years when CBL was used than in the other years [13];[14].

3.4.4 Peer Instruction

Peer instruction is an interactive teaching technique popularised by Harvard Physics Professor Eric Mazur in the late nineties [15]. Mazur developed his version of this practice to address his students’ struggle to apply factual knowledge to conceptual problems. In Mazur’s technique, multiple-choice conceptual questions are posed at key parts of the lecture. If the majority of the students’ responses (e.g. submitted by using IRSs [16]) are incorrect they are asked to turn to their neighbour to convince them of their answer. Peer instruction works on the theory that students at similar cognitive levels can at times explain content where educators may experience the “expert blind spot” [17]. Mazur claims his technique works best if students prepare before class and then test their application of knowledge in class where they have opportunities for rich feedback (self, peer and teacher). Mazur also sees this technique as a form of the inverted classroom which presents an opportunity for educators to understand the basis of the inverted classroom model.
3.4.5 Just in Time Teaching (JiTT)

JiTT is a teaching and learning strategy designed to promote the use of class time for more active learning. Developed by Gregor Novak and colleagues, JiTT relies on a feedback loop between web-based learning materials and the classroom [18]. Students prepare for class by reading from the textbook or using other resources posted to the web and by completing assignments (called WarmUps and Puzzles) online. These assignments often have complex answers; students’ work outside class serves as preparation for more complete work in class. The students’ answers are delivered to the instructor a few hours before class starts, allowing the instructor to adapt the lesson as needed. Importantly, JiTT allows the instructor to create an interactive classroom environment that emphasizes active learning and cooperative problem solving.

3.4.6 E-learning combined with electronic assessments by using Learning Management Systems (LMS)

Open source LMS like the popular representatives Moodle and ILIAS are already equipped with onboard tools to create complete e-learning suites with tutorials, videos, exercises, e-assessments with badges and so on.

3.4.7 Open Educational Resources (OER)

OER are any type of educational materials that are in the public domain or introduced with an open license. The nature of these open materials means that anyone can legally and freely copy, use, adapt and re-share them. OERs range from textbooks to curricula, syllabi, lecture notes, assignments, tests, projects, audio, videos and animations.

3.4.8 Massive Open Online Courses (MOOCs)

MOOCs are online courses that have open access and interactive participation by using the web. They provide participants with course materials that are normally used in a conventional education setting - such as examples, lectures, videos, study materials and problem sets. Apart from this, MOOCs offer interactive user forums, which are extremely useful in building a community for students, teaching assistants, and professors. The number of MOOCs have increased rapidly and if they follow the original idea they are free of charge. Only if you want to receive a verified certificate of completion, you need to pay a fee.

3.5 Recommended method - the 5E – Model

In contrast to common practice, the 5E-Model does not highlight the tools but focusses on the didactic concept. A class becomes a composition of various elements that serve different purposes.

![Figure 8. The 5E - Model](image-url)
The general formula is: Content follows the concept and tools follow the content!

Figure 9. Hierarchy of the different components

4 CONCLUSIONS

The use of digital media enables more active and student-oriented teaching. By utilizing digital teaching and learning resources, students have the option to learn at their own pace considering their individual situation.

How to treat the students as individuals can be transferred from other areas, e.g. online advertising. When we are browsing the internet, we are used to getting personalized ads, artificial intelligence and algorithms in the background know our needs (sometimes even better than we do) and show us personalized offers. Nowadays, students can expect that we regard them in the same way, so that they get the information and support fitting their individual needs.

Without digitalization this would be a not workable Herculean task, because it means in effect that the teachers must create individual plans for the single students including the necessary support. It’s obvious that we have neither the personal nor the financial resources to manage this.

But the digitalization gives us the opportunity to offer each single student an individual plan for his study. Thinking about modern didactic concepts including blended learning and inverted classroom scenarios leads us to solutions where each student is provided with personalized content, divided in self-learning-sessions for the knowledge transfer and onsite sessions to deepen the knowledge. Continuous online tests show us the individual needs of each student so that software with suitable algorithms is able to create tailored offers for the single students.

Study content can so be adapted to each student’s situation and to changes in vocational and academic requirements. The use of audio-visual and interactive media permits more authentic teaching materials and assignments. Digital formats that are designed with cross-cultural interests in mind and which relate to an international context can also facilitate joint learning and cooperation among students from various regions of the world. Digitally enhanced testing formats can be used in addition to pure performance evaluations to better reinforce and support the individual learning process of students.

Thus, a culture is created where the students are considered as clients, regarding everyone as a unique person with special needs to be satisfied.

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