Technical and Vocational Education and Training: Issues, Concerns and Prospects 28

Jens Drummer
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Vocational Teacher Education in Central Asia

Developing Skills and Facilitating Success

UNEVOC Network Member
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Preface

Over the last 3 years, internationally approved curricula have been developed in the GIZ programme “Professional Education and Training in Central Asia” in the area of food technology and vocational training. With the aim to ensure sustainability and to assisst in the implementation of the programme, an 18-month-strategy for “project-based learning” titled USPECH (Russian for “success”) was carried out. The articles compiled in this volume shall serve as scholarly contributions when describing the subject areas of the programme in which participants from Kazakhstan, Kyrgyzstan and Tajikistan closely collaborated. The basic idea of USPECH is described best with the words of Dr. Matthias Wesseler, one of our international experts, as found in the project proposal:

“Effective training for TVET quality teaching and learning is necessary, but it also can be a great professional pleasure for participants as well as for trainers and organizers if we succeed in meeting the participants’ needs and interests (sometimes ‘tacit’ ones) – and to apply methods which generate space for creativity and innovation”. With that approach, the book intends to serve both the international TVET sector in Central Asia and the global TVET research community, as well as their interest in state-of-the-art understanding of recent sectorial developments.

Indeed, it was most enjoyable to see how the trust and respect within the 30-headed participant group had grown and how the exchange of experiences mutually served all parties. Faculty of Education of Technische Universität Dresden played a decisive role, an important aspect of which was the implementation of the impressive results into their own work in the VET area in Germany.

I would like to express my deep gratitude to all participants for their professional commitment to the USPECH project. Thank you for the outstanding hospitality, which we have experienced in seminars in all three aforementioned Central Asian countries! I am convinced that such a team has the potential to initiate reform processes in the field of professional education in the respective countries. Accordingly, the strength and the motivation came from the awareness that our work will improve the education and the perspectives of young people in Central Asia and will pave the road towards sustainable development in their societies – and beyond.

The publication will be supplied as a printed book in the Russian and English language. It will additionally be available as an open access publication, in the hope that it will remain an active contribution to future work in the field of professional teacher education. Besides, it is our aim to build a bridge between the partners and the practice and science platforms in Central Asia and Europe, as well as to offer possibilities for common action.

July 2017 Uwe Munzert
Bishkek, Kyrgyzstan

Greeting for the GIZ Publication as Part of the Regional Programme "Professional Education and Training in Central Asia"

One of the great challenges of our current time is providing distinguished educational and vocational training opportunities. Vocational education and training are of immense importance in shaping life perspectives and are a vital prerequisite for active participation in any community. Long-lasting competitiveness and well-paid employment are possible only with sound training and professional development and are essential for the sustainable development of successful economies.

Tomorrow's society will depend even more heavily on education and vocational training. This applies to Hessen and all of Germany, as well as the entire world, calling into action all social actors. The German Development Cooperation – Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH – helps to meet the growing demands by supporting the international programme "Professional Education and Training in Central Asia".

A federal company with its headquarters in Hessen, the GIZ strives to contribute to the sustainable development of international cooperation throughout the world. For more than half a century, the company has been cooperating with various partners to develop solutions, providing people all over the world with perspectives and permanently improving their living conditions. The project-based learning programme, involving participants from Kyrgyzstan, Tajikistan, Kazakhstan and Germany, follows these goals as well. As part of the "USPECH network", important research partners, such as the Institute for Vocational Education at Technische Universität Dresden and the Institute for Food Technology at the University of Kassel, are joining forces to combine their expertise. With the slogan "Zukunft gestalten – Shaping the future", the USPECH offers a wide range of information on existing concepts and applications this year.

The publication at hand summarizes the results from the close cooperation between Central Asian and German partners. It provides a glimpse of the current implementation of successful vocational training in these economic regions. Germany's experience with the "dual model" is of particular interest, shaping the professional opportunities and perspectives of Germany's youth in a very distinct way.

The organizers and editors deserve all due credit and thanks for their great work. I genuinely hope the publication attracts an extensive and interested audience.

Prime Minister of Hessen Volker Bouffier

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Was involved in consultancy activities in more than 60 countries and published numerous articles and books and works today as an independent consultant.

Part I
Introduction

Chapter 1
Recent Technological Challenges in (Vocational) Education

Thomas Köhler and Jens Drummer

1.1 Introduction

It is rather difficult to obtain precise figures of trends in the current training and eLearning market, eLearning being understood as any activity by which learning content is partially or totally delivered by digital means, including open and distance learning (ODL) platforms, massive open online courses (MOOCs) and serious games (SG) as discussed by Marquet and Köhler for Europe (2017) as well as for the German school sector by Köhler (2017). Indeed educational approaches are embedded into the industrial configuration of the respective era – even though such is often a quite conflicting circumstance.

As described in recent forecast studies, which are mainly reports delivered by consultancy agencies or produced by international bodies, Western Europe is the second largest market in the world after North America and that global Western European 2016 revenues will be around €7.3 billion (Docebo 2016) of the €96.3 billion for the entire world. As a comparison, the video game industry should generate (only) approximately €87 billion in revenues in 2016 (Newzoo 2016). Central Asia may be described as a still growing region but with a similar variety of specific situations and conditions. Not only for Europe educational statistics however confirm that adoption of digitization in the educational sector is rather heterogeneous and lacks behind other branches (Erber et al. 2004; Köhler et al. 2013; Pscheida et al. 2015). That rather late adoption will be addressed to some extent by the subsequent sections of this paper.

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Although the quoted data is probably unverifiable and differs in other continents, figures show that the eLearning sector has surprisingly become more important than the gaming sector and that more and more people, students, workers and individuals are now placed in the situation of being tempted or obliged to learn remotely, which gives an overview of not only the existing industrial and business competition but also the remaining scientific challenge. This situation may be interpreted as the consequence of the progressive invasion of Information and Communications Technologies (ICT) in all activity sectors since the beginning of the 1970s. In fact, ICT has reduced the duration of innovation cycles considerably (from several years to several months, even weeks sometimes) due to the need for the industrialization of a new product. This is in Europe particularly true in automotive sectors, which employ directly or indirectly approximately 9% of the working population in France (Le Monde 2015) and 14% in Germany (statement of German government 2017[1]). By analogy, ICT is now considered being able to reduce the timeframe of adaptation of the working population to the requirements of the globalized economy and competition by increasing the level of competence without leaving the office or the factory (Edwards and Usher 2001). After having changed our production processes, digital means are now expected to serve our need for knowledge acquisition and competence development required by permanent innovation.

ICT is also considered to be a part of the solution for developing countries to reach the 2015 objectives for education, defined in 1990 during the Jomtien World Conference on Education for All (UNESCO 2014), and that still requires a good deal of effort from the countries concerned. In particular, the objective developing adult and continuing vocational education can benefit from the delivery of training content by digital means, in other words through eLearning products of good quality, especially for teachers and teacher trainers. In this regard, the role of ICT in lifelong learning has been recently reaffirmed in the Education 2030 – Incheon Declaration (UNESCO 2016). With a focus on rural areas – as they are representative for many regions in Central Asia as well as some regions in Europe and based on the "Rural Wings" project – a wide range of usage and usage scenarios of Internet via satellite in rural areas have been tested and evaluated by the contractors for the EU (see Kahnwald et al. 2008).While first online learning scenarios for rural areas were aimed at recognizing users (teachers, students, trainers, entrepreneurs, farmers, administrators, citizens, etc.) and capturing the diversity of their online activities. As a traditional broadband connection could not be realized in any of the cases, it was necessary to develop a new form of online learning applications and tools that could improve the everyday life of the rural community (e.g. access to educational resources, vocational training, e-governance, lifelong learning, etc.) (cf. Köhler and Neumann 2014).

In short, educational issues as well as economic issues are placing ICT in education and training as one of the main levers for the enhancement of the professional

[1] Retrieved from https://www.bundesregierung.de/Content/DE/Magazine/emags/economy/051/sp-2-die-automobilindustrie-eine-schluesselindustrie-unseres-landes.html on 11.03.2017

conditions of people and countries, so that the design of virtual learning environments (VLEs) becomes one of the key aspects of the success, but also the failure, of vocational education and lifelong learning. Of course, research does not claim to offer a single solution to this complex problem. Nevertheless, if respective professionals intend to increase both quality and observable effects on the knowledge acquisition and competence development, the wide adoption of ICT in vocational training and professional learning together with new tool may lead to the adequacy of human resources with social demands. Such understanding is the starting point for both the operationalization of generic methods and the subsequent designing of respective virtual learning environments.

1.2 Methodology of the Origination of the Present Article

In order to initiate this analysis, a pre-empirical study of theoretical and practical approaches from the author's point of view first took place. The basis for this was, in essence, the review of current discourses by means of educational, educational and educational literature. The reason for this was the cooperation in a working group on open educational resources at the German Education Ministers Congregation (KMK).

On the assumption that this selection is incomplete and also interpreted, and finally limited to the German and English language areas, the discussion with a total of eight groups of experts took place in a second step. Thus, the author was able to discuss his reflections, observations and its interpretation in the period from April to October 2016 with (I) a group of international vocational training experts in Central Asia, followed by (II) seminar leaders of general and (III) professional teacher training from all over Germany and (IV) working in two working groups to deepen them at an online conference with (V) Mongolian computer scientists as well as (VII) postgraduate students in the field of personnel development and finally (VIII) supervisory staff in enterprise training.

It turned out that the assumptions were incomplete on the one hand and will require further clarification. However, the question of a further empirical reasoning has never been raised. For the deepening of the considerations in the elaboration of the text, the author's thanks go to Christian Heimann (Department of Science, Education and Culture Baden-Wurttemberg), Beat Döbeli Honegger (Swiss Pedagogical University Zurich), Jens Drummer (Saxon Education Institute Radebeul), Matthias Wesseler (Unistaff Associates Kassel) and Werner Wollersheim (Leipzig University) not least together with the participants of the International Conference on "Future Trends in Technical and Vocational Education and Training" in April 2017 in Bishkek, for their encouragement to deepen the topic further.

1.2.1 Promises of User/Learner Involvement in Online Education by a New Openness Through OER and MOOCs

The conditions of school, vocational and continuous learning change globally; teachers are faced with the challenge of using digital media extensively in teacher training and vocational school, or to allow and support their use. Novel media concepts such as BYOD (bring your own device) or open educational resources (OER) represent only the head of comparatively extensive development dynamics.

What promises and challenges for vocational school and vocational teacher training are based on new media? A series of media didactically novel concepts is currently attracting considerable attention in non-school educational practice and increasingly also in specialist disciplines in education sciences. It is about the availability of private and personal technological infrastructures (BYOD) as well as about the question of institutional openness and openness (OER, MOOC, etc.) but also the authorship of knowledge (user generation of content). As a result, different learner behaviours can be expected, which can take place more independently than before and especially in new communities. Didactic principles such as that of simulation are complemented by the augmentation of reality; the support of educational activity through augmented (AR) and virtual realities (VR) becomes an everyday experience. These technological and socializing dynamics are accompanied by a quasi-comprehensive picture of all educational activities in the form of data. With the approach of learning analytics, Big Data has also reached educational practices.

In recent years, there have been increasing indications for an increasing willingness to discuss the effects of this type of technology-based learning (TEL) in a relatively emotive manner. However, the fact that this is still a challenge is shown by the current discourse about the digitalization of the vocational and general education schools (but also of the universities) and the concomitant conflicts. In the following, selected trends in media and eLearning, teaching and education approaches will be documented and discussed. In doing so, the author does not attempt to meet a single learning paradigm or a specific learning theory. Rather, possible educational and learning theories in the sense of an educational pragmatism (Köhler et al. 2008) are only introduced in the second step – although not all observations can be located in this scientific domain.

The subsequent section does not examine the question of the pedagogical core of this development; rather it investigates how the work with free teaching and learning materials can be translated into everyday school life and what this has to do with openness. We address five trends in a thesis-like manner, deal with the differences between this new form of media in the vocational school and conventional teaching and learning media and consider the applicability in the (vocational) school to finally allow discussing the basic conditions in teacher training, both in Europe and Central Asia.

While learning objects are usually produced by specialized publishers and released for use by the responsible educational authorities. The production of learning objects by the pedagogical specialists, i.e. teachers, in the preparation is limited to a few subordinate formats (panel, copies, test arrangements, etc.). Often these are also copies of objects produced on the publisher's side rather than actually produced freely.

What is happening in the context of the new openness? Educational materials (learning or knowledge objects) and educational institutions are open to any person who is interested in them, without having to prove access requirements or to obtain an authorization. This is a fundamental departure from previous educational practices as institutional affiliations and limitations become questioned. The focus is on the interest in a topic or object, which is similar to a freely accessible library, but without the need for an organizational commitment (membership, enrolment).

UNESCO has devoted itself to the possibility of using OER as a new core element of a wide range of educational efforts, as the definition shows:

> Open Educational Resources (OERs) 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, video and animation. (UNESCO 2015)

1.2.2 User Generation of Educational Contents and Learning Materials

As mentioned in the previous section, the question of the authorship is a central aspect for the creation of learning objects. Especially novel online platforms such as Wikipedia, YouTube or BLOGs lead to a change of the possibilities of use from the front desk to the production. While traditional mass media technologies such as press, radio, television and production are in the hands of a few specially qualified specialists, the picture is already changing with the introduction of the Internet. Almost everyone can in fact produce online content.

So what happens? Educational materials, learning and knowledge objects, as well as various other content, can be produced and published by anyone who has some interest in it. Any potential interested person can also access these objects, insofar as the insights and interests of each individual can be shared with any other person! Learning is possible without teaching materials (e.g. textbooks) usually provided by a teacher or produced by a small group of selected experts only (e.g. instructional specialists or subject authors).

The OECD study on *Participative Web: User-Created Content* (cp. OECD 2007) shows a collection of well-known tools of the so-called Participation Web that help the users of the Internet in creating contents of several formats easily. Moreover, the study defines the concept of the participative web as “based on an Internet increasingly influenced by intelligent web services that empower the user to contribute to developing, rating, collaborating on and distributing Internet content and customising Internet applications. As the Internet is more embedded in people's lives ‘users’ draw on new Internet applications to express themselves through ‘user-created content’ (UCC)”.

1.2.3 Independence of Learning Behaviour and the Socialization in New Community Forms

How do learners use the new technological and organizational possibilities? Looking at the learning behaviour, a new independence of the learner occurs. As well we should take into account that the learner becomes invisible, at least cannot be seen face to face by teachers. With a comparatively specific reference to the design of classroom situations in classical formats, this is referred to as open class, virtual school or mobile learning.

What is happening? The group of learners leaves the approach of a purely teacher-led activity to be replaced by a learner-driven community. In this respect, the social moment is preserved, but the learner is more likely to take over the control, since only activities according to their interests may be implemented. Here, every learner can and must decide where, when and which educational experiences are most appropriate – but not necessarily follow the path set by the educational institution and its representative. Whether this is equally suitable for every learner is not assured (see e.g. Drummer 2009). That such individual behaviour may be embedded into social contexts again is as well investigated in research (cp. Kahnwald and Köhler 2007) and discussed under the label of microlearning, which may occur as changing information behaviour in virtual communities of practice.

The basis of established teaching forms is a particular social organization. The vocational or general school class, which is an especially designed large social group (as well as a spatial configuration), is typical for the school, or even constituting it, in addition to the division of roles between pupils and teachers. In line with the so-called small or working group, the school class is a social entity that operates on a face-to-face basis and is stable in regulation over a period of many years. This small group also differs from a project group. In some instances, even in higher school years, project groups are often found in class form alongside the regular groups.

What happens when, as described above, this strict localization is dissolved and online communities are formed? It can be observed that these are superimposed with classical learning communities, both temporally and spatially. This is surprising because it can be assumed that online communication is less useful than individual face-to-face communication (Köhler 2016). However, this is obviously not applicable, as is shown by the widespread use of WhatsApp or Facebook-supported small groups. Also typical for an online community is the lack of limitation on the number of members when spatial barriers are eliminated. This increased number of members is also necessary because the invisibility of the other members (or learners) creates an uncertainty as to whether other persons are actually to be found, and only a significantly larger number of mostly several hundred members lead to a sufficient intensity of the exchange (Cheshire and Antin 2008).

Typical examples of these online forms of community in education are virtual learning communities where the learners encounter each other in an inverted or flipped classroom, or the communities of practice ("CoP", cf. Lave and Wenger

1991; Köhler and Kahnwald 2013). For the vocational and professional education context, this matches especially with the need to interlink the workplace with the educational context.

1.2.4 Data-Based Education Analytics: Online, Massive and Physical

The use of digital devices by the learner leaves large data records (Big Data), even if the learner or the lecturer does not intend this. In fact, any interaction between the learners and the learning object leads to an information technology reaction, other than learning with a paper-based learning material. In most cases, this data is neither collected nor used. Indeed, when learners or apprentices are aware of these data streams – as well as teachers – their discussion often turns around questions of data protection or fears of possible misuse. A systematic use of these naturally occurring data for the regulation of the teaching-learning process has so far hardly been considered.

If, however, the pedagogical activity is continuously monitored and the data can be used for an immediate as well as a long-term feedback process (e.g. online assessments or automated education activity records), the possibilities for an individually tailored learning support are given. Conceptual examples of this are the "learning analytics", the "tailored training" or, in a certain way, the "online assessment". While the tailor-made training courses as well as the online-based assessment do only follow the idea of Big Data, this has clearly placed the focus on educational research with the concept of learning analytics. However, on the basis of the idea of educational data mining (i.e. the fact that one can extract some useful correlations from the multitude of randomly occurring data), these transformations are still in a very early stage and may hardly be used in an everyday educational practice (cf. e.g. the study by Stützer et al. 2015 on social science analysis in higher education).

1.3 Conclusion: Toward a Better Understanding of the Interface Between Educational Practice and Online Technologies

The development of online technologies has affected educational practice dramatically and coined a new interest in the vocational and professional education domain. However, above all, as Marquet and Koehler (2017) write, the main interest in tools like MOOCs and VLEs is to implement qualitatively new learning objects that were not reachable with traditional 2D technologies, such as paper-pencil/blackboard-chalk/handbook-teacher. Retrospectively, it can be considered that most of the contents taught today are those that are compatible with the printing industry and writing by hand. Although many innovative ways of delivering content can benefit from the use of ICT (Sharples et al. 2015), by exploiting connectivity between learners' event/content-based learning opportunities and learning by doing experiences, they all aim to optimize existing teaching techniques supported by ICT. This, for instance, is the case for peer assessment in MOOCs and flipped classrooms in blended learning programmes (Fig. 1.1).

Recent changes in teaching practice and learning conditions listed above also suggest that openness, as provided by OERs, and further approaches need to be usable as well as to be available. Their use by learners and, occasionally, difficulties encountered by learners while using them can be explained by instrumental conflicts. However, more interesting, their design can benefit from the distinction between didactical objects and pedagogical (re)presentation of these objects to be used online. Altogether, this calls for the application of suitable theoretical paradigms that reach beyond classic learning theories on the one hand.

On the other hand, such new understanding of socio-technological conditions needs extension by additional consideration of framing institutional circumstances, which has rarely been discussed in educational literature and was rather a topic of some sociological and business studies. What is a remaining challenge is to educate and train teachers in a way that allows them applying such renewed analytical understanding in their daily practice when applying digital technologies in and outside the classroom. Authors intended opening up education-theoretical reflection by rethinking educational practice online toward an empowerment of its users.

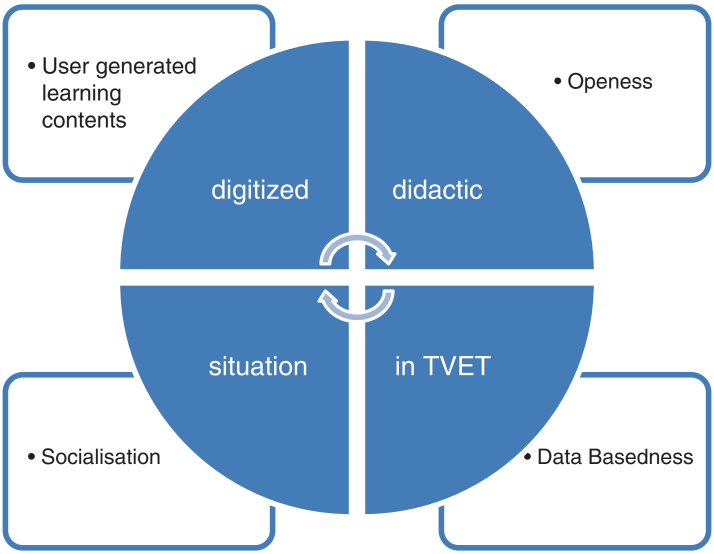

Fig. 1.1 Key components of didactic situations in TVET through digitization

1.4 Challenges in Vocational Education as Key Focus of the Book

All aspects of this article could be taken directly into the training of vocational teachers. This book, however, would like to present a broad spectrum of relevant contributions in vocational education and training from Central Asia and Europe. Indeed technical vocational education and training (TVET) has a serious linkage with industrial production in any economy or economic sector. This interface allows applying the design-oriented research approach in order to ensure fitting the need of a rapidly developing domain. As described above such is not limited to either Europe or the region of Central Asia, it is moreover a universal condition.

With respect to that consideration, the editors of the presented book, who are simultaneously the academic chairs of the 2017 International Conference on “Future Trends in Technical and Vocational Education and Training” in Bishkek, decided to structure the scholarly discourse into five parts, each collecting a bunch of recent contributions to the sector:

Part 1: Project-based learning
Part 2: Specific didactics of laboratory work
Part 3: Media and new technologies in TVET
Part 4: Evaluation and development of competencies
Part 5: Research methods in TVET

When editors structured the book into those five parts, the idea was that the first part should provide an overview over the large field of project-based learning. Authors present the potential of this method especially in the TVET. Indeed most of the articles are results of a large project which is labelled “USPECH” (this means success in Russian language), developed by the German Corporation for International Cooperation, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. In the first article of that part Christian Stehling and Uwe Munzert discuss Project-Based Learning (PBL) in general, while the next article does focus on the opportunity for strengthening the innovative potential of PBL for TVET in the context of the USPECH experiences, written by Navbahor Sharipova and Matthias Wesseler. The last article in the first chapter by Asylbek Isabekov and Gulzat Sadyrova analyses PBL in order to develop students’ creative abilities.

The following two parts discuss possibilities how specific didactics and new media technologies can be implemented in teaching. Part two has its focus on specific didactics of laboratory work, and Maksudakhon Abdullaeva analyses laboratory work in the education of food technology professionals. Franz Horlacher describes the theoretical-practical cake, which is linking theory and practice in food industry education. Finally, Manuela Niethammer shows the potential of the task-based learning for the sustainable development of food technology.

In the subsequent part three, media and new technologies in TVET are presented. First Lafiz Boboev, Zokirkhodzha Makhmudkhodzhaevich Soliev and Firuz Asrorkulov discuss the Virtual Laboratory and its meaning for an improved quality of education. The application of modern educational technologies for managing project activities in the context of a Master of Education is analysed by Rimma Masyrova, Viktoria Vyacheslavovna Savelieva, Janat Bisenbaeva and Bakhyt Atymtaeva. With their article on the significance of the Media Didactics Course for Masters of Vocational Education, Mamatair Joldoshov and Ainura Bekbolsunova follow that focus of innovative academic education, which is as well addressed by the considerations on the significance of using business simulations in training of bachelors and masters, presented by again Mamatair Joldoshov with Jypargul Sayakbaeva. The final paper of part three is authored by Masuma Bashirova, Alymkan Sattarova and deals with the use of new teaching and learning technologies for professional qualifications development in the system of the initial and secondary vocational education. An important part of teaching is the development of skills – therefore some examples of how this can be achieved are presented next. In addition, the evaluation is a special task in the teaching process – using the example of the evaluation of the implemented project, it is made clear how the quality can be improved. Finally yet importantly but not, it shows how research methods can be used in teaching.

Part 4 is devoted to the evaluation and development of competencies. It starts with a reflection on the technical training of teachers of vocational education in higher educational institutions, authored by Svetlana Udartseva, Tatyana Ikonnikova, Tamara Udartseva, Tatyana Chausova and Gulfarida Samashova. Approaches of engineering pedagogy as a suitable means in order to improve the quality of teaching in engineering education are presented by Steffen Kersten and next Ekaterina Golubina; Alexander Löser explains how competency-based exams function in professional education in Germany versus Central Asian TVET contexts. Finally the focus shifts to empirical work when Metwaly Mabed and Thomas Köhler present their learning performance research paper, which has been developed for monitoring academic achievement in electrical engineering for vocational secondary schools, and the quality management for projects and workshops article authored by Jens Drummer.

In part 5 papers continue with an even stronger focus on research methods in TVET. First the significance of scientific research in the professional development of students is investigated by Mukhabbat Ikrami, before Gafurjon Khakimov and Kalybek Dykanaliev define how to prepare Masters of Vocational Education for conducting research activities. The final paper then stresses the highest scholarly level of research training for doctoral candidates in the field of education and technology and is again presented by Thomas Köhler.

The book's Annex contains a list of authors' affiliations, listings and some further collections of empirical material on the potential of the task-based learning for the sustainable development of food technology as well as the English version of an electrical engieering achievement test for Vocational Schools.

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Part II
Project Based Learning

Chapter 2
Project-Based Learning

Christian Stehling and Uwe Munzert

2.1 Professional Education in Central Asia: A Short Introduction

In Central Asia one can find three levels of professional education: the higher education at universities, the primary and secondary vocational education and training (VET) at colleges and informal ad hoc trainings in small and especially microbusinesses. Even two decades after the collapse of the Soviet Union, there are still some distinctive features of its educational system in place, despite sometimes ambitious attempts for reforms in Central Asian countries such as Kazakhstan, Kyrgyzstan and Tajikistan. One of the main attributes in this context is a VET system that takes place foremost in state-run educational institutions, such as vocational colleges and universities, and to a much smaller degree in private companies. Another attribute inherited from the Soviet system is the focus on rather theoretical teaching and learning methods at those institutions, with only a limited portion of practical training and consequently, a limited application of the acquired theoretical knowledge into practice.[1]

While, in the Soviet Union, internships and practical trainings in state-owned companies were a crucial aspect for every student and apprentice, however, private companies are nowadays not systematically and sufficiently involved in VET. Internships in such companies, if provided at all, too often do not include the interns in the actual production processes. Thus, the quality of practical trainings too often depends on the financial and technical provisions of individual educational institutions. Until today,

[1] For a comprehensive overview of the VET system and VET teacher qualification systems (in German language) in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, see Tsimoshchanka (2013).

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a great share of Central Asian VET teachers as well as university teaching staff had gained their professional and teaching skills during the Soviet era. As a result, ex-cathedra teaching is usually the preferred method of passing on knowledge to students. In return, modern teaching methods, taking into account the latest didactical and pedagogical findings and approaches, are not the widely used standard yet. That is unfortunate since, in contrast to other developing regions of the world, the knowledge of Central Asian college teachers and university teaching staff, especially in rather technological subjects of study, is usually quite advanced. In fact, inadequate practical training in VET colleges and university studies is a perennial issue and a formidable obstacle for the promotion of direct foreign investment due to the lack of sufficiently trained professionals for the industry (Stehling 2015).

2.2 National Strategies to Modernize VET in Central Asia

Just as other Central Asian countries, Kazakhstan, Kyrgyzstan and Tajikistan are trying to address the aforementioned issues, in order to modernize their systems of education. These countries are working to improve professional education with the aim of aligning themselves closer to international standards.

Kazakhstan is regarding the German dual system as a role model for reforming its VET system with the aim of linking its VET system stronger to the needs of the industry.[2] It must be noted, however, that by doing so, the government prefers a "top-down" approach, in contrast to the dual system in Germany, due to the current lack of a truly developed cooperative system between the state and civil society actors such as unions and independent chambers of commerce and trade. The "State Program of Education Development in the Republic of Kazakhstan for 2011–2020" (Ministry of Education and Science of the Republic of Kazakhstan 2010) contains a variety of reform measures for all levels of education, including VET and higher education. The country is applying the "European Credit Transfer and Accumulation System" (ECTS) and has adopted its own "National Qualifications Framework" (NQF) for higher education, while planning to implement a NQF for VET until 2020. Strengthening practical aspects in VET and higher education is a prominent and positive feature of Kazakhstan's strategy to improve its professional education.

Kyrgyzstan is currently implementing its "National Sustainable Development Strategy for the Kyrgyz Republic" (Donors 2016), which also aims at improving the educational system. The main issues and forward-thinking possible solutions in VET and higher education are described in more detail in the "Education Development Strategy of the Kyrgyz Republic for 2012–2020" (Global Partnership for Education 2014). Primary and secondary VET as well as professional education in higher education are showing disparity between the knowledge and skills of graduates on the one hand, with the needs of the industry on the other hand. Teaching

[2] Short information on the German dual system and further information: Federal Ministry of Education and Research (2015).

staff who require further training and lack of governmental funds need to be addressed in order to improve the Kyrgyz education system. To tackle these problems, an institutionalized involvement of the private sector at all levels of professional education is intended but currently only driven forward by single educational institutions and entrepreneurs.

Since 2012, Tajikistan passed several laws which aim at reforming all aspects of its educational system, as a part of the “National Strategy of Education Development till 2020” (Global Partnership for Education 2012). A special focus in the strategy identifies the demands and needs of the labour markets and on restructuring the professional education. Since 2015, the country has been implementing a teacher training and education programme with the aim of centralizing the previous system in order to improve the quality. In comparison with Kazakhstan and Kyrgyzstan, Tajikistan is not ambitiously aiming at private sector involvement into its professional educational system. The main problem of the country in this context is the vast size of the informal sector of its economy. In 2014 the World Bank estimated in its report “The Skills Road” a percentage of 60% of Tajik employees working in the informal economy (Ajwad et al. 2014).

All three Central Asian countries are supported in their efforts by several international donors and organizations such as for instance UNESCO-UNEVOC, the European Union’s (EU) agency European Training Foundation (ETF) and GIZ. The latter is using the short-term training tool of project-based learning and formats for cross-border cooperation in order to supplement these long-term education development strategies.

2.3 Strategy for the International Cooperation in the Area of VET

Last but not the least, the process of ongoing internationalization and globalization has caused new challenges in the area of vocational education. “The national systems of vocational education are facing the challenge of international competition on one side and the necessity of international cooperation on the other side” (Dybowski and Walter 2001). One indicator for the competitiveness of national VET systems is evaluated by their quality of and their ability for innovation.

Many countries are interested in Germany’s experiences and know-how of vocational training (see the dual system). According to the publication of the “Deutscher Bundestag”, the financial and economic crisis of 2008/2009 has raised the interest in the dual system and elements of it, as it has proved its ability to contribute to the qualification of qualified employees by connecting theoretical learning in school with practical learning at the work place (Deutscher Bundestag 2013).

Thus, education and training focusing on the labour market’s needs as well as integrating the private sector into the education process will improve the employability of the young generation. Countries with a rather theoretical vocational education model that takes place only at educational institutions increasingly feel the pressure to reform and to improve their system. Employers criticize the lack of practical skills and the lack of a skilled labour force. Accordingly, many young people in Central Asia have little access to the labour market and may lack a positive perspective regarding their individual future and participation in society. Conversely, an investment into a skilled labour force fulfilling the needs of potential employers will be an important factor for the economic growth in those countries.

Kazakhstan, Kyrgyzstan and Tajikistan are among other countries in Central Asia that are taking great efforts to strengthen their economic growth by reforming their VET systems in order to further develop human capital. Furthermore, they are paying a lot of attention to the development of small and medium enterprises in order to promote economic growth.[3]

Germany promotes the reform processes of vocational education systems in Central Asia as a means of supporting economic development. The chosen strategies and aims can be quickly described by the following points:

1. Improvement of the employability of young adults by strengthening practical elements of in-house training
2. To support governments and social partners who want to integrate dual structures into their educational systems through transfer of know-how
3. To satisfy the need of skilled work force and technology transfer
4. To support the possibilities for further and ongoing training services
5. To support the introduction of an inclusive, integrated approach of VET in those countries where vocational education can be the driving force for growth and employment and thus contribute to the stabilization of fragile contexts

The "Deutsche Bundestag" states in its strategy paper that it is not intended to transfer the German VET system one by one but rather to adopt elements where feasible and necessary. Besides transferring elements of integrated and cooperative VET elements, much attention is paid to the adaptation process that takes into account the national preconditions and needs. Sustainability in the ongoing and, to an ever growing extent, independent development of the VET systems in the aforementioned countries is of high importance.

The German Government has published instruments and forms of international cooperation in the field of VET (id. 2013). Those mentioned below are implemented and are core activities of the present GIZ regional VET programme in Central Asia.

2.3.1 Quality Standards

Implementation of quality management systems and VET standards through:

- Common developed curricula
- New learning and teaching material and formats

[3] For details of those efforts, see, in Kazakhstan, Ministry of Education and Science of the Republic of Kazakhstan (2010); in Kyrgyzstan, Global Partnership for Education (2014); and, in Tajikistan, Global Partnership for Education (2012).

- Development of in-company training standards
- Qualification of teaching staff in colleges and universities
- Further qualification of trainers in companies

2.3.2 Marketing and Communication

- Increasing the acceptance and image of vocational education through internal and external communication
- Dialogue for educational policy on a regional political level
- Publication of findings, experiences and best practices

2.3.3 Support of Regional Academic Mobility

- Development of an academic network
- Exchange of experiences and best practices through exchange programmes for students and lectures

Based on the aforementioned conditions in the three Central Asian countries, one of the targets of the GIZ programme “Professional Education and Training in Central Asia” is to improve the quality of teachers’ and lecturers’ training in the field of vocational education in the area of food technology.

The governance of educational systems is a prominent topic of recent surveys (Dietrich et al. 2011). The question raised is on how to steer educational systems effectively without being focused on former, hierarchical and authoritarian structures or to become apparent on social dissimilarities. The focus of public attention is also the role of transnational agencies such as UNESCO, EU or GIZ, in the frame of globalization. Local multi-stakeholder networks are seen as an effective steering tool for educational processes especially in the area of VET.

In order to reach this goal, the demand of the food processing industry in all Central Asian countries for skilled labour force was taken into account, and new international accredited curricula fulfilling the Bologna Standards were developed in cooperation with universities, colleges and the private sector. Thus, the shortcoming of a highly qualified labour force shall be tackled by improving study programmes as well as the further and ongoing training of teachers in colleges and lectures in universities.

The implementation of the newly developed curricula is an essential part of the ongoing GIZ programme interventions that will occur from 2016 to 2019. Due to the experiences of the former programmes, a strong network, combining training institutions such as colleges and universities on an international level is necessary to successfully complete the task at hand.

Additionally the programme focuses on the regionalization of the vocational education and on the development of further and ongoing training programmes.

This aspect allows academic mobility and the mutual recognition of qualifications. In addition universities can specialize in a certain area of food technology such as milk and meat in Kyrgyzstan, fruit and vegetable in Tajikistan and bakery and brewery technology in Kazakhstan.

A project-based learning approach was developed and implemented in order to improve the quality of training for teaching and practical training staff. Twenty-two national teachers and lecturers applied with their own project in order to take part in the 18-month USPECH project and to build a network for scientific exchange and publication in Central Asia. The programme is supported internationally by the Universities of Dresden, Kassel and Berlin.

2.4 USPECH

According to the Federal Institute for Vocational Education and Training (BIBB) – Germany, "there is an increasing demand of the dual system 'Made in Germany', worldwide. The German government has reacted on the aforementioned demand in 2013 by developing their strategy concerning the cooperation in the area of VET (Berufsbildungszusammenarbeit BBZ 'out of one hand')" (Bundesinstitut für Berufsbildung 2016).

In principle you will find five core elements (sign of quality) for the German dual system in the international communication:

- The close cooperation between the state and the economy
- Learning in the work process
- The social acceptance of standards
- The qualification of VET personnel[4]
- The institutionalized scientific research and consultancy

> Effective training for TVET quality teaching and learning is necessary, but it also can be a great professional pleasure for participants as well as for trainers and organizers if we succeed to meet participants' needs and interests (sometimes 'tacit' ones) – and to apply methods which generate space for creativity and innovation. (Sharipova and Wesseler 2018)

> Since there is strong evidence that the core challenge of TVET capacity building – globally – is not so much a lack of knowledge but rather a lack of competence and practice, the proposal focuses on an innovative system of opportunities for learning from experience and practical exercise. (eid. 2017)

> Participants will know how to further develop existing networks and to strengthen their collective learning through cross-country cooperations. This dimension has not only a professional impact but also a 'political' one, by promoting mutual understanding and collaboration between the partner institutions and their countries. (Härtel et al. 2015)

Starting from 2008, seven modules for the ongoing and further training of VET teachers were developed by experts from the University of Dresden. Those modules

[4] Translated by the authors.

were integrated into the programmes of the respective institutions, responsible for ongoing and further teacher training in each of the partner countries. Several workshops were conducted with international experts giving trainings on various topics in pedagogies and didactics to teachers in the field of food technology.

While that was a rather centralistic approach as pointed out by Sharipova and Wesseler (2018), a more participative approach was implemented especially in the GIZ programme "Professional Education and Training in Central Asia" from 2013 to 2016. The development of the Bachelor of Science for Food Technology (BSc), the Master of Science for Food Technology (MSc), the Master of Education for Food Technology (MEd) and the Curriculum for Food Technician (College Level) was realized in cooperation with all national partners such as universities and colleges and with a strong involvement of the private sector. All aforementioned study programmes follow the Bologna criteria and are international accredited or like the M.Ed. in the accreditation process.

Thus the GIZ programme was orientating on the strategy of the German government as well as fulfilling the quality criteria of the German VET system as mentioned above. In order to strengthen the ownership and to create space for an innovative learning approach, the USPECH project was implemented as described by Sharipova and Wesseler (2018).

Taking into account our partner's potential and motivation and to foster sustainability, more and more of the GIZ program's activities will be under the responsibility of the national partner in the third phase from 2016 to 2019. Operating the network www.eduinca.net will be handed over to one of our partners, and a new PhD (institutionalized scientific research and consultancy) programme will be developed in cooperation with the private sector. USPECH participants will present a "network plan" until the end of 2016 focusing on:

- Innovation, development of competences and communication (internal and external)
- Visibility of activities and scientific motivation
- Coordination, regular meetings and secretary's office

One of the programme's major goals was to initiate learning processes in the network, based on the exchange of information, knowledge and experience. In his survey, Härtel et al. point out:

> The pure provision of learning options rather leads to incomprehensible creation of knowledge. In order to be able to plan such learning processes, steering is necessary through combining individual and collective bases of knowledge. (eid. 2015, pp. 306–307)

2.5 Conclusion

In order to improve living conditions and create perspectives for the young generation in Central Asia, study and training programmes have to be implemented that meet the needs of the regional labour market and fulfil the demand of a highly skilled working force. In a positive manner, the private sector has increasingly begun to take responsibility by cooperating in the development of modern training programmes. The participation in examinations is as important as providing internships with a well-organized share of practical training.

Many positive aspects have already been implemented such as the development and implementation of curricula and training programmes. For further widespread societal and systemic change, teaching and training staff must further be introduced to specific laboratory didactics, pedagogies and modern teaching methods. Project-based learning is one approach among others allowing to fully use the potential of students with the aim of raising motivation and developing independent learning as well as analytical and problem solving and critical thinking skills and teamwork. All of the skills aforementioned are widely regarded as key qualifications for modern labour markets.

In order to make training programmes for teaching and training staff more effective, networking is essential. Exchange of knowledge, experiences and best practice methods are a key for the sustainability and ongoing development on the international level. According to Professor Köhler et al., surveys have shown that learning and transfer processes within a network are happening, but rather by pure chance.

Meetings, workshops, publications and others shall be organized to plan and support those processes. Further surveys shall focus on evaluation of the development of effective tools and procedures in order to steer such learning processes in scientific networks.

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Chapter 3
Strengthening the Innovative Potential of Project-Based Learning for TVET

The USPECH Experience

Navbakhor Sharipova and Matthias Wesseler

3.1 Introduction: The USPECH Project and Its Potential

> Current research suggests teacher quality is extraordinarily important and likely the most important factor in schools. (Hanushek 2015, p. 193)

> The most important goal of introducing project-based learning is the promotion of innovative and productive thinking. (USPECH participant from Kazakhstan)

The purpose of the following article is to share some special experiences of the USPECH project,[1] we understand as the core of the project's significant potential: "Promoting innovative and productive thinking" (see quotation above).

At a first look, the project may appear as one of those classic capacity building activities – valuable as they are, certainly – with a sequence of workshops to transfer some knowledge and to develop some skills or competencies. Beyond these activities, however, in USPECH all participants engaged in project work – and finally in reflecting, analysing and writing about their experiences and insights during the programme. These projects have been designed and implemented by the participants themselves, strengthening their ownership in the project, integrating cognitive and metacognitive dimensions at the individual level and their context's needs at the institutional one.

[1] In order to respect the GIZ terminology, we use the term "programs" for the system of TVET activities in Central Asia; for USPECH activities, we use the term "project"; the term "project" however most often is also used to refer to participants' learning and development activities, such as "project-based learning" or "project work". We trust that our text is sufficiently clear so that readers will not get confused by these differences.

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The essence of USPECH, we believe, is emerging from a deeper level of project-based learning (Christensen and Johnson 2011; Senge 1994) and its impact on both the professional everyday work of the project's partners and the curricular or institutional changes induced by the participants' projects. Since this level is somewhat hidden to traditional methods of empirical research, we use a "hybrid" style of methodology, combining empirical data from the project's formal quantitative monitoring activities, from the partners' project reports, from the narrative interviews at the end of the last workshop of July 2016 and from the authors' personal observations – and even intuition: "emotion and cognition are supported by interdependent neural processes" (Immordino-Yang 2016, p. 18). Furthermore, we trust that our cooperative writing as co-authors – one from Central Asia, one from Germany – will strengthen the credibility of our analyses.[2] Thus, this paper will concentrate on underlying success factors, challenges of implementation and some emerging impacts based on the experiences of the USPECH project.

3.2 Promoting Project-Based Learning: The USPECH Concept

USPECH has been developed to complement the GIZ TVET project's efforts to design and to implement new curricula for food technology at BSc and MSc levels together with Central Asian partners: "Capacity building for TVET teachers and trainers in line with international standards is the necessary condition to meet the project's target" (GIZ 2015). Since 2008, GIZ has been successfully implementing a series of interrelated TVET activities in Central Asia and thus contributed to build a reliable basis of mutual trust and readiness to cooperate more closely in educational challenges: "Human capital, as we now call it, is extraordinarily important for a nation's economic development" (Hanushek 2015, p. 2).

The basic concept of USPECH has been designed in November 2014. The overall policy of USPECH is presented in this book's article by Stehling and Munzert (2018). Core elements have been an attempt to strengthen "ownership" – of problems, challenges and their solutions – based on individual project work and to develop the innovative power of professional "passion", recognizing that the quality of a student's teacher is the biggest factor in boosting that student's performance. In the frame of the overall goals – competence building for project work, networking and cross-regional cooperation – a series of workshops has been planned focussing on modules such as:

- Interactive teaching with a special view to project-based learning and teaching
- Media and instructional technologies (including online learning)
- Specific didactics and laboratory didactics

[2] Authors wish to express their gratitude to all USPECH partners for their openness to share their deeper learning results and professional impacts of project-based learning.

- Modern forms of quality exams (effective grading, competence-based examinations)
- Scientific writing and preparation for a joint publication

Beyond the activities within the field of project work and the modules mentioned above, an excursion to Germany took place, and a strong element of quality assurance has been a crucial aspect of USPECH from the very beginning. It was planned to disseminate the USPECH experiences in a publication and to discuss successes and challenges in an international conference (to be held in April 2017). GIZ offered additional support for laboratory equipment and invited a team of experts from the Technical University of Dresden, the Free University of Berlin and from the University of Kassel. Furthermore the GIZ office built a highly competent and committed support team assuring the smooth and effective operational development of USPECH activities.

Within the frame of innovative quality and sustainable development of TVET teacher training in food technology, the following indicators have been suggested as "expected results" (November 2014):

- Participants, satisfied and empowered with a higher degree of competence and motivation
- 18 projects successfully designed and implemented
- A book to disseminate USPECH's experiences finished for publication
- A professional network established at the regional level, including a coordinating team and an agenda for the near future

After some modifications according to the needs of partners and to the possibilities of GIZ, activities started with an invitation of potential participants to design and present their own projects in early 2015 as kind of an application procedure to participate in USPECH. This was a first significant success, showing the interest and thus the ownership of partners in Central Asia and beyond: 18 projects from different countries, institutions and teams have been presented. Out of these teams, 30 partners have been invited personally to join USPECH and to form an innovative learning community with view to the decisive source of "project-based" learning (see below). Several of these participants had also attended earlier GIZ workshops, a fact which facilitated an advanced teaching and learning mode from the beginning. In March 2015, the first workshop started in Dushanbe.

3.3 Presenting the Projects: The Essential Source of Significant Learning

The first workshop in the framework of the USPECH programme launched the work of project-based learning by recognizing the significance of our partners' project designs. Theories of project-based learning have been shared and discussed as well as experiences in TVET contexts in other countries.

Then the project management concept was introduced. The participants were equipped with tools to refine and modify their individually designed projects for future implementation. The importance of projects' originality, actuality, clear objectives, as well as potential risks of failure and complexities in implementation was specified. Moreover, participants were introduced into phases of project management (initiating, planning and implementation, control and completion of projects). Project teams have been given tips on a successful implementation of projects, by the following: setting clear requirements and documenting them in advance, clarifying roles and competences, ensuring the availability of resources before starting the project, involving all members of the team and informing them of the success of work.

Introduction into the theoretical background of project management supported by practical experience and examples triggered the motivation for implementation of 18 successful projects (9 from Tajikistan, 7 from Kyrgyzstan and 2 from Kazakhstan cf. Table 3.1).

Projects covered topics that have been specified in the call for application, namely, project-based learning, specific didactics, media and new technologies, evaluation of competencies, curriculum development, planning and organization of a study process, student coaching, etc.

Working on the projects has shown to be a living organism that could be changed, modified an adapted through the course of their development: some topics were narrowed down, some projects changed their objective and some teams adapted them more narrowly to the goals of their institution. A high motivation and commitment of partners and loyalty and interest of experts resulted in a trustworthy cooperation and accomplishment of outlined goals. However, achievement of the goals goes beyond the planned objectives of the programme. Taking a glance at the numbers that are drawn from interim reports and evaluation forms shows that participants' progress on their project work can be resumed. In addition to the reports, interviews with the participants have revealed some of the inner progresses that cannot quantitatively set a value on and measured.

Participants expressed their feelings of contentment about the development their projects brought to their professional and personal lives. Most of the partners, for example, appreciated the introduction into media and new technologies that "… changed their mindset from conservative to being more open to new technologies, thus impacting the whole working process and improving the organization of work". Besides the network in the professional sphere, participants built up strong ties with colleagues and the GIZ expert team by "… finding good friends, getting acquainted with Central Asian and German culture, and launching new mini projects in cooperation with colleagues and experts". Moreover, USPECH triggered some change in teachers' perception by "… developing a more tolerant attitude towards students' mistakes during studies, joint problem solution triggered by the coaching seminar, realizing the power of team work, using their communication skills in treating colleagues and students, replicating the most efficient part of experts' working format and design in their seminars and lectures" (quotes derived from the interviews, July 18, 2016).

Table 3.1 Projects implemented in the framework of USPECH

#	Title	Institution
1	Development of business games for formation of professional competence in Masters of Vocational Education	Kyrgyz State Technical University named after I. Razzakov
2	Development of teaching methodical complex for the course "Media Didactics" for Master of Professional Education	Kyrgyz State Technical University named after I. Razzakov
3	Curriculum development. Basic part. Direction: Vocational education	Kyrgyz State Technical University named after I. Razzakov
	Academic degree: Master	
4	Development of a didactical approach in "Lab Didactics" on the theme:	Kyrgyz State Technical University named after I. Razzakov
	"Production of hard cheese" for Master students of Vocational Education in Food Technology	
5	Creativity in the framework of the subject "Rhetoric"	Kyrgyz State Agrarian University
6	Improvement of planning an educational process, content and pedagogical means (on the example of food technology)	Kyrgyz Republican National Methodological Centre under Agency of Vocational Technical Education
7	Interactive learning methods as a means of improving the quality of the educational process	Karabalta Technical Economic College
8	Organization of project activities of Master of Professional Pedagogy	Eurasian Technology University of Almaty
9	Development of professional and pedagogical potential of bachelor students of vocational education based on an innovative approach to the educational process at the university	Karaganda State Technical University
10	"Improving the competitiveness of teachers in the labour market of Tajikistan"	Technology University of Tajikistan
11	"Improvement of laboratory equipment at Technology University of Tajikistan"	Technology University of Tajikistan
12	Innovative educational technologies in teaching the subject "food chemistry" for students of specialization "Technology of Food Production"	Technology University of Tajikistan
13	Innovative educational technologies in teaching the subject "Microbiology of Industry" for students of specialization "Food Processing" with the major in "Technology of bread, pastry and pasta"	Technology University of Tajikistan
14	Improving the quality of education on the basis of computer-aided design (CAD)	Technology University of Tajikistan
15	Ensuring food safety by (further) training of teachers based on the programme of standardization and certification of food industry	Technology University of Tajikistan
16	"Development of curricula for the courses on further training and retraining"	Republican Institute for further training and retraining of Tajikistan

(continued)

Table 3.1 (continued)

#	Title	Institution
17	Introduction of laboratory didactics in the courses on further training and retraining of professional education	Republican Institute for further training and retraining of Tajikistan
18	Further training of teachers on the preparation of laboratory teaching materials on food technology	Isfara Branch of Technology University of Tajikistan

3.3.1 Approaching the Innovative Potential of USPECH'S Project-Based Learning

3.3.1.1 USPECH'S Impact: What Kind of Data Are We Using?

> The word ‚learning' undoubtedly denotes change of some kind. To say what kind of change is a delicate matter. (Bateson 1987, p. 287)

This famous quote seems to be even more valid today, almost 50 years later, if we listen – for example – to the recent discourse in educational spheres on competence-based learning or to the research debates in neuroscience, as Antonio Damasio argues in his chapter "Educating the Cognitive Unconscious" (2012, p. 280): "… many questions remain …" (id. 2012, p. 132) … "In the past few decades the understanding of learning has deepened to the level of molecular mechanisms and gene expression" (id. 2012, p. 303).

Assessing, hence, the impact of programmes like USPECH is always a challenge, and GIZ for decades has tried to design reliable und valid chains of effects ("Wirkungsketten", GIZ 2015; cf. also Sebe-Opfermann 2013, on impacts of project-based learning in TVET contexts). Furthermore, in the USPECH context of continuous translations between German, Russian and English, we realized that there aren't any recognized standard definitions, even in the same language. The same word – competence, for example, passion or learning objectives – means different things to different people.

Although a mechanistic seamless chain of cause and effect in a complex educational context is beyond any effort of monitoring and evaluation, USPECH established from the beginning a system of quality assurance (cf. Drummer 2018) in order to understand progress, challenges and failures – and to learn from them.

The search for impact, accordingly, may start with sharing the sources of data we used to observe and monitor the programme. Basically we dispose of five different kinds of data:

- The original project designs by the partners, including stated objectives and approaches (18 texts) focusing on tangible results, sharing own values (!), clear agenda incl. resources and documentation, supported by institutional heads
- Workshop evaluation questionnaires (with a rather quantitative approach) (approx. 85 questionnaires from partners and some filled in by the GIZ staff and experts) and documented oral feedback at the end of the workshops

- Structured interim reports written by the partners on their project work's progress (combining quantitative and qualitative data) (34 reports)
- Narrative interviews with a sample of partners during the final workshop (July 2016; ten interviews)
- Participatory observations during workshops and meetings (with a qualitative focus)

The written and oral feedback produced many comments with rather positive assessments by our partners like "we need more of this kind of quality workshops" or "USPECH operates at the highest level: interesting, professionally effective and scientifically rich". These comments certainly convey an important message for the immediate further planning of the programme, even keeping in mind some kind of politeness bias involved. For a deeper analysis, we would however need more specific data to understand the potential impacts of USPECH. In general we believe that we can share with a high degree of validity, reliability and credibility in three different areas of the programme's induced impacts (Wesseler 2017):

- Individual learning, at different levels
- Institutional learning and change
- Learning as evolution of the "cooperating system" (GIZ 2015, p. 80)

3.3.2 Impact on Individual Learning: Innovative and Relevant Personal Growth

The current European debate on competence-based learning is just one more example of the efforts to observe and understand the enormous complexity of individual learning, let alone organizational or even "regional learning". For our purpose with special focus on *project-based learning*, we choose a rather biological and brain-science-based approach (Bateson 1987; Damasio 2012; Immordino-Yang 2016; Maturana and Varela 1992), where different levels of learning are observed. The most basic seems to be an accumulative process of gathering new information and skills (proto-learning). At a higher level, learning is happening within a deeper neural level generating new connections and constructing systems of knowledge, skills or competences (deutero-learning), and finally – with a high degree of metacognitive interactions – there seems to be a third level which is the most difficult but also the most productive and powerful one: a learning which develops new learning modes or mental models or mindsets (Senge 1994), or simply "learning to learn", not in a "sustaining" or "incremental" mode but rather "braking through" prior learning habits and thus contributing efficiently to "disruptive innovations" in perceptions, values, attitudes and actions (Christensen and Johnson 2011; Christensen et al. 2015).

This approach is close to the famous "pillars of learning", as designed by UNESCO: "learning to know", "learning to do", "learning to be" (!, added by authors) and "learning to live together" (Delors 1996). USPECH'S strong emphasis on "passion" for learning appears in this theoretical framework as a necessary condition for relevant metacognitive learning, recognizing "the fundamental role of emotions in learning" (Immordino-Yang 2016, p. 17).

The original designs of the partners' projects reveal an underlying set of quite innovative motivations and approaches, such as "I want to learn innovative educational methods which generate a motivational context for independence and intellectual self-reliance" (Tajikistan) or "The basis of education today should be formed not by subject matter but rather by a new mode of thinking and acting" (Kazakhstan) or "The main purpose of teaching should be to support the creative potential of our students" (Kyrgyzstan).

Thus, there was, already from the beginning, a high and significant readiness potential for innovative learning and work. Participants have been aware of the urgent need of innovation and change not just in their own teaching and research methods but also in general in their countries' TVET systems: "passion for learning" (Sarder 2016, XIX) became an underlying driver of the USPECH programme.

Similarly, partners have been aware of the need to create "a radical shift of mind set" (Senge, according to Sarder 2016, p. 173): "I want to fill myself with new energies and innovative potential" (USPECH partner's expectation) in order to be able to connect individual learning, innovation and institutional change. Accordingly, the USPECH programme challenged participants "with going deeper in conceptual knowledge, employing critical thinking skills" (Warren and Ott 2016, p. 2).

Taking a closer look on the project's partners' comments on their own learning results, we can observe a whole list of different professional knowledge and skills or competences at the first level (proto-learning), which partners did acquire from USPECH attendance and – most significantly – from their own project work: "Deepened knowledge on project management and scientific writing" (quotation from workshop questionnaire) (Fig. 3.1).

Going beyond these "incremental" or "sustaining", mostly cognitive learning outcomes at the first learning level (proto-learning, see above), we can observe at a deeper level also some highly significant metacognitive results (known as deutero-learning; see above, Bateson 1987).

It is not the directly offered workshop's content which seems to matter most but rather the underlying message of different modes of communication, interaction and teaching. First of all we observe a growing transfer competence from the workshop sessions towards the everyday practice of the ongoing project work (Adapted from Drummer 2016) (Fig. 3.2).

Another highly relevant learning outcome shows up in the workshop evaluations, such as growing cooperation amongst the partners themselves (Fig. 3.3).

Cooperation of partners has been valued as highly relevant and innovative because of the general academic culture which is rather based on individual efforts, especially in our partners' Central Asian institutions but also in most German universities or TVET colleges. Learning to work effectively in a team, as data showed, became an essential competence for project success. The generation of communities of learning or "communities of inquiry" (Kaliva 2015) copes with this essential

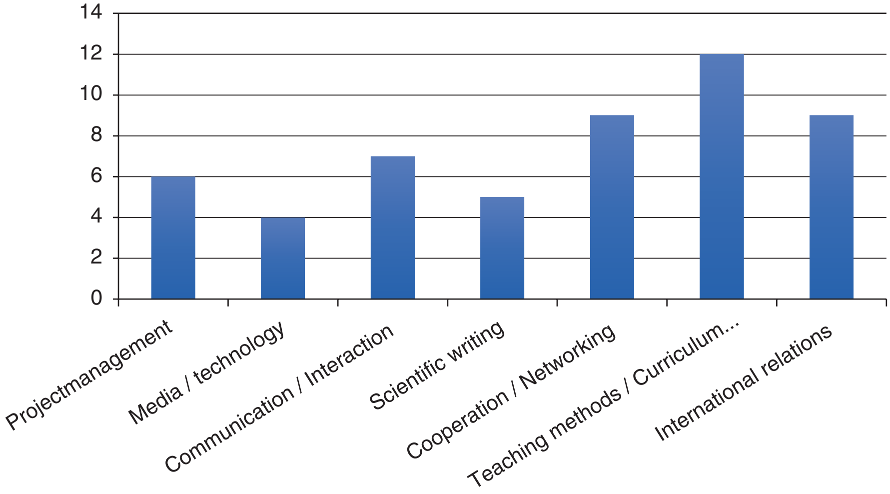

Fig. 3.1 Areas of acquired knowledge and competences (as expressed July 2016)

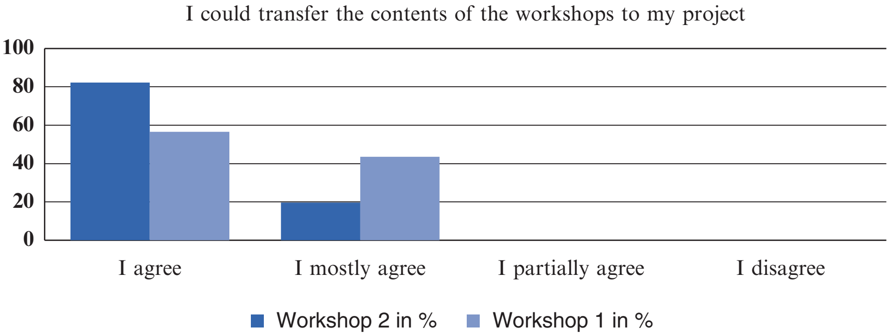

Fig. 3.2 Transfer of workshop topics to project work according to the first and second workshop

USPECH goal of regional networking: "I found a positive breakthrough to move forward in my work" (USPECH partner's interview, July 2016) or – just to mention one more partner's view – "These workshops are necessary, because they promote cooperation in TVET through sharing experiences and strengthening professional competences" (quoted from an questionnaire assessing workshop IV, July 2016).

Partners often mentioned that the excursion to Germany was not just an important incentive for them but rather a decisive learning opportunity with overwhelmingly complex experiences of being exposed to rather different kinds of TVET teaching and learning, such as innovation towards more student centeredness, openness or demand-based and independent teaching and learning.

In summary, USPECH shows that deeper learning and growing ownership are needed as success factors:

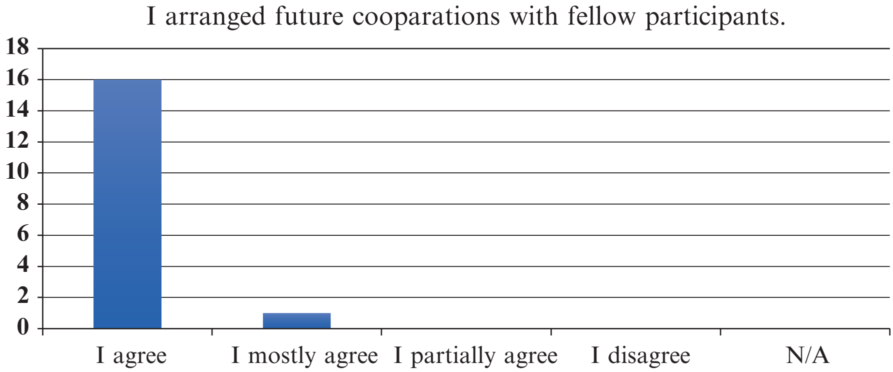

Fig. 3.3 From USPECH monitoring and evaluation activities (Adapted from Drummer 2015): assessing readiness potential for cooperation between partners

- A readiness potential from the beginning, for both partners and organizers and experts
- Followed by attractive relevant workshop inputs, methods, interactions and excursions
- Which finally succeed to create a space for productive and innovative personal growth

> Now, we ourselves take the challenges in our own hands. (A partner's oral feedback, July 2016)

3.3.3 *Impact on the Institutional Learning: Innovative Teaching, Communication and Cooperation*

One fundamental value of project-based learning depends on the balance of individual learning through project work (teams, management, materials, equipment, etc.) and the effect of the project's impacts, intended or unintended, on the professional institutional context: Since the original project designs have all been approved by the authorities of our partners' institutions, it was clear that these projects would gain an impact not just for the individuals involved but also for institutional learning and change: Project-based learning generates not only new knowledge and competences for the participating individuals but also change and innovation in their institutional contexts.

The second interim reports of the projects (March 2016) and other sources reveal a broad area of our partners' projects' influences at the institutional level:

- Progress in curriculum development (B. Sc. and M. Sc.): "… we launched a new Master's program, and the teaching will be according to the plan I developed" (USPECH partner's interview, July 2016).

- Institutional development through strengthened cooperation, sharing and capacity building: "I involved other staff of our Department and conducted scientific and methodical seminars" (USPECH partner's interview, July 2016); participating partners shared teaching materials, even beyond institutions.
- Opening up to closer cooperation with the private sector (a strong USPECH dimension!), designed, for example, several competence matrices – together with private sector representatives – for TVET graduates in food technology.
- Methodological and didactic innovations, such as role play, new laboratory methods of teaching and learning and design of modern, especially competence-based examinations (cf. Golubina and Löser 2018).

In spite of the general scarcity of resources, as continuously mentioned by the partners, they were able to upgrade their laboratories (with some support from GIZ), to improve their media equipment and to experiment with online learning activities. Sometimes these efforts resulted in personal promotions, in publications, in invitations to international congresses, in the development of innovative learning materials for the students and even in national quality awards.

It certainly would not be correct to claim all this as impacts by our partners' participation in USPECH. Our partners took their own learning in their "hands" and "hearts". The purpose of ownership and sustainability however guided the design of the workshops: "All that I learn during the seminars I analyse afterwards. I do not take all the knowledge, I take some elements. I squeeze the juice and then apply it when it is necessary" (a partner's interview statement, July 2016).

Beyond these significant success stories, there also have been challenges in the programme's progress such as the constant need for translation and its difficulty to define terms adequately in different languages; some institutional partners' contexts with their corresponding projects could not be aligned to the innovative learning processes during the programme (two projects even dropped out). In some cases GIZ was not in a position to assure all the equipment desired for the implementation of the designed projects, contributing thus to a certain degree of initial frustration.

Apparently – in some cases – the growing knowledge and competence of our participating partners contributed to generate some discomfort or even stress within their faculties: "people were even jealous" (a partner's interview statement, July 2016). Innovations always cause irritation, and it is one of the crucial challenges to transform those irritations into positive drivers of institutional change.

USPECH however created a "space" for sharing those challenges strengthening mutual recognition of efforts and support far beyond the face-to-face meetings during our workshops: "The most valuable message I got was that even with minimal resources one can achieve great results" (a partner's interview statement, July 2016). USPECH has been contributing to allow our partners to "boldly develop their own activities" as Franz Horlacher, a colleague of the international expert team, summarized his observations. Thus, the carefully growing ownership – not just of what a person learns but also of what she or he implements into her/his institutional context – is decisive. The priority of ownership in USPECH may lead to "breakthrough" innovations, which "disrupt" (Christensen et al. 2015) an obsolete mindset, some-

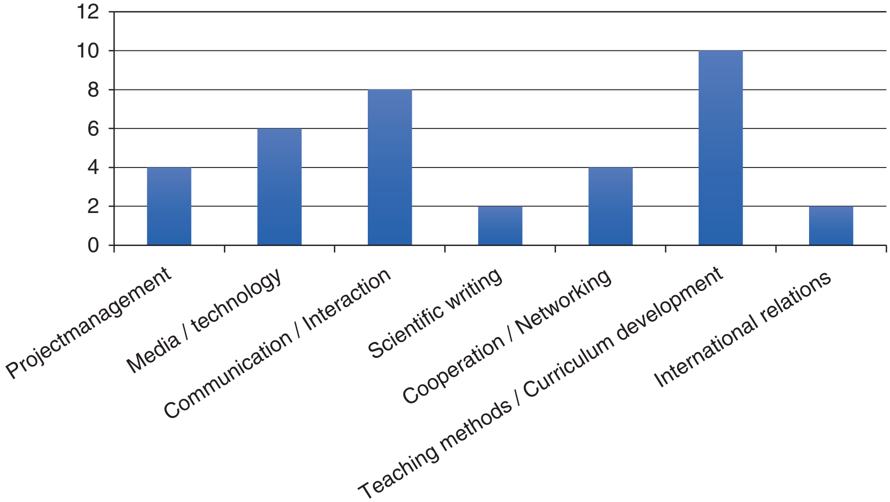

Fig. 3.4 Acquired competences implemented in everyday work

times to be observed in international TVET cooperation, where transferring knowledge is seen as more important than creating space for shared inspirations, personal empowerment and productive cooperation.

It is interesting then, to compare our partners' observations concerning their own learning results with their efforts to implement the most relevant things into their everyday professional practice: Beyond all specific topics offered during the workshops – valuable as they are, of course – it is "innovative teaching methods" and "communication and cooperation" amongst colleagues within their institutions and sometimes even internationally what mattered most (Fig. 3.4).

"The most important part for me is what I apply in relation to my colleagues: Good ways of treating people" (a partner's interview statement, July 2016). This is close to the essential fourth UNESCO pillar "Learning to live together" (Delors 1996) and has certainly an effect on the sustainability of the programme even beyond TVET and food technology: "There was a dream that we would have access to the educational and scientific sphere – the dream came true" (a partner's interview statement, July 2016).

3.3.4 Evolving the "Cooperating System": GIZ and Experts

Unfortunately, our reliable data of understanding USPECH's impact on the "cooperating system" itself are relatively weak: There have been questionnaires for us – the so-called experts and the GIZ staff involved – as well; some, however, have not been answered; others to our dismay, but understandably in view of the huge amount of data to be handled, have been lost. Our observation hence is mainly based on the authors' own intuition, a highly significant source of knowledge and insight according to neuroscience scholars such as Damasio (2012) or Immordino-Yang (2016).

What did we ourselves learn? How did our cooperation with USPECH impact our own way of seeing the world and constructing our own learning architecture? GIZ claims that this kind of learning is an essential "success factor" of cooperation (GIZ 2015, p. 80): "Learning as evolution" (id., 2015, p. 83).

A rough summary may contain the following issues:

1. A deeper understanding of the truly innovative potential of project-based learning for TVET teachers' capacity building; this will strengthen not only the effectiveness of participants' work but also the future employability of their graduates.
2. Ownership of participants is more essential to relevance and sustainability than brilliant scientific lessons (necessary as they are!): The potential of people, even if sometimes concealed in a "tacit" mode, finally makes the difference. Therefore, USPECH started with an invitation process built on the quality of participants' independent project designs.
3. Creating space for open and independent learning, for motivation and inspiration, should get more attention (cf. Köhler 2017); in this context, also the rich potential of the partners' projects should be recognized with more thoroughness.
4. Cooperation and networking amongst partners will be of growing importance to cope with sustainable development in TVET – and will possibly require further support from GIZ, especially with view to the regional challenges and potentials of food technology in Central Asia ("learning regions").
5. Multiplication of the core lessons learnt – via conferences, articles or books – is essential: again and again.
6. The quality of a programme such as USPECH also depends decisively on the quality and commitment of an organizing team and the smooth cooperation of invited experts.

According to a quotation from the staff's anonymous questionnaire (Workshop IV, July 2016), one of our colleagues summarized her or his assessment: "The opportunity to work independently has been used intensively by all partners … we achieved more than we had thought at the beginning".

Certainly, GIZ together with the USPECH experts' team – and certainly together with all our partners – is on a good way to cope more closely with the recent UNESCO demands on TVET: "UNESCO is at the forefront of global debates on the future of education and learning […] external demands on TVET systems go far beyond the familiar call for TVET to contribute to economic growth, employment and competitiveness. Today, TVET is considered to be a crucial vehicle for social equity and inclusion, as well as for the sustainability of development" (Marope et al. 2015, p. 8).

3.4 Conclusions: Sustainable Learning

"Who survives? Education decides on the future of humankind" (Klingholz and Lutz 2016): Global statistical data do not leave any doubt (cf. Hanushek 2015) about the decisive significance of education, especially TVET – and of the decisive importance of the quality of teachers.

Project-based learning is gaining growing recognition for its relevant and innovative learning impacts on both individuals as well as on institutions (Boss 2015; Warren and Ott 2016). This is the underlying context of USPECH within a setting of challenging socio-economic needs and educational conditions in the partner countries of Central Asia. Since 2008, GIZ is supporting relevant initiatives in curriculum design and human capital building (especially teacher training), starting from a rather centralistic approach inducing entire modules into existing curricula and moving in recent years towards a growing confidence in the competence of local partners.

If we carefully listen to our partners' voices, we do not hear a unanimous cheering and rejoicing of the USPECH project. Beyond all nuances and differences, there is however a powerful message: What is appreciated most is the recognition of our partners' potential – and the trust in their professional readiness to cope with the challenges: recognition and trust balanced with efficiency and monitoring. There is a clear tendency towards more independence in learning, especially in project-based learning. Obviously, partners appreciate workshops and inputs, materials and lessons, the presentations of new technologies and educational innovations but not as instructions to be followed. The added value of workshops and other inputs of the USPECH project have been perceived more as necessary tools to generate an open space for sharing, cooperation, mutual learning – and implementation. What seems to matter to them is rather the recognition of a larger mutual challenge amongst themselves and the GIZ team, including experts – and a common effort to support each other within the context of one's own institutional, cultural and economic constraints: "We take the necessary change in our own hands" (feedback quote from workshop participants, July 2016).

Certainly, this is an ongoing process. Learning never ends and certainly not project-based learning. USPECH is not a destination but rather one more step towards a sustainable, relevant and innovative development in Central Asia's TVET on its way to cope with the enormous challenges of effective teaching and learning and of assuring the high-level employability of future TVET graduates.

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Chapter 4
Project-Based Learning to Develop Creative Abilities in Students

Asylbek Isabekov and Gulzat Sadyrova

4.1 Introduction and State of the Art

The Bologna process principles introduced into the Kyrgyz Republic educational system (Government of Kyrgyz Republic 2011) form an innovative learning sphere to transform the training process. The new system, oriented at interactive learning, has replaced post-Soviet educational system. The system aims at developing student's creativity and proactivity as a "groundbreaker", highly adaptive to changes and competent in search for evaluation and introduction of innovations. Education faces new requirements, creative ability being one of the most important for graduates. We believe that project-based learning may help develop creative abilities in students.

The strategy for education development in the Kyrgyz Republic recognizes education as a priority area to accumulate knowledge and the building of skills (Ministry of Education and Science Kyrgyz Republic), while creating optimal conditions to reveal and develop the creative abilities in every person. Analysis of current educational standards and materials (mostly, primary and secondary education) used in Kyrgyzstan schools revealed that in some study books, only 15% of tasks are relative to creativity (Kaarman 2009). The creative component in many study books and methodological guidelines is at a minimum. School children tend not to evolve their creative abilities.

Students' creativity requires special attention. The educational impact to create independent and creative thinking skills cannot be acquired just because of the learning process. Thus, it needs fostering and cultivation. Project-based learning shall be integrated into the higher education system, in a well-thought-out manner to avoid imposing it to students and instructors; it should become a tool to improve

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the educational process; to facilitate better learning, skills, and abilities; and to stimulate educational motivation and general cultural growth.

Many researchers, for example, Adolf (Stepanova and Adolf 2011) and Wolkow (Wolkow et al. 2008), note the significance of creative skills for future teachers, highlighting the importance of identifying students who are the most capable, inclined to independent creative activity, and the need to create conditions and encourage them to manifest themselves maximally. It is also considered that future teachers should enlarge and expand research activities. For example, Krasilnikova and Bondarenko (2005) analyzed employers' requirements for the professional education of future specialists and identified that the first place among the requirements took creative potential, a flexible approach to work, and fast learner.

The survey of the KNAU students with Engineering and Pedagogics majors showed that most of them are not familiar with technologies that stimulate creative ability and did not have enough abilities for creative activities. Instructors working more than 3 years consider themselves competent in the creative approach to arranging the learning process (Raimkulova 2016).

The abovementioned case defines an actuality to study the issues on facilitating the creative abilities in students at the social and pedagogical levels. Creativity plays a great role for the overall growth and personality of each student. In the process of creative activity, developing such abilities as cogitativeness, comparison, analysis, and the combination of all these processes shapes the basis of future conscious and the demiurgic creative ability of every student. The process of building a creative attitude toward learning requires undivided attention, pressure on mental abilities, and great will. In our article we underline the belief that creativity can be taught and creative personalities developed. This plays a methodological significance for pedagogics, as every student has the creativity to foster in the training process as the basic factor for the development of an active creative position. Our attitude to creativity to create good results allows us to propose the sculpturing of creative abilities through various innovative technologies.

For innovative technologies to enhance students' creative activities, the following needs to be taken in to account:

- Age specifics;
- Creative ability execution/translation
- Conditions for co-creativeness (id., 2016)

The priority approach to enhance creative abilities, in our opinion, is project-based learning. Project-based training activity is a component of the project-based learning related to discovering and meeting students' needs via projects and creation of ideal or material outcome with objective or subjective novelty. It is a creativity-based study activity to solve a practical task, when students decide goals and objectives to be implemented in theoretical research and practical fulfillment under instructor's supervision. Here we find another component of project-based learning – instructor's involvement.

Professional education major students (group PO-1-14 in 2015–2016) used the individual project-based learning method. The “Rhetoric” discipline is introduced for students of vocational training on the fourth course in the spring semester, as a variable course. And this discipline, designed to teach how to effectively influence the audience using speech, how to achieve success, and how to speaking publicly, met the requirements that were set by the project itself.

The stages of individual student projects were as follows:

1. *Organizational and preparatory stage:*
   During this stage, there was collaborative work of a teacher with each individual student. The student, under the guidance of the teacher, was engaged in problem-solving, chose and substantiated the project theme, planned his forthcoming activities, and identified the main goal and tasks arising from the project theme. At this stage of the project activity, the main task of the teacher was to promote interest, first of all, to the technology of design training as innovative. It should be explained that students were not familiar with the project technology. After consideration and analysis of the “project concepts”, “project technology”, “project training”, etc., students, as mentioned above, decided to engage the individual projects on the discipline “Rhetoric”.
   Every student had to conduct one lesson (120 min) on “Rhetoric” applying innovative methods and creative approaches. The instructor suggested topics from the discipline training materials. Students had to design a lesson with creative elements and prepare all necessary teaching aids (select reference materials, determine lesson format, design presentation slide sand posters, prepare handouts, write questions to enhance interest, etc.).
   Thus, at this stage, the students together with the teacher actively participated in the problematization of their projects.
2. *Planning of the future project activities:*
   This stage was practical and responded to such questions as “What to do?”, “Reason to do it?”, “How to do?”, “What are the expenses?” and “What are the terms?”. Each student under the guidance of the teacher began to determine the character of the upcoming works, which included definition the lesson type, methodology, handouts, and organizational/time division of the lesson; terms and schedule of works; development of the stages contents; and selection the materials on the project topic.
3. *Project development:*
   This stage was characterized by the independent conducting of an individual task in accordance with plan and a schedule of lessons. Such work was carried out as preparing materials for presentation, preparation of illustrative material, preparation of video presentation, preparation of handouts, development of didactic games targeted to the project theme, etc.
4. *Final stage (defense presentation of the project) and evaluation of the results:*
   This important stage of the project activity of students was held publicly in the form of each individual student’s practical lesson. A listening public who acted

as students was organized. Only 10 of 16 students were able to implement their projects. The project defense presentation included a video demonstration, public defense, games with students, guessing a crossword puzzle, staging the historical events, reporting new information, etc.

4.2 Project Presentation

Project presentation was organized as a practical lesson. In the educational system of a higher educational institution in Kyrgyzstan, all classroom activities are divided into lecture, practical, and laboratory. In our case, too, when we say a practical lesson, we mean a theoretical lesson that is held within the walls of the university. The details of this practical lesson are described below:
At the end of every lesson, participants had extended discussion to analyze results together with Project team.

Example: Practical Lesson Extract
PRACTICAL EXERCISE No.6
Topic: Components of Communication: Speaker
Duration – 2 academic hours (2 × 60 min)
Goal: assess speaker's posture, image, and its elements

- Educational – to explain to students the goals of the speaker, to show his types and forms, and to form an idea about the communication of people and his role in life. Explain the essence of the following concepts: communication, verbal and nonverbal communication, and official, everyday, persuasive, ritual, and intercultural communication.
- Developing – to include students in the work at all stages of the lesson and to promote the development of their professional, operational, social, and communicative competences.
- Educational – to cultivate a respectful attitude toward the speaker, Observance of the culture of speaking and listening and its constituent elements, such as the ability to listen and understand and politely and correctly behave when expressing one's point of view.

Plan:

I. *Learn about "First Teacher" story by Dshingis Aitmatov (1975)*
II. *Brainstorming*
Questions:

Why has the story protagonist appeared in an embarrassing situation?
Why is knowledge an action in a relevant area?
What did he have to do to avoid a scandal?

(continued)

Evaluate a story's mood.
Why was the protagonist no longer afraid of public speaking?
What are the ways to struggle with stress?

III. *Practical task:*

Watch a short clip from the "First Teacher" movie (teacher's speech) and prepare a 5 min speech on "Image of ideal teacher."
Game "Instructor – Group of Students": Simulate communication scenarios, while the instructor speaks and students listen/do not listen/are disturbed/show interest, etc.
Difficulties at speaking: carry out exercise and discuss results.

Students themselves, sharing their impressions, noted positive points. Basically, they learned to explain their thoughts more reasonably and noted the improvement of thinking activity, such as analysis and evaluation of their learning activity. If before the project activity the students noted the absence of their "soft skills", then in the process of defense presentation, they started talking about increasing their self-evaluation and self-assertion and developing public self-presentation and reflection.

In evaluation of the completed projects, the following criteria were used: actuality and practical focus of the topic, the volume and completeness of the development, individuality, independence, completeness, preparation for the lesson defense presentation, creativity level, originality, speech culture, using of demonstrative features, appropriateness/inappropriateness of the material applicable for the lesson, the audience's activism/immersiveness, the innovativeness of the methodology, capacity amount, and depth of students' knowledge on the project topic.

4.3 Conclusion

Analytical work to develop students' creative abilities included several stages: research, technology, final, and result. All these stages helped to improve logical thinking, widely enhance creative abilities, and encourage students to undertake scientific research work. Project-based learning may be applied as pedagogical technique implying not only knowledge integration but also the application of up-to-date knowledge and further growth.

Through dialog-based learning, students learn to cogitate, address complex problems based on situation analysis and relevant data, compare opinions, take balanced decisions, take part in discussions, and communicate with people. Working in groups and in pairs, micro-research projects, role-playing games, discussions, etc. help a student stimulate and enhance creative activity as his/her own experience becomes a source of learning.

In this real experiment with professional education major students, the advanced were able to perform in-depth study, offer more different ideas, and develop a more complex solution. Less capable students were actively supported and assisted by teacher educators.

Thus, the article is directed to the application of the education project method in order to trigger the development of the creative abilities of teachers of professional education majors. Based on the studies of Krasilnikova and Bondarenko (2005), Raimkulova (2016), Kaarman (2009), authors considered the issues on activation and formation the creative capacity of secondary schools' future teachers.

Summing up, we came to the conclusion that project training should be considered as a didactic system in the preparation of future teachers of vocational training. It should be noted that it is not advisable to translate the whole educational process completely into project teaching.

It should be noted that the success of the students' project work depends on the following factors:

1. Acquaintance/non-acquaintance with the project activity methodology
2. Students' motivation for the project activities
3. Knowledge level of students on the topic of project activities
4. The teacher's qualification level – the organizer of the student's project activity
5. Psychological and social status of the training group
6. Material-technical, educational-methodological, and informational support of the project activities
7. Communicative and verbal competence of students

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Part III
Specific Didactics of Laboratory Work

Chapter 5
Laboratory Work in Education of Food Technology Professionals

Maksudakhon Abdullaeva

5.1 Introduction

A laboratory class allows integrating theoretical and methodological knowledge, practical skills of students into a single teaching and research process. Increasing their role is associated with the rapid development of the experiment in its modern form, as a result of which virtually all university graduates should be prepared for research work.

The meaning of the word "laboratory"[1] speaks for itself as it stands for the old notion of mental and physical effort to solve scientific or life-related tasks. The word "practicum" has the same meaning – the Greek word "practices" means "practical, active" standing for training exercises requiring intensive activities. Many fields of study have their specifics in laboratory exercises.

Joint work in groups is a very efficient way of conducting laboratory activities. Supervision of these exercises requires many efforts by instructors; they have to organize practical classes to facilitate students' in-depth independent work, engage students' mental activities, and provide them with methodology of performing practical exercises.

Exercises are crucial for practical classes. Exercise is an example discussed from the theoretical point of view. Usually attention is paid to the development of specific skills and abilities; thus, it determines students' basic activities, such as addressing issues, creating graphic projects, and clarifying categories and scientific concepts – all being prerequisites for creative thinking and strong speaking skills.

[1] From the Latin word "labora" – work, labor.

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Laboratory work is crucial in many fundamental, engineering, and special fields of study that are taught at universities. Those represent one form of learning activity and practical teaching methods where students create and perform experiments and tests by using special equipment, devices, testers, and other technical means. For example, in microbiology laboratory class, students comprehend, observe, and study microorganisms, bacteria, and fungus and study composition, operation, and measurement methods.

Laboratory work is necessary for achieving educational, didactic, and developmental goals within fields of study and their components (Ploskonosova 2002).

As a result, they provide interaction between theory and practice; encourage independence and ability to set and perform own experiments; facilitate comprehension, analysis, and design; strengthen ability to evaluate outcomes; and ensure the practical application of knowledge. For fields of study, laboratory work ensures introduction to equipment, devices, testers, and research techniques. In other words, students complement theory with factual data and, thus, identify and verify theoretical correlation (Skatkin 1980).

Microbiological production occupies one of the leading places in modern biotechnology and belongs to industries whose production volume is constantly growing, and the scope of application is steadily expanding. The successful development of the microbiological industry largely depends not only on deep knowledge in the field of production but also on the ability to solve emerging problems in the creation of new technologies of knowledge in the field of microbiology, biochemistry, genetics, and ecology of microorganisms. This determines the purpose of this course – the formation of students' basic ideas about the functioning of microbial populations and the possibility of managing them under industrial production conditions. (Ploskonosova 2002).

It defines the purpose of the course – formation of students' basic understanding of the microbial population's development and their management capabilities in terms of industrial production.

When learning microbiology, students should know:

- Basics of morphology and physiology of prokaryote (bacteria) and eukaryote (filamentous fungi and yeast)
- Cultivation and growth of microorganisms and environmental effects on microorganisms to handle their activity
- Food production microorganisms and spoilage microorganisms
- Basics of microbiological control at food production

Student has to:

- Learn microscopic examination and drug preparation methods
- Study microorganism sterilization and cultivation techniques
- Get acquainted with the methods of sterilization and cultivation of microorganisms
- Have an idea of the role of microorganisms in the formation of quality and safety of raw materials and finished products of the plant origin

An important place in the study of microbiology is the conduct of laboratory work. Essence of laboratory works consists in the use of practical training methods for the formation of new knowledge and practical skills (Ploskonosova 2002).

Depending on laboratory tasks, laboratory work falls into *introductory*, *experimental*, and *problem-solving* types.

At introductory laboratory classes, students study design and composition of production means (equipment, devices, tools, etc.), research means (testing units and gauges, etc.), and learn calibration and alignment techniques.

Experimental laboratory work follows experimental and research goals. Students might be tasked to study and master different research methods (e.g., methods to measure impact hardness at researching structural resistance); to construct, reconstruct, and completely construct various schemes (e.g., constructing electrical circuits to measure properties, changing design of gear mechanism to achieve variation of gear ratio); to study effects of various factors on object properties; to determine degree of conformity of experimental and calculation data; to verify, demonstrate, and confirm rules and consistent patterns; etc.

Problem-solving exercises also include organization and implementation of experiments. The difference is only in the level of the problem studied. The level of the problem means the level of complication for students: new object and new experiment conditions. Exercises to verify various hypotheses of educational and the scientific level of the problem fall under this group of laboratory practices.

Based on the activity-based approach to analysis of laboratory work, its structure includes the following stages:

- Introduction and motivation
- Operation and learning
- Control and evaluation
- Completion

The introduction and motivation stage involves definition and communication of laboratory theme, formulation of didactic and developmental goals, and motivation to achieve a goal. Operation and learning is the core of the whole process. It assumes preparation to practical exercises and actual performance. In the preparation phase, the instructor identifies methodology of using available knowledge, recommended sequence of activities, and organization of the work. At this stage, students receive a list of tasks and exercises, methodology of using available knowledge, and recommended sequence of activities. The instructors organize the process of the didactic project and actual implementation of laboratory work.

At the control and evaluation stage, students process experimental data and outcomes of laboratory tasks, summarize and give conclusions, and assess if they have achieved the goal (Poliakova 2015, pp. 188–190).

The completion stage means writing a report and submitting it to the instructor. Every stage is unique in its design, organization, and implementation. Details are provided below.

5.2 Introduction and Motivation Stage

5.2.1 Choosing and Defining the Topic

The topic of laboratory work is part of the curriculum; it is described in detail in a training program depending on students' major, number of hours allocated for laboratory classes, and availability of laboratory resources. Laboratory works that are more important for vocational training and strengthening practical aspects of future work go first in curriculum.

The definition of a laboratory work topic shall include necessary components of the primary objective to be addressed during class and indicate students' actions toward the objective. Action verbs to describe students' activities are – to study, to design/construct, to define, etc. Components of the primary objective are:

- Object – part of a tangible world, process, and phenomenon addressed at laboratory work
- Subject – part of object for study or research
- Procedure – nature, kind, and method of impacting an object to achieve result

- Object, subject, and procedure shall be new to students (Skatkin 1980).

5.3 Forms of Students' Arrangement in Laboratory Work

Organization of laboratory activities may differ depending on a method of conduct: frontal, cyclic, or individual. The characteristic of preparation and conduct determines the difference in organizing laboratory work: individual or group based. In the latter, case instructors need to think over rationale for group arrangements (chain, net, star, and methodology of group roles – identifying a leader) (Skatkin 1980).

- With the frontal form of the organization of classes, all students perform the same work simultaneously.
- In the group form of the class's arrangement, the same work is conducted in small groups of 2–5 people.
- At the individual form of organization of classes, each student performs an individual task (Skatkin 1980).

5.4 Definition of a Laboratory Work Goal

Goal – expected result, indication of a future state of a system (object). Since laboratory classes present one type of training, the goal of this activity is to modify student's personality. In the cognitive part of student's personality, these modifications may be characterized as standards of learning activity with indication of maturity level in compliance with goal taxonomy:

- Carry out actions based on external source of information (schemes, algorithms, instructions, etc.).
- Carry out actions independently on the grounds of available knowledge and methodology.
- Carry out automatic actions, i.e., properly shaped skills and abilities.

Often the objectives of laboratory work are formulated by the professors through the actions of the teacher (to form, develop, provide.) Or through the purpose of the experiment (determine the magnetic permeability, measure the hardness of steel). However, such formulations do not provide an opportunity to assess whether the main goal is achieved – a change in the personality of the learner, whether his/her ability to perform certain practical actions is formed.

The goal setting should provide an opportunity to diagnose the achievement of the objectives of the lesson. For example, the purpose of laboratory work is to study methods for measuring the hardness of metallic materials and to build the ability of students to measure the hardness of such materials. Proof of achievement of this goal will be the ability to independently and correctly choose the method of measuring hardness, perform such measurements, and evaluate the accuracy of the hardness determined (Dogadin 2003, p. 199).

Motivation for laboratory work often develops through describing practical and professional significance of outcomes, ensuring interest to the topic, encouraging competitiveness, etc. For instance, if you learn the method of measuring metal hardness you can apply it to control the heating of food item.

5.5 Operation and Learning Stage

5.5.1 Developing a List of Learning Tasks for Laboratory Class

Practical tasks solved during classes and performed in specific conditions by specific methods are means to achieve the didactic goal of laboratory work. These phases of achieving the goal develop on the ground of a general task breakdown and determine the action plan on solving the given task.

Components of the task structure: subject (task in its initial state), product (model of a required (end) state of a subject), requirements to task, procedure leading to modification of a task subject, means, approaches, and methods to achieve the final (end) state of a subject. If the procedure is explained to students, their activities will be just to reproduce; however, if the procedure is unknown or presented in general words, students become more creative. A list of laboratory work tasks, presented this way, allows making a plan of implementing operation and learning stage.

Important to note, that the plan can be fulfilled if only necessary material resources are available. Otherwise, there is a need to modify the plan to take into account the availability of material resources.

5.5.2 Application of Reference Knowledge and Work Methods

Basic theory application is necessary to implement practical objectives of a laboratory work.

Students may learn this part during classes or in preparation to the classes. Before granting access to the practical part of the work, instructors need to examine the knowledge of reference material with special focus on safety rules. In introductory laboratory work, description of reference material is usually part of input data: full-scale specimen, schemes, equipment, devices, etc.

Planning a laboratory class requires consideration of its type (introductory or experimental), as well as developing its plan requires selection of its type – traditional or factorial. Traditional plan assumes changes only in one independent variable and in factorial variables may be two or more.

Formation of an indicative basis (recommended sequence) of activities. Any action, including students' laboratory work, involves orientation, implementation, control, and correction. Orientation of activities is directed at correct and reasonable/rational set of the implementation part or selection of an implementation format. Its content may vary and differ in completeness of the stipulation activity conditions as well as in generality and production method. Completeness of a recommended sequence of activities may have or may lack structural components like:

- Object to be transformed or baseline for activity (problems, tasks, preparations, materials, scheme components, etc.)
- End product or result expectations (constant pattern description, numerical result, model, scheme, sample, product, etc.)
- Resources for activities (handbooks, tables, devices, tools, knowledge of procedures and rules, transformation methods, methods of procedure: mental and physical)
- Process technology (algorithm, design formula, demonstration or description of sequence of activities in kind of guidelines, flowchart, etc.) (Hutorskyi 2001)

Educational experiments are another special type of laboratory work. This type of experiments address two objectives: work to learn the methodology of measuring various features and work to study object behavior and properties, measurement of given properties depending on experiment conditions. In the latter, measurement methods serve as a framework, base operations used by students during research activities.

As a result of experimental laboratory work, for learning measurement methods, students will have to demonstrate abilities to determine object properties, measure properties with given methods, and, at a required quality level, apply methods to reveal and measure object properties to carry out experiments. Students will also have to verify precision of measurements, interpretation of nature, etc. Without proper knowledge of research and measurement methods, students will not be able to perform laboratory tasks to study the relationships and effect of miscellaneous factors due to the fact that experiment results may turn out unreliable. To performing laboratory work in order to learn measurement methods, students need to practice evaluation of measurement precision, note systematic, and random margins of error of credible interval and feasibility of using some methods and equipment (Chernilovskyi 2002).

Experimental work of a second type requires an action plan and performance algorithm. Due to didactic character, algorithms may be:

- *Reproduction algorithm*

- *Practical* laboratory task is addressed in strict conformity with set of rules; students follow this set of rules in reproducing operations (formal sequence of actions).
- *Algorithm of identification*
- *Verbal* description is replaced with drawings and photos; students have to assemble a scheme or mechanism in compliance with the given drawings and photos. Students have to identify parts of a given device, know how to read drawing legends, and distinct scheme elements to create a mechanism or scheme.
- *Problem-solving algorithm*

- It is the system of general rules and operations; students perform research activities directed at solution of a problem situation acting in a certain sequence.

Implementation of practical exercises may differ depending on a type of a suggested algorithm. If in an introductory laboratory work they use algorithm of identification, in experimental work to study methodology, they use reproduction algorithm. In research laboratory work, together with reproduction algorithms, they apply a problem-solving algorithm (Dogadin 2003; Poliakova 2015, pp. 188–190).

5.6 Control and Evaluation Stage

The goal of this stage is to process, analyze, and evaluate results and to make conclusions.

The control and evaluation stage of laboratory work is the activity of monitoring and evaluating the course and results of a particular process.

Control is the process of comparing a controlled object, activities with standards, norms, and criteria. Evaluation is an oral or written expression of control results.

In connection with the ideas to modernize education, control and evaluation must be changed radically. And then immediately the following questions are arising:

- What to evaluate?
- Who evaluates?
- How to evaluate?

And in no case should you confuse the two concepts – the "mark" and the "evaluation".

A mark is a quantitative measure of the level of knowledge and skills of a student. The marks of the student are fixed in the special documentation (in journal); the scale of marks rigidly establishes the level of mastering by the student of the uniform state program of the educational standard. In fact, the mark is formal.

Evaluation is a definition and expression in conventional marks, points, as well as in evaluative judgments of the teacher concerning the degree of mastering the knowledge and skills by the student established by the program, the level of diligence, and the state of the discipline. It can vary in any possible way.

Evaluation determines the nature of the students' personal efforts, establishes the depth and scope of individual knowledge, and promotes adjustment of the student's motivational and needs sphere. The assessment is emotional.

5.7 Learning Outcomes (Mastered Skills, Acquired Knowledge)

The main goal of the discipline teaching is in-depth study of the foundations of general and industrial microbiology and microbiology of food production. Formation of a scientific world outlook on the role of microorganisms in various processes of processing and storing food products. This will allow future bachelors to ensure a high level of sanitary-hygienic state of production, prevent losses, and get benign products, accounting for the main patterns of development of a technically useful and harmful microflora in the development of new types of food products.

Mastered skills:

- To provide aseptic conditions for working with biomaterials
- To use microscopic optical technology
- To conduct microbiological studies and evaluate the results obtained
- To observe the rules on personal hygiene and industrial sanitation and apply the necessary methods and means of protection
- To prepare solutions of disinfectants and detergents
- To disinfect equipment, inventory, premises, transport, etc.
- Master microscopy technique and the technique of preparing microbial agents and to get acquainted with methods of sterilization and cultivation of microorganisms

- To have an idea of the role of microorganisms in the formation of quality and safety of raw materials and finished products of plant origin

Knowledge acquired:

- The main groups of microorganisms, their classification
- The importance of microorganisms in nature and human life
- Microscopic and cultural studies
- Rules for selection, delivery, and storage of biomaterial
- Methods of sterilization and disinfection
- Concepts of pathogenicity
- Sensitivity of microorganisms to antibiotics
- Forms of exposure of pathogenic microorganisms to the organism
- Microorganisms used in industry enterprises and microorganisms – pests of food production
- The basis of microbiological control at the industrial enterprises

At the end of a laboratory work, students have to write a performance report in compliance with requirements for content and result evaluation criteria.

Reports should include:

- Correct title of the laboratory work
- Goals and objectives
- Test record (if applicable) or testing process protocol
- Tables, diagrams, and revealed correlation
- Conclusions
- Evaluation of results (to what extent results correspond to goals) (Ploskonosova 2002)

5.8 Conclusions

Microbiology (from the Greek micros (small), bios (life), logos (science)) – the science of the smallest, invisible to the naked eye organisms. Microbiology studies morphology, physiology, genetics, systematics, and ecology of microorganisms and their relationships with other beings.

Nutritional microbiology is based on knowledge of general microbiology; organic, physical, and colloid chemistry; and biochemistry and serves as a theoretical basis for any food technology.

Laboratory classes on discipline "microbiology" – an important stage in the training of engineers-technologists of food production. For their implementation, the student must familiarize himself with laboratory equipment, as well as with the technique of conducting basic laboratory operations.

Since microbiology laboratory contains electrical appliances, pure cultures of various microorganisms, students must strictly observe the rules of internal regulations and safety precautions. Before each laboratory work, the student should study the relevant section of the textbook, a summary of lectures, and a description of laboratory work.

When preparing a report on the work done in the workbook, it should be written down the date, the results obtained during the performance of laboratory work, and the conclusions. Conclusions should be consistent with the stated goal of the work.

In laboratory works, the use of methods of problem training is envisaged: business game, solution of situational tasks, search method, and elements of research work.

The application of the search method is realized when the students compile their conclusions after completing each task, as well as in a group discussion of the results obtained, when it is necessary to explain the results obtained.

Laboratory work on the discipline "microbiology" is a very important form of training, as they allow students to deepen and expand theoretical knowledge, to get acquainted with practical techniques for determining the raw materials quality and finished products, and to master the methods on experimental research and the results processing.

In laboratory classes in microbiology, students perceive, observe, investigate natural phenomena and technical and other processes, study the technology objects, and acquire skills in working with a microscope.

As a result of studying this course, students should distinguish the main groups of organisms, learn the characteristics of the metabolism of microorganisms, gain skills in working with a microscope, master the sampling skills for microbiological analysis, be able to perform microbiological analysis, understand the impact of environmental conditions on microorganisms and terms of food storage, and know the basics of hygiene and sanitation and existing rules and regulations.

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Chapter 6
The Theoretical-Practical Cake

Linking Theory and Practice in Food Industry Education

Franz Horlacher

6.1 Background

The Central Asian countries differ significantly in their economic development, as shown in the following overview (cp. Table 6.1, Germany Trade and Invest 2013, 53f).

While Kazakhstan shows a rather per capita high income, mainly due to oil and gas production, the other countries in the area score significantly lower. Those discrepancies also transfer to the food supply. As early as 2009, Kazakhstan joined the ranks of the world's largest exporters of wheat and flour, achieving self-sufficiency with those foods, even though the yield per hectare is drastically lower than the worldwide average (Belaya and Mykhaylenko 2010, 4). In Turkmenistan, Uzbekistan, and Kyrgyzstan, however, the supply situation with wheat is considerably below 100% (Perekhozhuk et al. 2013, 9), with Tajikistan having imported two thirds of its wheat in 2010 (Geppert and Oppeln 2011, 3). This dependence is especially important considering the elevated wheat consumption per capita in the country, being two to three times the German level (Perekhozhuk et al. 2013, 10).

Overall, due to the vast north-south extension of Central Asia, the area is characterized by very different climate conditions, allowing the production of a broad range of goods, including grains, fruits, and vegetables, as well as milk and meat. Due to the lack of modern refining processes, too little of these goods are used for providing food to the domestic population and for export. The meat production in Kazakhstan is a current example: The country exports slaughtered meat while importing large amounts of processed meat products (Belaya 2016, 3). Overall, the Central Asian countries import more refined foods such as canned meat and fruit,

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Table 6.1 Comparison of economic development

	GDP per capita in US $ 2013 (rounded)	Main contributors to GDP
Germany (Statista)	46.000	Service sector, production industry, construction
Tajikistan	955	Agriculture, trade, service sector
Turkmenistan	7.000	Fuels, energy, manufacturing sector (data from 2011)
Uzbekistan	1.950	Mining, manufacturing sector, public administration (data from 2011)
Kazakhstan	13.000	Mining, industry, trade
Kyrgyzstan	1.200	Mining, industry, agriculture

dairy products, processed meats, confectionery, and infant food (Belaya and Mykhaylenko 2010, 4). The value lost to the country due to imports further increases the dependency. Food production and processing is therefore of immense importance to the development of Central Asia.

Despite the overall high educational standard, the region still lacks specialists and managers "…trained in economically efficient, technologically up-to-date and ecologically sustainable technologies" (Zöbisch 2012, 1). It subsequently became inevitable to structurally redesign the current education in the food industry for specialists, engineers, and instructors. A prototype training course for food technology had to be developed, and an educational framework for the academic programs Bachelor of Science in Food Technology and Master of Science in Food Technology was created. The prototype training course required specific preparation and training for the instructors. The Master of Education in Food Technology program is based on the technical Bachelor of Science in Food Technology.

6.2 Prototype Training Course for Food Technician/College

Since the academic programs are described elsewhere, this section focuses solely on the interlinking of theory and practice in the prototype training course for food technician, i.e. food processing and production technician.

The structure of the prototype training course for food technicians is based on the vocational college concept. In the past, dual vocational training has not achieved the best results (Euler 2013, 12); the training of instructors for food technology and food processing and production consequently differs from the German approach. A 3-year or 6-semester full-time classroom-based education was deemed the best fit considering the educational system of all participating countries, resulting in a qualification equal to that of a dual vocational program.

Education in Central Asia is heavily based on traditional, instructor-centered teaching, with little interlinking between theory and practice (Stehling 2015). Accordingly this challenge had to be overcome with the newly designed prototype

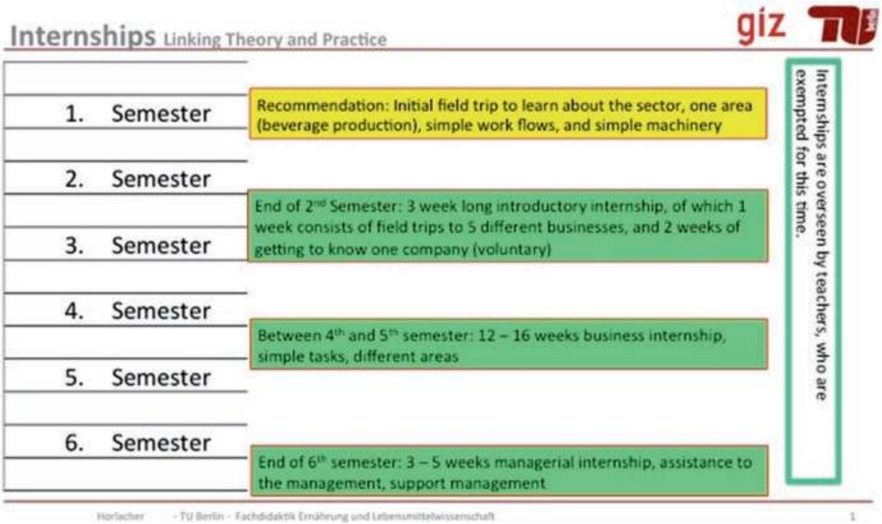

Fig. 6.1 Linking theory and practice in the prototype training course for food technology

training course. The curriculum provides numerous links by including a high percentage of practical working periods, some of which will be presented in this paper.

6.2.1 Internships

As of right now, practice plays an insignificant role in college education, a nuisance to be addressed by integrating business internships, which remotely resemble the concept of dual vocational training. As an important prerequisite for this approach, strong ties between the colleges and participating companies have to be developed and maintained. During the five internships integrated into the training, it is of great importance to allow the college students to handle tasks of increasing difficulty to gradually develop their responsibility for food production (see Fig. 6.1). The tasks will range from merely observing different production methods to supporting the management toward the end of the training. The instructing teachers must closely advise and oversee the students during the internships and develop a close relationship between school and businesses.

6.2.2 Food Sensory Technology

For the subject sensory technology, several groups of teachers from Central Asia were educated at seminars by a vocational school teacher specially trained for the assignment. To help the students develop the competencies in a theory-practice

Fig. 6.2 Sensory technology lab in Bishkek (Photo: Franz Horlacher)

module, sensory technology labs with several training spots were established with the German experts, using available resources at the University of Bishkek, Kyrgyzstan (see Fig. 6.2); the Technical University Dushanbe, Tajikistan; and the Agricultural University Almaty, Kazakhstan. The only sensory technology lab established at a college as of now exists in Kara-Balta, Kyrgyzstan. Here, German experts qualified additional instructors. This allows a consistent linking of theory and practice for the vocational college for food technicians.

6.2.3 Technical Drawing

Technical drawing is taught in the first semester of the 3-year college program. A potential problem consists in the subject being taught on a rather abstract level and the conventional introduction into technical drawing offered does not correspond well with the expected tasks of a future food technician. To avoid such issues, the following approach was proposed: Technical drawings (or parts thereof) of food processing machines from the field trips prior to the program are to be included in the lessons. During the field trips, the students are asked to take pictures with their mobile phones. The parts shown in the pictures are later to be discussed in class. The students are supposed to develop an understanding of technical drawings without having to create technical drawings themselves. This approach can teach students how correctly interpreting a technical drawing may reveal more and deeper knowledge than pictures. The acquired skills are also the foundation for process engineering and hygiene, both taught at a later time, to establish an understanding of potential cleaning tasks during food production.

6.2.4 Practice-Oriented Food Technology, Food Processing, and Production

To bridge the gap between theory and practice in the core subject of food processing, the ratio of theoretical training to practical work at the technical center was established at 1:2. The technical special subjects of the electives (part IV) are sorted into seven food groups, three of which are to be chosen for each college based on country-specific and regional demands. For a corresponding specialization, an appropriately equipped technical center must be available. For those teaching tasks, the current teachers must receive additional training to more closely link practice and theory.

6.2.5 Example of Linking Theory and Practice in the Technical Center

During a workshop in spring 2016 in Almaty (Kazakhstan), the following approach of linking theory and practice was demonstrated to the participating teachers and educational delegates with a task to be detailed further in this paper, since it presents a possibility to realize this way of teaching using limited resources.

6.3 Curricular Anchoring

The presentation started with the prototype training course for food technicians. Under 6.4.6, the program's curriculum lists the subjects 21a and 21b, Technology of Bakery Production. Among others, the presentation listed the following competencies as aspired learning outcomes:

- The college graduates apply specialized technological understanding in monitoring production workflows.
- They choose appropriate methods to solve pending technological tasks.
- They evaluate advantages and disadvantages of critical methods.
- In particular, the development of new methods.

The following contents are to be taught in the section "Pastry Goods":

- Production methods and production technology for pastry goods
- Discovering the production processes for certain pastry goods

Table 6.2 Specification of workflow and potential transfer

Brief specification of workflow	Potential transfer
Students correctly prepare devices for the experiment	Students autonomously organize experiments at the technical center and comply with hygiene regulations
Students perform the experiment according to the instructions	Students design experiments at the technical center and execute them
Pastries produced are evaluated appropriately	Students evaluate products produced by themselves appropriately and according to self-developed schemata (sophisticated sensory technology)
Equipment and materials are cleaned hygienically and put away	Students maintain equipment according to the HACCP concept
Results of the different groups are diligently logged	Students discriminately record their results and the results of others
Theory on foam formation is worked through in teams	Students establish the theoretical foundation from texts
Upcoming questions are answered and assessed with the instructor	… and self-critically reflect on their established findings
Different results are interpreted with the gathered information	Students interpret newly established insights in new situations

6.3.1 Comparative Work Test

These specifications served as the foundation for the design of the following tasks for a workshop, created in Almaty in cooperation with German experts. One focal point was a simulation of work with students in the technical center. The concept was based on the comparative work test (Rösch 1987).

> **Task:** Compare the listed methods of whisking eggs for foam egg batter using the example of the sponge cake mixture. Based on the test results and theoretical texts, deduct rules for the production of foam egg batter.

This task requires a small technical center. Each group needs a sturdy food processor, a work area, sufficient small appliances, and raw materials (eggs, flour, and sugar). The work sheets needed are provided online (Table 6.2).[1]

[1] http://forum.eduinca.net/

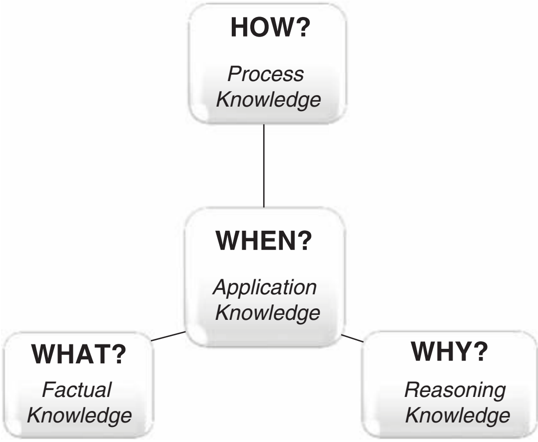

Fig. 6.3 Action knowledge according to Schelten (2011)

6.3.2 Intended Learning Outcomes

The learning process can be divided into two levels: On the one hand, students mainly learn manual methods at stations 1–5. Simultaneously, they learn about different processes during pastry production ("Discovering the production processes for certain pastry goods") while "assessing advantages and disadvantages of crucial methods…" by comparing results. Subsequently, they can "…choose appropriate methods to solve pending technological tasks…" and potentially develop new methods. Up to this point in the learning process, the students only learn different methods without addressing the deeper reason for the action and/or interpreting the results. Within the concept of action knowledge (Schelten 2011, 3; see Fig. 6.3), the students' comprehension level up to this point is merely process knowledge, amended by factual knowledge. For a sophisticated vocational training that links theory and practice, reason knowledge is needed to replenish the other types of knowledge to form application knowledge.

However only application knowledge allows for a "…specialized technological understanding in monitoring production workflows…." It is crucial for the students to understand the theoretical foundation of their actions, i.e. develop the so-called reasoning knowledge. In this example reasoning knowledge is gained by the foam formation of egg protein. The students understand the theory of foam formation using the work sheet and subsequently assessing their understanding. It is very important that the results of the experiment cannot be interpreted directly from the offered text. The work materials merely prepare the "next developmental zone" according to Vygotskij (2002). Interpreting the results from the experiments is only possible after the taught theory is thoroughly understood. This allows the students to develop a broadened understanding of the interconnections between theory and practice.

6.4 Conclusion

A modern and promising education in food production and food technology can only be achieved by permanently linking theory and practice on all levels of the educational process. The examples illustrated present one possible approach. The comparative work experiment, deducting its conceptual formulation from professional practice and achieving its results using scientific methods (Horlacher 2015), is particularly suitable for implementation in a technical center. The skills achieved constitute action knowledge (Schelten 2011), representing the constitutive element of professional self-conception.

In general, these approaches have to be refined according to regional specifications which are rather diverse in the states of Central Asia and as well differ in comparison to the situation of TVET in Germany. The conception of appropriate experiments reflecting regional peculiarities is very important for vocational colleges.

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Chapter 7
Potential of the Task-Based Learning for the Sustainable Development of Food Technology

Manuela Niethammer

7.1 Introduction

The sustainable development of food technology in countries of Central Asia requires that those professionals at various skill levels are trained, who are not limited to coping only with the tasks that entail innovative technologies. Instead, it requires professionals who shape and develop these innovations further. Potentials of skilled worker expertise for sustainable workplace organisation have been in discussion since the 1980s of the twentieth century (cp. Rauner 1988).

This expectation from skilled workers results in demands related to vocational education and training. The skilled workers must be empowered not only to understand the world of work and to "operate" the technical systems but also to question and optimise these continuously. This must be reflected in the didactic set-up of the vocational teaching-learning processes. Learning opportunities must be initiated in which the trainees are introduced to the organisation and sustainable development of their respective work domain. The underlying problem-solving processes must be addressed and reflected for learners. The laboratory training and the comparative work trial in particular offer a good opportunity for this.

The following section classifies the comparative work trial as a method in vocational education. The statements are based on the approach of skills-based and action-oriented vocational training, which was established with the reorganisation of occupations in Germany since the 1990s. With the so-called learning field concept, professional work, or more specifically occupational tasks, was made the fundamental reference point for vocational learning (see Bader 2003).

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7.2 Occupational Tasks as Reference for Vocational Learning or Which Content Is Important for Professional Work and thus for Learning?

Vocational tasks present an important reference point for skills-based vocational training. This also applies to the analysis of the relevant content (technical analysis), the methodological structuring of the teaching-learning settings as well as for the planning of performance or skills assessment.

For the analysis of education-related contents of the work, it must be considered that the concrete implementation of professional work is limited by overriding factors such as the organisation of work, the company size and structure, etc. In hierarchical working structures, the skilled workers are accustomed to routine tasks, whereas in companies with participatory organisational structures, skilled workers are more involved in addressing problematic and development tasks. The knowledge required for the work tasks, which can be further divided into practical and technical knowledge (Franke 2001; see also modelling approaches, such as theory of action regulation, Hacker and Ulich 1986), also correlates with these factors.

Practical knowledge here includes knowledge of adequate thinking and working actions and technical operations to perform a work task in view of the objective (Franke 2001, p. 17). If one compares such an action with a defined change of a work item, the action is defined as process unit. The practical knowledge includes the logical layout of all the process units necessary for the order processing.

The process unit is the smallest reference quantity for allocating the expertise which comprises of any relevant facts, circumstances and relations that characterise and consequently justify the course of action or order processing. These include at least the following aspects with regard to a process unit[1]:

- Work items (e.g. structure and properties of raw materials and products)
- Mechanisms and effects of natural and technological processes that lead to desirable (e.g. kneading of dough, fermenting tea) or undesirable (formation of grinding areas in the dough) changes in the work items, including the process conditions (e.g. temperature, dwell times, energy input)
- The functioning and operation of the equipment (hand-held vs. large-scale equipment), including the necessary auxiliary media, energy, etc.

For the structuring of educational content in the context of work tasks, the approach sketched in Fig. 7.1 is discussed in the didactics of professional disciplines (cp. Niethammer 2006; Kuntzen et al. 2010; Becker et al. 2010).

The general contents and content relationships outlined in Fig. 7.1 (every double arrow represents potential relationships between the concepts) should be underpinned

[1] Regardless of this work-based system, the technical expertise relevant in the context of the specific work task may be a subject of various scientific disciplines (food chemistry, food technology, biochemistry, chemical engineering, history, economics, etc.) and be present in a different systematically structured way depending on the subject area.

Educational content in the context of a specific work task,
e. g. preparation of a pastry

Practical knowledge, which is structured as a process chain for order processing. A generalised example is given for the preparation of a pastry	**Technical knowledge**, which is structured in the form of concept maps, whereby the terms for the underlying concepts and the arrows are related to each other. A generalised diagram is presented that reflects the underlying concepts and relations for a certain process unit.

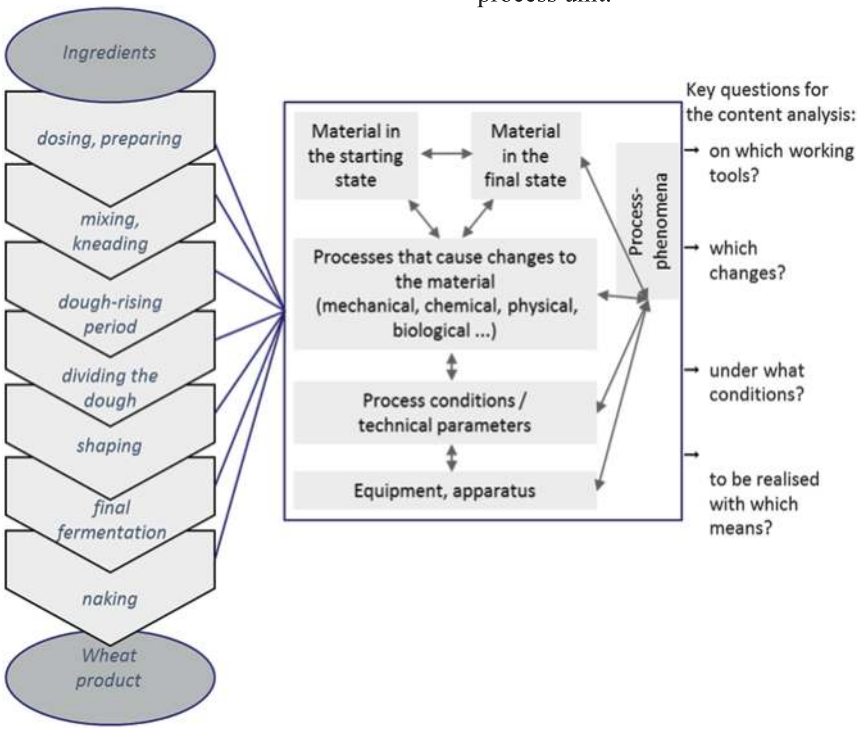

Fig. 7.1 Approach to structuring of educational contents in the context of professional work tasks as practical and technical expertise

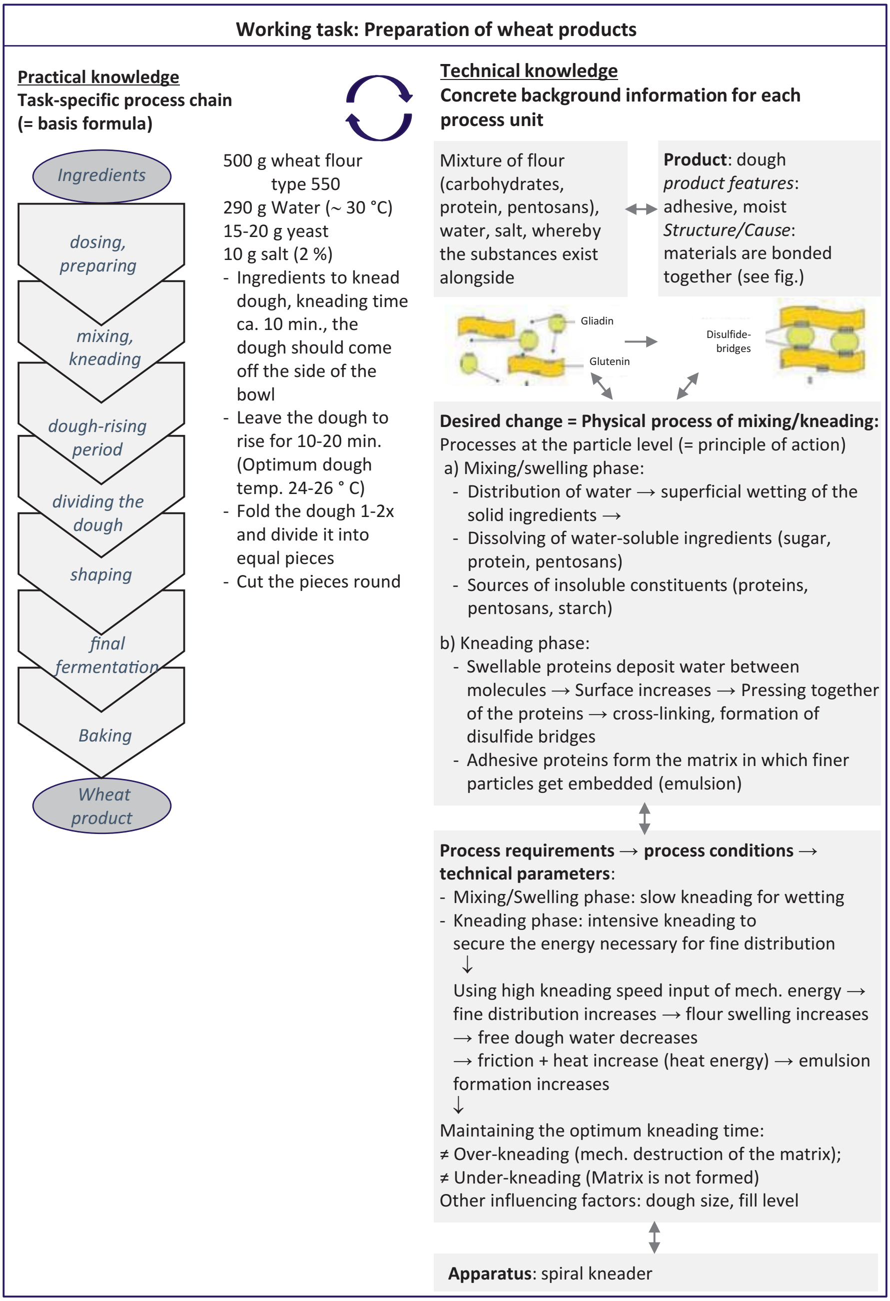

Fig. 7.2 Exemplary substantiation of task-specific practical and technical expertise using the example of the work task "preparation of wheat products"

specifically for each work item. In Fig. 7.2, this is illustrated for the task "preparation of wheat bread".

The technical and practical knowledge is not necessarily important for the realisation of every work task. This depends on the type of work item. In other words, the work requirements or task types can be classified through the relevance of the practical or technical knowledge to deal with a specific work task or situation.

Tasks that can be managed based solely on action-related knowledge have certain minimum requirements. Action-related knowledge corresponds to a minimum knowledge structure (cp. Frank et al. 2016). The requirements increase with the extent of the necessary specialised knowledge. If practical and specialised knowledge is necessary for solving a task, which can be correlated, this corresponds to the optimal knowledge structure (cp. Frank et al. 2016). Regardless of this differentiation, the respective required technical and/or practical knowledge has different characteristics that determine the difficulty level depending, inter alia, on the complexity or the necessary abstraction level of knowledge (see Niethammer 2006, Becker 2010; Kuntzen et al. 2010; Becker et al. 2010).

In correlation with this understanding of the knowledge required for the work task management, the work tasks can be classified as:

- *Routine tasks* as those that are to be dealt with following strict rules such that in this case, the practical knowledge provides a sufficient basis for correctly addressing the task.
- *Problematic objects* as tasks in which an incompletely defined situation or external influences mean that a routine execution is not possible. In this case, the condition-related appropriate course of action has to be generated first. For example, the raw materials in Central Asia exhibit significant quality differences, which are encountered through variety selection and genetic modification in industrialised countries. The basis for solving problematic tasks is both practical as well as technical knowledge.
- *Optimisation or development tasks* that are to be dealt with in a team. For these tasks, the routine processes should be questioned and modified (cp. e.g. Eberhardt and Schlegel 2011). In addition to the task-related practical and technical knowledge, they also require knowledge of the proper planning of development processes. If sustainable products are created and corresponding manufacturing processes are generated or planned in a resource-efficient manner, substantive and methodological expertise is required. Products or processes can only be optimised if the influence of each parameter on the process or the product is known or studied systematically. The latter includes, for example, that in every empirical analysis, only one parameter is varied keeping all other variables constant. Such knowledge is beyond the scope of the classical skilled workers. However, it is important if they are to contribute their expertise for sustainable workplace shaping.

The methodological planning of teaching-learning processes must satisfy the particular objectives and contents of vocational training. Thus, the development of occupational competence is[2] linked to the fact that the learners are already faced with tasks in training for which responsibility will be handed over to them later during their professional work life. A person can only learn to manage work tasks by practice. This implies that the pending work item is analysed, the expected results are derived, facts are already known, open questions are differentiated and alternative solutions are drawn up, implemented and controlled (principle of complete action). At that moment, the work task becomes a learning task for the trainee.

If work tasks are used as reference points of learning in vocational education, then each task carries a different learning potential, resulting from the above-mentioned requirements. They reveal themselves in the issues that arise most likely during the implementation of the task.

If a food item is being prepared following a recipe, questions will arise regarding the necessary steps and their execution (practical knowledge). If the ingredients are known as such and the instructions are clear, questions regarding the properties and the chemical characteristics of the ingredients or the mechanisms of the required technological or natural processes (mixing, kneading, baking, cooking, etc.) are hardly of any relevance.

Another situation and thus a different learning potential arises when the desired and expected effects of a certain process are not seen, e.g. the dough does not have the right consistency or the cake seems to have cuts after baking. The search for possible execution errors makes one scrutinise the entire process in depth. This implies issues, based on the used ingredients, the parameters and the possible interfering factors on the process (factual and procedural knowledge).

The sustainable development or optimisation of recipes also implies that the ingredients, the process parameters and possibly also the technology are questioned in order to generate a more sustainable recipe. This can include the substitution of ingredients with healthier ones as well as an increase in the resource-efficient products by minimising time or energy. Questions that may be associated herewith such as:

- Which substances are they? Which properties are technologically or nutritionally significant? Can these be influenced? What causes them? (The response may require the consideration of the chemical structure of the substances.)
- Which material changes occur? Why?
- What processes take place in the technological processing of the materials? (Model conceptions of the processes taking place at the micro level facilitate the derivation of process parameters and the justification of the process phenomena.)

[2] (Professional) competence is understood as the willingness and ability of an individual to recognise, develop and implement objective action potentials and subjective development potentials in professional, social and personal situations.

- Which conditions are conducive and which ones inhibit the process? Why?
- Which devices/equipment are suitable to ensure the necessary conditions/parameters? Which occupational safety measures result from this?

These questions are based heavily on the technical expertise and the knowledge of action. Development and optimisation tasks also comprise of the learning potential outlined for routine and problematic tasks. In addition, it also needs to be clarified that which criteria are important for the implementation of a development or optimisation process.

- Which influencing factors should be examined in what way?
- Which variables are to be held constant in order to be able to assign the effect clearly?
- How should the complex exploration process be logged such that uninvolved parties can also use the data?

It is clear that the task types provide different learning opportunities that are equally reflected in the teaching goals and content.

7.3 Didactic Concepts of Work-Based Learning and Their Potential for Sustainable Workplace Organisation

Depending on the goal-content relations, there are also some different didactic concepts for the presentation of the task of dealing with the work, including the resulting questions. Due to the complexity of the learning processes, the methodological design of teaching and learning processes should also be discussed with a multi-perspective approach in order to reflect all the relevant aspects. That cannot be done at this point. The focus should rather be given to the appropriate action patterns.

In the following tabular assignment, the work tasks are classified based on their learning potential, and the appropriate action patterns for didactic design of the respective task-based learning processes are assigned (cp. Table 7.1).

The comparative work trial corresponds to the systematic testing of work regulations under different conditions (independent variable), through which their effect on the entire work process (dependent variables) can be studied and characterised. To clearly understand the relationship between the respective different conditions and the achieved effects, the other conditions must be kept constant.

These “conditions” in the work process may relate to all elements of the work system. The following may be varied:

- Substances may be varied in type and quantity (material aspects).
- Technologies and working techniques, such as stirring vs. kneading (process-related aspects).

Table 7.1 Classification of work tasks

Work tasks	Examples	(Special) learning potential	Suitable educational concepts (action patterns)
Routine tasks	Producing a food product according to a given recipe	Practical knowledge	Four-step method (preparation, demonstrating, imitating, practising), learning guidelines method
Problematic tasks	Recognising and rectifying an execution error, varying recipes depending on the conditions	Technical and practical knowledge	Case method, project learning, role-playing, simulation game subordinated: research, teacher-student conversation, lecture, experiments, incl. various cognitive processes[a]
Development or optimisation task	Developing new products, optimising recipes, etc.	Technical and practical expertise and knowledge regarding the methodology of systematic development of products/technologies	As stated above, as well as comparative work trial

[a]A comprehensive picture of the diversity of different paths to knowledge cannot be sketched at this point

- Process parameters, e.g. temperature, dwell time, pressure, and speed (process-related aspects).
- Apparatus such as beater vs. mixer (apparatus-related aspects).

The comparative work trial may be considered a scientific method on which the optimisation and development of new sustainable products or processes is based. Unlike the simple experimental exploration of the effects of a parameter on a work process, the consistency of all other parameters is explicitly controlled. When exploring, the observation is solely directed towards the expected effect, and other consequences are hardly controlled. The analysis may be so highly focused that the relevant conditions are entirely neglected in the overall consideration. Likewise, the comparative work trial is to be distinguished from "test baking", with which the quality of the flour from the new delivery or grain harvest was also determined in the Middle Ages. However, the various test parameters were randomly set and varied here (see Horlacher 2015).

The requirements to be met by the learners in the comparative work trial are enormous. In order to understand and interpret the effects in comparative work trial correctly, a systematic documentation of all relevant process-related and product-related data is necessary. These shall be clearly documented for several manufacturing processes, where only one parameter is varied. In addition, the expected/desired values (target values or comparative values of the standard variant) shall be compared with the achieved parameters (actual values). By linking the different perspectives, the data situation becomes complex. Documentation and interpretation of the data requires a high degree of structuredness and cognitive ability. For illustrating this, a possible documentation for a comparative work trial for baking bread is given in the Annex.

The development of skills for sustainable development presents a particular challenge for the teachers as well. The comparative work trial offers a didactic concept to address and reflect the complex relations as well as methodological aspects that underlie the respective development or optimisation task with the learners.

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Part IV
Media and New Technologies in TVET

Chapter 8
The Project Title: The Virtual Laboratory and Quality of Education

Lafiz Boboev, Zokirkhodzha Makhmudkhodzhaevich Soliev, and Firuz Asrorkulov

8.1 Introduction

The need in using innovative methods in learning professional technical subjects in the educational institutions defines the up-to-dateness of this theme.

In spite of the sufficient provision of the educational institutions with the technical media of teaching, often teachers cannot give students the full complex of the knowledge, which is required in the modern era.

The electronic educational resources based on the modern computer three-dimensional simulation of physical processes and phenomena are being realized in the form of multimedia teaching and research laboratories or virtual simulators. The argument for using new technologies of virtual simulators is an active introduction of the modern means of computer simulation and information technologies in the sphere of education, as a new transdisciplinary area.

The main reasons for using the technologies of virtual simulators are as follows:

- The existing laboratory stands and workshops are not sufficiently equipped with modern appliances, devices, and tools.
- The majority of the laboratory stands and training workshops are put into effect after their withdrawal from the production, do not meet the modern requirements and outdated, and thus can distort the results of the experiments and serve as a potential source of danger to the students.

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- The laboratory work and stands require annual upgrading, which leads to additional financial cost.
- The areas like construction material engineering or physical chemistry, in addition to the equipment, need consumable materials, raw materials, reagents, etc., the cost of which is sufficiently high.
- The modern computer technologies allow to see the processes, which are difficult to see in the real world without the use of additional equipment, for example, due to the small size of the observed particles.
- The virtual simulators allow to simulate the processes that are fundamentally impossible in the laboratory conditions.
- Safety is an important advantage for using virtual laboratories in the cases of working with high voltages or chemicals.
- Due to the inertia of the work or processes, it is difficult to carry out repeated analysis or verifications in some laboratory equipment during the allotted time.

Considering the abovementioned facts, it is necessary to introduce a new, effective, and affordable teaching methodology, which would facilitate the solution of the following tasks:

- Initiate sufficient interest among the audience, thus will increase activity and independence of their educational work.
- Attract the attention of listeners, considering their psychological peculiarities, to improve the perception of educational material due to its multimedia character.
- Provide full control on learning of the material by each student.
- Facilitate the process of repetition and training in preparing for exams and other forms of knowledge evaluation.
- Release teachers from the routine monitoring and counseling activities.
- Use extracurricular time to study the design in the form of home assignments.

Exactly from this point of view, the introduction of information technologies promotes optimal solution of the above problems and elimination of the number of shortcomings of the traditional method of teaching. The multimedia teaching and research laboratories, which are created on the computers, can help in solving these issues fully.

8.2 Practical Application

The amount of hours allocated for teaching of chemistry in the higher educational institutions of the Republic of Tajikistan is not sufficient to capture all the themes of the chemistry lessons. The multimedia means are regularly used in the lessons as innovation methods for accelerated education of students.

To this end, the Branch Office of the Tajik Technological University in the city of Isfara uses multimedia technology as a modern method of teaching in all subjects and especially in chemistry.

While teaching chemistry, it is efficient to use computer technologies in the classroom for teaching new materials (presentations for lectures), developing skills (educational testing), as well as carrying out practical works in chemistry.

The purpose of the computer application in a chemistry class is to create didactic active environment conducive to productive cognitive activity in the process of learning new material and developing students' thinking.

By implementing new technologies in the educational process, we give students the opportunity not only to learn the subject but also to operate a computer. Many tasks in the computer variant of the subject allow developing the creative abilities of students, looking at the subject from the other angle and expressing themselves in new activities. A definite positive side of introducing new technologies allows us to make a new step toward the future, where the computer is a means for realizing our capabilities and talents (Paluch 2015).

When working with the multimedia technology, the students are actively involved in the cognitive activity from the beginning. During such training, they learn not only to acquire and to apply the knowledge but also to find the necessary learning tools and sources of information and to be able to work with this information.

8.3 Use of Virtual Laboratories in the Chemistry Lessons

The objectives for use of virtual laboratories in the lessons:

- Create a bank of training modules that can be used in the lessons.
- Implement the idea of individualization of learning in accordance with the speed, which is the most appropriate to each student.
- Optimize the monitoring process to check students' knowledge.
- Minimize the likelihood of the formation of students "inferiority complex".
- Improve the quality of education.

The extensive use of the animation and chemical modeling by using computer makes the teaching and learning process visual, understandable, and remembering. Not only the teacher can check the students' knowledge by using the test system, but also the student himself/herself can control the degree of grasping the material. The use of virtual tours greatly expands the students' horizons and facilitates the understanding of the essence of chemical production. We believe that the main advantage of the computer design in the chemistry class is its use when considering explosion and fire processes, reactions involving toxic substances and radioactive substances, in short, everything that makes a direct danger for the health of students.

8.3.1 An Interactive Whiteboard as a Mean for Productive Learning of the Educational Material in the Chemistry Classes

An interactive whiteboard is a touch-sensitive screen connected to a computer, which transmits the image from the projector to the board. It is enough to touch the surface of the board and to operate it.

No doubt that an integral part of the chemistry is an experiment. In the traditional lessons, students do practical work, the purpose of which is to examine the properties of the substances with the help of observations. When conducting experiments, the students observe only the external effect of interaction and express the changes occurred with the substances in the form of equations, by using chemical formulas and mathematical symbols. Why do some chemical reactions occur and others do not? What happens to the atoms and molecules in the process of chemical reactions? To see this, one needs to look into a completely different world – a microworld, which is really closed. Not everyone has the ability to abstraction. So, in parallel with the demonstrations of experiments, we have decided to show with the help of graphics, animation, and sound effects, using electronic presentations and work on the interactive whiteboard how this world of atoms is arranged and what happens to the atoms and molecules in chemical reactions (Balanova 2013).

An interactive whiteboard use is the matter of topical interest. The lessons conducted with the help of an interactive whiteboard are more productive compared to the traditional lessons. It is known that 87% of the information comes into the brain through the visual channel of perception (Norenkov and Zimin 2004). The use of a computer and interactive board opens up great opportunities: the brilliance and different effect of entry, movement, and exit of objects. With the help of graphics and animation, one can show how gradually a structural formula of the substance appears and how consistently transfer of complex reactions happens; it can display the mechanism of chemical reactions – in which chemical bonds are broken and are formed again – and at the same time how reactive molecules are aligned with each other; it is possible to show how the speed of the reaction takes place.

Thus, an interactive whiteboard gives much greater opportunities for joint activities of the teacher and students compared to the traditional board:

- A lesson with an interactive whiteboard is better provided with the use of visual methods and information, contributes to the increase of interest and attention in the class, and gives the opportunity to save study time, to check homework quickly and effectively, and to deepen the knowledge in the study of the chemical reactions by designing molecules on the interactive whiteboard and improving the knowledge on the types of chemical bonds.
- At such type of lesson, you can return back to the previously received information.
- The modern interactive whiteboard creates a special spirit of cooperation in the classroom. An interactive whiteboard is nice.

There are “teacher–computer”, “student–computer”, and “teacher–student” interactions. Conducting lessons with the interactive whiteboard broadens the horizons of interaction: it provides the broad possibility for combining “teacher–computer–student” interaction. The lessons using ICT arouse a desire of the students to make presentations themselves and to show them to the classmates (Ivanov 2009, pp. 207–211). No reports and messages can withstand the presentations on the interactive whiteboard.

8.4 Conclusion

Thus, the effective application of virtual laboratories in education contributes both to the improvement of the quality of education and saving of the financial resources, as well as creating the safe and clean environment.

Considering the above facts, it arises a need in introducing a new, effective, and affordable method of training – interactive learning by using virtual laboratories and interactive board.

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Chapter 9
Application of Modern Educational Technologies for Managing Project Activities of Master of Education

Rimma Massyrova, Viktoria Vyacheslavovna Savelieva, Janat Bisenbaeva, and Bakhyt Atymtaeva

9.1 Introduction

The timeliness of the article's subject is determined by the global changes in socio-economic and cultural conditions of human life activities related to the development of postindustrial society where exactly education and science can fully enhance the human capital.

In this respect, a project activity opens the great opportunities aimed at spiritual and professional development of a Master's personality based on application of the modern educational and learning technologies considering the integration of the activity, student-centered, creative, competent, and methodological approaches.

The main challenge is to search and to select modern technologies for managing project activities of degree seekers in Masters of Education in the context of university education.

The purpose of the article is to justify the effectiveness of modern technologies for managing project activities of a Master of Education in the education process of a university.

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9.2 The Essence of the "Project Activities" Concept

The education modernization requires active application of innovations that admit further changes of approaches for construction of educational process, as well as construction of individual trajectories in vocational training of a Master. The teaching efficiency in the future will depend on his/her creative work and competence in innovative scientific activities. In view of this, an important prerequisite is a Master's willingness to implement project activities.

The analysis of the "Standard rules for higher and postgraduate educational organizations activities" determines the quality of vocational training of Masters in the higher educational institutions of the country, and hence, its result is determined by many factors, including the high level of formation of key competencies, which play a leading role (Government of the Republic of Kazakhstan 2012):

- Subject-specific competences – possession of knowledge and its practical application in a changing environment
- Social competence – sociability, the ability to plan, cooperation skills, language proficiency
- Methodical competence – willingness to learn, ability to learn
- Personal competence – self-determination and decision-making ability

The following important professional competencies are to be formed:

- The ability to forecast, model, and define promising trends in the development of professional activities
- The willingness to design and modernize scientific and methodological activities
- The willingness to design innovative projects

Masyrova defines the concept of "project activities of a master" both the educational-informative and research-creative activity, which assumes uniqueness of the output or service created, and is a complex of motivational, cognitive, behavioral, and evaluative components (Masyrova et al. 2016, pp. 121–127).

In the context of the problem study, we will consider the structure and content of project activities.

The analysis of theoretical literature reveals the existence of many approaches for defining the structure of project activities. One of them is described in the concept of the enriched school education and reflected in the works of the number of modern researchers Drujynin (2007), Kolesnikova (2005), Pahomova (2005), etc. The authors consider the project structure as a triad consisting of:

1. Motivation (focus on project activities)
2. Productive (creative) thinking
3. A set of skills (cognitive, practical training)

We have identified the real state of awareness about the competence of Masters in project activities based on the survey with participation of 100 people. They were requested to answer questions relating to training in Master's degree programs and awareness of project activities. The question "Is a project activity an important part of a Masters' program?" was answered by 88% of Masters as important, but not enough to deal with it constantly. Twelve percent of Masters believe it is a very important and necessary in education. According to the response for the question "What type of project activities have you ever participated?" 22% of Masters have participated in writing of scientific projects in various scientific fields. Eighteen percent of Masters have publications about the project findings in the collections of scientific-practical conferences of various levels. Sixty percent of the respondents accepted the lack of experience in project activities. Then, we have offered Masters to evaluate their individual level of knowledge in the field of project activities. As a result, it was found out that 67% of Masters attribute themselves to the average level, 33% – to the lowest level. The question "Do you plan to do research in the field of project activity?" was answered by 48% of Masters of not excluding the possibility of radically changing the field of activity; 52% planned to deal with project activities.

These data indicate a lack of competence of the majority respondents in project activities. This enables to pin down a problem that needs to be considered while organizing a universal model of step-by-step and sequential formation of professional competences related to the project activities.

Any process is being developed according to certain stages and levels. We have drawn up and characterized a scale of levels and relevant indicators to differentiate Masters according to their degrees of competence in project activities. In the study, we defined three levels for formation of Masters' competence in project activities: sufficient, moderate, and initial.

The sufficient level of Masters' competence in project activities is determined by his/her sustainable interest in scientific-research activities and the presence of a constant positive motivation. Master's degree students show activity and initiative in implementation of project activities. They have the deep understanding of the nature, structure, and process of scientific-research activities.

The sufficient level is characterized by the ability of Master's degree students to analyze their activities and to identify ways and means of self-development. They conduct activities independently regardless of types of conditions. A Master of the sufficient level is a future scientist, focused on democratic style of work, able to work in a team and to take executive decisions. His/her general management skills are highly developed.

The moderate level of competence of Masters in project activities is defined by an indicator as a positive attitude toward this kind of activity, semi-independent implementation of the substantive work in a short period. Masters of the moderate level understand the necessity and importance of research skills in their work and

Table 9.1 The levels of Masters' competence formation in project activities

Level	Experimental group	%	Control group	%
	Number		Number	
High	4	8	3	6
Middle	10	20	11	22
Low	36	72	36	72

carry out these activities consciously, purposefully, but not regularly. At this level, they have weakly expressed motivation for independent research activities, nonsystemic possession of research skills, local knowledge, and superficial knowledge about the nature, structure, and process of the scientific-research activities. Masters understand the existence of link between knowledge and skills but face difficulties in application of knowledge in practice.

The initial level of Masters' competence in project activities is characterized by unstable interest and lack of motivation for scientific-research activities. Students do not realize the necessity and importance of applying research methods. They possess only certain types of project abilities. These skills are superficial, unsystematic, and insufficiently stable and are applied by students in the level of replication. Masters of this level prefer a strict guidance as compared with independence and initiative. As a result, Masters are dissatisfied with this type of activity and do not want to do academic work in their professional activities.

The next stage of the study was testing of the competence of Masters. A total of 100 Masters took part in the experimental-research work.

This stage of the study allowed making quantitative and qualitative characteristics of each level. The results of diagnostics of the Masters' levels of formation and competence in project activities are presented in Table 9.1. According to the knowledge levels, Masters were divided into two equal groups. Each group consisted of 50 Masters.

Based on the ascertaining stage of experiment, it was estimated the average value of the level of competence formation for control and experimental groups of Masters. The results showed the prevalence of the low level, 72% in the experimental group and 72% in the control group; middle level, 20% and 22%, respectively; and high level, 8% and 6%, respectively (Table 9.1).

Overall, the analysis of experimental data revealed the presence of contradictions between orientation of Masters for implementation of project activities and their weak theoretical and practical competence. The analysis of the findings resulted in the need for more focused training of Masters in project activities based on application of modern educational technologies.

Based on the findings of the ascertaining experiment and generalization of the foreign practical experience, we offer the following stages for project activities of Masters:

- Find project ideas
- Form the project team

- Form the project theme
- Define the project environment
- Plan the project
- Analyze the project
- Search for resources.
- Control execution of the project.
- Evaluate the project.
- Implement the project (create an output).

In organizing project activities of Masters, the implementation of the identified steps requires application of a set of modern educational technologies:

- Student-centered learning
- Self-developing learning technology
- Humane and personal technology
- Learning through play
- "Pedagogical workshops" technology
- Modular technology.

9.3 Conclusion

The analysis of the questionnaire data revealed the growing needs of Masters in project knowledge and skills.

A project activity of a Master's degree student is an innovative method, uniting motivational, cognitive, behavioral, and evaluative components.

A project activity allows forming research, communicative, presentation, and managerial skills required for a Master in his/her independent life activity.

In the longer term, the materials of this study can serve as a basis for development of a special course for Master's degree students "Arrangement of project activities of graduate students".

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Chapter 10
The Significance of the Media Didactics Course for Masters of Vocational Education

Mamatair Joldoshov and Ainura Bekbolsunova

10.1 Introduction

The timeliness for introducing media didactics in the system of higher education by integrating of the media educational technologies in training of future professionals is determined by coming into existence a fundamentally new concept in vocational training, including media education strategies that aim at forming media education culture as an essential component of the professional culture of a future specialist. This means media didactics of higher educational institutions, as well as the new and advanced educational technologies.

The analysis of application of the media and innovative technologies in teaching and learning process for masters of vocational education in the context of technical and humanitarian higher educational institutions of the Kyrgyz Republic and the Republic of Kazakhstan has led us to the development of the study guide Media Didactics.

It is commonly known that the new multimedia technologies resulted in creation of new forms of knowledge management and knowledge arrangement. According to the new principles, training means independence, cooperation, interactivity, and creativity. The course Media Didactics contributes to introducing new forms of learning, creating the new role of a teacher, active introducing of the new technolo-

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gies in the learning and teaching process, and providing free access to media resources.

The introduction of the course Media Didactics for masters of engineering is an important factor in modernization of education. At present, in the context of modern vocational education, the multimedia pertains to the most dynamically developing and promising technology.

The development of scientific and technological progress and introduction of modern computer and telecommunication hardware, capable to store, to process, and to provide various types of information; introduction and development of modern multimedia systems; and methodical innovations have changed drastically the training of masters in universities, as well as approaches of the learning activities at all levels of the educational system.

The traditional didactics objectives are to describe and to explain the training process and its implementation, to develop more modern teaching and learning processes, and to organize an educational process, new training systems, and new learning technologies. The principles of general didactics, which in their unity objectively reflect the most important regularities of the learning process, play a defining role in selecting content, methods, and forms of education.

Each academic discipline has its own characteristic features and regularities, as well as requires special methods and organizational modes of study. Private didactics or teaching methods deal with these issues. According to the researchers, all private methods are pedagogical disciplines based on the same fundamentals as the general didactics discloses. Thus, the general didactics is a theoretical basis for all private methods. Private methods and general didactics are developing in close unity.

10.2 The Significance of Media Didacticsin the Learning Process

Media didactics is a specialized subsection of general didactics, which has been developing together with the introduction of technical devices to reproduce the curriculum materials stored. Media didactics deals predominantly with the didactic and methodological aspects of development, application, and validation of media technologies in the system of vocational education. Furthermore, the issues of designing and optimizing the learning and teaching process by using media facilities, the required educational conditions, the psychological peculiarities of perception, and, in the center, the technical, organizational, and personal conditions for the use of hardware and software are raised (Schaub and Zenke 2007).

Media didactics, as the didactics' section, deals with the function and influence of media facilities in learning and teaching processes and explores which media facilities are the most suitable for these processes and how to design and to use them to activate the learning process for attaining the learning goals (Bendel and Hauske 2004).

Media didactics handles functions and effects of media facilities application in the teaching and learning process. It is intended to select media facilities in the optimum way and to introduce it by taking into account the achievements of academic success and existing context (Merz-Abt 2005).

The media skills, which are acquired by teachers in daily life, more and more benefit as a training capacity and must inevitably be taken into account as educational conditions while planning media resources in the educational process of a higher educational establishment.

10.3 The Experience in Introduction of Media Didactics

The analysis of the literature, the challenges in the theory and practice of vocational training in engineering and pedagogy for students and masters by using multimedia tools, and the study of the work experience in this field have enabled us to develop a study guide Media Didactics and to solve successfully a number of problems set in the educational process of the Kyrgyz State Technical University named after Razzakov.

The study guide Media Didactics, which we developed with the use of innovative learning technologies, consists of the following: curriculum, syllabus, teaching materials for practical training, tests, and lecture materials based on the selected materials. In addition, it was complemented with the multimedia products, i.e., animation and interactive programs.

A successful lesson is a lesson that has a constant feedback from trainees. Above all, the possibility of a flexible and rapid redesigning of the training episodes' models is provided by interactive methods and techniques (Astvasaturov 2009a).

The interactive technologies and techniques exist in pedagogics long time ago, when no information and communication technologies in the educational process exist. The modern educational technologies orient us not toward the rapid and forced learning of educational material but for purposeful formation of a system of knowledge, the development of analytical and logical thinking, and professional competence of a specialist.

While implementing the project, we have become convinced that the media didactics is one of the most promising directions in the use of information technologies in education. The application field of the media didactics is very broad, and its potential has not yet been fully explored.

The importance of the use of multimedia technologies in the educational process relates to the further development of informatization and the widespread dissemination of the global computer network Internet.

The necessity for application of multimedia technologies is caused by the transition from the knowledge paradigm of education toward the competency, which involves the development of creative capacities of students through interactivity; multimedia in this regard opens immeasurable cognitive capabilities.

This list definitely needs to be complemented with the knowledge and skills in the field of information technologies, which is an integral part of business qualities of a bachelor and a master, but also significantly enhances his/her creative and business activity. Ability to work with text and spreadsheet applications, graphics software, and databases and visualize the results of scientific studies is only part of the requirements for masters. Proficiency in media culture, the ability to make the best use of personal computer and information technologies, to analyze and to synthesize spacetime reality and so on, supports a modern specialist of any profile in proper decision-making.

Currently, the specialized software such as Microsoft Power Point and Macromedia Director considerably has simplified creation of multimedia products. This software allows to:

1. Work with sound, for example, using the Wave Studio software, as well as with audio files, which are created in other specialized software
2. Work with graphic video images, created based on CorelDraw and Photoshop
3. Compose sound, graphics, and video components (Astvasaturov 2009b)

In addition to the above listed media technologies, all we know about open educational resources (OER) in the Internet space, which contributes to the development of students' interest in training and professional advancement, as well as helps them to form images and models, especially in the study of technical objects. Thus, in most cases, the multimedia application has a positive effect on the motivation of students and masters.

While developing the study guide *Media Didactics*, we used the materials learned in the GIZ and other workshops, such as:

- Development tools OER eXeLearning XHTML editor, iBooks Author, Google Blogger
- Video and audio materials, webinars Articulate, Adobe Acrobat Connect Pro
- Complete e-Learning course or training module Moodle – a specialized system for learning management
- Hot Potatoes – software shell program

Hot Potatoes is a software shell program, which offers teachers the opportunities to create their own interactive tasks without the knowledge of computer programming languages and attracting specialists in the field of programming. Hot Potatoes allows creating interactive learning exercises on the Web based. The peculiarity of this software is the possibility to store the tasks created in a standard Web page format; students need only Web browser (e.g., Internet Explorer) for their use. The software helps to create ten types of exercises in different languages in different disciplines by using text, graphics, audio and video information. Exercises are created by five software blocks (each block can be considered as a stand-alone software):

1. JQuiz – Quiz – questions with multiple choice answers (four types of tasks). A teacher has the opportunity to make comments for each answer
2. JCloze – Filling the gaps
3. JMatch – Match making (three types of tasks)
4. JCross – Crossword
5. JMix – Sequence recovery

All exercises are performed in the training mode (testing mode is only available for questions with multiple choice answers). The result of the tasks is assessed in percentage. Unsuccessful attempts result in reduction of points. The sixth version of the software contains additional block Masher (tools) that allows combining exercises and other training materials into a thematic block, lessons, and training courses.

10.4 Conclusion

The existing multimedia courses and educational software products allow already today to design a training session in a new way. An integrated approach to the use of multimedia technologies in the study of a relatively closed section of the curriculum (with reasonably stable content and well-established teaching methods) of a higher educational institution in the context of audience by using an interactive whiteboard can become a promising and important approach.

As noted above, the multimedia technologies immeasurably expand opportunities for arranging and managing training activities and allow practically realizing the great potential of promising guidance papers, found in the traditional teaching, which, however, remained non-demanded or could not give the desired effect because of certain objective reasons.

Despite of wider using of multimedia training systems in the teaching and learning processes at all levels and in various forms of education, there is an acute shortage of educational multimedia and software available for public at large. Moreover, multimedia introduction to academic subjects and disciplines of the secondary and higher schools is limited both by technical capabilities and conceptual-methodological frameworks.

The aim of our study was to contribute to at least partial liquidation of the existing knowledge gap in the course Media Didactics. The long-term observations of experts resulted in conclusions that a new pedagogical idea in the mass teaching practice is usually more successfully studied and promoted on the theoretical and methodological levels, but its immediate implementation stage (the process of technology mastering) is delayed for various reasons.

Accordingly, the study guide Media Didactics facilitates to improve training of masters of vocational education in the teaching and learning process of the technical higher educational institutions.

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Chapter 11
The Significance of Using Business Simulations in Training of Bachelors and Masters

Mamatair Joldoshov and Jypargul Sayakbaeva

11.1 Introduction

In the period of independence of the Kyrgyz Republic, it became necessary to develop a legal framework for functioning of the education system in the new socio-economic and political context. The main importance and the need to reform the system of education were stipulated by the entry of the Kyrgyz Republic into the world educational space. In this regard, the government of the Kyrgyz Republic has developed the legal and regulatory framework: "Law on Education", program "Cadres of XXI century", "Bilim", and others that indicate implementation of a clear state policy in the field of education.

The modern conditions of development of manufacturing techniques and technologies raise high demands to the level of professional qualifications of specialists. Formation of technical and technological knowledge and skills of students of secondary vocational schools to a large degree depends on the quality of training of the teachers of professional education.

An occupation of a teacher of professional education is one of the most significant, requiring both engineering – technical – and also the deep psychological and pedagogical knowledge and skills, certain personal qualities, a large amount of knowledge, and a high degree of technical thinking.

According to the statistics in the system of initial vocational education in the Kyrgyz Republic, only about 6% of teachers have engineering and pedagogical education, and only 11% are qualified masters of industrial training (IT). A third IT masters have a qualification category, which is below the category of school graduates. Many teachers of general technical and special disciplines have only technical education.

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The development of higher education in the world imposes the new increased requirements to the training quality of the personnel that necessitates improving radically the study and educational work in the educational institutions, to enhance its efficiency, to use new methods and teaching aids. In many respects, the solution of this problem depends on the qualification of the teachers of vocational education, their competence, and skills. In the current situation, a vocational training teacher becomes a key figure in providing vocational education.

11.2 The Analysis of the Business Simulations Use in Training of the Teachers of Vocational Education

Any human activity, including a training activity, happens due to influence of the number of factors, the main of which are the needs. The needs cause the reasons of acts and behavior, which the psychology calls motives. The main purely human need is a cognitive need.

A number of errors, sometimes typical and expected ones, often accompany professional formation of a young specialist. How to avoid them?

To answer this question, it is necessary to indicate the main weaknesses in the training of specialists: lack of theoretical and practical training, the duration of the period of adaptation to the professional activity, and inability to solve professional problems in the extreme conditions.

A content area in business simulations is to imitate specific conditions and dynamics of production, as well as the actions and attitudes of people employed there, in other words, to reconstruct or to simulate two realities – the production processes and the structure of the professional activities of specialists.

According to the experts, in a higher educational institution, the game must represent an independent informative activity of a student in the framework of specific "rules and conditions aimed at searching, processing, and mastering educational information to make decisions in a problem-based situation". Thus, the game becomes a learning environment for intellectual development of students because of providing a dynamic thinking and memory efficiency in the process of mental and cognitive activity (Platov 1991, p. 192).

A business simulation, as a learning method, allows to live a certain situation and to examine it in direct action. The following seven main qualities are formed during a business simulation:

1. The ability to communicate on a formal and informal basis and effectively interact on an equal footing.
2. The ability to exercise leadership qualities.
3. The ability to orient in conflict situations and to resolve them properly.
4. The ability to receive and to process the necessary information, to evaluate, to compare, and to assimilate it.
5. The ability to make decisions in uncertain situations.

6. The ability to manage time, to distribute the work among others, to give them the necessary power, and to take immediate organizational solutions.
7. The ability to show managerial capacities as an entrepreneur: to set long-range objectives and to use beneficial opportunities.
8. The ability to assess critically the likely consequences of the solutions made and to learn from own mistakes.

A business simulation cannot be the basis of a training. It can complement theoretical material and act as a final stage of mastering of the training material.

As one of the most active methods of a training, a business simulation has the following features: activation of thinking and behavior of the participants, a high degree of involvement in the process of the game, and mandatory interaction between the participants and the game materials.

Meanwhile, the advantage of the business simulation consists precisely in the fact that in a short period of time, several conflict situations can be concentrated, which need to be resolved. A student is guided by the rules while fulfilling the game actions. The rules are an essential element of a business simulation. Two types of rules are distinguished – the rules that limit actions of players and the rules-sanctions that punish players for misconduct – but these rules should be set by the game players themselves, and they must comply with them. If the rules are beam down, the game will not work (Shetinina 2013, pp. 15–24).

A lesson with a business game usually consists of the following main parts:

- A teacher's instruction on how to play the game (purpose, content, final result, an indication how to conduct, to form play groups, and to distribute roles)
- Study of the game documentation by players to determine the content of the game (scenario, rules, didactic materials), distribution of roles within the subgroups
- The actual game (study of the situation, discussion, and decision-making, attainment of the goal, arrangement of game materials)
- Determination of the game winners
- Summarizing and analyzing of the game by the teacher (analysis and evaluation of the progress achieved, analysis of the actions and activities of participants, the mistakes made in the game, and their causes, allocation of grades).

The position of a teacher in the course of the game is multifaceted: Prior to playing the game, he/she is an instructor who explains the content, procedures, and rules of the game; during the game, he/she is a consultant; when summing, he/she is the chief justice and head of the debate.

The experience shows that adaptation of the experts in business simulations is more effective than in the actual practice, as there is an opportunity to intensify professional relations, to pay attention to certain aspects of the professional activities, for example, to show typical errors in performing certain actions (Abramova and Stepanovich 1999, p. 192).

The skills and knowledge, which are acquired during several months in practice, can be acquired during several lessons in a higher educational institution. In this case, the adaptation has more creative nature, because a student have almost no psychological barriers and fear for making mistakes, and that is important; all the student's activities are subject to a deep, qualified, and friendly analysis.

The contents of the subject matters "Methods of professional training", "Methods of teaching special subjects", and "Basics of pedagogical excellence" were analyzed in order to find an effective system for training of the teachers of vocational education.

To form educational, social, and organizational competencies, we have developed the business simulations "Lecture", "Analysis of a lesson", "Meeting with employers", and "Protection of teaching materials" and introduced them in the educational process among students in the field of vocational education of the technical higher educational institutions.

The experiments on the use of the business simulations resulted in enhancing the independent cognitive activity and form the professional competence of students provided that:

- Business simulations reflect the essence of their future profession.
- They practice skills in the conditions that are most closely approximate the reality.
- The contents of the business simulations are aimed at forming professional competencies of future masters and mastering of pedagogical skills by them.

The self-analysis of the results of the business simulation was carried out based on the outcomes of the survey. After processing the outcomes of the questionnaires, we found that:

1. The business simulation helped 80% of the students to understand better the theoretical material. They pointed to the lack of literature study, insufficient use of information sources, the novelty of the learning method, and failure to comply with labor discipline.
2. Sixty-eight percent of the students were able to implement their game plans for consolidation of the theoretical material.
3. Thirty-two percent of the students have not realized their plans because of insufficient preparation to fulfill their roles and functions, ill-preparedness to solve both standard and nonstandard tasks, and difficulties in making decisions by the game team.
4. Eighteen percent of the students liked the collective decision-making, productive communication with colleagues, opportunity to discuss and to correct decisions, and mutual help and mutual learning in the course of the game.
5. Thirty-two percent of the students believe that their main mistakes were inability to communicate kindly and to interact with colleagues, insufficient competence in formulating additions and questions, as well as comparing competently data carriers.
6. 72% of the students expressed the preference for the execution of the role of a leader; 60%, the role of a man of action; 68%, the role of a man of ideas; and 48%, the role of a man of contacts.

7. Twenty percent of the students believe that in case of the collective decision-making, it is difficult to assess the contribution of each participant in decision-making fairly and objectively; they feel injustice in putting down one common score for the whole group.

The purpose of the instructional techniques for forming a game team is to make an individual activity inappropriate and to approve the necessity of collective and group work in the eyes of the players.

A game team formation is closely linked with the problem of involving players in the game: no problems occur when the objectives of the game originally attract interest of the players and when the game players are genuinely interested in being acquainted with a new method of learning.

The main problems encountered during the game were:

- The creation of creative and competitive environment in the lesson, where criticism and self-criticism are becoming the norm and appropriate behavior
- Introduction of the participants in play activities, abidance of personal interests of participants to the collective decision-making
- Education of the correct attitude to the background information and the ability to use it while solving practical tasks
- Development of skills to work in the team and with the team
- Development of skills to express thoughts technically and literary competently and to give arguments for own decisions.

While conducting the business simulation, we have identified a number of pedagogical effects:

- The students showed interest in introduction of simulation games to the educational process.
- The students have been intensively developing their skills: creative, system technical, cooperation, and communication.
- The students were trying to develop a proactive stance, to participate in the competition, contributed to the socialization as individuals.
- Evaluation of the instructional work has character that is more objective.
- The things, which seemed boring, uninteresting, and hard in ordinary situation, became easy and interesting in the game.

11.3 Conclusions

Eventually, the use of business simulations in the educational process of the technical higher educational institution contributes to the advancement of training of bachelors and masters in the field of vocational education.

The proactive attitude of the students in the business simulations becomes apparent, bears so much long character, but not sporadic one, that the very atmosphere of the business simulation makes its participants to be active. First and utmost, while designing a game, it is necessary to create a model of the real socioeconomic system in the structure of which managers or specialists will elaborate managerial decisions and acquire the necessary skills.

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Chapter 12
The Use of New Teaching and Learning Technologies for Professional Qualification Development in the System of the Initial and Secondary Vocational Education

Masuma Bashirova and Alymkan Sattarova

12.1 The Quality of Education Is an Indicator for Achievement of Results

Today the education has become one of the most important indicators and the priority areas of the global social evolution. The human capital formation and human fulfilment for the benefit of individuals and the society implies a special responsibility of the state in constructing of the education system, focused on result orientation and needs satisfaction of the society (Molchan 2014).

The quality of education is one of the most reliable indicators of the future development of any nation (the national sustainable development strategy of the Kyrgyz Republic for the period 2013–2017).

The main directions in enhancing the credibility and quality of vocational education are laid down in the National Education Development Strategy until 2020.

The action plan for implementation of the National Education Development Strategy in the Kyrgyz Republic for 2012–2020 designates the fundamentals for the result-oriented qualitative education, i.e. training of skilled workers of the appropriate level and profile, competitive in the labour market, competent, responsible, mastering their professions and well-oriented in the allied areas, able to work effectively in the specialty, ready for continuous professional growth, having social and professional mobility and satisfying the needs of a person in receiving the appropriate education.

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12.2 The Ways for Solution of the Problems Related to Providing the Result-Based Quality Education

The introduction of the state standards for the initial vocational education of the new generation has become one of the solutions of this problem. The principal difference of the new standard underlies in orienting towards the value, but not the subject matter. The key concept of the modern education is the concept of competencies and their formation, which is stated as one of the main purposes of the vocational education.

The ongoing intensive upgrading and modernizing of all components of the educational process at all levels of the vocational education system objectively has raised the bar of the professional requirements for teaching staff.

However, without the professional development of teachers and formation of the teaching staff, which meets the demands of the modern life, it is impossible to improve significantly the quality of education and its competitiveness.

The issue of continuous professional development of teachers and masters of vocational education is a determining factor in the education reform and a key factor in the work of the Republican Scientific-Methodological Centre (RSMC) of the subordinate structure of the state agency for initial and secondary vocational education.

The study of the outcomes of the training needs' analysis of the teaching staff of the educational institutions of the initial and secondary vocational education testifies that teachers and masters of vocational training are not always ready to accomplish the tasks, which the state sets before them, as their professional competences and mentalities do not meet the requirements for modernization of the vocational education. Ill-preparedness of the modern teacher in achieving a high quality education is partly stipulated by the outdated psychological-pedagogical knowledge.

More than 60% of the teaching staff of the system needs to upgrade the knowledge on modern approaches in teaching and evaluating students' achievements and in the development of social partnership, and more than 50% of teachers needs to enhance the capacities in the field of key competencies (communicative, leadership, information and communication competence and professional ethics).

In this regard, the modules, which were developed with the assistance of the GIZ project in the framework of a regional teacher training network (vocational pedagogy/didactics) in the countries of Central Asia (Kazakhstan, Tajikistan, Kyrgyzstan and Uzbekistan) allowed creating a system for capacity enhancing of the teachers in vocational didactics.

The modules have been developed jointly with the teaching staff of the Dresden Technical University and covered the following topics:

- Labour market-oriented action
- Modern methods of training
- Selection and development of training and learning tools
- Monitoring and evaluation of the learning performance

- Models in vocational education
- Progressive crop production technologies (special didactics for the agricultural sector).

Each module lasts for 36–72 h and can be considered as a separate unit in the didactic system of the vocational pedagogy, or the modules can be used in various combinations and thus form a training course for the trainees according to their personal needs. This approach provides flexibility in qualification upgrading and is a good precondition for forming a system of the continued development of the teaching staff.

The modules developed are incorporated in the professional development system and hence provide the professional training of the teachers of vocational schools. This is especially important for the initial vocational education system, as 60% of the teachers and masters do not have the basic education in the field of professional didactics.

It should be noted that to a certain point, the established qualification upgrading practice was a chaotic and fragmentary structured system and almost was not able to meet both the needs of the education system and a teacher. Introduction of the modules developed allowed to overcome the existing situation and to provide greater susceptibility of the educational environment to the individual needs of consumers of educational services and the changing public needs in quality of the modern education.

During the 2 years of implementation of these modules, a total of 264 teachers of the vocational education system have taken the training courses. The teaching employees have the opportunity to take the training modules on personal demand, at a convenient time and in the convenient form of training.

The analysis showed that the most requested module for teaching staff is a module about the modern educational technology, the main objective of which is to increase the effectiveness of training and to optimize educational process in connection with the modernization of education. It puts forward new demands for training of a subject teacher, brings forth new problems, makes to master new technologies and to create new teaching methodologies based on the use of modern information learning environment. It is necessary to form a motivation for learning and purposeful cognitive activity. The active use of the modern technical media of teaching is not a privilege of an individual teacher. The technical media of teaching are becoming an integral part of the learning process everywhere, where the enthusiastic teachers exist and where the learning process has become a creative work (Gulina 2012).

In the module, "Selection and development training and learning tools", trainees (methodologists, deputy directors on educational-methodical work and production, teachers and masters of the production training) of the professional development courses get acquainted with the principles of the development of study guides and teaching aids to be used for lessons. Focusing on the development of technical media of teaching (TMT) is based on the student-centred approach and visualization of the materials for students. The teachers need to learn the skills on how to design lessons step-by-step, with the use of modern teaching and learning tools. At the same time along with learning on how to create a link to the subject, they learn how to create a link to the situation of the modern labour and business process, as well as to the processes and methods of production as the training and learning tools are oriented to the specific professional activities (Kruglikov 2005).

After studying Module 3, the participants of the qualification development courses will have the following competencies:

- Develop various teaching aids and study guides according to the principles of the proper graphic design.
- Develop the targeted training and learning tools and methods to be used for lessons, in particular, to distinguish what different didactic functions, such as information, formulation of the problem, etc., are performed by the technical media of teaching.
- In the professional development courses, trainees work in groups and support each other while applying the modern training and learning tools that have links to the subject knowledge and work processes.
- Know how to use the potential of the digital training and learning tools while performing the training and work assignments.
- Duration of the module makes 72 h overall (2 weeks).
- Theoretical classes: 48 h (8 days, 6 h per day)
- Practical phase: 24 h (in the practical phase it will be applied teaching and learning tools and methods, which were developed at the workshops during the theoretical or practical courses).

12.3 Conclusions

The use of technical media of teaching in the process of training skilled workers and mid-level professionals is of paramount importance, since without them, it is impossible to master the general and professional knowledge and to form effectively their practical skills and abilities. That is why the solution to the problem of effective use of the technical media of teaching is one of the urgent tasks of professional pedagogy.

In addition, in the conditions of implementation of the modules, as the system of a continuous education, the competences of a worker of the education system are gradually forming and developing in the following areas:

- Designing a pedagogical situation, pedagogical process and pedagogical system
- The positive positioning of himself/herself, as a professional, as well as own educational establishment in the market of educational services, both by the manager and the teacher
- The effective interaction of the teacher with the colleagues, as well as the effective cooperation between educational institutions and social partners.

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Part V
Evaluation and Development of Competencies

Chapter 13
Technical Training of Teachers of Vocational Education in Higher Educational Institutions

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13.1 Introduction

The quality of the higher education and implementation of the principles of "formation of the leading knowledge system", "science-based education" and "lifelong learning" are the platforms of change that are taking place now in the national education systems. The modernisation of the education system of the Republic of Kazakhstan (RK) is directly aimed at the global integration and recognition of the education-specific documents of the Republic of Kazakhstan by the international community.

The training of the highly skilled and sought-after specialists directly depends on the level of competence of the teacher, i.e. his/her professional and pedagogical education and abilities to arrange the educational process and to educate trainees for the professions, which meet the requirements of the modern labour market. This person must be able to perform the overall technological and special professional tasks and have strong fundamental knowledge and skills.

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The training of teachers of vocational education remains the complicated academic and research challenge consisting of the humanitarian, social, psychological and pedagogical, industrial (business skills) and general engineering (in one of the narrow profiles) components. Each component is a separate issue of the relevant sciences. An integrative structure of the activity of a teacher of vocational education questions a priority component (engineering or pedagogical), both in the activity and in the training of engineering and teaching staff.

The study of Udartseva states that essentially a teacher of vocational education is a specialist, naturally combining the quality of a highly skilled worker and a professional teacher, who, along with the psychological and pedagogical competences, is equipped with the technological competencies (Udartseva et al. 2014). The higher educational institution has studied the experience of training specialists for the system of technical-vocational education for the purpose of developing innovative models for technical training of Bachelor of Vocational Education. At present, it is important for the development of the Republic of Kazakhstan and the modern production.

Today the pressing issue is to train a teacher of vocational education of the new formation, capable to organise and to manage educational activities with high quality aiming at training of personnel for the accelerated innovative industrialisation, organising vocational activity for improving efficiency of educational services, easily adapting to the modernisation of the education system, upgrading its content and improving the quality (Smirnova 2016).

13.2 The Analysis of the Education Systems of Bachelor of Vocational Education

A comparative analysis of the educational standards of the higher educational institutions and model curricula for the specialty "vocational education" was carried out for the purpose of searching for an effective training system of teachers of vocational education:

- Kazakhstan (2012 and 2013)
- Russia (2011 and 2014)
- The Republic of Belarus (2013).

The following criteria have been defined as the comparative features: field of education, standard period of study, professional qualification (degree), workload in hours and/or in credit units by cycles, components and parts.

The training duration in all standards is 4 years, in the Republic of Belarus – 5 years. In Kazakhstan and Russia, after studying in the bachelor's programme (4 years), the alumni have the opportunity to continue their studies in masters' programmes (2 years). In the Republic of Belarus after graduating from the specialist programme, the alumni have the opportunity to study in master's programmes (2 years), i.e. a master's programme is the highest level of university education too.

The training standard of the Republic of Belarus defines in details the tasks of professional activity, professional competence and requirements for each field of study. Russia and Kazakhstan have standards on "vocational education (branch wise)", and the standard of the Republic of Kazakhstan (2012) is unified for all specialties according to the levels of education, and a field of education is determined by the university itself.

While formulating a specialist's qualification (degree), all standards under a graduate mean "Bachelor of Vocational Education", and in the Republic of Belarus, it is a teacher-engineer (for graduate of a specialist programme).

To analyse the training workload, we indicate the following:

1. Kazakhstan (all standards): a model curriculum includes four components and is divided into the cycles: general education courses (GEC), basic courses (BC) and major courses (MC). Each cycle has compulsory and optional components. Besides, the cycle of "additional types of training" (ATT) is also included. They are physical training, internship and the intermediate state control.
2. Russia (2009, 2011): a typical curriculum includes six components and is divided into the cycles – humanitarian, social and economic, mathematical and natural science and professional. Each cycle has a basic and a variable part. Besides, it includes physical training, practical training and on-the-job training and the final state attestation.
3. Russia (2014): significant changes were introduced in the curriculum structure (three components) – block 1 (theoretical training), basic and variable parts; block 2 (practice), variable part; and block 3, the final state attestation.
4. The Republic of Belarus (2013): the most detailed structure of the typical curriculum (12 components) – three cycles of courses – social and humanitarian, natural science and general professional and special disciplines; implementation of term projects (papers); optional subjects; physical training; additional types of training; getting blue-collar profession; practice; examination period; final attestation, 3 weeks; and graduate thesis, 10 weeks.

Thus, all curricula include both theoretical and practical training and final attestation. The typical curricula have the aggregative structure: Kazakhstan (all years), four components, and Russia (2014), three components.

It should note the other side of the state standards and analyse it, i.e. the sections that describe the scope and types of activities of the graduates, as well as the competences, which should have a Bachelor of Vocational Education.

To develop an effective structure for training of engineering and pedagogical personnel for the system of technical and vocational education considering the modern trends of industrial-innovative development of Kazakhstan, we will analyse the training quality of specialists according to the State Compulsory Educational Standard (SCES) of the Republic of Kazakhstan based on innovative approaches.

The main area of activity of a graduate in all standards is the sphere of education. Moreover, the standard of Russia provides a more detailed description compared to the standards of Kazakhstan and Belarus. The distinctive characteristics are the spheres of the graduate's activities, indicated in the standard of Belarus: the work in the field of machinery production.

The analysis of the objects of professional activity indicated that the standards of Russia and Belarus define the objects as the education process and education plus production processes, respectively. The standard of Kazakhstan describes the objects through educational institutions that, on the one hand, cover the diverse educational institutions and, on the other hand, limit the selection of the actual object of the graduate's work.

An important characteristic of the graduate's activities is the types of professional activities that are directly related to the determination of the list of subjects to be studied and their content for the formation of competencies of future professionals.

The Kazakhstan standards have contradictions in the description of the types of professional activities of a bachelor, namely, the types of professional activities include the following:

- Education (teaching and educational, pedagogical)
- Organisational and technological
- Project-related
- Scientific research.

Further, the standard describes the common tasks of the professional activities of a bachelor, which are designated in accordance with the types of the professional activities:

- In the field of educational activities
- In the field of experimental and research activities
- In the field of organisational and administrative activities
- In the field of socio-educational activities
- In the field of instructional and pedagogical activities
- In the field of educational and technological activities.

To have an objective assessment and analysis of the scope of activities, we have taken the routine tasks of professional activities, which do not contradict the described types of professional activity in the standard of the Republic of Kazakhstan.

The foregoing outcomes allow us making the following conclusions. First, the requirements to the level of education of the standard of Kazakhstan SCES 2010 do not pay sufficient attention to the production and technological training of a teacher of vocational education. Secondly, the standard of Kazakhstan SCES 2010 has the inconsistency related to the requirements for the level of education and the requirements to the training outcomes, in particular: a Bachelor of Vocational Education must be able to operate a modern technological equipment at the level of work qualification of the third degree, which is not reflected in the requirements to the training outcomes. Third, the requirements to the professional competence according to the type of activity in the field of educational and technological activities do not reflect the demand to the level of education in the field of "exploitation of modern technological equipment at the level of work qualification of the third degree".

Thus, the standard of Kazakhstan SCES 2010, the specialty 5V012000 – Vocational Education – has inconsistency in the description of the skills requirements for a teacher of vocational education related to operating modern technological equipment at the level of work qualification of the third degree. In addition, the requirements for formation of production-technological component of the activities of a teacher of vocational education are not fully and clearly written. This is a significant shortage in view of the above analysis and conclusions made while studying the requirements of modern production in the conditions of innovative development of the Republic of Kazakhstan in training of engineering-pedagogical personnel for technical and vocational education system.

It should be noted that there are no fundamental differences in the training of Bachelor of Vocational Education in the specified countries. They just distinguish the training components (socio-humanitarian, general technical, psychological and pedagogical, technical and technological (engineering) and operating skills). However, the approaches to formation of competencies are different, which are determined by the requirements and structure of the regulatory and planning documents.

From the above named, we can conclude that the provision of quality training of personnel with higher education for all areas of activities can be combined to the system. This system is to be provided with the high level of qualification of the teaching staff of the universities, the compliance of the legal and planning documents (including SCES) with the requirements of employers operating in the conditions of industrially innovative development of Kazakhstan and the efficient management of the educational institution.

13.3 The System of Technical Training of Bachelor of Vocational Education in the Context of Dual Education System

The next stage in designing the system of technical training was the questionnaire survey of the employers (directors of colleges and managers of industrial enterprises) about the need in including the elements of dual system in the training of teachers of vocational education (Ikonnikova et al. 2016).

The analysis of the system of training of teachers of vocational education was presented above. The requirements to a graduate laid at the level of educational institution, which develops the training and planning documentation. The modern production makes the new demands on the quality of training of specialists, which must correspond to the industrial-innovative development of Kazakhstan. What are the main criteria for working in huge factories? Do the competences, reflected in the regulatory and planning documents, meet the requirements of the modern production?

To address these issues, we have conducted a questionnaire survey of employers of the machine-building enterprises of the city of Ekibastuz and directors of the colleges.

The competent specialists of these enterprises were requested to rank the selected competences of future specialists according to the regulatory documents and to assess the importance of the subjects chosen by the higher educational institutions to build competences of graduates in the specialty “vocational education”. Based on the above analysis made, we will focus on the technological part of training of teachers of vocational education (engineer-teacher) and mark out the professional subjects and special competences of the technological training. On the other hand, exactly the employees of industrial enterprises can most accurately assess such types of competences.

The purpose of the questionnaire survey is to identify the importance of the level of competence reflected in the regulatory planning documentation of the higher educational institutions for forming the industrial-technological component of the activities of teachers of vocational education (mechanical engineering is defined as the study field). To have clarity and systemacy of the general idea, the questionnaire suggests a scheme for formation of competencies and scope of activities of the teachers of vocational education.

It was proposed to rank the competences of future teachers of vocational education in mechanical engineering, which were extracted from the regulatory documents and aimed at establishing production and technological component according to the following system:

T – (theoretical training), if for the formation of the high-level competences, the conditions of the educational institution are sufficient.

TP – (theoretical and practical training), if for the formation of the high-level competences, the theoretical training in the institution will be ineffective without a practical training in a manufacturing enterprise.

The enterprise specialists were requested to put any mark in the appropriate column of the questionnaire with regard to the evaluating competences.

While developing the questionnaire, we have distinguished the subjects that form the production and technological competences (with a breakdown of each subject), as well as the relevant practices, defined by the universities such as the Karaganda State Technical University (KarSTU), the Pavlodar State University (PSU) named after S. Toraigyrov, the Russian State Vocational and Pedagogical University (RSVPU) and the Belarusian National Technical University (BNTU).

The data of the questionnaire were processed, and the results were presented below.

In the opinion of 50–75% of the specialists that the enterprise conditions would be more effective in case of possessing the competences, we have the results according to the above list of the higher educational institutions: 19%, 36%, 41% and 20%.

In the opinion of 75–100% of the specialists that the enterprise conditions would be more effective in case of possessing the competences, we have the results according to the above list of the higher educational institutions: 14%, 33%, 29% and 53%.

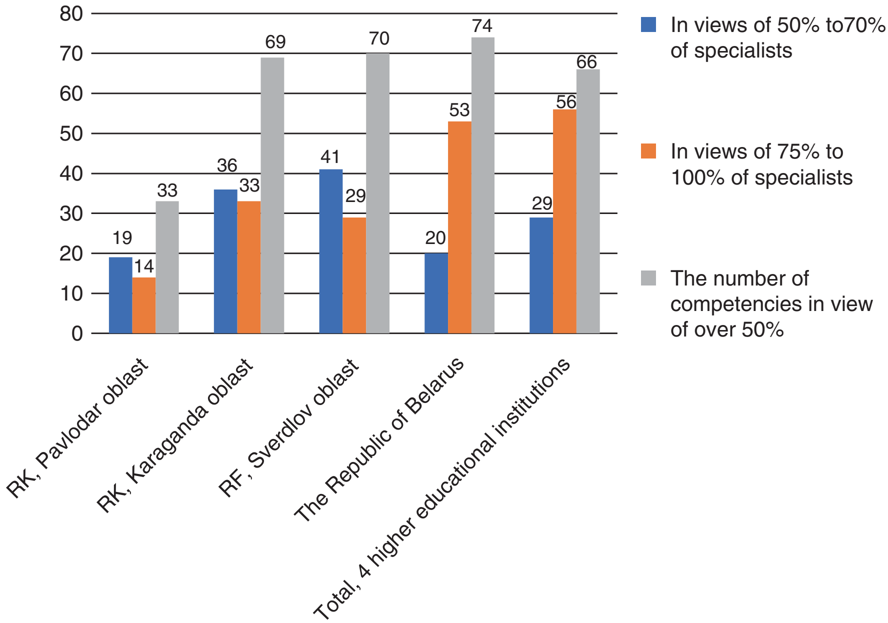

Fig. 13.1 The scope of competences, the formation of which is efficient in the context of actual production

If taken into account the views of more than half of the respondents, then theoretical training in the institutions will be ineffective without a practical training in a manufacturing plant for forming a high level of competences. Such competences by the universities revealed 33%, 69%, 70% and 74% according to the proposed order of the higher educational institutions. Besides, PSU has low percentage, while the other three universities have approximately the same percentage of competencies against the reflected ones. According to the experts, it is more effective to build competences under the conditions of actual production. For illustration purposes, we will show the results of the survey in the diagram (Fig. 13.1).

In general, according to more than half of specialists of the enterprises of the machine-building industry, 66% of the competences reflected in the regulatory planning documentation of the considering countries should be formed under the conditions of real enterprises in order to train teachers of vocational education with good knowledge of technological and productional realities.

The analysis of the outcomes of the employers' survey reveals the competences, the formation of which is only effective in the context of the enterprises, that is, 100% of the respondents have put the corresponding marks. For example, the following competencies were allocated for PSU: the ability to express thoughts on the use of constructive solutions in the field of mechanical engineering, the technical and technological abilities and skills according to the educational path, the skills for operating modern technological equipment at the level of work qualification of the third degree, the skills in selecting the optimal methods and the skills in improving the basic technological processes of production, including designing executive programmes, evaluating the impact of technological factors on the quality of parts and others.

The dual bachelor programme has a special interest in the phase of searching for the suitable learning technologies for the formation of production-technological competences of Bachelor of Vocational Education. Essentially, the dual form means parallel learning in the educational institutions and in the workplace. The required competence is attained in the dual programmes through a special connection of theoretical training at the university and practical consolidation of the theoretical materials in the enterprises (Erahtina et al. 2015).

The educational institutions experienced in implementing a dual form of education confirm that such training method helps to get a decent education; provides both, the knowledge and skills; and guarantees the employment; it aims to help adapting in the enterprise and self-realisation of the graduates in their professional activities, and an enterprise gets the qualified experienced professionals after completion of the education.

13.4 Conclusion

Thus, the current model of training of Bachelor of Vocational Education must necessarily include elements of the dual training. To this end, since 2015, the higher educational institutions of the Republic of Kazakhstan need to conduct over 50% of training sessions in the relevant industry enterprises. So, the majors in the Karaganda Technical University – “theory of cutting”, “technology of mechanical engineering”, “technological equipment of mechanical engineering”, “standardisation and technical measurements” and “metal-cutting tools” – are being conducted in the machine-building plant №1.

Establishment of the applied qualification centres is another important step towards the improving of the training model of teachers of vocational education (Gotting et al. 2016). The lessons at the centres are completed by taking qualification exams to get a work qualification. The performance analysis showed that the students studying the subjects in the context of enterprises have higher scores on these subjects, as well as higher level of technological competences.

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Chapter 14
Approaches of Engineering Pedagogy to Improve the Quality of Teaching in Engineering Education

Steffen Kersten

14.1 Understanding of "Engineering Pedagogy"

Engineering pedagogy has a very long tradition at Technische Universität Dresden. The discussion on technical education and technical teacher training at TU Dresden (at that time Royal Technical Educational Establishment in Dresden) can be retraced to 1851. With the establishment of the Institute for Engineering Pedagogy by Hans Lohmann in November 1951, teaching and research in the field of engineering pedagogy were finally institutionalised. Lohmann focused his research on the relationship of technology and technical teaching. Therewith he laid the foundations for an understanding of engineering pedagogy, the purpose of which is the targeted design of technical and technologically specific teaching and learning.

A central role in Lohmann's approach of engineering didactics was played by the concept of technology. He defined technology by its function "to transform the natural world" (cp. Lohmann 1954, p. 619). The task of an engineer is to develop this technology. Engineers are therefore to become qualified in such a manner that they are able to solve technical design problems. In contrast to this, the activity of natural scientists is focused on the discovery of relationships in the world and, thus, solving scientific knowledge problems. Invention and discovery require different ways of thinking and, thus, different methods of academic training.

Another concept of engineering pedagogy which was developed in the 1990s needs to be distinguished, though not necessarily separated, from the latter understanding. For students in engineering science courses, a future engineer's ability to accomplish social communicative processes in modern structures of production and service has become a focal point of engineering pedagogical considerations.

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In Greek language, the etymological meaning of the term “pedagogy” includes the word “agein”, which translates to the English word “lead”, in addition to the word “pais” (boy). Thus, the focus of this view of engineering pedagogy is the development of teaching concepts for the preparation of future engineers for their leadership roles in changing structures of production and service. The following article is aimed primarily at an understanding of engineering pedagogy in the context of pedagogy of university engineering education.

14.2 Concept of a Demand-Oriented “Engineering Pedagogy”

An object-related reasoning concerning the designing of learning and teaching processes in academic engineering education illustrates the scientific character of related questions. Verifiable pedagogical and/or psychological qualifications are legally fixed requirements for a teaching career at all levels and in all types of schools of general and vocational education. In contrast, in the sector of higher education, it is assumed that lecturers have teaching abilities due to their high academic qualifications.

Evaluation results regarding the teaching quality in higher education significantly show this assumption to be only partially correct (cp. Krempkow et al. 2006). A major reason for this is the complexity of the influence factors and relationships concerning the design of a demand-oriented education in engineering sciences. In this context, the term “design” includes planning, implementation, and evaluation of teaching and learning in engineering education.

The requirement to gear engineering education to the demands of the economy, which is determined by the specifics of the engineering labour, is meant when speaking about demand-oriented and employment-based engineering education, respectively. Requirements are understood as necessary personal dispositions for successfully managing the profession-specific work activities. They are thus determined by the prevailing structures of production and service. The change from Tayloristic production structures to structures of lean production in the past 40 years has considerably changed the engineering activities and with them the requirements on engineers. A reference in this context is a study by Frieling (1993), who investigated these changes in the German automotive industry in the 1990s in detail and characterised the new production structures as follows:

- Process-chain-oriented company organisation instead of functional hierarchies
- Customer orientation instead of product orientation
- Responsibility for the project/venture and budget instead of hierarchically structured task management
- Working in teams or groups instead of working alone
- Complete operations instead of individual/single acts
- Self-regulation instead of standardised input/guidelines

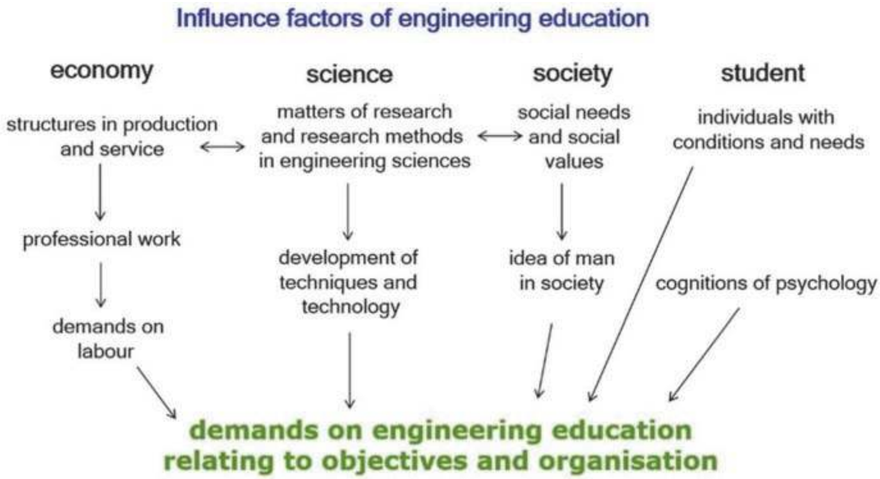

Fig. 14.1 Factors influencing on demand-oriented design of engineering education (Kersten et al. 2011, p. 3)

- Involvement instead of heteronomy
- Continuous improvement instead of hope for innovation. (id., Frieling 1993, p. 32)

Modern engineering education has to consider these developments in its curricula and training methods (Fig. 14.1).

In addition to these dynamic requirements, a variety of stable long-term requirements related to the personality dispositions of engineers result from typical engineering activities. An example is the typical way engineers think/reason. For instance, in the analysis or the design of technical systems, the thinking in the categories of "part-whole" in the relationship between structure and function plays a vital role. The calculation of technical systems by deductive structures of thinking is based on trusted statements or laws. However, in technologically diagnostic processes, progressive-reductive patterns of thought in cause-effect relationships play an essential role. Such considerations lead to scientifically based decisions for teaching methods in engineering education in order to support the development of such structures of thinking.

A second major factor influencing the training of engineers is the field of engineering sciences itself. A scientific discipline is defined by its particular matters and methods of research. Regarding the matters of engineering sciences, the terms technique and technology play a key role. Technique and technology contain processes of change (form and structure), transport, and storage of material, energy, and information (cp. Wolffgramm 1994). The views on what technique is and which function it has in relation to nature and society is also subject to changes. A change of the matter of a scientific discipline has an impact on teaching in this discipline. The systems of statements in engineering sciences (descriptive matters), the systems of typical action rules for engineering activities (regulatory matters), and the systems of typical standards for engineering activities (normative matters) are different from those of 60 years ago. Without adaption, Lohmann's approach to teaching technology is likely to fall short of meeting the requirements of modern engineering education. However, it can be considered a suitable starting point for the development of modern concepts of engineering education.

Closely related to the term "technology" is the society as a factor influencing engineering education. Technique not only arises from the application of natural laws and theories in engineering sciences but is also part of the technical possibilities and the socially desirable aims (cp. Heidegger and Rauner 1991, p. 20). In this respect, the development of technique and technology is also driven by social needs. In addition, a society also has an idealised image of its members. Maturity, ability to be democratic, and willingness to active shaping are just a few personality traits that are included in this ideal. From this follows the educational mission of our universities as well.

The fourth important factor influencing engineering education is the low rate of success that students have at German universities, which is often explained by deteriorating levels of education in preceding educational institutions and the resultant lack of ability to study. I do not agree with such a general statement. However, even if this thesis were true, it is economically not justifiable to let half of all young people who are interested in engineering fail in their educational intentions.

So why not use concepts of engineering education which consider these changes in the anthropogenic conditions of the students and which are based on the latest findings of educational and developmental psychology in the design of teaching and learning in higher education? Perhaps the obstacle is the inadequate funding of universities and the resulting poor student-teacher ratio but certainly also to the largely inadequate insight of the teaching staff at universities in these complex relationships of engineering pedagogy.

14.3 Curricular Approaches of Engineering Pedagogy

Qualified engineering activities are the foundation of any long-term economic development. Therefore, the prime task of universities is to provide academically trained professionals for the economy. The economic development of the world, with its associated increase of more qualified activities in manufacturing, services, and research, increasingly require well-trained engineers that meet the requirements of the economy and society. To this end, the discussion about curricular approaches of engineering pedagogy will contribute by improving the quality of academic engineering education.

The discussion of qualification concepts for teachers in engineering education is not new. Founded in 1951, the Institute for Engineering Education was primarily responsible for the qualification of teachers for the GDR's engineering education. In connection with the 3rd Higher Education Reform of the GDR, university

Table 14.1 IGIP – curriculum engineering pedagogy

	Module description	CPs at least*
	Totally	20
	Core modules	*7*
MC1	Engineering education in theory	2
MC2	Engineering education in practice	3
MC3	Laboratory didactics	2
	Theory modules	*5*
MT4	Psychology	2
MT5	Sociology	1
MT6	Engineering ethics	1
MT7	Intercultural competence	1
	Practice modules	*5*
MP4	Presentation and communication skills	2
MP5	Scientific writing	1
MP6	Working with projects	1
MP7	ICT in engineering education	1
	Elective modules (1 CP per subject)	*3*
ECP8	Evaluation of student performance	1
ECP9	Quality management	1
ECP10	Portfolio assessment	1
ECP11	Creative thinking	1
ECP12	Coaching and mentoring in education	1
ECP13	Collaborative work	1
ECP14	Teaching subject in English (CLIL)	1
ECP15	Info literacy	1

* One credit point corresponds to 25 to 30 hours of work. http://www.igip.org/igip/ing-paed-igip

pedagogical qualifications became a compulsory prerequisite for a teacher's license at universities (GdDDR 1968). In the following years, the East German universities developed appropriate training concepts in order to comply with this law. This historical aspect of German university pedagogy has, in my opinion, not been exhaustively scientifically investigated.

With the founding of the International Society for Engineering Pedagogy (IGIP) in 1972, the first European body was created to coordinate the discussion about appropriate engineering pedagogical qualifications. Adolf Melezinek has very great merits in this respect. The decades-long international exchange on questions of engineering pedagogy led to a curriculum on the basis of which 35 accredited training centres are now offering further education for an "International Engineering Educator (IGIP)". The modular-structured curriculum addresses a very broad target group (engineering students, university lecturers, vocational school teachers), which, however, does not take into account the features of specific professional fields. Nevertheless, a standard has been developed with this curriculum, which forms the basis for many national approaches. Currently, various universities from all continents of the world are working to provide special modules for this curriculum for an online study (Table 14.1).

One of the accredited training centres for “International Engineering Educator (IGIP)” study courses is the TU Dresden Institute of Vocational Education. Financed by the European Social Fund, we had the opportunity to develop and test a needs-oriented continuing education course for academic teachers in the field of engineering science between 2010 and 2012. We are currently continuing this work in cooperation with Chilean universities. On the basis of empirical data collection at the University of Applied Sciences Zittau/Görlitz and the Universidad Autònoma de Chile, the following needs in the field of engineering didactics were identified:

1. “Theoretical and practical knowledge about the didactics for the teaching and learning process in engineering”
2. “Evaluation and assessment of the students’ learning achievements”
3. “Knowledge about how to design effective measurements of the learning accomplishments”
4. “Didactics principles for the teaching and learning processes in engineering”
5. “Knowledge of special forms for teaching at the university level”
6. “Organisation of teaching and learning processes for the scientific formation of engineers”
7. “Use of didactic resources and of information and communication technologies (ICTs)”
8. “Knowledge about the procedures for the recollection and measurement of the learning achievements”
9. “Analysis about the concrete activity of engineering and the knowledge coming from the engineering sciences”
10. “Knowledge about the scope of action of didactic resources”
11. “Structuring of teaching and learning processes for the scientific formation of engineers”
12. “Knowledge about the design of didactic resources for the teaching and learning process”
13. “Knowledge and ability for the preparation, execution and feedback of the teaching process”
14. “The fundamentals to determine the technical subject matters within the field of engineering” (Kersten et al. 2015, p. 6)

These empirical investigations formed the basis for the development of a curriculum for an advanced training course in the field of engineering pedagogy, which has been evaluated as a success several times at German, Chinese, and Chilean Universities in recent years.

The different modules are systematically based on each other. All modules are aimed at the development of scientifically based, application-oriented action rules for the planning, execution, and analysis of academic teaching and learning in engineering sciences. The didactic concept of the training programme provides teaching-learning arrangements in coordinated phases of classroom study, self-directed learning, as well as individual coaching (cp. Fig. 14.2).

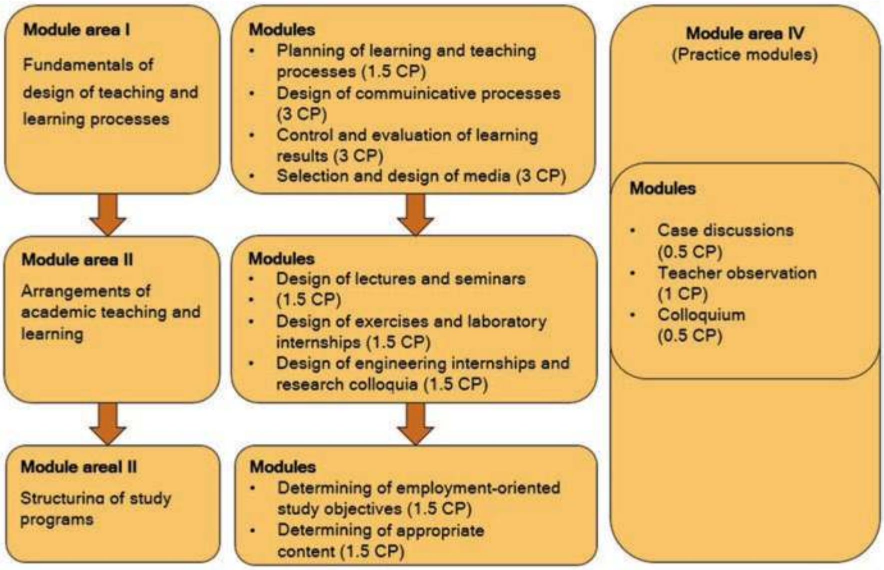

Fig. 14.2 Developed curricular structure for the university didactical qualification of teaching staff in engineering sciences (Köhler et al. 2013, p. 19)

In particular, the phases of self-directed learning and individual coaching are supported by Internet-based learning scenarios. The selection of the e-learning tools is determined exclusively by their didactic purpose and functions.

All modules are represented in a contemporary learning content management system. These are arranged similar to the course structure and include the multimedia-based learning materials. This includes the learning content, exercises of varying difficulties, examples of teaching and learning scenarios, and tests. In addition, extensive tools for communication between learners and experts are available: chat, forum, wiki, email, podcasts, and blogs. The participant can store their files in a private folder and document their progress in a portfolio. In addition to designed and managed online courses with extensive features, it is also possible to form individual online learning and working groups. The managing of the course content, the access control, and the communication can be done by the teaching staff or by skilled management personnel. For mobile learning, a special mobile version is made available (cp. Fig. 14.3).

The demand-oriented advanced training is accredited both by the International Society for Engineering Education (IGIP) and by the Scientific Society for Engineering Education (IPW). The detailed module manual can be read in Köhler et al. (2013).

The focus of the current discussion on the pedagogical further training of academic teachers of engineering sciences is a curriculum approach of the Scientific Society of Engineering Education (IPW). Under the leadership of Gudrun Kammasch, an international work group of specialists from different scientific

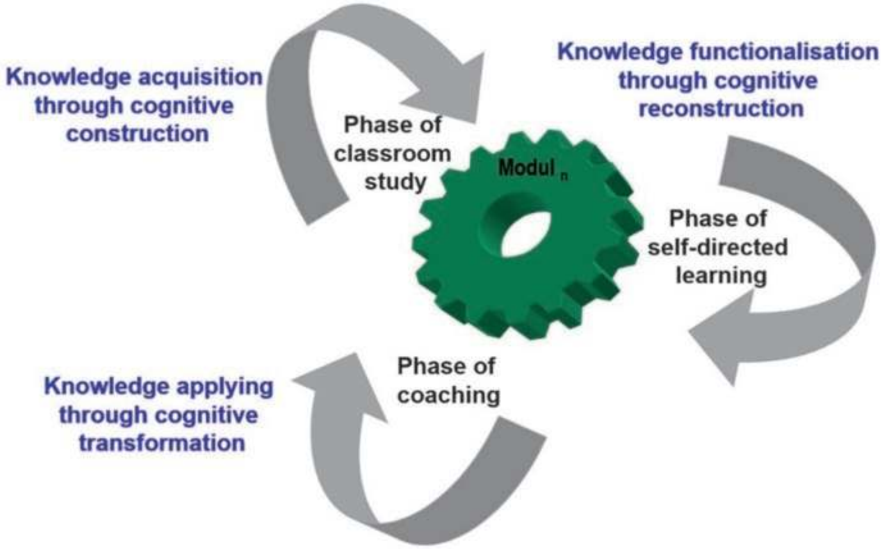

Fig. 14.3 Structure of a learning and teaching arrangement (Hortsch et al. 2003, p. 65)

disciplines has designed an engineering pedagogy curriculum and presented it in Eindhoven at the annual conference of the society 2015.

The starting point of curriculum development includes the guiding principles of a scientific, humanistic, and intercultural engineering education (cp. Fig. 14.4).

- "Promoting technical education for a comprehensive sustainable development in the sense of European and external European humanism
- Respecting the diversity of scientific traditions and developments in different cultures – promoting a fruitful scientific exchange
- Importance of practice for the learning process, for the study and in the working world
- Interpersonal relationship as the basis of teaching and learning
- Strengthening the personality of students in the sense of ability to be creative and judgmental as well as a high level of 'self-activity'
- In this sense, technical education has a civic, social and cultural perspective." (Ingenieurpädagogische Wissenschaftsgesellschaft IPW 2016, p. 250)

These typical fields of activity of a university lecturer in engineering sciences, the resulting requirements, as well as the demonstrated guiding ideas led to the following modular structure of the advanced training in engineering pedagogy.

Engineering pedagogical colloquium at the end of the curriculum. The detailed module manual can be read in Ingenieurpädagogische Wissenschaftsgesellschaft IPW (2016, p. 255)

Comparing the three curriculum drafts of the IGIP, the TU Dresden, and the IPW, we can find similarities and differences. An essential commonality lies in the extent of the further training. The IGIP has defined this as 20 CP and thus created an

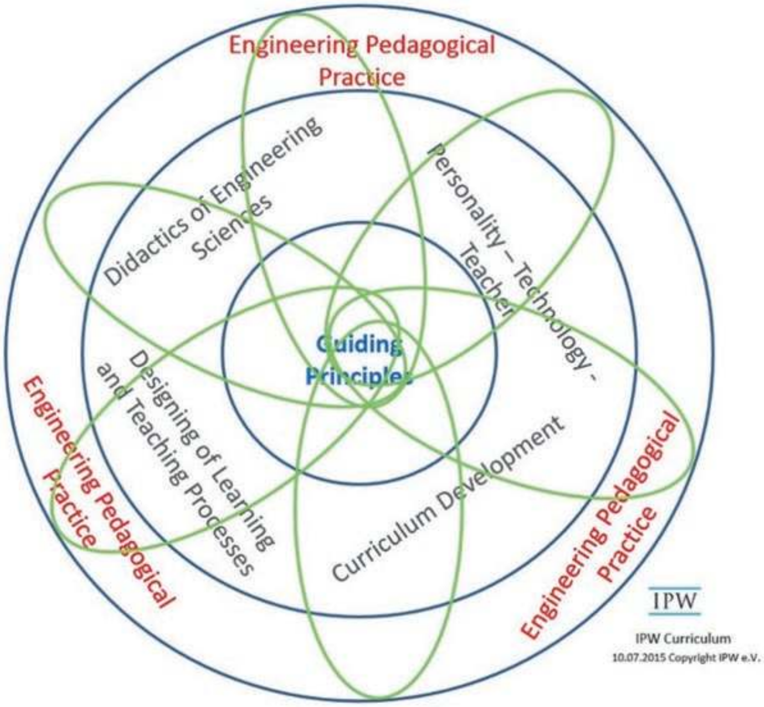

Fig. 14.4 IPW – curriculum design – engineering pedagogy theory and practice (Ingenieurpädagogische Wissenschaftsgesellschaft IPW 2016, p. 249)

accepted standard. The recommended for the presence time is 200–250 h. The observance of these formal standards was one of the prerequisites for the accreditation of the TU Dresden curriculum by the IGIP International Monitoring Committee (cp. Table 14.2).

The IGIP curriculum follows a classical study structure. First, discipline-oriented foundations (pedagogy, psychology, sociology) are taught, followed by selected applications (project work, communication, etc.). The typical fields of activity of a university lecturer and the related requirements are not recognisable in this curriculum. The reason is the openness of the target group. With its former President, Melezinek, IGIP has a great radius of influence in Eastern Europe. In Eastern Europe, however, the term "engineering pedagogy" also includes the training of technical vocational school teachers.

The curriculum of the TU Dresden focusses very strongly on the fields of activity of university lecturers in engineering sciences. The qualification objectives were determined empirically through the analysis of activities, requirements, and needs. The developed study structure is therefore very application-oriented, though systematic. It leads from micro-didactic questions, including the psychological basis, to the curricular development of courses in engineering education. The target group here is exclusively lecturers of the engineering sciences.

Table 14.2 Engineering pedagogical colloquium at the end of the curriculum (id., 2016, p. 251)

"Engineering Pedagogy in Theory and Practice"	6 CP
Laboratory and workshop didactics	3 CP
Technology communication (scientific writing)	3 CP
E-learning, use of media	2 CP
Aspects from anthropology, psychology, and sociology	3 CP
Control and evaluation of learning results in the engineering education	2 CP
Optional modules	1 CP
Aspects of ethics in science and technology intercultural competences cross-section modules (option modules) complex forms of teaching and working	2 CP
Didactics of preparation for the professional life	2 CP

The IPW curriculum also focuses on the target group of teachers of engineering sciences. Although the fields of activity of the university teachers were the starting points of the discussions, they were strongly superimposed by humanistic, ethical, and intercultural aspects. The result is a very open curriculum, which can be adapted to the needs of the respective university and the respective engineering sciences.

Irrespective of the advantages and disadvantages of the illustrated curricular designs of an engineering pedagogy, the decisive positive fact is the intensive strive for the pedagogical qualification of university teachers. For a long time, the high scientific competence of a professor in their field was considered as a guarantor of quality teaching. Discussions concerning engineering pedagogical qualifications, medical pedagogical qualifications, etc., the establishment of university didactical centres, and the expansion of university pedagogical further training offers are positive signals for a rethinking in this regard.

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Chapter 15
Competency-Based Exams in Professional Education

Ekaterina Golubina and Alexander Löser

15.1 Competency-Based Exams

When providing education services, educational institutions' primary aim should be to enhance the quality of their services and also the level of knowledge students acquire during this process. Average performance levels indicate the quality of education not only in a particular institution but also in the whole educational system. In the context of general education, this principle serves large-scale international comparisons like the PISA and the TIMMS study. Therefore it is worth exploring this aspect further in the context of professional education.

Indeed one of the forms to ensure education quality is by examination. In educational institutions in Germany and in the Central Asian countries of Kazakhstan, Kyrgyzstan and Tajikistan, exams are used as tools to evaluate interim performance, as well as a final assessment. While the interim performance evaluation serves to provide feedback and recommendations for students' further development as well as for teachers' professional activities, the main aim of the final exam is to some extent to assess skills and competences and to provide an overview of a graduate's abilities that can be used on the labour market. In other words, the exam results provide a short, unified and clear description of a potential employee' skills and comparability. To ensure better quality and labour market orientation, exams should be competency-based.

In literature, 'competences' are discussed differently, and there are big differences between European and Anglo-American understandings. The following

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definition meets the understanding of the authors and will be used throughout this article. According to Weinert (2001), 'competences are inherent or developed by a person cognitive abilities and skills to solve particular problems and connected with this motivational, volitional and social readiness and ability to responsibly and successfully use these solutions in different situations'[1] (id. 2001, p. 271). In this way, the main objective of competency-based examinations is not only to define the level of knowledge students have but also their ability to apply this knowledge in solving different types of problems, mainly in their professional life.

The three abovementioned Central Asian countries recognize the importance of linkages between the educational system and the labour market (Stehling 2015). Thus, the National Sustainable Development Strategy for the Kyrgyz Republic for 2013–2017 underlines that VET institutions should adequately collaborate with the private sector. The Strategy 'Kazakhstan-2050' states that curricula should have more practical content and should focus on labour market needs. The Tajik National Education Development Strategy also admits that the VET education does not meet labour market requirements and companies should take part in educational processes. So, all three countries recognize that integrating elements of dual education into the national VET systems is crucial for increasing the quality of vocational education. It is also stated in these documents that employers should be involved in assessing graduates' skills, as national legal frameworks contain further details on this issue.

15.2 Research Methods and Data Collection

In this research, interviews have been carried out. These interviews are based on literature and study of examination protocols. First, in the framework of a GIZ project in Tajikistan, a series of examinations for motorcar mechanics under the guidance of the German experts has been carried out. Observation criteria such as planning and organizing examination process and follow-up were agreed upon in advance and served as a basis for observations during preparing and conducting examinations. Then, the observations were documented in the form of protocols. Based on the latter, face-to-face interviews with teachers from Kazakhstan and Kyrgyzstan have been carried out. Another method used in this research is to study and to compare legal acts in the sphere of vocational education and training in the given countries. Results are presented in the form of recommendations provided in this article.

15.3 Legal Frameworks for Carrying Out Examinations in Professional Education in Central Asia

Since officially certified performance is a precondition for labour market entry, the performance should be assessed accordingly and final exams are strictly regulated. Taking into consideration that these requirements are of a compulsory nature, only

[1] Translation by authors'.

relevant state bodies can be responsible for providing the main rules and regulations. In Kazakhstan, Kyrgyzstan and Tajikistan, these are ministries of education and, partially, ministries of labour (in the field of adult education). Germany follows the principle of the dual system in professional education. Based on this principle, professional associations such as the Chamber of Crafts (Handwerkskammer) or the Chamber of Industry and Commerce (Industrie- und Handelskammer) are responsible for the content of educational plans and examinations. Thus, as members of these associations, private companies are involved in the professional education and examination processes. In turn, every association has its own examination regulations.

For example, if one compares the examination regulations of the Chamber of Crafts Kassel, a city in the Federal German State of Hessen, with the national assessment regulations in VET in Kazakhstan, Kyrgyzstan and Tajikistan, it stands out that the regulations of Central Asian countries are more general. Rules on the appointment of the examination committee members and preparation of the examinations are quite vague. Not all aspects of conducting exams (for instance, participation in exams of persons with special needs) are covered, and assessment criteria are not clearly provided. In this way, regulations leave much room for interpretation, which transfers added responsibility onto examination committees and makes the results of assessments more difficult to compare.

Nevertheless, forms of final assessment and requirements of different examination committees can be more or less compared.

From Table 15.1, one may conclude that the legal provisions in Central Asian countries and Germany specify various types of examinations:

Written exams: This is usually the most common examination type in Central Asian countries, as it ideally ensures unbiased assessment and is easy for documentation. If students have complaints about their assessment, the exam results can also be easily reviewed. Apart from closed questions and multiple choice questionnaires (tests – this type is considered in this article as a separate type of examination), questions can be used, which require thinking out of the box, analytical skills and explanations of conclusions. However, there is hardly any complex task-setting. Most written exams test students' knowledge in a particular subject but not necessarily their abilities to find solutions to complex problems.

Tests: As a form of the written examination is mostly used for continuous monitoring of students' performance, this method has gained increasing popularity among teachers. First of all, it allows assessing large groups of students in a finite time period as well as opportunities for comparison. Secondly, it limits the ability of external influences to compromise the quality of the assessment. Tests also help evaluate students' knowledge across topics of the training course. On the other hand, the nature of this method does not allow for a comprehensive measurement of acquired knowledge or an evaluation of the ability to use this knowledge and bring it to implementation (Furs 2005).

Oral exams: These are used for interim performance evaluations and presentations of the diploma project. The standard form involves students answering questions posed directly by examiners who then ask clarifying or control questions. In the three Central Asian countries, this form is used most often. Other forms of oral

Table 15.1 Forms of final assessment and compositions of examination committees at VET institutions in Kyrgyzstan, Kazakhstan, Tajikistan and Germany

	Kazakhstan	Kyrgyzstan	Tajikistan	Germany
Legal act	Model regulations on interim evaluation and final assessment in VET institutions[a]	Regulations on final assessment of graduates of VET institutions[b]	Regulations on final assessment of graduates of VET institutions	Law for vocational training[c]
Form of assessment	Diploma project, incl. oral presentation and/or written examinations	Examinations based on theoretical and practical testing procedures. Oral examination could be included		
Examination committee	Teachers, production masters and experts from companies	Teachers from the given and other VET institution, experts from companies and other institutions	Teachers from the given and other VET institution, experts from companies and other educational institutions	Minimum one teacher, an employer representative, an employee representative (based on the dual education system structure)
Chairperson	Expert in a particular field	Expert in a particular field, approved by Ministry of Education	Employer representative	Representative of the examination committee

[a]Model Regulations on interim evaluation and final assessment in VET-institutions adopted by Ministry of Education and Science of the Republic of Kazakhstan (2008)
[b]Regulations on final assessment of graduates of VET institutions adopted by Government of the Kyrgyz Republic (2012)
[c]Berufsbildungsgesetz (2015)

exams such as case-related debates, discussions of case studies and role games are barely used at all. One reason could be that teachers lack skills in assessing students' performance in such an 'unstructured' way. Or, overwhelmed by reports and other paper-work, they simply do not have the time to invest in more sophisticated forms of examination. Support from managerial personnel should play an important role here, but it is not always forthcoming.

Practical exams: Most of these exam types are used in technical vocational education. This type of examination requires more time for preparation which entails both the design of tasks and the testing of equipment that should be ready to use on the day of the exam. Observations from Tajikistan, for instance, show that this rule is often neglected and equipment is in nonworking condition (and is sometimes even being repaired) as the examinations take place.

As different types of exams assess various types of competences, a combination of examination forms is often used. For instance, skills evaluated during oral examinations (presentation skills, ability to explain the way of thinking) cannot be fully assessed by purely practical exercises and vice versa. When using the practice-oriented approach, not only knowledge and skills but also competences are evaluated with a focus on the labour market. It is the role of the private sector to evaluate whether skills acquired during the training are applicable in the labour market. Especially crucial is this when national qualification frameworks are missing (among the three countries, only Kazakhstan has developed this framework).

Based on an observation of examination processes in the three countries, it follows that students lack experience in handling comprehensive tasks and have insufficient problem-solving skills. One reason could be that tasks are usually given based on particular parts of a training course and comprehensive tasks that require extensive problem-solving skills are the exception rather than the rule. This is closely connected with the teaching methods. The value of understanding complex problems and interconnections between problems should be made integral to the whole training process.

15.4 Requirements of Examiners and Examination Committee

15.4.1 Examiners and Members of the Examination Committee

During interim performance evaluations, students' knowledge and skills on specific topics are assessed by their teachers. However, for final exams or presentations of a diploma project, an examination committee consisting of a minimum of three members, and usually up to five or seven, is formed. The qualitative composition of the board is also considered. This is ensured by the principle of parity, which means that apart from the teaching and managerial personnel of the educational institution, representatives of potential employers should be included into the committee. As stated above, educational institutions are vital measurements for the private sector, since when employing graduates, companies rely on their grades and assessment given to them by educational bodies. The grades earned in final exams and the average final grade in most cases play a significant role in ensuring a young person's entry into the labour market. Thus, the examination committee should embody not only specific knowledge but also practical experience in the topics to which the questions relate.

For this reason, a minimum of one employer representative should be present. This is provided in the legal provisions in all the Central Asian countries mentioned. However, the rule is not always followed: many representatives of companies (especially in the private sector) do not recognize the importance of being involved in examination processes and view participation in examinations as a distraction from their everyday work.

It is possible that it is precisely the fact that representatives of the private sector are only involved into the process as late as in a final exam which reduces their interest and trust in the results of assessments. For this reason, their involvement into the entire training process of a student or trainee is a key requirement to improve the VET system embedded in the national strategies.

15.4.2 Methodological and Didactical Skills of Examiners

Apart from specific knowledge, the examiners should possess methodological and didactical skills (a competence matrix for examiners can be developed) related to the topics of the exams. Examiners should follow the same rules and ensure a standard pattern of behaviour. Observations of several exams in VET institutions in Tajikistan, however, indicate that the quality of the examiners, or rather the quality of their procedures and methods, is not equal or consistent. This is especially true regarding their approach of asking questions: some ask interposed questions, others guiding questions and others still simply observe and take notes. In this regard measurements to develop consistency should be taken, for instance, conducting exam-related trainings for teachers.

Examiners should know how to ask appropriate guiding questions, provide pedagogical or even psychological support to students and remain unbiased. Neutral and bias-free treatment of students during examinations is one of the main requirements for competent examiners. Sometimes it is not easy to meet this requirement, however, since some factors can lead to a distortion of an examiner's perception and, consequently, result in subjective judgments over students' competences. German scientist Sebastian Walzik names the following factors: first impression, prejudices, stereotypes, contrast effect and context effect (Walzik 2015). Examiners cannot adopt an appropriate unbiased position if they have a particular relationship with students (relatives, colleagues, etc.). Hence, this fact should be excluded during the formation of the examination committee, although it is not clearly mentioned in the examination regulations of either Kazakhstan, Kyrgyzstan or Tajikistan.

Another critical task for an examiner in competency-based examination is to distinguish competences from performance. For instance, a student can find a solution of a task by good luck (performance) or by applying his or her skills (competence). In order to make sure that the student can really apply and implement his or her skills, the teacher should ask at least one additional question or ask the student to explain their way of thinking and how they came to a solution. Or, in other cases, due to some unanticipated factors (excitement, confusion, or non-confidence) young people can underperform, but a guiding question or a sign of support from the examiner's side can help them to relax and apply their real potential. The given example relates to oral exams. In written exams it is not feasible to use these methods (provoking, supporting, guiding questions), but other methods can be used in order to make students use their potential. One is to develop an appropriate way of formulating questions or problems. A very easy and telling illustration of this is provided by Sebastian Walzik 2015):

$$(1)\ 3\times 2+1=? \qquad (2)\ 1+2\times 3=?$$

Which of these two tasks helps assess students' competences?

Although the right answer in both cases is the same, the first task (1) allows only assessing the ability of a student to fulfil simple arithmetic operations. The second one (2) helps students show not only knowledge of arithmetic but also their ability to apply math rules.

Moreover, examiners should know how to handle non-standard or even emergency situations. What to do if a participant is late due to objective or subjective reasons? As a common rule in Central Asian countries, latecomers are not allowed to enter the examination room and should take the exam later (upon decision of the examination committee). However, this leads to increasing examination costs borne by educational institutions. Therefore it would be reasonable to introduce a solution such as late arrivals – up to 15 min can be accepted (at least for written exams) – without adding extra time after the end of the exam. This goodwill regulation could meet requirements on examination effectiveness and simultaneously reduce stresses connected with repeat exams.

Another non-standard situation is a power blackout or breakdown of equipment used during the examination. On the one hand, it is of course impossible to foresee all non-standard situations and provide description of steps to follow. Therefore training should be made available for examiners on ways to handle unforeseen circumstances depending on the educational institution's capacities and the preparations made by examiners for such situations.

15.5 Training of the Examiners

As mentioned above, the methodological and didactical preparation of examiners is one of the most vulnerable components of the educational systems in Kazakhstan, Kyrgyzstan and Tajikistan, which requires additional testing. Some teachers, who also act as examiners in their institutions, report a lack of instructions providing clear guidance for examination processes and competences assessment. There are also no guidelines on the way students should be treated (how to provide necessary support, while remaining bias-free, how not to be distracted by external factors such as students' looks or noises outside of the class room, etc.).

Taking all these arguments into consideration, it is advisable to carry out not only singular trainings but also regular further trainings for examiners. Systematic feedback should be provided to aid quality control, and possible improvements should be discussed. Then, the lessons learnt should be applied in preparation for and during examinations (Weiß 2011, p. 45). Crucial support is also provided to examiners in the form of general information, practical advice and platforms for the exchange of experience. Measures to explore these opportunities in the Central Asian countries should be taken.

15.6 Conclusion

Experience has shown that the legal framework for competency-based evaluation is in place in all the aforementioned Central Asian countries. However, the frameworks, regulating examinations in Central Asia, are rather general compared to the ones in Germany (Bundesministerium für Wirtschaft und Energie 2017). For this reason a member of the examination committee has a much higher responsibility regarding the implementation of comparable standards into examinations as well as comparable assessment criteria. Neither Kyrgyzstan nor Tajikistan has implemented a National Qualification Framework yet, leaving Kazakhstan as the only country that has met this requirement. Even more important is the participation of the private sector in defining the content of trainings and apprenticeships as well as being part of examinations to evaluate competences acquired.

To fulfil this weighty responsibility, members of the examination committees require all possible support in the form of ongoing trainings and facilitating the exchange of experiences between committees. Taking into account that the national strategies in these countries focus on the implementation of dual elements in professional education in order to meet the needs of a rapidly changing labour market as well as on tackling challenges inherent in economic globalization, examiners have to be both highly skilled and experienced. There are encouraging examples of responsible cooperation with the private sector. Clear descriptions of job profiles on the part of the private sector will help train young people according to key requirements and consequently improve their perspectives in the labour market. Experience exchange of best practices in VET networks can be a focal point for continuous improvement in the area of evaluation of competences, as well as the ongoing training of examiners.

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Chapter 16
Learning Performance in Vocational Secondary Schools: Testing Academic Achievement in Electrical Engineering

Metwaly Mabed and Thomas Köhler

16.1 Introduction

16.1.1 Learning Performance, Academic Achievement, and Knowledge

Learning performance links to the future career opportunities, especially, in the vocational education field (Adams 2014). Therefore, it is not surprising that the academic achievement of students is a top concern of educators. Academic achievement is often used to refer to the knowledge obtained by students through a school program or curriculum. According to Algarabel and Dasi (2001), academic achievement is defined as "the competence of a person in relation to a domain of knowledge" (p. 46) or the proficiency of students' performance in a certain course. From the given importance of this topic in an educational context, it is necessary to do the process of exploring, assessing, and evaluating academic achievement by a particular test. AERA, APA, and NCME (AERA et al. 1999) pointed out that academic achievement tests "are measures of academic knowledge and skills that a person acquired in formal and informal learning opportunities" (p. 124). Other definition of academic achievement test can be found in the *Dictionary of Education*, which defines "a test that measures the extent to which a person has acquired certain information or mastered certain skills, usually as a result of planned instruction or training" (Shukla 2005). Consequently, academic achievement tests tend to measure

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recent learning performance and are closely tied to particular subjects or courses (Ariyo 2007). As outcome of a doctoral research and development project, the presented test has been discussed by several reviews. The presented publication results from a conference presentation at KICSS 2014 (Köhler and Mabed 2014; Mabed and Köhler 2016), focusing on the test construction and its quality. The recent publication intends to provide access to the test itself in a way that it may be reused easily in regular educational situations.

16.1.2 Testing Academic Achievement

Testing academic achievement may serve three major functions (Srivastav 2000): (a) measuring the effectiveness of learning performance at a particular point of time in an educational program; (b) predicting the behavior of students across different situations; and (c) assessing various psychological traits and characteristics. The information, which is collected by the achievement test, moreover, supports the decisions concerning the placement or diagnostic issues during the instruction process. Furthermore, Smith (2001) argues that there is a wide range of reasons of using academic achievement tests. Those are to (a) identify where the student falls along continuum of knowledge acquisition; (b) classify students in groups according to their scores in the end of a course; (c) determine the eligibility for particular educational programs; and (d) measure the effectiveness of instruction process. Whether the achievement test is a norm-referenced measure or a criterion-referenced measure, the vital issue is that its results should represent accurately the evidences concerning student performance to enhance the learning process as a central goal in any educational organization.

In vocational education, indeed, the precise specification of what to measure is poorly understood. Only recently, a renewed understanding of how testing learning outcome is linked to teaching activity is taken into account for developing measure. The development of academic achievement tests in order to assess students' learning performance in electrical engineering is more beneficial for research and practice. Although many researchers are interested in measuring academic achievement (Bayrak and Bayram 2010; Carle et al. 2009; Choy et al. 2012; Haislett and Hafer 1990; Rivkin et al. 2005; Romano et al. 2005; Selçuk et al. 2011), no existing measure was found to be adequate to deal with the electrical engineering content in this study. The necessity for the construction of such a test cannot be understood without discussing the influence of an achievement factor in many aspects of students' professional skills in vocational secondary school. Therefore, the construction and development of an appropriate test to measure students' achievement in electrical engineering will enhance the quality of learning outcomes.

16.2 Empirical Method of Test Developmenting and Resulting

16.2.1 Aims, Procedures, and Data Analysis

The aim of this study is twofold. The first purpose is to identify the learning performance that reflects students' assimilation of the electrical engineering content. The second purpose is to describe the construction of a reliable and valid academic achievement test designed to measure students' learning performance. To achieve these goals, the researchers developed an academic achievement test in several phases by following the systematic approach and the procedures, which have been provided in Crocker and Algina (1986), Downing (2006), and Osterlind (1998) as well as in the light of the standards (AERA et al. 1999). Statistical analysis was conducted using PASW (Predictive Analytics SoftWare) Version 18.0 for Windows.

16.2.2 Development Phases

The construction of the academic achievement test consisted of eight subsequent development phases as follows:

1. Clarifying the purpose of the academic achievement test (Crocker and Algina 1986)
2. Identifying the educational objectives (Bloom et al. 1956; Crocker and Algina 1986)
3. Performing panel of experts
4. Developing test blueprint (AERA et al. 1999; Crocker and Algina 1986; Osterlind 1998)
5. Determining and generating test questions (Osterlind 1998; Quellmalz and Hoskyn 1995)
6. Preparing test instructions (AERA et al. 1999)
7. Performing panel of experts (Crocker and Algina 1986) and
8. Conducting the pilot study.

16.2.3 Resulting Test

The main outcome of the presented study is the test to be applied in the context of regular vocational or general school activity. Due to the field condition, it has been developed in both English and Arab versions. The complete achievement in electrical engineering test may be found in the annex and was as well published in the dissertation of Mabed (2013).

The test in its English version starts with an easy to understand test instruction to be read by the students before completing it. The main section of this test consists of 60 multiple questions. Each question has four possible answers (A, B, C, and D), and one must choose the correct or best answer. As well, a pocket calculator is recommended for students when completing this test. Answers to all questions are collected on a single final sheet with answer boxes for each question. Afterward this sheet may be easily used by the teacher for calculating the outcome on the basis of a graphical template.

Even though the test would be available as a browser-based version, it is designed in a way to work as paper and pencil as well, without using a computer in order to conduct the test, which does not necessarily need to take place online. The duration of the test has suggested with approximately 100 min in order to provide an adequate time for answering the whole test with all its items (cf. Mabed 2013) and should be applied in the context of regular educational activities in vocational secondary schools.

16.3 Findings on Test Quality

16.3.1 Test Validity

The researchers were keen to utilize a valid academic achievement test. Therefore, it was a focus to check the validity of academic achievement test. However, test validity is defined as "the process of collecting evidence to establish that the inferences, which are based on the test results, are appropriate" (Adams 2014, p. 21). From this meaning, the validity term is related to the scores, which are obtained from applying the test more than the test items itself. In the same stream, a complete description of the validity issue is found in (AERA et al. 1999): "Validity refers to the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests. Validity is, therefore, the most fundamental consideration in developing and evaluating tests. The process of validation involves accumulating evidence to provide a sound scientific basis for the proposed score interpretations" (ibid., 1999, p. 9). The process of assessing validity includes many actions such as asking test takers and experts about their subjective opinions on the content of the test items, as well as using factor analysis to evaluate the item internal structural (Kline 2005). In this study, the principal components factor analysis with a varimax rotation statistical procedure was employed to calculate the factor loadings and eigenvalues of the answers for the sample by using the statistical program PASW Version 18.0.

Two criteria were determined to achieve satisfactory validity of the test items. First, the factor loadings should exceed the minimum threshold of 0.5 as recommended (Hulland 1999). Second, the items with multiple loadings should record a higher load on their related level than the load value on other levels (Gefen and

Straub 2005). The results revealed that the factor loadings of the five items were less than the cutoff of 0.5. Moreover, four items were loaded greater onto another level than their corresponding level.

In summary, 9 out of the 70 items were removed from the academic achievement test. Then, the factor analysis with the varimax rotation was run again over the dataset for 61 questions. The results showed that the factor loading value of each item was at 0.5 or above and there was no cross loadings in between the test items. The first component referred to the application level, and it had an eigenvalue of 20.89. The second component indicated to the knowledge level, and it had eigenvalue of 9.86, while the third component referred to the analysis level, and it had eigenvalue of 5.00. Finally, the fourth component pointed out to the comprehension level, and it had eigenvalue of 3.22. Accordingly, all eigenvalues were more than the cutoff value of one. Moreover, the four levels accounted 64% of the total variance.

16.3.2 Test Reliability

Reliability as an indicator was calculated during the construction of the test. While the test was defined as a scale describing student behavior in a specified domain, test reliability refers to the stability of this scale when the testing procedure is repeated on a population of individuals or groups (AERA et al. 1999). Cronbach's alpha was 0.97 higher, that is than the restrictive criterion of 0.7 (Fornell and Larcker 1981). Since the academic achievement test consisted of four levels (knowledge, comprehension, application, and analysis), it is not sufficient to compute the reliability for only the entire test when the score of sublevel will be used. According to standard 2.1 (AERA et al. 1999, p. 31), "For each total score, sub-score, or combination of scores that is to be interpreted, estimates of relevant reliabilities and standard errors of measurement or test information functions should be reported." Thus, the reliability for each level in the achievement test was also reported, as shown in Table 16.1. In regard to the knowledge level, Cronbach's alpha was 0.967 for the 15 items, and the item correlation values ranged from 0.69 to 0.88.

Concerning the comprehension level, the reliability coefficient alpha Cronbach was 0.94 for the 15 items, and the item correlation values ranged from 0.51 to 0.77. In regard to the application level, an internal consistency analysis showed alpha value of 0.96 for the 22 items, and the item correlation values ranged from 0.52 to 0.86. Regarding to the analysis level, Cronbach's alpha coefficient was 0.94 for the

Table 16.1 Results of knowledge level reliability on the academic achievement test

Test level	No. of items	Cronbach's alpha	Mean	Variance	SD
Knowledge	15	0.967	11.42	28.22	5.31
Comprehension	15	0.939	9.71	26.71	5.17
Application	22	0.958	14.68	56.43	7.51
Analysis	9	0.936	4.54	13.14	3.62

nine items, and the item correlation values ranged from 0.53 to 0.92. As a result, the items of levels in the achievement test presented satisfaction reliability criteria.

16.3.3 Item Analysis

The level of item difficulty is considered by further indicators that can be used to determine if the item is useful enough to be included in the academic achievement test or not. The difficulty level of an item refers to the proportion of students answering an item correctly. The item difficulty index, also known as the p-value, is calculated by dividing the number of students who answered the question correctly by the total number of students who answered the question (Srivastav 2000). Furthermore, the difficulty index can range from zero to one. While zero value indicates that no student answered the item correctly, one value indicates that all students answered the item correctly. The first case points out that the item is very difficult, whereas the second result explains that the item is too easy. In the present study, the item is considered difficult when the difficulty value was less than 0.25. In addition, the item is considered to be easy when the difficulty value was greater than 0.80. The results illustrated that the test items provided acceptable difficulty values ranged from 0.30 to 0.78.

On the other hand, the value item discrimination provides a suggestion of the degree to which an item correctly differentiates among the test takers on a certain domain (Whiston 2005). Steps of calculating the discrimination index were described by Kline (2005). First, those students who have the highest and lowest overall test scores are sorted into two groups: the upper group which is made up of the 25–33% who have the highest overall test scores and the lower group which is made up of the bottom 25–33% who have the lowest overall test scores. Subsequently, the p-value of each item for the upper and lower groups is computed.

Finally, the item discrimination index is provided simply by subtracting the p-values of the two groups, upper group and lower group. However, the item discrimination indices diverge from −1.00 to +1.00. The overall test scores were arranged in the descending method. Subsequently, the top 19 students (27% of the total number 69 of students) were included in the upper group, while the lowest 19 students (27% of the total number 69 of students) were selected in the lower group. The item discrimination indices were calculated. The items were categorized concerning their discrimination indices according to the criteria recommended by Ebel (cited by Mitra et al. 2009). The item with an index of discrimination of 0.40 and higher is considered an excellent item, while the value ranging from 0.3 to 0.39 is regarded as good item. Therefore, the item discrimination value of 0.2 to 0.29 is considered as being acceptable, whereas the ratio from 0 to 0.19 refers that test item should be revised. Moreover, the item with a negative discrimination index value should be removed from the academic achievement test. Fortunately, the findings reported that all discrimination indices for the test items were positive values.

Moreover, the results showed that the test items which provided sufficient discrimination value ranged from the good to excellent item.

Based on the results of item analysis, 61 items was the number of test questions that were found to be valid enough to evaluate student achievement in electrical engineering. Conversely, the total number of the test items was 60 items. Therefore, one item was removed from the academic achievement test.

16.4 Discussion and Conclusions

Measurement of learning performance as a means to assess academic achievement and thus the development of knowledge on an individual level is a core educational activity not only in vocational secondary schools. Only empirical data, independently of its specific format, is one of the key indicators in each educational measurement. However, measurement is often difficult, and appropriate tools need to be subject-specific and reliable. Due to that, the present study addresses the construction and validation of academic achievement tests in order to measure students learning performance in the electrical engineering. The development of the academic achievement test included a rigorous process of planning, creating, and testing. However, many of the researchers explained that careful attention must be paid to the purpose of the test, because the usefulness of test interpretations depends on the agreement with which the purpose and the domain represented by the test have been explicated (AERA et al. 1999). Therefore, the purpose, the educational content, and the target population of the academic achievement test were identified. This test aimed to assess student's learning performance in the electrical engineering for vocational secondary school in Egypt (Mabed 2013).

According to Crocker and Algina (1986), one or more actions may be applied during the development of an instrument such as content analysis, review of the literature, critical incidents, direct observations, expert judgment, and instruction objectives. The researchers had taken into account several activities to overcome the problems, which might be inherent in the test. For that reason, the test items should reflect the knowledge directly related to electrical engineering. Therefore, the content of electrical engineering was analyzed to identify the educational objectives. After experts' review has been applied to test phase and content validity, the output was a 76-item objective, reflecting five main topics in the electrical engineering. To increase the content validity of the test, the importance of each topic and the number of pages were determined during preparing the blueprint of the academic achievement test.

Those 76 items were generated to assess student's learning performance in electrical engineering. The academic achievement test items covered four taxonomy levels, which include knowledge, comprehension, application, and analysis. Presenting a clear, simple, and concise direction is an integral part of well-constructed test items (Osterlind 1998). Therefore, the first draft of the academic achievement test and the directions for the test takers were given to a panel of experts to judge the appropriateness of them. Authors conducted the pilot in order to collect evidence that determines the validity and reliability issues. The characteristics of the pilot study sample were similar to the target group to use for the final test. The results from the pilot study suggested that the academic achievement test demonstrated acceptable reliability across the test.

The alpha coefficient for the whole test and all the sublevel was reasonable:

1. The academic achievement test showed evidence of discriminant and convergent validity.
2. The principal component factor analysis as the extraction technique and a varimax rotation as the orthogonal rotation method procedure were executed by using the statistical program PASW. The results of factor analysis revealed that the application level explained the higher proportion of the variance, while the comprehension level accounted for the lower percent of the variance.
3. Moreover, the academic achievement test had a good item difficulty falling within the range of 0.30 to 0.78 with a discriminative index of the test items ranging from 0.41 to 0.79. Since the academic achievement test items were designed to reflect predetermined objectives, this variation in value to the items would be expected.

In sum, the findings indicated that the 60-item test holds promise as a valid and reliable academic achievement test to measure student's learning performance in electrical engineering. With a duration of approximately 100 min for answering the whole test, it may be applied in the context of regular educational activities in vocational secondary schools. The calculation of the scores is supported by an easy to be used template.

Finally yet importantly, the construction and development of the academic achievement test in the present study should be considered in the light of a few limitations. The academic achievement test is related to electrical engineering content in the vocational education school. Moreover, although the research sample of pilot study was appropriate for the correlation matrix and factor analysis, it was relatively small. Future research utilizing a larger sample size is necessary to provide evidence regarding the test validity.

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Chapter 17
Quality Management for Projects and Workshops

Jens Drummer

17.1 Introduction

When speaking about projects, one has to ask: What is a project? Here one may apply the definition from the Project Management Institute: "A project is a temporary endeavour undertaken to create a unique product, service, or result. The temporary nature of projects indicates a definite beginning and end" (Project Management Institute 2008, p. 5).

The next question is for which one uses a project in the working context? In many areas, the implementation of a project is the ability to implement innovative ideas. Here, the project method has the advantage that usually all the project members identify with the project due to the uniqueness of their interaction to the project.

To ensure a successful completion of a project, it is necessary to check from time to time on the reaching of milestones and also on the implementation of objectives. This is quality management. However, why is quality management in projects so important and how can it succeed? One of the major reasons for the establishment of quality management is the improvement of processes and the results of projects (Brunner and Wagner 2011, 6ff). To ensure a certain quality, appropriate tools and methods are used. Especially questionnaires are often used for the measuring of quality in workshops and projects (cp. Groh et al. 2012, 236ff; Eid et al. 2015, 36f).

Research confirms that the best way to ensure the quality of a project is to define it as an objective of the project (Lock 2013). However, projects always take time, and time is an important resource that needs to be monitored. Often, after some time has passed, a project may become stalled. To avoid such, it may be helpful to evaluate the project in specified periods. This evaluation is a part of quality management

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and as well increases the visibility, relevance and sustainability of each project (Bruhn 2013, 6f).

Using the example of several projects which were carried out at various universities in Central Asia in the field of vocational teacher training, especially in the context of developing a Master of Education Food Technology M.Ed., the author shows how a quality evaluation can help ensuring the successful completion of a project. While the workshops took place in the period of 2015 to 2016, the framing programme called "USPECH" (which is the Russian word for "success") consists of 18 projects and runs from May 2015 to December 2016 and is considered as an implementation programme and is linked with the longer-lasting EDUINCA network (cp. Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH 2010).

17.2 Quality Assurance in the USPECH Workshops and Projects

Subsequently it is described how quality assurance in each area, i.e. in the USPECH workshops and projects, was carried out. The first part will focus on the projects' quality assurance, and in the second part, the workshops are considered.

Ideally an evaluation must be planned from the beginning of each project when the objectives for the project are defined. By then it is possible to derive the content of the questionnaires, and each objective which is to be verified should be addressed by at least two questions in the questionnaire. All questions were uniquely formulated, and when the questionnaire was developed, it was tested first. In the test phase the questionnaires will be issued to persons who are not involved in the projects. Thus it is possible to detect some difficulties which may occur when the subjects are requested to complete the questionnaire, i.e. have to understand the respective questions. Once these difficulties have been corrected, the survey may start (cp. Moosbrugger 2012, 36ff). In the case of this study, standardised and introduced questions were used and adapted for the special case. The complete questionnaire was sent to test persons. They answered the questions from their point of view. After this they gave feedback where they had difficulty in understanding the questions. Based on this feedback, the questionnaires were adapted.

17.2.1 Elements of the Quality Assurance for the USPECH Projects

As first step of the quality assurance for the USPECH projects, a call for submission of project ideas was sent to all potential candidates who previously did participate in projects. The call included the following conditions: (1) the project must be innovative in the field of TVET, (2) the project idea must be performed for the first time, and (3) the entire project must be completed within 1 year (this period was later extended to 18 months).

From the proposed projects, only those projects which included the best ideas as estimated by GIZ (Gesellschaft für Internationale Zusammenarbeit GmbH - German International Collaboration Association) and seemed to be realisable were selected. Some more extensive project ideas were then discussed with the applicants in order to reduce the extent to a 1-year duration of the project.

To ensure the quality of projects and also to reduce the risk of failure of projects, different questionnaires were used (one for the start, two for intermediate results, and one for the final results) which were completed by all projects.

At the start of the project, all project teams received a questionnaire covering the following contents:

- Objectives of the project
- Milestones and the planned date of realisation
- Project content
- Support needed for successful implementation.

This first questionnaire was completed once by each project team, and based on the answers, the contents of the accompanying workshops were planned. Throughout the period of 12 months, a total of four accompanying workshops for all project teams were conducted by a group of international experts with the project managers as participants.

Each workshop covered a part of the project management as a topic. Thus, participants had received information about each impending project phase step by step. For example, in the first workshop, the participants were informed about important aspects of the project start. Furthermore, each workshop dealt with a specialised topic which was helpful for the implementation of the projects. The topics of the workshops were:

- Use of media in teaching
- Specific didactics in food technology
- Networks in educational context
- Scientific writing.

In addition, the status of the implementation process of the projects was discussed, evaluated and recorded through questionnaires in each workshop.

17.2.2 Findings of the Project Evaluation

In the questionnaire completed at the start of the projects, the respondents were asked specifically about the project objectives and planned milestones as well as the necessary support for each project. This was checked and analysed by the GIZ.

Fig. 17.1 Satisfaction in the project – comparison between the first and second interim reports

Great attention was given to the requirement that the objectives corresponded to the SMART[1] model (Bernecker and Eckrich 2010, p. 226). In some cases the evaluator suggested a discussion with the project group to adapt the objectives, while the theory of the SMART model was a part of the content during the first workshops. A second part of the questionnaire covered the planning of the milestones. It came out that majority of the projects had a very realistic milestone planning and very few projects specified one milestone only. In these cases more important milestones were discussed in cooperation with the project group.

Based on this questionnaire, the actual planning of the workshops was then carried out, and the best possible support was given to all projects and all according implementation activities. Later it was shown that this was also an essential element to the success for all projects.

During the project phase, another questionnaire was used for observing the course of the projects. One aspect of this questionnaire constituted the motivation and satisfaction with the interim results of the projects. It was seen that it was satisfying as one may see that the motivation of project staff did increase over the period of the programme in all the projects. The satisfaction with the implementation of their own projects also steadily increased within all projects (see Fig. 17.1).

Due to the fact that the projects are close to completion at the time of reporting, there is limited opportunity to comment about the completion of the projects. However it was explained to respondents (usually the heads of the project teams) of all projects that they had to finish their endeavour in the planned time. The fact that none of the projects failed has shown that, among other things, continuous monitoring and controlling were helpful (cp. Fiedler 2016, 6ff).

[1] **S**pecific, **M**easurable, **A**ssignable, **R**ealistic, **T**ime-related.

17.2.3 Ensuring the Quality of the Workshops

To ensure the quality of the workshops, each workshop used a standardised evaluation form which consisted of two parts. In the first part, all participants wrote down their individual expectations at the beginning of the workshop. Only at the end of the workshop had all participants completed the second part of the evaluation form where they were asked about the workshops' quality. This part included a set of questions about:

- The quality of the execution of the workshop (eight multiple choice questions)
- The quality of the results of the workshop (six multiple choice questions)
- The possibility of transferring the knowledge acquired into the workshop towards the projects (two open-answer questions)

The participants received the questionnaire in paper form. In principle, it is also possible to offer questionnaires in digital form, for example, as a form on the Internet. However, to ensure that each participant has the opportunity to complete the questionnaire, the paper format was preferred.

All the evaluation forms were analysed using the statistical software SPSS.[2] Then the data was descriptive and variance analysis evaluated.

In order to ensure the influence of the findings, the experts who participated in the workshop were informed about the results of the evaluation by using digital documentations. In addition, the participants were informed about the results during the next workshop. With this procedure it could as well be demonstrated that the management of quality is an important part of each projects' activities.

17.2.4 Results of the Workshop Evaluation

Throughout the USPECH programme, several workshops were planned in order to support the implementation of the projects. It turned out that participants' expectation clearly confirmed the expectation of project-wise support. Indeed all respondents chose the respective item in the evaluation form from the second workshop onward.

At the beginning, the expectation was high that participants would refresh already known knowledge (cp. Fig. 17.2). This expectation even increased for the second workshop from 9% to 24% and to the fourth workshop to 54%.

All workshops have been performed a competence orientation which demanded awareness of the specific objectives for each workshop among all participants. In the evaluation this has been addressed in detail. Data shows that from workshop to workshop, more participants confirmed the statement: "The objectives of the workshop were presented". At the first workshop, 70% of all participants did "totally

[2] **S**tatistical **P**ackage for the **S**ocial **S**ciences.

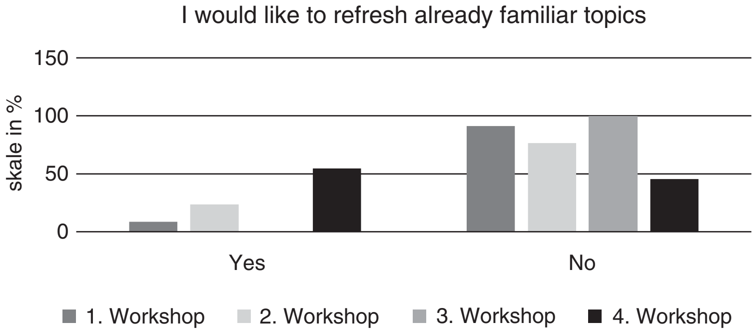

Fig. 17.2 Refresh already familiar topics – comparison between the workshops

agree", while at the last workshop, 92% of the respondents answered that way. The author suggests that this is connected with the fact that all workshop leaders did receive the results of the evaluation.

Another item focused on participants' satisfaction with the relationship between theory and practice. Along with this item, an increase in the number of participants who responded "totally agree" has been clearly observed.

In the last part of the evaluation form, factors including the growth of competence in teaching were measured. Results showed that the work focused by the lecturers also led to an increase in skills among participants. Here it was measured that in the third workshop, 58% of the participants did show a considerable increase in competence for teaching, while at the fourth workshop, 100% of the participants showed such growth.

17.3 Summary

Overall it can be concluded that the instrument of quality assurance led to improved quality standards in both projects and workshops. Importantly – which has also been shown – the projects did profit from specifically planned supporting workshops with a partial focus on project management and quality development. Data collected confirms these workshops assisted the projects both at the organisational and a substantive implementation. Through appropriate planning of each project phase, it becomes possible that the projects may be completed in time and within the budget planned.

In relation to the theory of quality management for projects, the presented findings underline the statements of Groh et al. (2012) and Curlee and Gordon (2010) that the support of projects is one of the most important parts for a successful execution and completion. Through the use of quality control, all workshops are expected to be completed as scheduled, due to the accompanying support. Thus, at an early stage, difficulties were detected, and corrective action was taken. Ensuring the quality has significantly contributed to the overall success.

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Part VI
Research Methods in TVET

Chapter 18
The Significance of Scientific Research in the Professional Development of Students

Mukhabbat Ikrami

18.1 Introduction

The development of the modern food industry has a number of peculiarities, among which the most essential are the following:

- Increases the significance of the functional and balanced articles of food (related to many food substances) and products of the therapeutic and prophylactic purposes required for the certain population groups and aimed at providing therapeutic and dietary actions. A wide range of consumers – children, elderly people, workers of the hazardous industries – need these healthy articles of food.
- An important task of the food industry is to find new sources of raw materials, to construct new articles of food and to create new food processing technologies.
- The urgent problem is to develop new techniques and to improve the existing methods of analysing raw materials and articles of food, as well the methods of calculation of their nutritional value.

Addressing the foregoing problems requires not only the training of specialists-generalists possessing the knowledge of the basics of modern production and the methods of technical-chemical control but also:

- Possessing the knowledge of narrow-profile specialists, having had in-depth fundamental and professional training
- Being able to conduct scientific researches, as well as complex scientific experiments and observations

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- Being able to use new data about the known elements and chemical substances that are not synthesized in the human body but are vitally important, as the only way they can pass into the human body are through articles of food
- Being aware of the chemical and physical processes occurring in the food production in order to manage and to optimize the processes.

The urgency and importance of this work consist in the fact that the scientific activities of students are an integral part of the learning process. Besides, it has the great importance in improving the quality of instruction, developing the creative potential of students and improving the formation of professional skills as well as self-reliance and the ability to think and to make decisions.

A large number of academic papers describe the research activities of students, their place in the educational process and their significance. For example, "the scientific activities of students will play a leading role in improving the quality of specialists' training towards a decisive turn to the development of creative abilities of future specialists, as the learning process by merging with the scientific researches of students is increasingly becoming a real professional activity, which now forms the fundamentals of the development process of a future specialist" (Timofeeva et al. 2007, 462–463). The paper Lohonova (2010) and Chudesova (2008) states that "a scientific activity provides comparison of data, juxtaposition of judgments and opinions of different authors, elaboration of own views related to the issue, which is of the student's interest. The SRS system will enable the universities to train individuals with creative thinking, capable of having unconventional innovative thinking, which are so necessary for successful development of science and industry". The article describes various forms of research activities of students, including paying much attention to the project method of SRS implementation. "A project for a student means an opportunity to fully disclosure his/her creative potential, as well as it is the means of self-realization. It is an activity that allows a person to express himself/herself individually or in a group, to try one's hands at something, to apply own knowledge, to bring benefit, and to show the results achieved to the public" (Dubovina 2012, 124–126; Pokushalova 2011, 115–117).

This article summarizes the experience of the Chemistry Department of the Technological University of Tajikistan, as well as the applying types and forms of scientific researches of students.

18.2 Research Work of Students: Types, Significance and Results

An important and mandatory part of the educational process in the credit education system of the Technological University of Tajikistan is the individual work of students, planned by a teacher's guidance and without it. Allocation of as much credits as for class activities in the curriculum confirms the significance of students' individual work. It is well known a large number of forms of individual work, among which, in our opinion, scientific research occupy an important place.

While teaching chemical disciplines at the Chemistry Department of the Technological University of Tajikistan, the following types of student researches conducted successfully:

- Elaboration of papers and reviews on specific topics
- Research-intensive education (RIE)
- Involving students in implementing individual sections of researches on scientific subjects of the Department
- Execution of individual and group projects.

18.3 Research-Intensive Education (RIE)

The themes of research activities are to be approved at the Department meetings and to be as close as possible to the food production processes. The academic and research term papers, as a rule, deal with the study of physical and chemical characteristics of food, for example, determining the acidity of milk and dairy products by various methods, determining the qualitative composition of fruit and vegetable juice, and studying the laws of stability of disperse systems on the example of any article of food.

Performing of the semester research activity consists of a literature study, fulfilment of an experiment, designing a report and defending the paper outcomes. Such requirements for the term papers can solve the following problems:

- Reveal the creative potential of students.
- Develop the students' skills to work with literature.
- Develop the students' abilities to self-planning and implementing experiments.
- Foster better learning of the techniques for implementing laboratory experiments.
- Independently perform mathematical processing of the research results.
- Learn and apply the rules of drawing up and executing term papers and reports.

We believe that the semester papers in each chemical discipline, which executed in the form of educational and research activities with the students of the first and second courses, are the most important form of individual work with students. The results of these studies find practical application in the educational process. For example, laboratory work in physical chemistry "study of the polymers' properties" was preliminary tested by the students, as a research-intensive education semester. The laboratory practice in analytical chemistry also included a research-intensive education semester on "chromatographic separation of plant pigments".

The students together with the teachers report the outcomes, both at the students and national conferences. Besides, the outcomes have been presented at the national competitions for the best students' papers and took the first and second places. But the main result of our work is to achieve the objectives mentioned in the beginning of this article.

18.4 Involving Students in the Scientific Researches of the Department

A form of individual work of students is to involve them in performing scientific researches of the Department, which enables students to develop their creative potential, to deepen the knowledge and to have insights of the essence, goals and objectives of the chosen specialty. Below the examples of application of similar studies in the educational process are provided. A second year student has conducted the study "The use of natural dyes in the production of dairy desserts". The aim of this study was to investigate the possibility of using dyes extracted from the flora of Tajikistan for colouring dairy products, which was one of the important topics of the Department of Chemistry. The study included familiarization with the literature on this subject and making a literature review, mastering the dairy desserts production technology under the laboratory conditions, studying the methods and conditions of dying the dairy products, and drawing up a report. While carrying out these types of activities, the student learned the theory about the requirements for the raw materials, as well as mastered various methods of milk analysing and standardizing (determination of acidity through acid-base and potentiometric titration, determination of milk fat by a butyrometer, defining the density by hydrometer), the technology of yoghurt production, as well as developed the methods for using and dosing of natural colouring extracts to obtain the optimal results. A part of the work performed, namely, the determination of the milk quality by different methods, was counted as the semester activity in analytical chemistry; the other part (determination of the properties of the resulting product) was counted as the semester activity in the physical and colloid chemistry. The results were presented at the scientific conference of students and aroused the interest of the audience, which is an incentive for further creative growth of students.

The following researches have been performed as part of the themes of the Department: "The study of the colour stability of the dye extracts by photocolorimetry method", "Determination of the dyes content in the natural food dyes", and "Determination of flavonoids and carotenoids in the food raw materials".

18.4.1 The Group Project

In our view, the Department has an interesting experience on conducting of researches with the group of students enrolled in various courses. So, as per the students' scientific society program, the Department has been working on the study of the water quality of various rivers and sources in Tajikistan and its influence on the technological processes of food substances. Under this theme, there were identified hardness of water, content of oxygen, iron, manganese, and other elements in the water sources in the city of Dushanbe and the surrounding areas and the influence of the content of calcium, magnesium and iron on the quality of the canned products. The experiments on various aspects of this theme were performed by the students of the first, second and third year separately, and the analysis and synthesis of the results were made together.

18.5 Outcomes

The scientific and research efforts of the students in each chemical discipline has its own characteristics associated with both the specifics of a discipline and a contingent of students. The level of complexity of the research tasks depends on the course of studies of students. In the first year while studying inorganic chemistry, RIE aims at expanding and consolidating the knowledge and skills obtained in the lectures, laboratory works and seminars. As a rule, the first year students do not master the techniques of the laboratory practice. Therefore, they are asked to implement easy experimental and research activities, which develop their skills and abilities in making laboratory experiments. The examples of such work may be the following: "Water purification by distillation", "Salt cleaning by recrystallization and salting out-methods", "Determination of pH of the solutions by visual measurement", and "Solution preparation of the exact concentration".

On the second-third year, the themes of the students' researches relate to the analysis and determination of the physical and chemical properties of food products, i.e. analytical, physical, and colloid chemistry. Implementation of these activities requires more training of the students, and their abilities to have a creative approach to solving this problem. The above indicated could be confirmed by the example of "Determination of acidity of fruit and vegetable juice". The acidity determination is possible in several ways: by visual measurement, acid-base titration and potentiometric titration. The selection of the method depends on the characteristics of the object analysed, objectives of the study, and analysis of the conditions. For example, the acidity determination of the highly coloured juice is impossible by applying the methods of visual measurement and acid-base titration, as these methods are based on fixing indicators of colour changes depending on the acidity of the medium. The best method for these types of juice is to use potentiometric titration. At the same time, for the solutions (juice, beverage, etc.) that do not have an intense colour, the first two methods can be applied, but it requires multiple dilutions, which reduces the colour of the juice analysed but at the same time decreases the accuracy of determination. In the cases where no high accuracy of the results is required, and there is no possibility to use instrumental methods, the use of these methods is sufficiently justified. When performing RIE a student must take into account these nuances.

It should be noted that in addition to these analysis, the experimental part of the work includes preparation of a workplace, cleaning of the required chemical dishes, adjusting the devices and preparing solutions of the required concentration. After the experiment one needs to design a report on the work performed. Often, drawing up a report requires reflecting results of the experiment in the form of tables, graphs, and mathematical calculations. A report is to have a list of references.

The individual work of students while performing the above-indicated forms of the researches allows solving many problems such as:

- Mastering of theoretical material, which due to the limited time was not presented in the lectures
- Training on planning of experiments
- Consolidating the skills in implementing chemical experiments, which are acquired while performing laboratory and practical work (preparation of solutions, weighing, selection of indicators, work with devices, techniques for washing glassware, safety regulations, etc.)
- Learning on how to process mathematical and graphical results of experiments
- Gaining skills in working independently with literature and the Internet
- Learning the rules on making reports and term papers
- Identifying interrelations between disciplines on the example of using the knowledge of mathematics and engineering graphics in the course of mathematical and graphical processing of the results of the experiments
- Justifying for the necessity to study inorganic, organic, analytical, physical and colloid chemistry, and other disciplines for future professional activities.

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Chapter 19
Preparing of Masters of Vocational Education for Conducting Research Activities

Gafurjon Hakimov and Kalybek Dykanaliev

19.1 Introduction

The science is a real advantage for people. (Wolfgang Goethe)

In Kyrgyzstan and Tajikistan, vocational education (VE) is divided into three levels: initial, secondary, and higher. The *initial VE* ensures obtaining a working profession (of the primary qualification) and is implemented in the educational institutions, called vocational schools; the *secondary VE* in the colleges; and *higher VE* in the educational institutions having the status of a university (university, institute, academy).

In order to integrate the system of vocational education into the world educational space, the Kyrgyz Republic and Republic of Tajikistan have switched to a multilevel training system. These universities have already trained Bachelors according to this multilevel educational system, and in the upcoming 2016/2017 academic year, they will move to the second level of training – training of Masters of Vocational Education.

According to the State Educational Standard of Higher Vocational Education (SES HVE), Masters of Vocational Education should be ready to implement the following tasks:

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1. Educational and professional
2. Scientific and research
3. Pedagogical designing
4. Organization and management
5. Production and technological

To accomplish the above tasks, a Master of Vocational Education must have certain competences in the educational standard: universal and professional.

19.2 The Competencies of Masters of Vocational Education

In the context of globalization, a major factor for the successful functioning and training of competitive specialists that meet the requirements of the labour market is the integration into a single educational space.

The colleagues from Central Asian countries, namely, Tajikistan, Kyrgyzstan, and Kazakhstan, have initiated and implemented several educational projects within the framework of the international GIZ project and the regional program "Vocational education in Central Asia", the component "Vocational education – training of teachers of the secondary vocational education" of the *SUCCESS* program (Education and Teacher Network in the PBBZ framework).

According to Alekhina O. F., Gontar V. V., and Lavrenteva V. A. "a qualitative development of the intellectual potential is characterized by the increase of the personal qualifications of each employee's capabilities in the field of research and development work to make the highest quality decisions within his/her competence" (Alekhina et al. 2004, p. 44).

It should be noted that the qualification characteristics and competences of Masters are reflected in the Regulation "On Master's degree programmes", approved by the Municipality of the Republic of Tajikistan as Regulations on baccalaureate, specialist, and Master's degree (Municipality of the Republic of Tajikistan 2007).

19.3 The Competences of Masters, Formed as a Result of Implementation of the Scientific Researches

As a result of the implementation of a scientific research, a graduate student must acquire the following professional competences:

- Present the results of the research, compare, and critically evaluate the generalized results obtained by the domestic and foreign researchers; identify and formulate relevant scientific problems in the selected theme of the industry.
- Justify the timeliness, theoretical, and practical significance of the chosen research topic.

- Conduct independent research in accordance with the program developed.
- Present the results of the study in the form of the thesis, articles, patents for inventions, adoption deed, speaker's paper, or research report.
- Under the direct supervision of the leading scientist in the field, develop training guidelines and work programs of the training courses.

Based on the *goals* and *objectives* of the research project, a graduate student *must know*:

- Specifics of the scientific researches in the chosen field
- General scientific and special methods of researches in the field of the Master's program
- Principles of arranging of the scientific research activities
- Content of the research tools
- Technology of the scientific research activities
- Be able to:

  Formulate the scientific range of problems in the selected field.
  Justify the urgency of the chosen research area.
  Choose the means and methods for solving the problems set in the scientific research.
  Use the methods of the scientific research.
  Justify the conclusion of the research results.
  Have peer review and review of the scientific publications.

- Possess:

  Methods for conducting research in the chosen field
  Methods of analysis and self-assessment and critical approach, contributing to the development of the individual researcher
  Techniques for processing of the empirical data obtained and their interpretation.

19.4 The Structure and Content of the Scientific Research of a Graduate Student

As a result of the research work, a student should get practical skills on how to conduct research activities and to process the findings. The specific practical skills and abilities are defined in the Principal Education Program (PEP) of the higher vocational education. The total number of credits of the PEP for training of Masters makes 120 credits (100%). Thirty credits are allocated for the research-oriented subjects and the research practicum – this is the fourth part of the total number of credits, i.e. 25%.

The level of readiness of Bachelors to the scientific research (SR) is shown in the below diagram (cp. Fig. 19.1). Under the readiness for the scientific research, we

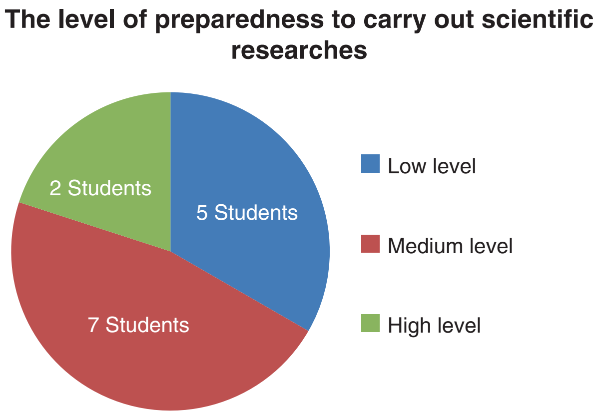

Fig. 19.1 Research activities

understand the successful defence of the graduation thesis (GT). The diagram is made according to the results of defence of the final qualifying papers of Bachelors of Vocational Education. The diagram shows that only a third of graduates are ready to carry out.

Total number of persons completed the training – 14 students (100%), of which:

- Five Bachelor's degree students defended their graduate thesis (GT) and received the grade of "Excellent", which makes 36%.
- Seven Bachelor's degree students defended their graduate thesis (GT) and received the grade of "Good" – 50%.
- Two Bachelor's degree students defended their graduate thesis (GT) and received the grade of "Satisfactory" – 14%.

It should be noted that the scientific-specific subjects and other types of research activities of students in the training programs of Bachelors of Vocational Education make up only 10% of the total number of credits, i.e. 24 credits of the total 240.

Based on the above indicated and on the recommendations of the GIZ program's experts, the total number of credits of the subjects that form the scientific research competence of Masters, increased up to 25%.

In the course of the scientific research activities, the students in the Master's programs use the technology of classical (traditional), student-centred learning, information technology, technology of project, and problem-based learning, adopted in the educational process.

The students in the Master's programs can apply the scientific methods, which include observation, comparison, counting, measurement, experiment, generalization, abstraction, formalization, analysis, and synthesis, induction and deduction, analogy, modelling, idealization, ranking, axiomatic, hypothetical, historical, and system methods (Rahimov 2007, p. 12).

19.5 Provision with the Training and Methodological Package for Conducting Scientific Researchesand Self-Preparation of Master's Thesis

The graduate students must be provided with the following:

- Access to the databases and library stocks in accordance to the full list of subjects (modules) of PEP
- The possibility for the rapid exchange of information with foreign universities, companies, and organizations

As part of the research activity, a Master student shall:

- Plan scientific research activities, including familiarization with the subject of the research in this field of activity, and define methodologies and methods of the research.
- Conduct research.
- Draw up the research report, which includes scientific publications on the topic of research, abstracts about the results of the work, research reports, adoption deed, and patents for inventions.
- Make self-assessment of the activities performed during the period of research.

19.6 Forms of Midpoint and Final Assessment Following the Results of the Scientific Researches

The form of the midpoint and final assessment of the scientific researches of the graduate students is an attestation of the results for the whole period of implementation of the research work in the Department (where a student studies) to be held by a special commission with the participation of a research supervisor of Master's thesis.

First, a graduate student defends his/her Master's thesis in front of the Department Commission. After getting the conclusion of the Department, he/she is allowed to defend the thesis at the meeting of the State Attestation Commission.

Assessment criteria:

- The level of performing experimental and research programs, the degree of independence, quality of the data processing, and their interpretation considering the development of the research activities of the graduate student.
- The degree of psychological readiness of the graduate student to work in the modern conditions, his/her understanding of the goals and challenges of the modern specialist in the chosen field of industry.
- The level of development of didactic skills, methodological, and technical training to conduct scientific research in modern conditions.

- Assessment of the ability to plan and to predict the results of his/her activities, to consider the real possibilities and reserves.
- Assessment of the activity of work of the graduate student to improve his/her professional level, the search for effective methods and technologies in conducting researches.
- The degree of development of personal qualities of the graduate student (the culture of communication, the level of intellectual, and moral development and others).
- After each year of education in the Master's degree program and based on the results of the research performed, the graduate student submits for publication the following: theses, articles, reports, or scientific report, as well as prepares presentations for the scientific and scientific-practical seminars, conferences, and forums in order to develop his/her rhetorical abilities.

19.7 Conclusions and Further Perspectives of the Researches

Currently, three persons are enrolled in the Master's program of KSTU named after I. Razzakov. The university tests the program for training of Masters of Vocational Education, elaborated jointly with the experts of the GIZ project, which is totally new to Tajikistan and Kyrgyzstan.

The PEP Regulation allows introducing changes in the program for up to 15% of the total list of subjects.

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Chapter 20
Research Training for Doctoral Candidates in the Field of Education and Technology

Thomas Köhler

20.1 Introduction

The doctoral program "Education & Technology" (E&T) is the result of previous efforts to internationalize and structure the doctoral dissertation with the aim of improving the scientific quality, the international scientific competitiveness, and also the individual feasibility of doctoral projects in education and media technology studies in a generalized way. Intensive international exchange programs and target agreements at the Technical University Dresden were established to support the E&T program and the curriculum development project necessary to initiate the program. The goal was to develop institutional structures to support doctoral candidates and to contrive a sustainable solution.

These activities have been utilizing common and local project funding synergistically and were supported by partnering institutions, so as to enable an effective contribution to the long-term stable, and thus sustainable, development of the doctoral program. The main activities of the partners within E&T are:

1. The development of an international curriculum for the doctoral students, coordinated by the three doctorate-granting core universities and possibly other partners, thereby offering Web 2.0 methods for cooperation within the international peer group, supplementing the existing E-Learning content and applications
2. To hold an annual summer school, usually lasting 10–14 days, which alternately takes place at the participating university and specialist or teacher training colleges
3. The facilitation of international practice phases for doctoral students at a research institution involved in the network

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4. The development of internationally structured and focused doctoral regulations with the possibility of two doctorate-awarding universities granting joint international degrees in the form of a co-Tutelle
5. The development of mechanisms for marketing, recruitment, and staff development, the promotion of qualified selection mechanisms to assure the selection of suitable candidates, and effective career development
6. To develop and implement an independent scientific evaluation of E&T.

The following figure illustrates the interaction between the participant-related elements in their originally planned configuration (Fig. 20.1):

An extensive, although with regard to local services from partner institutions not complete, overview of the activities and services for doctoral students can be found on both the doctoral training network[1] website and the TU Dresden Faculty of Education website.[2] Here, it is evident that the activities have evolved from the original project into a specified curricular structure in order to ideally serve the needs of the dissertation phase and the respective audience, with this process resulting in the structured doctoral program.

20.2 Challenges for Research on Teaching-Learning Technologies Between Specialized Scientific Justification and Transdisciplinary Project Orientation

20.2.1 Initial Situation and Problems

In 2008, the Media Centre of the TU Dresden was founded to meet the supply and service tasks of facilitating the development and introduction of information and communications technology in teaching, study, training, and research at the TU Dresden.[3] The center was preceded by two parallel existing precursor institutions, the solely service-oriented Audio-visual Media Centre and the strongly research-oriented Media Design Centre. With this background, the new Media Centre has evolved from a basic working and research site to a hub supporting young scientists in the field of “Education & Technology”.

The research topics include E-Learning, knowledge organization, multimedia applications, an introduction into multimedia teaching, and learning opportunities for education and training at the TU Dresden. All faculties and institutions of the TU Dresden cooperated in creating this endeavour, and suitable policies for staff and organizational management were established to support the institutional integration of these technologies throughout the entire university.

[1] cf. http://www.edu-tech.eu [December 30, 2017].

[2] cf. http://www.tu-dresden.de/ew/doc [December 30, 2017].

[3] cf. http://tu-dresden.de/mz [December 30, 2017].

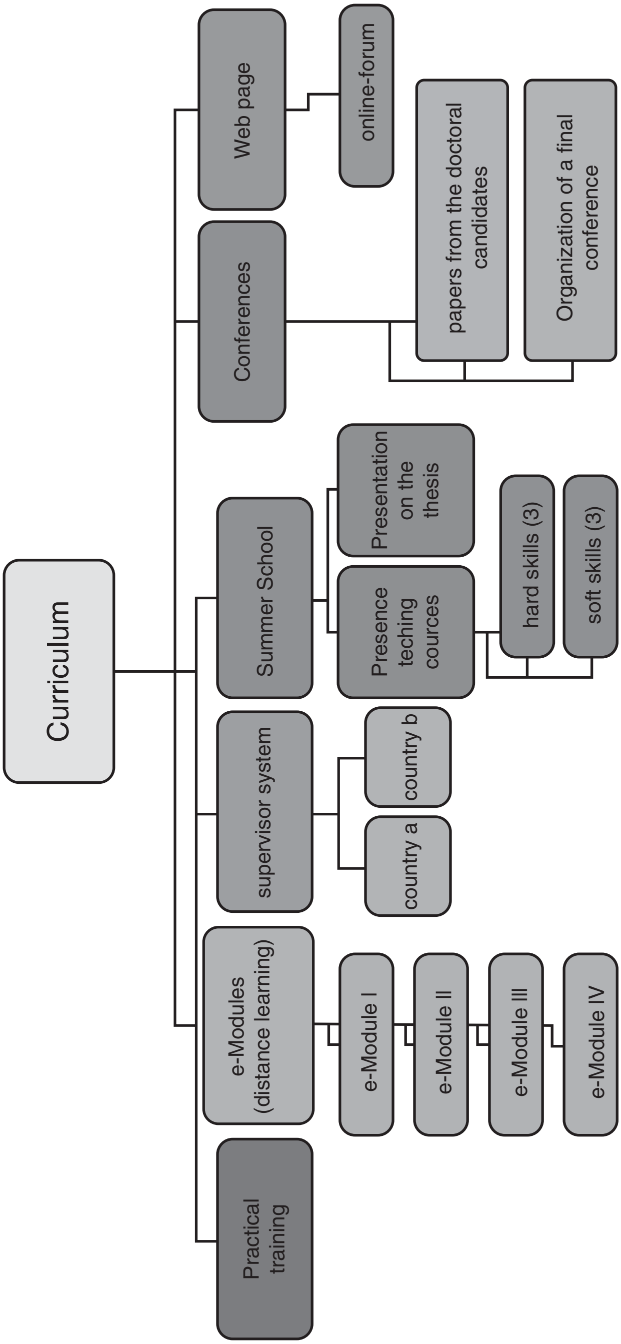

Fig. 20.1 Main components of Education and Technology

Most current research projects dealing with the development of practice follow an interdisciplinary approach. National and international comparison reveals that this development is not unusual – indeed a number of particularly larger colleges follow a similar approach, trying to bridge the gap between research and service. Although not always focused on the media domain, German examples include the Media Centre of the University of Leipzig, studium.digitale at the University of Frankfurt/Main, and the University Didactic Center Dortmund. International comparisons include the LISEC at the University of Strasbourg and Intermedia at the University of Bergen – which also illustrates a trend toward commercialization of (research) services, similar to the spin-off of Education Sachsen Enterprise owned by the public universities in Saxony.

As a central scientific institution, the new institute "Media Center" does not have permission to award doctorates; however, it employs a large number of young scientists from various disciplines. In order to use the scientific profile and to generate a sufficient level of innovation, it was and is necessary to offer qualification opportunities for young scientists. At the Media Center, the young scientists are normally employed in one or more of the many research and development projects on a third-party funding basis. The researcher's qualifications span several disciplines of educational, social, media, and possibly economic science, teaching, computer science, and other areas, creating a multitude of individually unique cases. Additionally, intensive, often project-related, reasons lead to university-wide and international cooperation with a lively exchange and research and transfer partners at home and abroad.

More so than many academic domains, research on online learning requires multidisciplinary teams, typically consisting of scientists from pedagogy, media informatics, and other application domains. Specialists from other disciplines complement these fields, forming a heterogeneous mosaic of various qualification backgrounds with great variation in terms of knowledge, research methodology, and localization of the scientific domain. This problem has itself been the subject of research (Reitmaier 2011). Although there are now interdisciplinary courses teaching education or university didactics (e.g., the Master of Higher Education at the University of Hamburg[4]), not all doctoral students have access to sufficient theoretical resources.

To make matters worse, gaining access to doctoral programs at many schools is impossible without relevant pre-qualification in a certain domain, for example, a diploma in computer science or a master in education – even if the candidate has been scientifically active for several years and was even able to submit international publications. Another potential for conflict lies in defining the list of accepted scientific approaches, since the interdisciplinary perspective in the participating sciences typically advertises positions on the edge of the discipline rather strongly and provocatively.

Sometimes, the interdisciplinary approach also experiences lower acceptance and is considered inferior research. This is not a new development, as shown when, for example, in the natural sciences the position of special didactics is weakened

[4] https://www.hul.uni-hamburg.de/studium/mohe.html [December 30, 2017].

when professorships are replaced by employment for academic lecturers (cf. University of Potsdam) or when several independent methodology chairs are merged into one so-called area of didactics (cf. TU Dresden). Their innovation potential is often underestimated by the so-called basic science disciplines, prevalent in their hesitation to transfer the respective special didactic chairs from the science department to the education department (cf. TU Dresden).

20.2.2 Disciplinary Research Approaches and Curricula of Participating Chairs and Professors

How can solutions to this range of problems appropriately address both the need for the creation of a scientific profile of a multidisciplinary field and the challenges provided by the theory-practice transfer? A first requirement is the adequate training of young scientists in the respective non-university subject areas – without requiring an additional second or third academic degree. For this purpose, between 2006 and 2008, an international and interdisciplinary team of scientists developed four thematic modules as part of a project funded by the Erasmus Curriculum Development plan for the training of doctoral candidates. Since their creation, these modules have been available for use in summer schools and for individual E-Learning[5]. The four selected modules deal with findings from the fields of media didactics, cultural studies, media education, and business computer science, for the essential theory approaches on an introductory level, written in English (see Köhler and Misoch 2008; Köhler 2013):

1. Didactics (technology and organization) of collaborative learning (first author: Prof. Dr. Thomas Köhler, TU Dresden)
2. Social and Cultural Implications of New Media and ICT (first author: Prof. Dr. Daniel Apollon, University of Bergen)
3. Pedagogic Design of Media and Technologies (first author: Prof. Dr. Pascal Marquet, ULP Strasbourg)
4. Information Systems and Knowledge Management within Virtual Environments (first author: Dr. Maciej Piotrowski, UITM Rzeszów)

In 2014, authors were able to apply for funding of the European Social Fund Sachsen under the "e-Science Research Network Saxony" to add a fifth module covering research methodology of digital and open sciences:

5. E-Science and Digital Research Methodology (first author: Prof. Dr. Thomas Köhler, TU Dresden).

Another key element in the structured international doctoral program "E&T" is the annual summer school with about 25–35 PhD students and 5–10 teachers. These summer schools have been conducted since 2008 and, in addition to professional scientific research, always contain methodical and sociocultural activities. The sum-

[5] www.edu-tech.eu.

mer school was first funded as a so-called intensive program by DAAD 2008–2010 and OEAD 2012–2014. In 2013, support from the European Social Funds was obtained. The Franco-German University was funding a project for the implementation of a conference for doctoral students in 2014, supplemented by a bilateral Erasmus cooperation. In 2015, only funds from the national German Research Excellence Program could be applied, and in 2016 the financial basis was provided mainly by institutional funds before in 2017 the summer school was organized at the University of Yogjakarta as a joint measure with the DAAD-supported TVET alumni network meeting. This 10th anniversary summer school did therefore for the first time take place outside Europe what was a great success in both scholarly outreach and academic travel logistics. In most cases, local sponsors were also addressed successfully in order to support individual activities from each very extensive program. A detailed overview of the current activities at all summer schools is located at www.edu-tech.eu. For each of the summer schools, a special thematic focus was defined, including "Digital Culture", "E-Learning meets eScience", or "Education Research & IC Technology".

20.3 Administrative Arrangements and Developmental Needs

20.3.1 Status of Doctoral and Authorization Procedure

Graduating students can have the status of either external research assistant or doctoral student, depending on the shape and place of employment. Enrolment takes place, if desired or necessary, regardless of the recording on the list of doctoral candidates. The TU Dresden now has the option to admit scholars who do not meet the domain specific educational requirements, a policy created to regulate admission to doctoral studies in accordance with the doctoral regulations. Basic requirements for acceptance upon application to the dean are (a) the acceptance by a professor of the department, (b) a relevant specialist qualification on Master level or equivalent degree, and (c) an exposé about the research topic comprehending theoretical, methodical and project management considerations, which allows a selection decision by the deans doctoral committee.

The selection procedure developed in the context of E&T goes beyond the previous practice. This process must especially be followed in the selection of candidates in an international context, since the international field of educational science is not very standardized and as well influenced strongly by the varying approaches of individual university professors. Due to that any innovated process must also be guided by the provisions of the often renewed doctoral regulations, which also allow admission with a B.A. degree in exceptional cases, after a trial year.

One option would be the introduction of a unified selection process for all doctoral candidates, an approach followed in France. The preparation of Erasmus Mundus doctoral students at the TU Dresden is standardized and organized similarly.

Structuring the selection process of all doctoral students in a unified way would allow using previously established processes. The establishment of such a selection process requires considerable work and effort, since the selection method must be able to identify needed skills in doctoral students. Additionally, supportive feedback must be provided to those candidates not chosen for the program, enabling them to enhance their skills and consequently their future chances. The feedback should take into account the candidate's previous academic qualifications as well as the quality of the research program and in particular the scientific capacity of the prospective doctoral students.

20.3.2 Existing Doctoral Regulations and the Need for Amendment

Since 2006, the Faculty of Education at the TU Dresden has tried to improve conditions for doctoral dissertation in the interdisciplinary field of Education and Technology. With the reedition of university law by the end of 2008, a crucial framework was established in order to renew the existing doctoral regulations of 1995. This renewal required extensive discussion in the education department's council as well as a legal review. The main innovations took place in 2011 with the introduction of a paragraph on the joint international doctoral degree, the so-called co-Tutelle. It was accompanied by the implementation of a joint, bilingual doctoral certificate and also includes, if necessary, the reference to a structured form of doctoral training to be provided by coursework in the doctoral phase and the recognition of requirements completed under different technical conditions for the doctoral promotion.

The co-Tutelle was first implemented with the University of Bergen (2013), the University of Strasbourg (2015), and the University of Yogyakarta (2016). After adopting the renewed doctoral regulations at TU Dresden's Department of Education, the university partners in Strasbourg, Bergen, and Yogyakarta were tested for adaptation needs, so that the standardized implementation of binational doctoral dissertations was enabled in these locations as well. For all partnering institutes the TU Dresden's model is used as a template.

20.3.3 Measures to Comply with the Regular Period of Completing the Dissertation

Doctoral studies in the structured program E&T realistically require a period of 2.5 to 4.5 years, as shown by an unpublished analysis of about 25 degrees carried out by the Examination Office at the TU Dresden. This period is significantly shorter than the average graduation time, which in Germany is 4.5 years (Jaksztat et al. 2012).

Effective measures have to ensure the sustainable operations of the program by (1) evaluating the transparency of the doctoral program's structure in empirical studies, (2) providing a steady exchange within the peer group of doctoral students and their supervisors, and (3) supporting and guiding the increasing internationalization of the research context (Burkhardt 2008; Jaksztat et al. 2011, ibid. 2012). These three aspects require appropriate contact information and tools for cooperation and communication (Mohamed and Köhler 2010). Important elements of the structured program E&T include colloquiums, first carried out biweekly and since 2013 weekly during each semester, the summer school, the E-Learning platform with a videoconferencing solution for location-independent participation in the colloquium, a community function, domain-specific self-learning modules, and regular individual consultation appointments with the doctoral supervisor (Köhler et al. 2011).

Due to the large number of doctoral candidates with a background in social science, transferring service activities from supervisors to the community of doctoral students can promote quality and ensure consistency regarding the rejection of so-called individual doctorates (cf. Borgwardt 2012). Besides quality assurance of PhD projects, improved cooperation between doctoral students in the research context is of major importance. This cooperation must extend beyond the Anglo-Saxon model of extensive curricular shares (classes), as research has demonstrated the great importance of scholarly and research cooperation for research quality and motivation of doctoral students (Wissenschaftsrat 2011).

This cooperation may also mobilize additional resources prevalent within the peer group (Mohamed and Köhler 2010, ibid. 2011), such as access to the working results of other doctoral students, which may be accessible before their official publication without the fear of abuse of interim results. In E&T, this is applicable by the synopses of all projects planned which is made visible for doctoral students in the online platform, as well as interim results from the preprint stage and even elements from the consultations with the doctoral supervisor. This approach allows a qualified discussion of papers to be published within the group of doctoral students.

20.4 Outlook: Sustainability, Innovativeness and Dissemination

The sustainability of the structured doctoral program E&T was ensured by the abovementioned universities having incorporated the elements of a joint doctoral training into their doctoral or study rules. An important step toward securing this element structurally is achieved by strictly implementing local promotion regulations. Secondly, these international offers were designed in a way to be compatible with local regulations.[6] The abolishment of additional tuition fees in Europe and the

[6] For an example, please refer to the respective website of TU Dresden's Dept. of Education: http://tu-dresden.de/ew/idoc [December 30, 2017].

possibility of free access in accordance with the Erasmus Charter are essential characteristics of the doctoral program as well.

The network may be extended to include additional universities. Already at this stage, partners in non-European countries have expressed their desire to join the network. However, the shorttime inclusion of international prospects is currently not planned due to limited capacities. Once appropriate resources have completed the network in its current configuration, the integration of more partner institutions is planned. Additionally, analyses were performed evaluating the possibilities of using other instruments of the Erasmus program for specific target groups, such as the faculty members. This strategy has been successfully practiced by various partners as well as the Erasmus Mundus worldwide cooperation. The Department of Vocational Education at the coordinating university (TU Dresden) and national programs of non-European partners have successfully provided international teaching resources, providing the foundation for the network's extension beyond European borders. Targeted regions are mainly Central Asia, Southeast Asia, and China.

This concept is innovative in several respects: first, in terms of the joint development of a curriculum supported by various European universities. One distinct aspect is the active participation of Fachhochschulen, i.e. Universities of Applied Sciences which ususally do not have the permission of awarding a doctorate, in the network. They are involved in the Bologna phase III trials (postgraduate and doctoral studies), resulting in an expansion of the area of higher education.

Second, the concept includes innovative assistance for doctoral candidates, which, in the case of the co-Tutelle, provides two mentors from different partner universities and thus different (European) states. This initiates the internationalization of doctoral supervision and improves the quality of care.

Finally, scientific conferences serve as part of the summer schools to present the network and its scientific output to the outside academic world, representing an important opportunity for international exchange. They enable other academic institutions and universities researching the field of education, media, and technology to learn about the research of young scientists involved in the E&T and to meet them in person.

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Annex

Potential of the Task-Based Learning for the Sustainable Development of Food Technology

Test Recipes[1]

Ingredients

Flour/shreds according to type indication	1000 g (T 550)	100%
Baker's yeast	60 g	6%
Table salt	20 g	2%
Baking agents (see experimental factor)	....g	....%
Water (see below)	....g	....%
Fat (butter)	20 g	2%
Sugar	....g	....%

Framework conditions/material parameters

Room temperature	20 °C
Temperature of flour	....°C
Desired temperature of dough	28 °C
Temperature of liquid to be added	36 °C

[1] According to Horlacher, F. (2015), unpublished lecture notes.

J. Drummer et al. (eds.), *Vocational Teacher Education in Central Asia*, Technical and Vocational Education and Training: Issues, Concerns and Prospects 28, https://doi.org/10.1007/978-3-319-73093-6

Process parameters

Kneading time	Mixing phase: strokes, 80....
	Kneading phase: strokes, 920....
Dough fermentation phase	10 min
Bulk fermentation	30 min
Baking	35 min

Apparatus: spiral kneader

Process- and result-oriented documentation of data

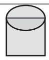
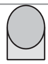
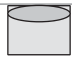
Trial number	1	2	3
Experimental factor (precise description)	*0-trial* comparative sample	2% *baking agent* – emulsifying baking agent (diacetyl tartaric acid)	5% *baking agent* – enzymatically active malt baking agent
Amount of water used for preparation of dough	580 ml	620 ml	620 ml
Dough			
Dough weight calculated	1680 g	1740 g	1770 g
Dough weight yielded	1660 g	1720 g	1750 g
Dough consistency after kneading	Firm, slightly moist, slightly sticky	Firm, drier than **1**	Very soft, viscous, and very sticky
Dough resting time			
Dough temperature reached	28 °C	28 °C	27 °C
Dough resting time	10 min	10 min	10 min
Dough deposit (unit weight)	415 g	430 g	435 g
Unit fermentation			
Unit fermentation	30 min	30 min	30 min
Baking			
Baking time	35 min	35 min	35 min
Particular observations or variances/differences			

Evaluation of data on ....

Basics

Theoretical yield of dough: $\frac{(\text{flour} + \text{water}) \times 100}{\text{flour}}$	Practical yield of dough:	$\frac{(\text{flour} + \text{water} + \text{all ingredients}) \times 100}{\text{flour}}$
Baking loss (BV): dough weight (TE) – wheat product weight (GG)	Baking loss in %:	$\frac{(\text{dough weight} - \text{wheat product weight}) \times 100}{\text{dough weight}}$
Yield of wheat product (GA): $\frac{\text{wheat product weight} \times 100}{\text{amount of flour per wheat product}}$	Volume yield:	$\frac{\text{volume of wheat product} \times 100}{\text{amount of flour per wheat product}}$

Calculations and evaluations regarding the wheat product

Trial number	1	2	3
Amount of flour used per wheat product	250 g	250 g	250 g
Wheat product weight per unit	360 g	360 g	386 g
Baking loss	....%	....%	....%
Yield of wheat product	....%	....%	....%
Volume of wheat product per unit	1150 ml	1400 ml	800 ml
Volume yield			
Shape, appearance			
Browning and crust	Light, firm, normal browning and crust	Dark in the upper section, otherwise smooth and light like **1**	Dark crust, burst-open bubbles
Fluffiness and crumb appearance	Normal pores, evenly distributed	Very light, very fluffy, very fine pore structure	Density, firm pores
Crumb structure	Normal, does not crumble	Very smooth, fluffy, very soft	Slightly agglomerating, nonelastic crumb (press of the thumb remains visible)
Smell and taste	Normal, pleasant, typical	Poor in aroma, slightly yeasty	Off flavours, slightly sweet
Comments			

The Achievement Test (English Version)

Test Instructions

Dear student, read the following instructions carefully:

- This test consists of 60 multiple questions. Each question has four possible answers (A, B, C, and D). You must choose the correct or best answer.
- Calculator is recommended during this test.
- Use an HP pencil to mark in the answer sheet.
- Read each question carefully.
- Try to answer every question.
- Use the answer sheet to answer the test questions.

Example

This test is for the subject of:

(A) Automatic control
(B) Mechanical engineering
(C) Electrical engineering
(D) Drawing engineering

Answer Sheet

Ⓐ Ⓑ ● Ⓓ

- Locate the question number on the separate answer sheet provided, and fill in the circle that corresponds to your choice.
- Now turn this page and answer the questions.

1. An electric machine is used to convert the kinetic energy to the electrical energy in the presence of magnetic field:

   (A) Generator
   (B) Transformer
   (C) Motor
   (D) Battery

2. The uppermost value for the alternating current through a complete cycle is the:

   (A) Average value
   (B) Maximum value
   (C) Instantaneous value
   (D) Root-mean-square value

3. If the maximum value of AC is $10\sqrt{2}$ Ampere, the root-mean-square value of AC will be equal to:

   (A) $\sqrt{2}$ A
   (B) 5 A
   (C) $15\sqrt{2}$ A
   (D) 10 A

4. EMF generated between the poles of an electrical generator is equal to half of its maximum value when the angle of turning the coil is:

   (A) 30°
   (B) 45°
   (C) 60°
   (D) 75°

5. The value of EMF depends on the following factors *except one*:

   (A) Number of turns of coil
   (B) Strength of magnetic field
   (C) Speed of turning coil
   (D) Generator pole type

6. Two wave forms of sine will have the same phase angle if:

   (A) $\Phi_1 - \Phi_2 = 0$
   (B) $\Phi_1 - \Phi_2 < 0$
   (C) $\Phi_1 - \Phi_2 \neq 0$
   (D) $\Phi_1 - \Phi_2 > 0$

7. The value of an alternating voltage is the equivalent DC voltage that can deliver the same amount of energy to a resistor as the AC does over a cycle:

   (A) Maximum value
   (B) Root-mean-square value
   (C) Average value
   (D) Instantaneous value

8. The unit of the electrical frequency is:

   (A) Ampere (A)
   (B) Volt (V)
   (C) Watt (W)
   (D) Hertz (Hz)

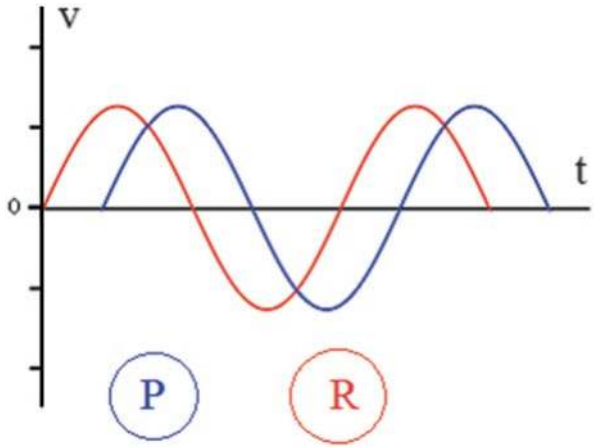
9. If the value of maximum voltage is 100 V, the average voltage value will be equal to:

   (A) 75.3 volt
   (B) 63.7 volt
   (C) 40.3 volt
   (D) 25.7 volt

10. If a device is connected for measuring the current in AC circuit, the reading of this device will be indicated to:

   (A) Current instantaneous value
   (B) Current average value
   (C) Current RMS value
   (D) Current maximum value

11. In the wave form represented below, it could be inferred that:



(A) The wave form P leads the wave form R.
(B) The wave forms R and P have the same phase angle.
(C) P and R wave forms are mirror image of each other.
(D) The wave form R leads wave form P.

12. The form factor of an alternating current is:

(A) Multiplication of the maximum value in the RMS value
(B) The ratio of the RMS value to the average value
(C) Multiplication of the instantaneous value in the RMS value
(D) The ratio of the maximum value to the RMS value

13. An AC voltage is described mathematically by the equation:

(A) $e = E_{max} \sin(\omega + t)$
(B) $e = E_{max} \cos(\omega t)$
(C) $e = E_{max} \sin(\omega t)$
(D) $e = E_{max} \tan(\theta)$

14. The value of EMF in a generator will be equal to zero when the level of coil is:

(A) Making 60° with magnetic field lines
(B) Perpendicular on the magnetic field lines
(C) Making 45° with magnetic field lines
(D) Parallel with magnetic field lines

15. An AC circuit consists of only a capacitor. What is the relationship between current and voltage?
    (A) Current and voltage are in the same phase.
    (B) Current leads voltage.
    (C) Voltage leads current.
    (D) Voltage is a mirror image for current.

16. The unit of the inductive reactance is:
    (A) Farad
    (B) Joule
    (C) Henry
    (D) Tesla

17. An AC circuit contains of a resistance only. If the frequency is increased in the circuit, the resistance value would be:
    (A) Increased also
    (B) Decreased
    (C) Not changed
    (D) Multiplied

18. In an AC circuit including a resistance only, the phase angle between current and voltage is equal to:
    (A) 0 degree
    (B) 45 degree
    (C) 60 degree
    (D) 90 degree

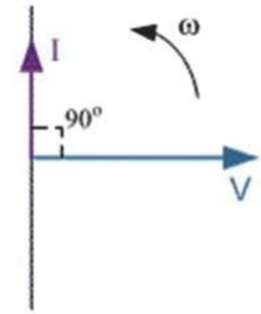
19. The value of inductive reactance of the coil depends on:
    (A) Frequency and inductance values of the coil
    (B) Inductance and capacitive values of the coil
    (C) Capacitive value of the coil and frequency value
    (D) Number of turns and capacitive value of the coil

20. In the diagram below, what is the current value in this circuit?

    (A) 2 A
    (B) 0.5 A

(C) 15 A
(D) 5 A

21. The diagram below introduces the angle between voltage and current in an AC circuit which contains:

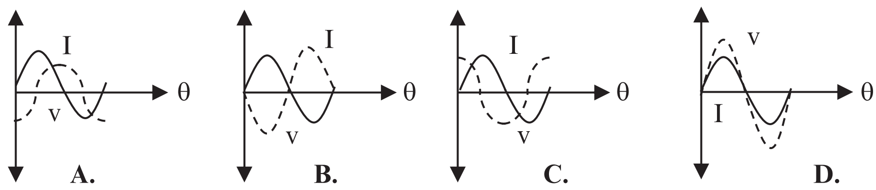


(A) Resistor
(B) Inductor
(C) Transformer
(D) Capacitor

22. When the source frequency increases in an AC circuit, the current value will decrease because the circuit includes:

(A) Resistor
(B) Inductor
(C) Capacitor
(D) Transformer

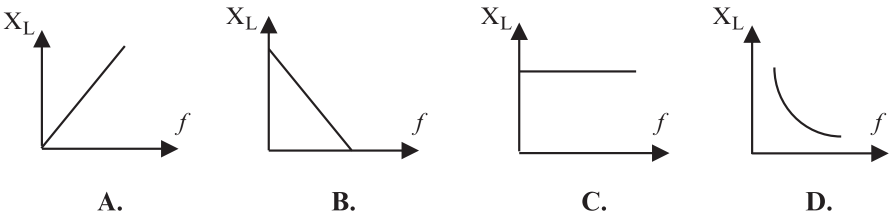
23. One of the following graphs represents the voltage change (V) and the current (I) in a resistive circuit. Which one is it?



24. Terminals of a coil connect to a car battery. In that case, the total resistance of such coil will be equal to:

(A) (R) only
(B) R + (Lω)
(C) (Lω) only
(D) R + 2 Lω

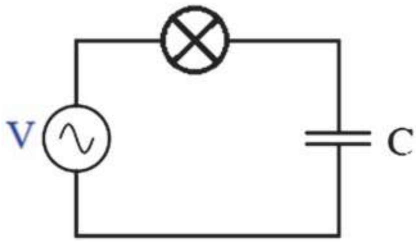
25. An inductor is connected with an AC source. If we increase the frequency from zero gradually, the changes in the inductive reactance are represented by the graph:



26. An inductor with an iron core is connected with an AC source. When the iron core is withdrawn from the coil, what can happen to the current and frequency?

(A) Frequency fixed and current decreased.
(B) Frequency increased and current increased also.
(C) Frequency decreased and current decreased also.
(D) Frequency fixed and current increased.

27. In the circuit shown below, when the distance between capacitor conductors increases, the lighting of the lamp will:



(A) Increase also
(B) Disappear
(C) Decrease
(D) Not change

28. In the case of connecting two electrical elements in series with an AC source, the total current is equal to the current value in:

(A) First element = current value in the second element
(B) Second element + current value in the first element
(C) First element ÷ current value in the second element
(D) Second element × current value in the first element

29. A pure inductor is connected series with an AC source. If this inductor is replaced by a capacitor, the current flow in the circuit will:

(A) Increase
(B) Multiply
(C) Decrease
(D) Not change

30. An AC series circuit consists of resistance 3 Ω and inductive reactance 4 Ω. The impedance will be equal to:

(A) 1 ohm
(B) 5 ohm
(C) 7 ohm
(D) 12 ohm

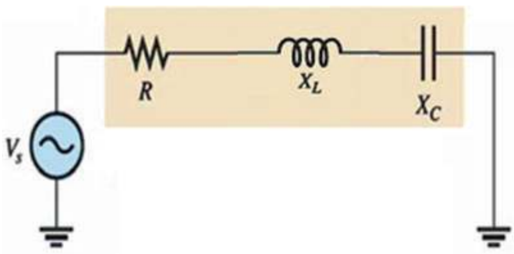
31. When resistors and inductors are connected together in series circuits, the circuit total current will have a phase angle somewhere between:

(A) 0° and positive 90°
(B) 90° and negative 120°
(C) 0° and negative 90°
(D) 90° and positive 120°

32. An AC series circuit consists of resistor and capacitor. If the voltage drop on each element is equal to 4 V, the total voltage drop in the circuit will be equal to:

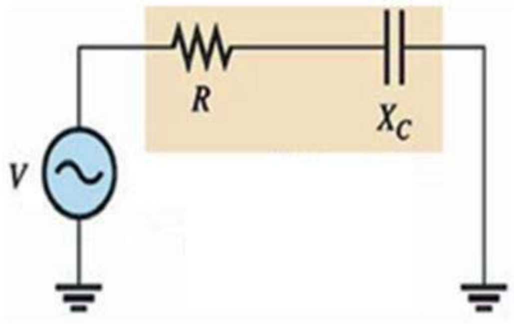
(A) 1 volt
(B) 4 volt
(C) 8 volt
(D) 16 volt

33. In the diagram shown below, the resistance is 6 Ω, inductive reactance 24 Ω, and capacitive reactance 16 Ω. If the AC source is replaced by the DC source, the total resistance will be equal to:



(A) Indefinitely
(B) 10 ohm
(C) 0 ohm
(D) 6 ohm

34. In the circuit diagram shown below, the capacitive reactance is 6 Ω, resistance is 5 Ω, and current source is 2 A. The reactive power in this circuit is:



(A) 24 V/A/R
(B) 20 V/A/R
(C) 18 V/A/R
(D) 15 V/A/R

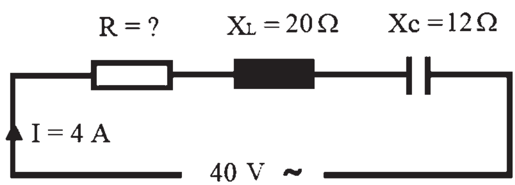
35. In RLC series circuits, when the capacitive reactance is greater than the inductive reactance, it can be concluded that the circuit is:

(A) Inductive and the phase angle negative
(B) Capacitive and the phase angle negative
(C) Inductive and the phase angle positive
(D) Capacitive and phase angle positive

36. In RLC circuits, the true power is in the greatest value when the inductive reactance is:

(A) Less than capacitive reactance value.
(B) Greater than capacitive reactance value.
(C) Equal to capacitive reactance value.
(D) Inductive reactance doesn't affect it.

37. In the circuit diagram introduced below, what is the value of the resistance R?

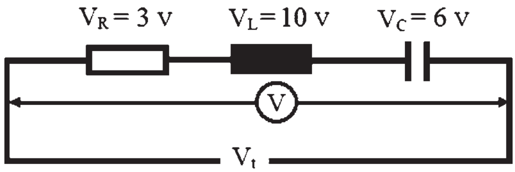


(A) 32
(B) 10
(C) 8
(D) 6

38. Based on the power triangle in AC series circuits, when the phase angle decreases, the true power is:

(A) Multiplied
(B) Decreased
(C) Increased
(D) Not affected

39. Inductor, resistor, and capacitor are connected in series with an AC source as shown in the diagram. The voltmeter will read:



(A) 19 volt
(B) 12 volt
(C) 5 volt
(D) 3 volt

40. The current and voltage will have the same phase angle in a parallel RLC circuit when:

(A) XC = XL
(B) $R + X_C + X_L = 0$
(C) $R = X_L$
(D) $R = X_C$

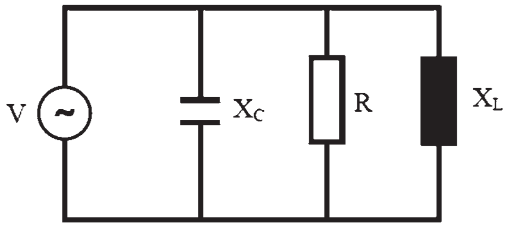
41. Two resistors are connected together in parallel with an AC source. The value of total voltage will be equal to:

(A) Half drop voltage on the first resistor
(B) Multiply drop voltage on the second resistor
(C) Drop voltage on the first resistor
(D) Half drop voltage on the second resistor

42. Inductor and resistor are connected in parallel with an AC source. The value of the total current:

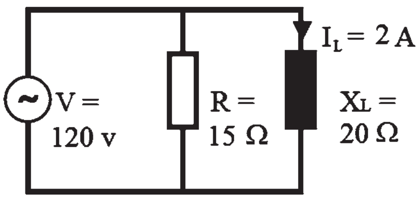
(A) Lags to voltage by angle Φ
(B) Lags to voltage by angle 2 Φ
(C) Leads to voltage by angle Φ
(D) Leads to voltage by angle 2 Φ

43. In the circuit diagram shown below, if the capacitive reactance is less than the inductive reactance, the voltage drop in this circuit would be:



(A) Lead the current phase angle
(B) Lag the current phase angle
(C) Equal to the current phase angle
(D) Mirror the current phase angle

44. In the circuit diagram shown below, the resistor and the inductor are connected in parallel. The value of the reactive power in this circuit is:



(A) 40 V/A/R
(B) 60 V/A/R
(C) 120 V/A/R
(D) 240 V/A/R

45. From triangle power in a parallel AC circuit, when the cosine angle is the greatest value, it can be concluded that:

(A) True power is equal to apparent power.
(B) Reactive power is equal to apparent power.
(C) True power is equivalent to total power.
(D) True power is equal to reactive power.

46. An AC parallel circuit consists of resistor and capacitor. The current in the resistance is 3 A and the current in capacitance is 4 A. The total current will be equal to:

(A) 1 Ampere
(B) 5 Ampere
(C) 7 Ampere
(D) 12 Ampere

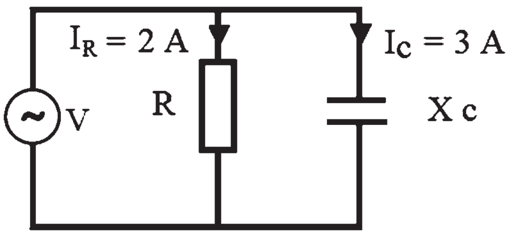
47. Resistor and capacitor are connected in parallel with an AC source. The power factor is 0.5 and the true power is 40 W. So, the apparent power in this circuit is:

(A) 100 V/A
(B) 80 V/A
(C) 40.5 V/A
(D) 20 V/A

48. An AC circuit consists of resistance and capacitor. The voltage lags to current by angle 45°. It can be concluded that:

(A) $X_C < R$
(B) $X_C = R$
(C) $X_C > R$
(D) $X_C = 2R$

49. In the circuit diagram represented below, the resistance is 6 Ω. So, the real power in this circuit is:

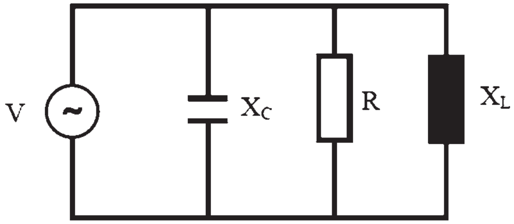


(A) 8 Watt
(B) 11 Watt
(C) 18 Watt
(D) 24 Watt

50. In a RLC parallel circuit, the total current is 2 Ampere and the power factor is 0.5. The current flow in the resistor is:

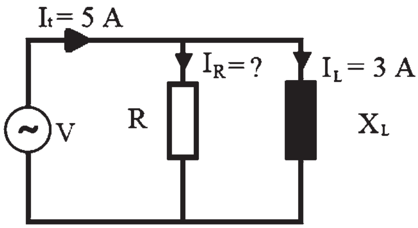
(A) 1 Ampere
(B) 1.5 Ampere
(C) 2.5 Ampere
(D) 4 Ampere

51. In the diagram shown below, the current flow in the resistance is 4 Ampere, the inductance is 2 Ampere, and the capacitance is 5 Ampere. The total current is:



(A) 1 Ampere
(B) 2 Ampere
(C) 4 Ampere
(D) 5 Ampere

52. In the circuit diagram shown below, the current flow in the resistor R is:



(A) 15 Ampere
(B) 8 Ampere
(C) 6 Ampere
(D) 4 Ampere

53. The resonance frequency in series case is the frequency that happened when the current is:

(A) Minimum value
(B) Equal to zero
(C) Maximum value
(D) Direct

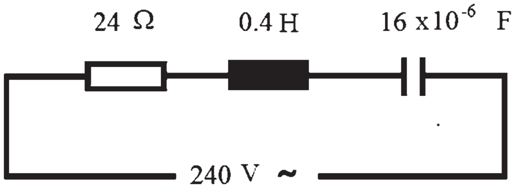
54. In a resonance case, the circuit impedance Z is equal to:

(A) Current I
(B) Resistance R
(C) Inductive reactance XL
(D) Capacitive reactance XC

55. A resonance circuit contains a capacitor 4 μf. If we want to increase the frequency to twice its value, we must replace the capacitor by another equal to:

(A) 1 μf
(B) 2 μf
(C) 8 μf
(D) 16 μf

56. The circuit diagram shown below is a resonant circuit. The total current in this circuit is:

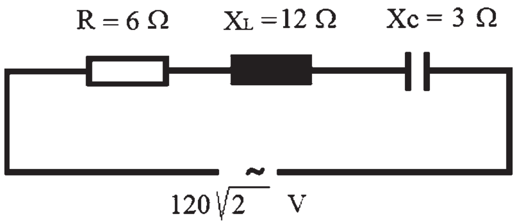


(A) 6 Ampere
(B) 10 Ampere
(C) 15 Ampere
(D) 30 Ampere

57. A resonant circuit consists of capacitor and inductor. If we put insulation between the capacitor conductors, the circuit resistance will:

(A) Decrease and current increase
(B) Increase and current also
(C) Decrease and current also
(D) Increase and current decrease

58. The circuit diagram shown below is a resonant circuit. The total current in this circuit is:



(A) $10\sqrt{2}$
(B) 20
(C) $20\sqrt{2}$
(D) $40\sqrt{2}$

59. The amplifier quantity in parallel resonant circuit is:

(A) Impedance
(B) Voltage
(C) Current
(D) Resistor

60. A resonance circuit consists of inductor and capacitor. The reactive power is:

(A) Equal to true power
(B) Minimum value
(C) Equal to zero
(D) Maximum value

End of the Test

Answer Sheet

Name: ……………………………………………Date: …………………………

1.	Ⓐ Ⓑ Ⓒ Ⓓ	31.	Ⓐ Ⓑ Ⓒ Ⓓ
2.	Ⓐ Ⓑ Ⓒ Ⓓ	32.	Ⓐ Ⓑ Ⓒ Ⓓ
3.	Ⓐ Ⓑ Ⓒ Ⓓ	33.	Ⓐ Ⓑ Ⓒ Ⓓ
4.	Ⓐ Ⓑ Ⓒ Ⓓ	34.	Ⓐ Ⓑ Ⓒ Ⓓ
5.	Ⓐ Ⓑ Ⓒ Ⓓ	35.	Ⓐ Ⓑ Ⓒ Ⓓ
6.	Ⓐ Ⓑ Ⓒ Ⓓ	36.	Ⓐ Ⓑ Ⓒ Ⓓ
7.	Ⓐ Ⓑ Ⓒ Ⓓ	37.	Ⓐ Ⓑ Ⓒ Ⓓ
8.	Ⓐ Ⓑ Ⓒ Ⓓ	38.	Ⓐ Ⓑ Ⓒ Ⓓ
9.	Ⓐ Ⓑ Ⓒ Ⓓ	39.	Ⓐ Ⓑ Ⓒ Ⓓ
10.	Ⓐ Ⓑ Ⓒ Ⓓ	40.	Ⓐ Ⓑ Ⓒ Ⓓ
11.	Ⓐ Ⓑ Ⓒ Ⓓ	41.	Ⓐ Ⓑ Ⓒ Ⓓ

20.	Ⓐ Ⓑ Ⓒ Ⓓ	50.	Ⓐ Ⓑ Ⓒ Ⓓ
21.	Ⓐ Ⓑ Ⓒ Ⓓ	51.	Ⓐ Ⓑ Ⓒ Ⓓ
22.	Ⓐ Ⓑ Ⓒ Ⓓ	52.	Ⓐ Ⓑ Ⓒ Ⓓ
23.	Ⓐ Ⓑ Ⓒ Ⓓ	53.	Ⓐ Ⓑ Ⓒ Ⓓ
24.	Ⓐ Ⓑ Ⓒ Ⓓ	54.	Ⓐ Ⓑ Ⓒ Ⓓ

25.	Ⓐ Ⓑ Ⓒ Ⓓ	55.	Ⓐ Ⓑ Ⓒ Ⓓ
26.	Ⓐ Ⓑ Ⓒ Ⓓ	56.	Ⓐ Ⓑ Ⓒ Ⓓ
27.	Ⓐ Ⓑ Ⓒ Ⓓ	57.	Ⓐ Ⓑ Ⓒ Ⓓ
28.	Ⓐ Ⓑ Ⓒ Ⓓ	58.	Ⓐ Ⓑ Ⓒ Ⓓ
29.	Ⓐ Ⓑ Ⓒ Ⓓ	59.	Ⓐ Ⓑ Ⓒ Ⓓ
30.	Ⓐ Ⓑ Ⓒ Ⓓ	60.	Ⓐ Ⓑ Ⓒ Ⓓ