R&E-SOURCE https://journal.ph-noe.ac.at
Online Journal for Research and Education
Special Issue 17, Dec. 2019, ISSN 2313-1640

Relationship between Vocational Education and Science

Jan Válek[1]

Abstract

In the Czech Republic, the form of accreditation of degree programs at universities has changed since 2017. At first, the whole university is accredited by the National Accreditation Institute and then the university itself accredits new programs internally. This brings considerable problems to the newly accredited or upcoming Vocational Education Training (bachelor and master degree). At first glance, this step may seem simplifying, the opposite is true. The Ministry of Education, Youth and Sports continues to interfere in program accreditation by its Framework Requirements. There is a space for inclusion of science subjects in the curriculum of the university program so that its graduates have a comprehensive view of the world around them. Students should see, at least in their own field, the natural sciences and why they do some of the tasks the way they do them.
The aim of the lecture is to present some examples in the context of their specializations. At the same time, it will be shown what inertia the changes we have to make due to changes in society have.

Beziehung zwischen Berufsbildung und Naturwissenschaften

Zusammenfassung

In der Tschechischen Republik hat sich die Form der Akkreditierung von Studiengängen an Universitäten seit 2017 geändert. Zunächst wird die gesamte Universität vom Nationalen Akkreditierungsinstitut akkreditiert, und dann akkreditiert die Universität selbst neue Studiengänge intern. Dies bringt erhebliche Probleme mit sich für die neu akkreditierte oder anstehende Berufsausbildung (Bachelor- und Master-Abschluss). Auf den ersten Blick mag dieser Schritt vereinfachend erscheinen, das Gegenteil ist der Fall. Das Ministerium für Bildung, Jugend und Sport greift aufgrund seiner Rahmenbedingungen weiterhin in die Programmakkreditierung ein. Es besteht die Möglichkeit, naturwissenschaftliche Fächer in den Lehrplan des Universitätsprogramms aufzunehmen, damit die Absolventen einen umfassenden Überblick über die Welt um sie herum erhalten. Die Schüler sollten zumindest auf ihrem eigenen Gebiet die Naturwissenschaften kennen lernen und wissen, warum sie einige der Aufgaben so erledigen, wie sie es tun.
Ziel der Vorlesung ist es, einige Beispiele im Kontext ihrer Spezialisierungen vorzustellen. Gleichzeitig wird gezeigt, welche Trägheit die Veränderungen haben, die wir aufgrund von Veränderungen in der Gesellschaft vornehmen müssen.

Keywords:	*Schlüsselwörter:*
Accreditation of degree programs	Akkreditierung von Studiengängen
Framework requirements	Rahmenbedingungen
Science	Naturwissenschaft
Curriculum design	Curriculum-Design

[1] Masaryk University, Faculty of Education, Dept. of Physics, Chemistry and Vocational Education, Poříčí 7, CZ 60300 Brno, Czech Republic

1 Introduction

The changes taking place in the labor market are very rapid. Contemporary education thus prepares pupils for professions that do not even exist today. This preparation is not easy, because even teachers themselves do not know what pitfalls / tasks their pupils will face. From this point of view it is necessary to prepare teachers for their future profession already at the universities. Helping teachers, as well as their pupils, to face threats in practice can be an approach that has proved its worth in the context of past decades. So an approach where we can achieve the goal by analyzing, naming problems, proposing solutions, and updating solutions. Such practices, students learn in science subjects.

Currently, there are numerous re-accreditation of Vocational Education Training and Vocational Specialized Subjects teachers in the Czech Republic. This step gives us the opportunity to strengthen science disciplines in their future curriculum.

In the past, not only the Czech education system was inspired by its neighbors, and subsequently many steps were taken in a similar way. The same applies to accreditation of study programs. As in Austria, for example, the university must first obtain the so-called institutional accreditation with the Agency for Quality Assurance and Accreditation Austria (Agentur für Qualitätssicherung und Akkreditierung Österreich) and subsequently can internally accredit individual study programs. In Germany, this is similar, where the Foundation for Accreditation of Study Programs in Germany Stiftung zur Akkreditierung von Studiengängen in Deutschland grants institutional accreditation to individual universities.

In the Czech Republic, the procedure is similar, ie: At first, the whole university is accredited by the National Accreditation Bureau for Higher Education (Národní akreditační úřad pro vysoké školství) and then the university itself accredits new programs internally.

University accreditation is the responsibility of the University itself and its internal bodies. The subsequent program accreditation is prepared by the guarantor of the forthcoming program. This activity is quite demanding in terms of administration; therefore, the guarantor performs it in cooperation with his team.

This brings considerable problems to the newly accredited or upcoming Vocational Education Training (bachelor and master degree). At first glance, this step may seem simplifying, the opposite is true. The Ministry of Education, Youth and Sports continues to interfere in program accreditation by its Framework Requirements. We will discuss some aspects in more detail below.

2 Requirements for newly accredited fields

Despite the responsibilities and authority that universities have gained by granting institutional accreditation, the Ministry of Education, Youth and Sports still determines the conditions for individual programs across the board. These new conditions are listed in Table 1 for Vocational Education Training - VET Teacher (bachelor degree), and in Table 2 for Vocational Specialized Subjects - VSS Teacher for Secondary Schools (master degree).

	Credits	Hours
Teacher's propaedeutic e. g.: Pedagogy, Psychology, General Didactics, School Pedagogy, Inclusive Didactics, ICT Methodology, Foreign Language	63–83	1890–2490
Field and Didactics	54–72	1620–2160
Practice	23–29	690–870
Theses	9–18	270–540

Table 1: Framework requirements for Vocational Education Training - VET Teacher (bachelor degree).

	Credits	Hours
Teacher's propaedeutic e. g.: Pedagogy, Psychology, General Didactics, School Pedagogy, Inclusive Didactics, ICT Methodology, Foreign Language	60–70	1800–2100
Field and Didactics	10–12	300–360
Practice	14–20	420–600
Theses	6–12	180–360

Table 2: Framework requirements for Vocational Specialized Subjects

- VSS Teacher for Secondary Schools (master degree).

		Credits
Field studies	Field of Study 1 + 2	55 + 55
Teachers profiling	Subject Didactics 1 + 2	5 + 5
	Practice	8
	Pedagogical-psychological module	27
Subjects according to the needs of the university	ICT Methodology, Foreign Language	8 + 8
	Theses	8

Table 3: Requirements for Vocational Education Training Teacher (bachelor degree) in year 2016.

		Credits
Field studies	Field of Study 1 + 2	26 + 26
Teachers profiling	Subject Didactics 1 + 2	7 + 7
	Practice	14
	Pedagogical-psychological module	13
Subjects according to the needs of the university	ICT Methodology, Foreign Language	7
	Theses	14

Table 4: Requirements for Vocational Specialized Subjects Teacher for Secondary Schools (master degree) in year 2016.

Tables 3 and 4 set out the requirements imposed by the Ministry of Education in force in 2016, when the last wave of accreditation took place. We can see that the individual proportions have changed significantly. They differ in the number of credits, which also affects the number of hours that are devoted to each section. According to the Ministry of Education, the current frame of credit is lower for vocational part, which significantly reduces the scope for development of scientific literacy, even if it is necessary to include science in the preparation of future teachers. We can also talk about the overall humiliation of vocational competencies in the context of the present time. That is, we basically bring up universal but unfortunately professionally ignorant pupils and students who, without the ability of their own expert opinion and judgment, will be a cheap labor force in the future society.
Technology and virtually any other discipline is applied physics, chemistry and other scientific disciplines transformed into practice. In the following we will discuss in more detail how science contributes to the overall development of an individual.

3 Development of scientific literacy

Science has become a regular part of the cultural life of the people, especially because it is accepted as a rational approach of the reality. Scientists specialize in specific directions of research, which brings new knowledge throughout the society. Because science reacts to events in society and at the same time is a product of the intellect of scientists in particular time, there is a mutual influence of the two actors in the development process.
As a result, natural sciences (but not only them) represent a generally accepted image of science in society. The specialization of sciences occurs with the development and improvement of specific procedures and due to the requirements of the society. We can give a concrete example where technology, science, art and the inner motives of man meet: Photography. Photography is not just a reflection of reality, but also its specific interpretation. The photographer works with light, shadow, composition, focus to see reality differently. To take a different look at things that we've missed before. Photography is the work of imagination and at the same time capturing what really exists. (Feynman, 1965), (Harris, 2008), (Bradford, 2017)
In science we ask *why*, in technology rather *how*. In science, these are primarily discoveries, in technology, concrete implementation of solutions and inventions. Successful application of scientific knowledge is behind unprecedented technical development. This fact is very important for society as the school prepares new

scientists. And if not directly scientists, then innovators who will seek in technical practice how to make some processes more effective, which has also happened in the past. So, the basics of technology and craft are historically older than many of us realize, because the technical skills people needed in everyday life. This is very important to realize when we talk about the interconnection of science and technology or technical education.

It is also important to realize that science / scientists communicate with society. If we are to talk about and understand the same problem, we need to unify our ideas about the meaning of the words they express reality. The teacher needs to think hard about what words he can choose to appropriately identify and explain the scientific problem without confusing students. This means that we must speak the same language, and it does not matter whether we mean mother tongue or professional language. In this respect, science helps students classify ideas, shape questions appropriately. The teacher must have the right questioning system in place in order to pass it on to his pupils. The questioning system falls within the logic of the natural sciences, whereby means of exclusion questions we can advance knowledge. But this is because we have a good knowledge of our own field or related fields. Here in the technical fields we will most often encounter issues from physics, chemistry and biology. Asking questions can be supplemented by appropriate methods (Harris, 2008), (Bradford, 2017):

- Observation - observation of a phenomenon in its natural conditions without the observer interfering with the process of the phenomenon (lightning during a storm, sunrise, observation of bird behavior, ...)
- Experiment - observation of the phenomenon under artificially prepared conditions in the laboratory. In experiments we induce a certain phenomenon, change the initial conditions and observe the influence of these initial conditions on the process of the phenomenon.
- Theoretical methods - logical analysis of the examined phenomenon
- Creating hypotheses, either by observation, experiment, or based on the basic knowledge of the phenomenon, we create a scientifically justified idea of the process and of the causes of the phenomenon and verify the truth of our idea.

The above methods of scientific work are basically universal no matter what the science is. However, individual fields of study have different areas of research and approaches to problem solving differ. Science in general is united only in that its conclusions are in principle verifiable. We must admit that our way of looking at reality is not as distinctive as we often believe. Much of what we know is a matter of trust and agreement, be it an individual or a society with science / scientists. But to believe and not to think about problems is very conformal for many citizens. It allows to manipulate the presented reality. Science, not only in vocational education, should open the eyes of students so that they become not only consumers of unverified facts, but also try to verify suspicious information themselves. (Feynman, 1965), (Harris, 2008)

From theorizing, we are slowly moving towards research in science. Basic research is primarily motivated by discovery, it is not focused on finding a very concrete result. Applied research is focused on a specific goal. Scientists know what they want and why, but sometimes they don't know how to do it. Moving to an application is not a simple step. Applied research converts discoveries into means to meet human needs. Teachers and their students are also looking for a way to achieve their goals. And here again we see how science manifests itself in everyday life and in pedagogical practice. Secondary vocational education plays a very important role in this process, as it not only provides the students with a theoretical basis for understanding what is happening around them, but also helps in designing ways in which new ways of achieving the goal can be identified. Therefore, it is necessary for students to formulate their needs correctly and appropriately. Their teachers help them in the initial phase of their studies. One of the methods that students can use is the method of scientific approach by identifying their problem or need and setting the goal they want to achieve. (Bradford, 2017)

When we do research, we usually investigate the relationship between the two variables. If the results of the experiment point to a relationship between the investigated quantities, there is a need to formulate the conclusions of the research. Results and conditions are analyzed by logical thought processes (comparison, analogy, abstraction, idealization, concretization, generalization, analysis, synthesis, induction and deduction). We realize the generalization of knowledge by transferring the conclusions drawn from the sample of observations to the whole examined system, this is called inductive reasoning. Inductive thinking is almost essential for everyday life. It gives the ability to learn from individual experiences and adapt to change. One should then be able to transmit the details objectively to the whole, and to make more general conclusions.

These are the procedures that science teaches. If we manage to apply them in school practice, we can raise an individual who cannot be easily influenced by disinformation or fake news. (Harris, 2008), (Bradford, 2017)
However, it must also be pointed out that, as important as it is to teach pupils the above-mentioned procedures, it is also important that students have a basic board of knowledge without which the scientific apparatus cannot be properly worked. Science/scientist works not only with empirical data, theoretical knowledge, laws and principles. Just as the theory that covers the phenomena of a particular scientific discipline is based on postulated axioms, we, too, have to teach our students, future teachers, to choose between them. Therefore, we need to develop students in as many differentiated disciplines as possible, because only then will he/she be able, based on his/her own experience, to answer for himself/herself which method is best suited at a given moment.

Summing up the various steps of scientific work, we get the following:

1. Problem identification.
2. Selection, sorting and evaluation of existing information on the phenomenon.
3. Creating a hypothesis aimed at solving the scientific problem.
4. Solution plan for hypothesis verification - choice of methods and techniques.
5. Custom solutions.
6. Evaluation of obtained results and their interpretation.

The individual steps of scientific work are generally well applicable not only to pedagogical practice, but also to everyday life. We can give examples from different fields (Pecina, 2017):

- I cannot roll out the dough for cookies.
- Suddenly a wet spot appeared on the wall in the apartment.
- The car stopped suddenly while driving on the road.
- I have taken remedial measures for the patient and this is not successful.

Science answers the questions of what the world is like, whether it is our will or not. The outcome of science is deeper knowledge, ideas, knowledge that are neutral in themselves.
We can protect students from their future mistakes in practice by preparing them to work with models or work in model situations. As we can see, this is the result of everything that has been mentioned above about the combination of science and vocational training by scientific methods we can evaluate the degree of agreement between the theoretical model and observation or happening in the real world. This will help them shorten the time required to integrate into teaching practice and everyday life.

4 Education for the future

The profession of a teacher is one of the so-called regulated professions in the Czech Republic. So, it is necessary to plan the profession properly. The composition of the subjects that should be in the curriculum must reflect expected development in society. As well as working with digital technologies and social networks, science must be part of the teacher's equipment (not only VET or VSS teacher). In vocational education we prepare our students for life in the labour market, which can be characterized as Industry 4.0. It is more important for students to pass them such information and to teach them such skills that enable them (and to their students) to live a happy life and ensure sustainability, progress and a healthy environment in changing climatic conditions.
The task of school "science" is to ensure the literacy of the citizen, in our case we are talking about science literacy. Within the school science curriculum, the student gains a lot of interesting and useful knowledge. He understands that he does not have to "rediscover" things from the beginning when someone has already discovered before him. They will understand that they need and use to a large extent the knowledge of their ancestors. They learn from their own experience and others. In order to become science literate, students need a basic sum of knowledge about nature and its functioning.
The student gains awareness of science as such, i.e. understands the basic features of scientific exploration of the world. They will learn to work with their own mistakes. What he has never met, he thinks about it and critically doubts. The advantage of science teaching is that we can test on real tasks how such doubts can be cleared up and how controversial matters are being argued.

Teacher respecting Industry 4.0 gives students a space for autonomous orientation and their own thinking, which leads to a real literacy. If the student tries to reveal the essence of the phenomenon himself, we will be able to distinguish more sensitively between methods and approaches to solving problems in the future. The ability to orientate and choose what is optimal for the task is also part of education.
With the advancement of automation and the deployment of smart factories, it will be necessary to innovate processes in technical education. The main areas of innovation can be summarized as follows (Pecina, 2017):

- Innovation in the field of content of teaching technical field and subjects.
- Innovation in the field of training of teachers of technical subjects.
- Innovation in the field of further education of teachers of technical subjects.

Issues of technical creativity and innovation in the education process should also be considered. Inherent in the areas of work of teachers is Emotional intelligence (the ability to deal with emotionally tense and stressful situations).
The university courses for future VET teachers and VSS must therefore students learn such techniques and pass them information that enable them and their students to succeed in practice.

5 Conclusion

We believe that the requirements for the content of education in schools and universities should be set by experts who know not only the current state of science, the development of knowledge and the needs of practice, but in the same time to estimate what their development will be.
The composition and methodological elaboration of curriculum should then be created by a university preparing future teachers together with experienced teachers and practitioners.
However, it should not be forgotten what secondary education is aimed at, i.e. to prepare students for everyday life, for employment in the labour market, for the capacity of lifelong learning and to teach them to get the right picture of the world around them.

We are aware of the difficulties in education in current technological developments (Industry 4.0). It will be important to equip students / graduates with competencies to help them deal with situations we do not currently know what could happen.
The role of the teacher will gradually change from a major source of knowledge (in the 18th century) to a guide and manager of education (in the 21st century). The teacher cannot no longer be only a specialist in a relevant profession area but must be a good organizer of students' activities during school education.
Therefore, this image needs to be true and there is no distortion. For the future, science also helps us in the fact that although some theories are already known, we do not have practical applications yet. Science and its methods help us in everyday life, for example in the decision-making process, so science is always needed to be represented in the educational process.

References

Bradford, A. (2017). What Is Science?. *Pure Science*. Retrieved from: https://www.livescience.com/20896-science-scientific-method.html

Feynman, R. (1965). *The Character of Physical Law*. (p. 192) Modern Library.

Harris, W. (2008). *How the Scientific Method Works*. HowStuffWorks.com. Retrieved from: https://science.howstuffworks.com/innovation/scientific-experiments/scientific-method.htm

Pecina, P., Sládek, P. (2017). Fourth Industrial Revolution and Technical Education. In L. Gómez Chova, A. López Martínez, I. Candel Torres. *11th International Technology, Education and Development Conference*. Spain: IATED Academy. s. 2089-2093, 5 s. ISBN 978-84-617-8491-2. doi:10.21125/inted.2017.0621.

Understanding Science (2012). *How science works*. Retrieved from: https://undsci.berkeley.edu/article/howscienceworks_01