Key Issues and Themes in Education

Integrating E-Learning into the German TVET system

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1 Abstract

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E-Learning and it's derivatives like m-learning are a hot topic in education world wide. Projects like the OLPC (one laptop per child) try to bring internet access to developing countries in order to enable e-learning there. The Khan Academy offers learning material for free.

But how sustainable are the didactic concepts of e-learning systems? What are the limitations of computers in teaching? How can they be integrated into the German concept of learning fields and competencies?

2 The Didactically Model of Training in the German TVET System

The German TVET system uses the so called dual educational system were trainees are trained in vocational schools and parallel in their training company. On average, a typical trainee spends 2 days per week in the vocational school and 3 days per week in the company.

The key idea behind the dual educational system the parallel on the job training in the training company and the more theoretical training of the backgrounds in the vocational school. There are several laws and standards regarding the vocational training system

in Germany, which I will introduce in the next subchapter to outline the foundations of the German TVET system.

The training company has to be meet certain requirements to train trainees. These requirements are divided into two kinds of requirements – requirements of the training company and personal requirements of the trainers.

The company must have a workplace available for the trainee and be equipped with modern tools, machines and devices, which are required to train a trainee according to the training regulations. Additionally, the training company must have access to the regulations, standards and laws that govern the training system in Germany.

The trainer (the person or persons who train the trainee) must meet the personal requirements to train trainees. Those are, for example, the eligibility to train persons who are under age. This eligibility can be revoked if someone breaks[1] laws regarding the legal protection for children and young persons (§20 Abs. 1, 2 BBiG[2]).

The professional requirement is usually met by anyone age 24 and older and with a graduation as skilled labour in the profession. But these aren't sufficient, the trainer also has to meet requirements for vocational education and training and industrial pedagogy. These are usually verified by passing the so called *Ausbildung der Ausbilder*-examination (train the trainer). The competent bodies – the chamber of industry and commerce or the chamber of the crafts – can also recognise trainers with sufficient practical experience in their fields (§20 Abs. 3 BBiG).

The vocational training act (BBiG) remits training regulations for each of the 344 recognised training professions. The training regulations define the standards for the training at a federal level – including the length of the training, the curriculum, the name of the profession, the requirements to work in the profession and requirements for the final examination. The regulations are legally binding for every company or craftsman that wants to train a trainee.

This concept leads to a vocational training system that connects a thorough scientifically sound theoretical background training in the vocational schools and a likewise thorough practical training in the training company.

2.1 The Learning Fields

Since the discussion of so called key skills[3] in the 1980s.

The Curricula for all newly created or reorganised training professions are organised using the concept of learning fields. Until the introduction of learning fields, curricula for TVET schools were organised in the classical set of subjects of the profession like mathematics, German, English or accounting, economy, commodity economics and anatomy. This lead to a segregation of teachers and their subjects taught and organised the teaching in a more or less artificial division inherited from the classic subjects taught at universities.

[1] This often happens in hotels and restaurants as they often ignore the maximum working hours for under age trainees.

[2] BBiG == Berufsbildungsgesetz == German Vocational Training Act, a federal law.

[3] Not to be confused with the Key Skills Qualification as used in England, Northern Ireland and Wales.

To overcome this segregation and allow for a more practical approach, the so called learning field concept was developed. The key idea behind the learning field concept is the modelling of the teaching in TVET schools after the practical work done in the specific profession.

To achieve this, the curriculum for a profession contains several learning fields modelled after the action fields of the specific profession. A typical curriculum contains 10 to 15 learning fields and often offers a specialisation into certain areas. Car mechatronics for example, can focus on either motor cars, commercial motor vehicles or motorbikes. Most of the basic learning fields are shared among similar professions, for example the learning field »Setting up a construction site« is included in the curricula of all building labourers like bricklayers, carpenters or scaffolders.

By using the learning field concept, the training in TVET schools is process oriented. The designers of the curriculum come together at a round table at the German federal institute for vocational education (BIBB). They usually consist of scientists and researchers from German universities, teachers of the profession, trainers from training companies and master craftsmen (Meister) and representatives of trainees. Together they analyse the professional action fields, these are the typical fields in which a skilled labour in a certain profession typically works. After identifying these action fields and finding the most common actions, the learning fields are modelled.

Each learning field consists of a title, the number of hours it should be taught, the training year in which it is taught, the aims of it and the actual content. Since the learning field is based on professional action fields and business processes it represents the typical tasks and actions of a profession. However, since it is also a didactically concept and not just a representation of a profession, it also requires a didactically reflection by the creators of the learning field.

The learning field itself enables and requires the teachers to create specific learning situations for their pupils. Every learning situation has to correspond to the learning field. But since the learning fields only define aims like *The pupils plan the creation of a construction site with regards to the industrial health and safety standards*[4] the teachers are free to create a specific learning situation on their behalf. This offers the teachers enough freedom to adjust to the learning process of the pupils and the specific class they teach. Although the curricula are set on a federal level and legally binding different schools and classes might need different learning situations. A vocational school almost exclusively training car mechatronics from the research workshop of Porsche might need different learning situations than a vocational school training 25 car mechatronics coming from 25 different small garages.

To create a specific learning situation the teachers have to use the model of complete action. This means the pupils are required to do the whole action on their own, from gathering information to planning the action, deciding on the required tools and methods to finally checking and evaluation the outcome of the action. Be it a drywall or an accounting process. This forces the pupils to solve a typical task of their profession on their own and enables – and even forces – them to learn and work autonomous. This

[4]translated from the definition of the learning field »setting up a construction site«

not only allows them to solve a task but also enables them to learn all about organising problem solving and transferring these skills to new situations with different aims.

The ability to solve a task on ones own and being able to transfer this skill to a new situation is theoretically modelled in the concept of action competence (*Handlungskompetenz*).

2.2 Competencies

Alongside with the concept of learning fields and learning situations the concept of competencies and competency development has been introduced.

Historically, the vocational training has been focussing on skills, proficiency and knowledge[5].

Skills have been defined as »all congenital and acquired psychic requirements [...] that are necessary to attain a performance« (Kirchhöfer, 2004, p 61).

Proficiencies are »automatized and stable manual, technical or mental forms of action. They are acquired by training and practice« (Kirchhöfer, 2004, p 61).

Knowledge describes acquired knowledge which consists of propositional knowledge (knowing that) and procedural knowledge (knowing how) (Sonntag and Schmidt-Rathjens, 2004).

These terms are still used in everyday language in Germany and in simpler training systems. They are also often mistaken or mislabelled as competencies, but they are clearly distinct from them.

Unfortunately, there are several dozen definitions of competencies, since ever author can make up an own definition, as long as the definition is useful. Another problem are the different kinds and types of knowledge existing in the German language since Immanuel Kant and the lack of fitting translations into English.

However, since this paper discusses the usability of e-learning systems in the German TVET system I will only use the definition of competencies used by the standing conference of the ministers of education and cultural affairs, since they are the governing body of vocational education.

The German definition(s) of competencies differ much from the definitions used in England, as Mulder, Weigel and Collins (2006, pp 18) show »that the competence approach is largely behaviouristic, that the emphasis on competence assessment is unbalanced, and that it frustrates learning and development more than it supports it. The use of the competence concept is reduced to assessment and the ability to successfully demonstrate skills and abilities. Furthermore, a critical comment is that competence is formulated in terms that are too general, which means that they do not have any discriminative power in assessments. And apart from that, the link between competence and performance is not direct. Various competencies can influence certain performance, and certain competencies can influence various fields of performance«.

Sekretariat der Kultusministerkonferenz (2007, p 15) defines the required competencies as following:

[5] *Fähigkeiten, Fertigkeiten und Kenntnisse*

Occupational competence consists of 3 independent dimensions: professional competence, self-competence and social competence.

Professional competence describes the readiness and skill to solve tasks and problems goal oriented, appropriate, method-driven and autonomous based on expert knowledge and know how. The final result can be assessed.

Self-competence is the readiness and skill, as an individual personality, to clarify, think through and assess developmental possibilities, challenges and limitations in family, vocation and public life. Own talents should be identified and developed and life choices be made. It consists of attributes as confidence, the ability to take criticism, independence, reliability and sense of responsibility and duty. The development of reflected moral values and the autonomous commitment to these moral values is another important factor.

Social competence is the readiness and skill to live and shape social relations, to appreciate and understand affection and friction, to communicate in a rational and responsible minded way. This especially includes the development of social responsibility and lived solidarity.

Methodological competence readiness and skills of goal oriented, planned approach when solving tasks and problems (e.g. when planning work stages).

Communicative competence readiness and skill to understand and organise communicative situations. And part of this is in particular also to perceive, understand and explicate own intentions and needs and those of others.

Learning competence readiness and skill to understand and evaluate information about facts and circumstances and coherencies to integrate them into mental structures and representations. This also includes the readiness and skill to develop learning techniques and learning strategies for lifelong learning in the vocation and private life.

Every learning system – traditional or electronic – has to develop these competencies to be accepted in the German TVET system.

3 E-Learning

3.1 Computers and Learning

Computers have been compared to the human brain since the first Computer, Konrad Zuse's Z3 was built in Berlin. Edmund Berkeley even titled on of his books about computers *Giant Brains, or Machines That Think*.

However, the concept of describing a computer as a brain is more than just a simplification, it is simply wrong. Computers fall under certain limitations simply by their

design. These limitations have to be considered when discussing artificial intelligence and learning in the context of computers.

The formal definition of a computer was created by Alan Turing with the following 7-tuple:

Following Hopcroft and Ullman (1979, p 148), a (one-tape) Turing machine can be formally defined as a 7-tuple $M = \langle Q, \Gamma, b, \Sigma, \delta, q_0, F \rangle$ where

- Q is a finite, non-empty set of states
- Γ is a finite, non-empty set of tape alphabet symbols
- $b \in \Gamma$ is the blank symbol (the only symbol allowed to occur on the tape infinitely often at any step during the computation)
- $\Sigma \subseteq \Gamma \setminus \{b\}$ is the set of input symbols
- $q_0 \in Q$ is the initial state
- $F \subseteq Q$ is the set of final or accepting states.
- $\delta : (Q \setminus F) \times \Gamma \to Q \times \Gamma \times \{L, R\}$ is a partial function called the transition function, where L is left shift, R is right shift.

Anything that operates according to these specifications is a Turing machine. Every program (algorithm) run by a computer is limited in it's function by the conceptual limitations of the Turing machine. A computer program can never generate a random number, analyse a text hermeneutically or predict human behaviour.

3.2 Learning Theories - the Foundation of Learning

Every scientific sound discussion of learning needs an acceptable definition of learning and a learning theory. The most common used learning theories in literature are behaviourism, cognitivism and constructivism. I will describe their key issues in the following paragraphs and discuss their usefulness for the creation of e-learning systems.

3.2.1 Behaviourism

Behaviourism has been inspired by the famous experiments of Iwan Petrowitsch Pawlow.Pawlow did research on the amount of salivation among dogs. He tried to measure the salivation in dogs when they were presented with dog food but realised that the dogs would start to salivate when they were presented with a stimulus that they connected with being given food.

Pawlows work had a huge impact especially in the US-American psychological community. Edward Thorndike and especially Burrhus Frederic Skinner used Pawlow's ideas to develop the theories of operant conditioning. Operant conditioning was later used as the base for programmed instruction by Skinner, where he tried to apply his behaviouristic theories to teaching in a classroom setting. Programmed instruction can be broken

down to 3 key ideas: information has to be broken down into small chunks; the speed of learning is defined by the learner and feedback is given instantly to the learner.

Behaviourism has been widely discarded in the scientific community due to it's disadvantages. The most common points of criticism are the ignoring of the learning process itself by considering the learner's brain to be a black box. Emotions and especially motivation is completely ignored. The tuition is usually teacher centred, that is the teacher is very active and the learners are usually not active. Typical forms of programmed instruction are teacher-centred teaching, blackboard and PowerPoint®©™ supported talks and repeating exercises. This limits the meaningful use of programmed instructions down to learning processes where new reactions should be automatized, eg. in many drill programmes in the armed forces or safety relevant behaviour of electricians. Even paramedics and emergency physicians train systems like the triage[6] in very behaviouristic training sessions (Erpenbeck and Sauter, 2007, p. 153).

Behaviourism has been popular in US-American psychology and pedagogy and is nowadays still used by companies that offer human resources development. Behaviourism has also been very popular in e-learning systems of the first and second generation. This is not very surprising, since computer programs are limited in their abilities and programmed instructions can easily be implemented as computer program. Another factor might be that computer scientists (and also often managers in companies) find programmed instructions and behaviourism in general very appealing, since it allows one to create training programmes very easily and they allow for easy measurement of training success. And in the field the failure or problems of such a training programme can easily be blamed on the learner, since programmed instructions completely ignore the learning process and important factors such as learning motivation.

Despite all criticism, programmed instructions can still be used in training programmes or e-learning systems. Programmed instructions divide the learning object into several small chunks. After finishing one chunk, the learner has to pass a test to proceed to the next level. This helps the learner to learn a high amount of data and facts in very short time but he has to follow the programmed way of instructions in it's very own linear fashion. A learner is not able to take a different route to reach a learning objective. The programmed instructions also are not able to adapt to an individual learner, so especially already advanced learners often dislike these e-learning systems and feel »like they are forced into a straight jacket« (p. 106 Schulmeister, 2007).

Behaviouristic elements or programmed instructions can however be used as parts of a blended learning system. They can be useful in parts where several reactions have to be trained or facts/data have to be memorised. But the learning management has to keep in mind the different learner types and their level of advance and allow them to leave the single pathway of chunks. If these conditions are met, programmed instructions can be used to train learner in these rather simple tasks or knowledge of facts, eg. in vocabulary trainers or programmes to train computer programmers in special programming habits (cf Erpenbeck and Sauter, 2007).

[6] determination of the order in which wounded are treated, usually used in the military or at larger accidents

3.2.2 Cognitivsm

The critique of Behaviourism lead to the cognitivist revolution in the USA in the 1950/1960s. Influenced by the early works of Kurt Lewin and the Berlin School of Gestalt Psychology in the 1920s (cf. Lewin, 1926; Lewin, 1922), Noam Chomsky's critique of B. F. Skinner (cf. Chomsky, 1959) and Ulric Neisser (cf. Neisser, 2014).

Cognitivism describes the learning process (formerly ignored by Behaviourism) as an active process of perception and undergoing experiences. New knowledge is created on the base of already existing knowledge structures of the learner. The learning process itself plays a vital role in cognitivism, the learner is tutored by a teacher in solving specific problems. The learner has to find the solution and the methods and tools for the problem solving on his own. Learner and teacher communicate with each other in two directions.

Erpenbeck and Sauter (2007, p. 156) criticise cognitivist learning settings for being to laboratory like because cognitivism is said to ignore emotional motivational factors. These laboratory style settings are too much tailored to fit the already existing previous knowledge of the learner resulting in a learning setting that is not really realistic and hard to transfer to a work situation.

The authors suggest to develop e-learning systems that focus on usability and adaptivity. The teacher or e-learning system has to interact with the learner and react on his behaviour. But this would require the e-learning system to diagnose all aspects of competency development and to enable the learner to make own decisions about the learning path.

3.2.3 Constructivism

Constructivism is not a single learning theory with clearly defined features like Behviourism or Cognitivism. Constructivism is more of a Weltanschauung that can be used to explain the creation of a representation of the world in a human's mind (cf. Siebert, 2002; von Foerster and Pörksen, 2006; von Foerster, 1993).

Maturana and Varela (1980) is considered to be one of the ground breaking works of Constructivism. The authors created the concept of *autopoeisis* to describe the self maintenance state of living cells. It has since then been introduced into psychology, sociology and philosophy to describe the process how the human mind creates knowledge.

Another backbone of Constructivist theories are the works of Jean Piaget. He was also researching the process of knowledge creation in his theory of *genetic epistemology* and laid the foundations of developmental psychology as distinct field of psychology (Piaget, 1996). His student Hans Aebli later became one of the founding fathers of pedagogical psychology with his works (Aebli, 1993; Aebli, 1987).

The key idea of constructivist creation of knowledge have been set out by von Glasersfeld (1995, p. 51):

- Knowledge is not passively received either through the senses or by way of communication;
- knowledge is actively built up by the cognizing subject.

- The function of cognition is adaptive, in the biological sense of theterm, tending towards fit or viability;
- cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality.

Based on these ideas, several authors have created a constructivist didactic. Erpenbeck and Sauter (2007, pp. 157) base their recommendations for successful e-learning systems on constructivist theories and describe learning as an:

active process creation of knowledge can only happen through autonomous and intrinsic active involvement of the learner;

constructive process a direct transfer of knowledge is not possible, the learner constructs new knowledge based on his already existing knowledge structures and mental representation of the world, the learning process has to be designed after the individual biography of the learner;

emotional process Stress and fear influence every learning process in a negative way, learning under pressure stays shallow and superficial. New knowledge is created on the base of positive emotions like success and joy;

self-organised process learning is a self-organised process by the learners, they manage the whole learning process autonomous and adjust it to their individual learning tempo;

social process learning is a social process, knowledge is created while interacting with others and reflecting on the learning process;

situative process new knowledge is created in the context of learning situation and learning system, learning should be perceptible and transferable into the lifeworld.

Lifelong learning and learning on the job can be supported by creating a learning environment – be it an e-learning system or a traditional training – that enables a self-organised learning process and supports the connection of learning and tasks that have to be solved in the process. Modern communication tools like Web 2.0 enable the creation of well designed and successful learning systems.

The roles of learner and teacher in a constructivist learning system have been described by Erpenbeck and Sauter (2007, pp. 158) in the following way:

- learner and teacher communicate bi-directional and in an emancipated way;
- they work together to identify and solve problems;
- teacher cooperate with the learner and support them at problem solving, they act as a learning coach;
- the teacher control the learning process based on the stipulated learning objectives;

- they flank the learning process and coach the learner;
- the create opportunities for the learner to create their own learning process and individual processes of knowledge construction.

3.3 E-Learning and Competencies

Every definition of competencies in psychology or pedagogy include motivation in it. Simply because there is no action without motivation – be it extrinsic or intrinsic. Manfred Spitzer, head of the ZNL TransferCenter for Neuroscience and Learning in Ulm, describes some interesting experiments with several apes. To research extrinsic motivation of learning, some apes were conditioned to press a certain button on a small keyboard to receive a small amount of fruit juice.

Erpenbeck and Sauter (2007, p. 137) complain that the current research and development of e-Learning ist rather driven by computer science and technical processes and is more intended to develop shunting yards for expertise and process knowledge. They created an overview of computer mediated teaching and learning forms and assessed their strength and weaknesses for competency development.

Virtual Communities Virtual Communities can be divided into moderated learning communities and non-moderated communities of practice. The technical implementation of both does not differ much but the management of the communities is organised in a different way.

Learning Communities are usually used in the framework of a blended learning system. The purpose and objectives are usually derived from a formal curriculum. They usually implement high quality learning processes that have been didactically processed and are managed with different tools and methods.

Communities of Practice are distinct groups that are usually organised in a loose way. They are implemented to allow persons who have to solve the same or similar tasks to meet and exchange their experiences and ideas. They are pretty wide spread in fields like project management or software engineering. The technical implementation can be very similar to learning communities with the use of message boards, mailing lists, chat rooms, video conferences etc. However, the use of the technical implementation differs a lot. Communities of practice don't implement a formal curriculum and therefore don't know formal learning objectives and matching didactically methods. Instead, individual learners or users choose their own learning objectives, contents, topics, strategies, methods and evaluation methods. The technical challenge when designing and implementing a software for a community of practice lies in developing technical methods that allow and enable the self-organisation of the community without constraining the community to much or ending up in endless discussions and flame wars.

newsgroups, mailing lists and message boards Usenet newsgroups and mailing lists already exist since the early 1970s and are still active and used for discussions to

certain topics. The big advantage of both systems is the asynchronous communication. This means the communication partners don't have to be on line and available simultaneously like with a chat or telephone conference.

The more recent message boards gained popularity in the 1990s and lowered the technical knowledge required to access newsgroups and mailing lists dramatically. This lead to a massive rise of message boards that focus on a certain topic – be it a football club, a computer game or model making. Message boards additionally offer all technical features a HTML based website can implement, therefore didactically elements like images, videos, animations or quizzes and surveys can be included.

Each of the three media are not just there to broker information like a knowledge base (eg. Wikipedia) but allow for individuals to cooperate in group work, which would not be possible without the internet.

A great example is the acceptance and use of mailing lists in open source projects. Open source is in general a piece of software were the source code is freely available. Prominent examples are BSD, Linux, LibreOffice, The Gimp or Mozilla Firefox. I have been involved in the NetBSD project, an open source operating system started in 1993 and derived from the original BSD of the University of California at Berkeley. Almost all development work by the more than 350 developers and numerous contributors is coordinated via mailing lists. Synchronous communication eg. chat rooms or video conferencing would not work, since all developers live in different time zones and continents around the world. The available mailing lists are a great tool to become involved in the project.

Weblogs and Wikis Blogs and wikis are not only tools for knowledge development and transfer, but also include personal and social competencies. However, more research is required to include blogs and wikis in organisations and communities of practice. Wikis could be combined with yellow pages in organisations to find competent members of an organisation. Blogs could be used as portfolio or learning journal in formal research or learning processes. A special form of blogging would be a vlog or video log, where the log entries are not written but recorded with a camera.

Computer games Computer games always automatically develop competencies, and be it just hand-eye coordination by using a computer mouse to click at things.

Especially strategy games like World of Warcraft, EVE online or ArmA 2 also develop social competencies, soft skills and strategic planning and management. They enhance all the skills that are usually required in skilled labour, yet they are not used in a professional and scientific sound way Erpenbeck and Sauter (2007, S. 139).

Simulator The use of simulators has been a standard for several decades in the training of aircraft pilots or tank drivers. Since powerful computers and 3d projectors are cheaply available now simulators can be created with standard office PCs.

Simulators can be used in assessment centres to simulate work tasks very realistic and assess the competencies of a candidate. Another use is the very realistic training and particularly self organised learning. It is also possible to simulate very specific or dangerous situations, for example the flight through a thunderstorm or the use of a crane during a heavy storm. This trains pilots or drivers in a realistic but cheap way to master dangerous situations.

Folksonomy/Tagging Tagging creates a user generated tag or taxonomy of data sets like photos, blog entries or a bibliography. Social tagging or a so called folksonomy (a portmanteau of folk and taxonomy coined by Thomas Vander Wal in 2004[7]) is a process where different users collaborate on creating tags or their individual tags are joined together in a database. A good examples is Bibsonomy.org, a web based bibliography that supports tags. Every user using Bibsonomy.org has a unique user name under which he can save his own bibliography including the tags he has given the different entries. However, everyone can search through the database and look up interesting tags like social psychology or neuroscience. This allows any user to profit from the bibliographies of others by accessing their lists and tags.

Semantic Web The semantic web is acutally a meta method of information and knowledge management. The key idea is to encode a semantic into concepts, terms and relations. This is done in order to enable computer programs like search engines to »understand« the semantics (meaning) of a text. An example would be the ability to discriminate the family name *Smith* from the occupation of being a metalsmith. This concept has been described as early as 1945 by Vannevar Bush in »As we may think«[8]. Computer science has done a lot of research with regards to this field, yet there has been no convincing concept or program been develop that is able to operate with the meaning of something. And coming from a cognitivist/constructivist background with extensive experience in database development I doubt that there ever will be a computer program being able to handle meaning.

Mobile Learning is a learning form where the mediated knowledge is broken into smaller parts (»chunks«). The learner is then able to consume those chunks with a mobile device (tablet, smart phone) when and where he wants to. It is imperative for the designer of such an environment to consider these special circumstances.

4 E-Learning in the Learning Fields

Since there are 344[9] recognized training professions in Germany I will focus on the IT specialist training.

[7] `http://vanderwal.net/folksonomy.html` as of 2014-12-06

[8] `http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/` as of 2014-12-06

[9] `http://datenreport.bibb.de/html/5771.htm#schau_a4_1_2-1` as of 2014-12-06

Method	Competencies: Personal C.	Action C.	Professional C.	Social C.
Folksonomy		medium	strong	
Semantic Web		medium	strong	
P2P	medium	medium	strong	stark
Blog	strong	medium		medium
Vlog	strong	medium		medium
Moblog	strong			medium
E-Portfolio	strong	medium	medium	
Wiki	medium	medium	medium	strong
Bliki	medium	medium	medium	strong
RSS			strong	
RSS-Feed	medium	medium	strong	
Podcasting	strong	medium		medium
M-Learning		medium	strong	
Rapid Learning		medium	strong	

Table 1: Level of Dissonance and Labilisation, (Erpenbeck and Sauter, 2007)

The IT specialist was introduced in 1997 alongside with management assistant in informatics, management assistant in IT systems and IT system technician.

The official curriculum[10] for the IT specialist consists of 11 learning fields:

1	The Enterprise and it's environment
2	Business processes and operational structure
3	Sources of information and working methods
4	Simple IT-Systems
5	Professional Englisch
6	The Design and Implementation of application systems
7	Interconnected IT systems
8	Market and Business relationships
9	Public Networks and services
10	Administration of IT-Systems
11	Accounting and Controlling

Table 2: Learning fields in the KMK curriculum of IT specialists

Especially the technical fields (4, 6, 7 and 10) can make use of an e-learning system.

[10] `http://www.kmk.org/fileadmin/pdf/Bildung/BeruflicheBildung/rlp/Fachinformatiker97-04-25.pdf` as of 2014-12-06

5 Conclusion

All newly created or modernized training professions in Germany are organised in the learning field concept and use the competency model. This requires every e-learning system that wants to be integrated into the training system to follow these concepts. However, the design and implementation of such a concept in an e-learning system is not easily achieved.

The underlying constructivist approach of the competence model cannot easily be translated into a computer program. There has to be a lot of research done to achieve true competence development in e-learning systems. Current e-learning systems focus too much on simpler behaviouristic (programmed instructions) or cognitivist approaches in their didactic.

The required bidirectional communication between learner and teacher and the adaption of the teaching system towards the learner cannot easily be adapted into computer programs. Mechanisms like machine learning or data warehousing could be used to analyse the behaviour of learners, but this could be a problem with regards to data privacy laws. Another problem for machine learning and adaption to users is the amount of data required. The learner has to use the system for a certain time until he generates enough data that can be analysed by the algorithms.

Computers could be used to mediate the communication between learners and teachers, be it in a simple 1:1 relation or m:n. Especially the newer Web 2.0 tools like social networks, Wikis or computer games can easily be used to bring learners and teachers from all over the world together. But such a system would be merely a computer mediated communications system. The teaching would still have to be organised by the teacher(s).

Other systems like a folksonomy or a web forum can be used to support the teaching. In fact, there is a popular web forum available at `www.Fachinformatiker.de`. Many of the discussions there focus on the subject matter taught in the TVET school or on the final examination project. This system is very successful in what it does, but it is still just a communications system. It allows every IT specialist to enter a forum where other IT specialists hang out, so it merely emulates a school yard.

Simulations and simulators seem to be more promising. Especially the technical IT specialist learning fields can benefit from them.

Hubert Feyrer created a virtual Unix lab as his doctoral thesis at the Universität Regensburg. The lab is an e-learning system with diagnosis via a domain specific language as base for an architecture for tutorial assistance and user adaption (Feyrer, 2007a; Feyrer, 2007c; Feyrer, 2007b).

However, »[t]he Virtual Unix Lab is intended to provide an adaptive tutoring system, not a learning management system« (Feyrer, 2009, p. 8). The objective of the lab is to tutor students hearing the lecture on system administration and taking the corresponding exercise. So it is used in a blended learning setting and was supervised by the tutors of the university at it's implementation and evaluation. It also focuses more on skills, proficiency and knowledge than competencies, especially professional action competence.

But it is a good starting point for the evaluation of adaptive tutoring systems that

might be further developed to implement true competency development. Or at least that subset of competency development that can be implemented as a computer program.

Another huge problem might be the management level of using an e-learning system. There are several learning management systems like the popular Moodle that implement a lot of management functions. These functions have to integrate into the well established German TVET system. This includes the management of school classes, learning fields and data of the pupils. All this has to be done while observing the strict German data protection laws.

To sum it up, a wide variety of e-learning systems exist, but none of them follow a cosntructivist, competence oriented approach. So none of the existing systems can be used on it's own in the German TVET system.

Some of the existing systems can be integrated into the training system in a blended approach. But for a complete e-learning system the underlying didactical models of the TVET system have to be observed. And that has not been implemented yet.

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