

Transforming teaching for tomorrow's needs

Transformando la enseñanza para las necesidades del futuro

Dr. C. Andreas Slemeyer

Technische Hochschule Mittelhessen. University of Appl. Sciences Giesen. Germany.
Correo electrónico: andreas.slemeyer@ei.thm.de

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Abstract

For hundreds of years universities have been the main centers for disseminating knowledge, supporting learning and conducting research. With the beginning of the Digital Age this situation has been changed in a dramatic manner. The provision of information is no longer restricted to libraries; information can nowadays be found in any place on earth as long as there is access to the internet. And learning activities are no more restricted to the auditorium. Students may create their own learning spaces for working in a group. So why do we still continue with our classical teaching methods in spite of knowing how boring it might be for many of our students? Why do we neglect the dramatically increased possibilities of finding information, creating and testing new products with the help from tools provided by the internet? And: How can we meet the expectations and requirements of companies, industry and the society with regard to the competences of our future graduates? In this paper we argue about these questions.

We need to make more use of the curiosity of the students in exploring new spaces of the internet. By training their information retrieval competences they might take over a new and important role in the teaching and learning process in providing substantial information and new ideas. As long as their search activities are focused on real and everyday problems and take place in a social and collaborative environment, they will be highly motivated to share their own findings critically evaluated by their peers. This also opens the scene for new ways of assessing their contributions.

The described scenario does not mean that teaching is no longer necessary; it will still be needed for creating a general understanding of principals and methods and their application in science, but time for teaching will be reduced by far in order to focus better on the students' learning activities.

Resumen

Durante cientos de años, las universidades han sido los centros principales para diseminar el conocimiento, apoyar el aprendizaje y conducir la investigación. Con el comienzo de la Era Digital, esta situación ha cambiado de manera dramática. La provisión de información ya no sólo se restringe a las bibliotecas; en la actualidad se puede encontrar información en cualquier lugar de la tierra, siempre que haya acceso a internet. Las actividades de aprendizaje no se restringen solo al salón de clases. Los estudiantes pueden crear sus propios espacios de aprendizaje para trabajar en grupo. Entonces, ¿Por qué todavía continuamos con nuestro método de enseñanza clásico en vez de conocer lo aburrido que es para muchos de nuestros estudiantes? ¿Por qué rechazamos las posibilidades crecientes de encontrar información, crear y probar nuevos productos con la ayuda de herramientas provistas por internet? Y, ¿Cómo podemos satisfacer las expectativas y requisitos de las compañías, industrias y sociedad con relación a las competencias de nuestros futuros graduados? En el artículo se hace un análisis teórico para intentar responder estas preguntas.

Necesitamos hacer más uso de la curiosidad de los estudiantes para explorar nuevos espacios de internet. Ellos deben tener un nuevo e importante rol en el proceso de enseñanza-aprendizaje para proveer información substancial y nuevas ideas a través del entrenamiento de sus competencias de recuperación de información. Siempre que sus actividades de búsqueda se centren en problemas cotidianos reales y tengan lugar en un ambiente colaborativo y social, ellos se sentirán más motivados para compartir sus propios descubrimientos y ser críticamente evaluados por sus pares. Esto además prepara el escenario para nuevas formas de evaluar sus contribuciones.

El escenario descrito no significa que la enseñanza ya no es necesaria; será necesaria para lograr la comprensión de principios y métodos así como su aplicación en la ciencia, pero el tiempo para la enseñanza se reducirá con el objetivo de centrarse más en las actividades de aprendizaje de los estudiantes.

Key Words

Information retrieval, digital age, teaching and learning methods, collaborative learning, peer evaluation.

Palabras claves

Recuperación de información, era digital, métodos de enseñanza-aprendizaje, aprendizaje colaborativo, evaluación por pares.

Introduction

When I started my studies of Electrical Engineering in the 70s of the last century, the way of teaching and learning was more or less the same like centuries before. We just sat in an auditorium listening to the lecturer in front, taking notes from a large blackboard. The main difference was that the number of engineering students had increased dramatically during the 60s. The university management tried to solve this situation by dividing the cohort into smaller groups (which was positive!), distributing them into different class rooms and – as an attribute to the advanced technology – installed TV monitor sets for the transmission of the lecture with a fixed camera, which was poor in quality and did not allow any interaction with the lecturer. The next technical “revolution” was the introduction of overhead projectors. Most of the lecturers disliked this technique although it offered important advantages compared to the blackboard: handwriting in a natural way, the possibility to include copied material from books or other sources into the presentation and to reuse it in the next lecture.

In those days most of the lecturers were still capable of managing all the technical equipment needed for teaching, even cordless microphones. Nowadays the world has become far more complex, and we as teachers often experience a situation where the students seem to be more capable to deal with complex technical equipment. This is certainly the case for the elder generation of teachers facing the challenges of modern computer technology as “digital immigrants” whereas our students are “digital natives”.

Learning in a changing world

In times when books were rare, teachers were the masters of knowledge. Reading aloud from books in front of a group of students – this is the verbal meaning of the word “lecture”. Some teachers do still believe that as soon as they start to speak the students will start to learn. Since the beginning of the digital age, this situation has changed in a positive way, because information can be copied and distributed worldwide. Nowadays you just need access to the internet in order to find nearly any information. The generation of digital natives seems to be much more competent in browsing the internet than their teachers. But do they always understand the information they find? There is still a strong need for navigating them through the jungle of bits and putting the collected fragments into a systematic context. This should become one of the main roles and competences of future teachers.

Nowadays getting access to information is in general no longer the problem. The actual question is how to retrieve and select valuable and meaningful content from the nearly unlimited amount of data in the World Wide Web. We know from our own teaching experience that with the raise of a new technology we tend to add it to our course without considering what to replace. This leads to an overloaded curriculum where every teacher is stressed to cover all subjects in a comprehensive way, which leaves no time for real learning. Training methods of how to reduce content and how to teach in an exemplary way should become compulsory for every new teacher.

Therefore we have to ask ourselves: do we teach the right subject contents? Do our graduates meet the expectations of real professional life, especially those of the stakeholders in the industry? The following diagram in Fig. 1 depicts the situation in Germany, but this might be representative for many other countries. It shows that there is a mismatch between the expectation of the industry and the competences and skills acquainted at the university. While the level of theoretical expertise is highly ranked, we recognize a clear deficit in all other mentioned fields. Besides hands-on and methods/system know-how which might be seen as specific engineering competences, the other criteria can be attributed to the field of personal and social skills and competences. But where are the courses in engineering curricula which form these so highly demanded skills? Most of the universities do not have a satisfying answer regarding the practical application of these requirements, although there are excellent examples of how to develop technical and non-technical competences at the same time.

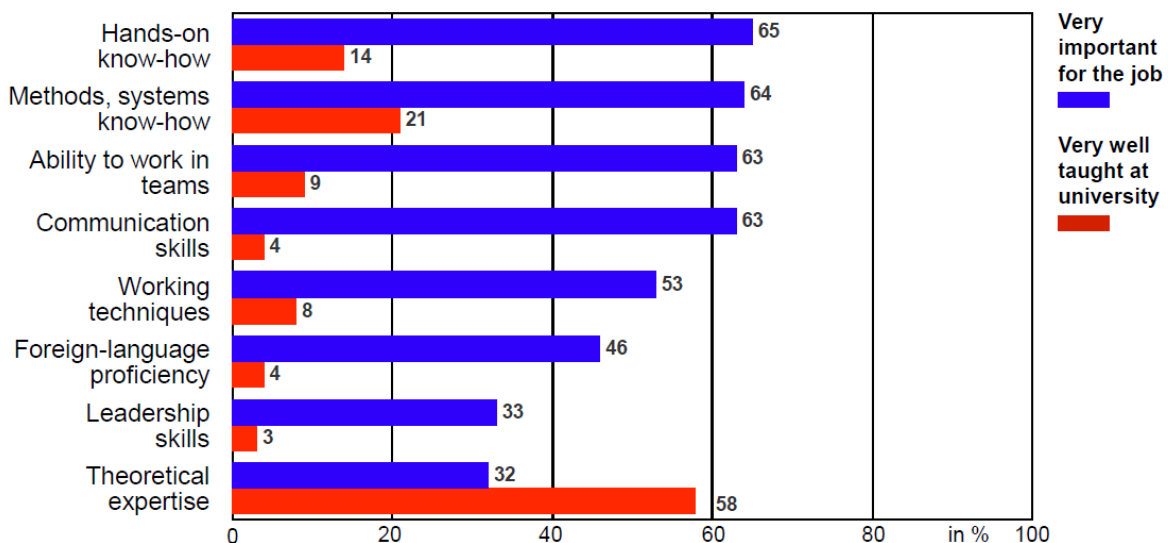


Fig. 1. Mismatch of skills as observed by young professionals in electrical engineering in Germany.[1]

During the last two decades many new tools and formats have been developed using ICT resources. An important step was the installation of open-source learning platforms like Moodle which support organizing teaching and learning processes, provide access to learning resources and web-based lectures and allow a bidirectional communication with the students. A new format was the creation of MOOCs (Massive Open Online Courses), where up to one hundred thousand students were able to enroll and pass their exam – quite impressive in figures.

However the question remains, whether and to which extend all these recent developments can support the formation of competences needed in the near future. What kind of role will the teacher play in the teaching and learning process? And which competences will they need for that?

Important steps in the development of teaching and learning methods – a personal view

Until the middle of the 19th century universities were accessible only for a very limited group of the society: the academically cultured bourgeoisie. The growth of the industry created the need for more graduates of natural sciences and engineering. This resulted in a gradually raising number of students. The foundation of many technical universities took place in this époque. It was combined with the opening of new learning spaces: scientific laboratories. They added an important element to the traditional teaching method, as students were “allowed” to put hands on instruments and material and carrying out experiments or conducting their own research. This was a step away from the teacher-centered instruction towards self-guided learning, and it proved to be more effective and motivating than solely giving instruction

The history about the needs for self-guided learning and “learning by doing” may be started far back with Confucius (551 – 479 BC):

*Tell me and I'll forget.
Show me and I'll remember.
Involve me and I'll understand.*

Another important influence came from the Greek philosopher Aristotle (384 – 322 B.C.) who stated:

*For those things which we must do after learning,
we learn to do by frequently doing;
as by building houses, we become house-builders,
and by playing on the harp, harp-players.*

Both quotes underline the need for the activation of the student in order to apply new knowledge for solving a given task and therefore transforming knowledge into new skills and competences.

Over the centuries many other pedagogical researchers continued to shape this model of "learning by doing" like John Amos Comenius (1592 – 1670), Maria Montessori (1870 – 1952) or Jean Piaget (1896 – 1980), to name a few. Although mainly working with children, their findings can also be applied to adult learning processes.

In 1896 John Dewey, a psychologist at the University of Chicago, opened what he called a Laboratory School. By conducting learning experiments with children and observing their progress over years he formulated "a set of beliefs that were to guide his successors for years to come": [2]

1. Students begin learning by experimentation and develop interests in traditional subjects to help them gather information.
2. Students are part of a social group in which everyone learns to help each other.
3. Students should be challenged to use their creativity to arrive at individual solutions to problems.
4. The child, not the lesson, is the center of the teacher's attention; each student has individual strengths which should be cultivated and grown.

In contradiction to traditional competitive approaches, such a learning environment favors collaboration among learners. The teacher is no longer in the center; he acts as a facilitator "guiding students to independently discover meaning within the subject area" (Dewey, 1897). Peers on the other hand play a valuable role by supporting this process.

So under which circumstances can learning take place in the most efficient way? Lev Vygotsky, a Russian psychologist (1896 – 1934) gave an answer to this question. He created a model called "*Zone of Proximal Development*" (Fig. 2). It describes the range of tasks that a person is able to perform by herself. Falling below the lower limit of the zone creates boredom, whereas surpassing the upper limit may cause stress except that there is a person he named "*The more knowing other*" for supporting learning. Within these limits the learner is in his comfort zone which means that he is open to new challenges for learning. By completing challenging tasks successfully, learners gain confidence and motivation to embark on more complex challenges.

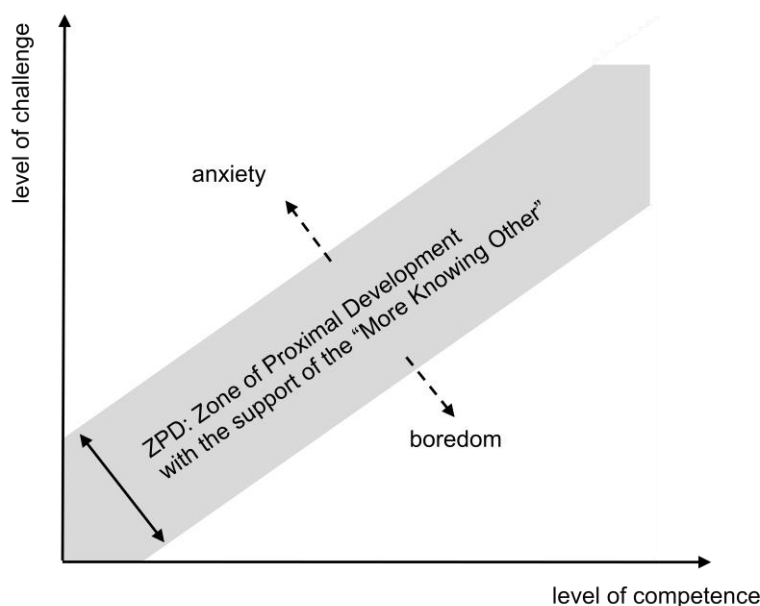


Fig. 2. Vygotsky's Zone of Proximal Development (ZPD)

In the 60s of last century many teachers felt that the static system of instruction-based teaching became increasingly ineffective. Students claimed more self-determination and freedom of learning. This led to the formation of a new paradigm of teaching and learning: the theory of constructivism. It is based on the findings of Dewey, Piaget and many other researchers in the field of educational psychology. They stated that learning is an active, contextualized process of constructing knowledge, based on previous knowledge and personal experiences. New information is linked to prior knowledge. This means that mental representations of knowledge are only subjective.

Setting the social focus in a constructivist environment means:

- to encourage experimentation and collaboration among students,
- to share their ideas,
- to stipulate and support reflection, peer review, feedback and evaluation.

Based on the principles of constructivism, a variety of teaching and learning methods that had been known for years, experienced a new interest starting in the 60s: group and project work, case studies or experiential learning. Other forms were developed like service learning, inquiry- and problem-based learning. The latter received a broad application especially in medical and engineering sciences, and even new universities were founded with a curriculum taking problem-based learning as the principal method of teaching and learning.

Need for a change in teaching and learning

In spite of the proliferation of different new teaching methods in schools during the last decades many universities remained quite reluctant for changes. This stagnant situation may become a real thread for the future of higher education, as there are many challenges given nowadays:

- a loss of orientation due to the exploding mass of information available in a more and more complex world,
- the increasing number of students admitted in spite of limited personal and financial resources,
- the information overload of many study courses due to the lack of competence to reduce course content,
- a visible change of the students' attitudes with regard to an academic engagement,
- the differences in information literacy between teachers and students,
- the competition between universities and other institutions offering informal training,
- a lack of interest of many teachers in learning about and applying new methods of teaching and learning, especially those using digital media and ICT tools,
- the willful ignorance of leaders in the management of most universities about the need for a change.

Looking into the future and based on my own experiences in teaching, my personal question is:

How can we change the curricula in a way that there will be less teaching, but more learning?

Transformation of Engineering Education

Preparing our students for their academic future can take place in different fields. The main focus should lay on establishing a motivating and challenging learning environment where the students find the time to develop their own competences and personality. This is not an easy task in times of large groups, but if we would concentrate our teaching on building up a sound basis of science, engineering principles and analytical capabilities, we would find more time for working in projects with the students. What we need, is to move "from the sage on the stage to the guide on the side" (Alison King). Inquiry- or problem-based learning applied to real world situations would be very efficient and motivating methods for extending the students' knowledge and for building up their competences.

In this context information technology will continue certainly to play an important role in the future. It will help to create and guide learning communities; provide access to an innumerable amount of information; offer tools for design, simulation and test. In an open learning environment students can enroll in web-based courses all over the world. Nevertheless we must become aware of the limitations of those technical systems. Or with the words of Charles M. Vest from MIT: "Computers do not contain the essence of teaching and learning. These are deeply human activities." [3]

Hence we must define the steps that need to be taken for preparing the future. It is my strong belief that sustainable teaching and learning can only take place if the teachers are adequately trained in order to be able to adapt to changes in society. They should have a wide repertory of pedagogical methods and the ability to flexibly react to our students' needs to support active learning the best.

Transforming teaching – in my opinion – requires a multi-perspective approach on different levels addressing different agents. Here are some personal suggestions:

a) teacher level

- new methods of teaching and learning: activation, self-guided learning, social & collaborative learning, project- and problem-based learning, feedback, self- and peer assessment, portfolio work,
- training of ICT competences for teaching, learning and assessment, web-based training courses, information retrieval and project management, integration of social media,
- development of non-technical personal competences, adapting to the role as coach, tutor, facilitator,
- professional academic staff development as a life-long learning process with teachers as "visible learners" (John Hattie).

b) department level

- coordination of curriculum planning, joint teaching & learning activities,
- development and exchange of joint course material with other departments or institutions,
- support of group activities by providing technical infrastructure (networks, learning spaces ...) and personal support (tutors),
- expansion of teacher training courses, exchange of teachers' experiences,
- reward system for new approaches in teaching and learning,
- a new appellate procedure that focuses not only on the technical expertise of applicants, but also on their pedagogical competences.

c) university management level

- development of a common vision of teaching & learning processes,
- support of change process activities,
- building strategic networks with other universities,
- joint strategic cooperation with the industry in research, but also in curriculum development.

The list might be continued including other stakeholders like government institutions. Besides a long-term perspective for funding it should establish a mechanism supporting change processes in teaching and learning.

Funding in general is a critical issue for the quality of higher education. In the management there is sometimes the view that with more money spent for ICT systems more students could be educated and graduated. This holds only true to a certain degree, as an investment in human resources, especially in tutors, can have a higher positive impact on learning.

Any change needs favoring conditions. It can be lead as a top-down or a bottom-up process, although a joint vision of both groups would be the better situation. But there are more conditions to be fulfilled, as Thousand and Villa pointed out in Tab. 1. [4]

Vision	Consensus	Skills	Incentives	Resources	Action Plan	Effect
missing	Consensus	Skills	Incentives	Resources	Action Plan	Confusion
Vision	missing	Skills	Incentives	Resources	Action Plan	Sabotage
Vision	Consensus	missing	Incentives	Resources	Action Plan	Anxiety
Vision	Consensus	Skills	missing	Resources	Action Plan	Resistance
Vision	Consensus	Skills	Incentives	missing	Action Plan	Frustration
Vision	Consensus	Skills	Incentives	Resources	missing	Treadmill
Vision	Consensus	Skills	Incentives	Resources	Action Plan	Change!

Table 1: conditions for a change according to Thousand and Villa.

Conclusion

As a final remark I wish to come back to John Dewey who made about 100 years ago a visionary statement about the need for a continuous transformation of teaching:

"If we teach today's students as we did yesterday's, we are robbing them of tomorrow." [5]

We should always be aware of our responsibility to provide good teaching. So let us increase our efforts in transforming our teaching into real learning.

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Author

Andreas Slemeyer

Technische Hochschule Mittelhessen. University of Appl. Sciences Giesen. Germany.

