A didactic-methodical concept for virtual interactive vocational education and training

With advances in new technologies, education is rapidly taking off in new directions that will substantially change the way learners learn but also the way teachers teach. In today's digital world, finding new ways to engage students is becoming more difficult. When home technologies such as mobile phones, tablets and games consoles are highly advanced, finding educational engagement with technology in the classroom can be even harder, especially if the technology deployed there is less advanced than the technology used at home.

For this reason, new technologies such as tablets and smartphones have been used in the classroom in order to improve the learning process. Further new technologies that have been making headlines in recent years are virtual reality (VR) and augmented reality (AR). Relevant studies show the exponential growth of these innovative technologies in different areas and in many parts of our lives.

Education will benefit from these technologies. Vocational training will also begin to feel the impact of virtual and augmented reality over the next few years. The ability to experience training in 360° is invaluable e.g. with VR it is possible to view a working engine from all angles without leaving the classroom. Vocational training is all about the interplay between theory and praxis i.e. gaining knowledge and building experience to learn through practice. The key to success in vocational training is giving Trainee the opportunity to experience the reality of being in an unfamiliar working environment, but this is often difficult and expensive to achieve. AR and VR offer in this context a great advantage by enabling students to go back through scenarios again and again, without additional expense or inconvenience and to revisit challenging situations at their own pace. The Strength of VR/AR in technical education lies in the fact that it makes students want to learn more about the topic, which in turn contributes to the success of the lesson.

Practical usability in educational institutions

We believe that the use of new powerful digital interaction devices based on VR and AR as an educational tool is necessary and it brings great benefits to our diverse target groups in improving the learning process. They play an essential role in improving the practical knowledge of trainees and their ability to solve problems independently. They enable the transfer of the students' theoretical knowledge to a real industrial problem without taking any risks. This can be applied in experiments that have proved difficult to perform, in traditional

classroom settings, or in training and analysis of unrealized or elaborate processes.

The virtual environment offers the trainees the ability to interact and experiment with items and constructs in a similar way they would do in real world. The AR-Glasses promise through the free visualization meaningful application scenarios for the teaching and learning concept; the wearer
is supported during his activity by additional context-based virtual information and objects. The recording of VR scenario data allows the teacher to reconstruct a teaching situation in order to discuss individually made mistakes with the student in an educational conversation. The ability to individually address the strengths and weaknesses of the learner improves the learning process. The learning scenarios are generated according to the educational goals and adjusted to the progress of training and target group. Leaving reality using VR-Headsets can help the trainee to perform and understand certain tasks that previously could not be realized due to the elaborate designs and security considerations.

For this reason, the integration of technology tools into the curriculum is becoming part of good teaching.

Didactic-technical conception of an AR/VR-based education and training

The support of education and training by VR / AR consists of two sub-concepts:

- *training process* of the trainees during the lesson using VR headsets and
- *support process* throughout the work in the labs using AR glasses.

A didactic-methodical and technical integration of these technologies in the learning and education process requires a purposeful conception going through the four major phases: Analysis, design, implementation and evaluation.

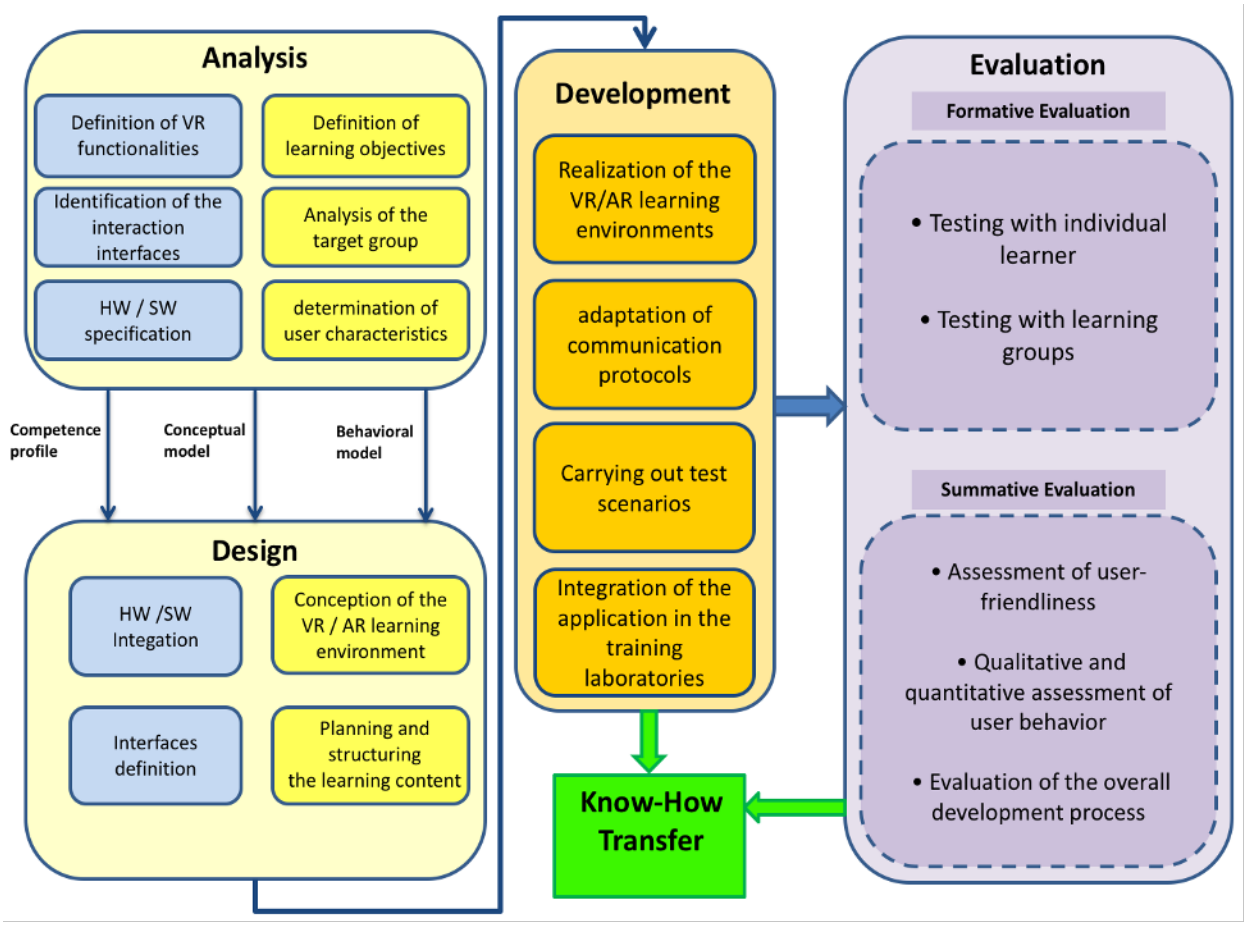

Illustration: Didactical-technical concept

1. Analysis and specification

In this phase, courses and learning objectives are identified and an analysis of the target group is carried out. The learner is considered as an actively constructing individual in this model. Initial requirements of learners can be determined by pre-tests on a representative sample of learners or by a selection of the results in previous training processes and by interviewing their trainers. This step enables the determination of the addressee's characteristics for the learning situation (previous experience, knowledge, skills, learning motivation, cognitive strategies, mental models). The behavioral model of the task can be determined according to the desired goals and functionalities of the virtual environment as well as to the behavior of the user and its corresponding action-level. The learning scenarios and situations of the VR should be selected based on the learning mode of the learners (level of internal differentiation).

2. Design and modeling

The results from the analysis phase are used in the design phase as a basis for planning and structuring the content, including learning activities, exercises and learning tests. The learning material should be prepared with didactic tools (such as proven examples, applications,

notions, rules, questions and tasks). This step consists of selecting the appropriate behavioral interfaces and the physical environment in order to determine the appropriate mental representation for user interaction. A physical model of the virtual environment is created according to the application goals. The selected 3D content is prepared (object scan, photogrammetry, CAD constructions). The interfaces for the software and hardware integration are defined and the communication protocols for the interaction are adapted.

3. Application and system development

In the development phase, the interactions, exercises and graphics are developed and incorporated into test scenarios. The hardware and software are integrated, the headsets are tested for software connection and the virtual learning environment is built up. The learning environment is characterized by many factors, such as the handiness, degree of reality, interaction and intuitiveness. VR is especially effective when used in an interactive environment. The interaction with the content should therefore be implemented as realistically as possible in order to promote active learning. The learning system should be straightforward, easy to access and uncomplicated. Functional tests should be performed in the various stages of development.

4. System and process evaluation

In the final step, tests are carried out to evaluate three aspects; some tests evaluate the usability of the interfaces. These tests make it possible, on the one hand, to quantify the adequacy between the measurement properties of the system and the psychophysical properties of the user. On the other hand, they allow the actual usage behavior of the interfaces to be quantified and qualified in order to verify if they correspond to the desired and programmed one. It is also a matter of analyzing the mental strain while using these interfaces. The results of these tests are intended to improve the interfaces design process. Further tests evaluate the data history to measure whether and how well the goals defined in the analysis phase were achieved. The reversibility of actions also makes it possible to bring a strategy into question and to examine the impact of a new one. Technical tests have to be carried out in order to optimize the overall development process for quality, safety and robustness, as well as cost and improvement of functionality if necessary. The following methods are suitable for evaluation: Assessment based on behavioral observation and analysis, content and media analysis, performance measurement, comparative investigation, interview survey, cost-effectiveness analysis, etc.

Pedagogic-didactic added value in vocational training

A conscious use of the VR/AR systems benefits the educational process, because the VR environment with the 3D representation makes the teaching or training more interesting and enjoyable. At the same time, it provides learners with the necessary information needed for their educational goal.

In order to ensure the didactic added value in the use of VR and AR in a vocational training framework, the following points should be taken into account in the concept: the educational goals, the technological aspects, the cognitive abilities of the trainees and the pedagogical strategies of goal-oriented teaching. By taking into account the intuitive, realistic interaction and high psychological involvement of the human being, the VR/AR learning system will be made user-friendly, which in turn increases the effectiveness of the learning.

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