Evaluation Procedures of the University Graduates' Readiness for Railway Professional Activities in the English-speaking Countries

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Abstract

This article presents an analysis of the system of engineering education in general and railway engineering training, particularly in the USA, Great Britain, Australia and Singapore. These countries were chosen to be the most advanced in the sphere of introducing professional standards and qualification requirements into the process of engineering education that are carried out on the principles of a competency-based approach. The objective of this article is to single out the most effective procedures of evaluation of engineering competences as well as the algorithm of setting correspondence between educational programmes and national professional standards. On the basis of examining a broad range of governmental, cooperative and educational documents, the authors investigated some issues in technical higher education, assessment practices of graduates’ vocational readiness, and ideological concepts towards learning outcomes. Currently, there are various schemes of organising engineering education, however, all of them are directed at enhancing the quality of training, introducing competency-oriented methods and technologies, and searching for the most effective ways to make engineering education competitive on the world market. The review presented in this article is of a certain interest for the scientific community, researchers of this problem, and bodies of higher vocational education in the sphere of railway transport.

Keywords: Assessment and Evaluation of Competencies, Competences, Competency-based Education, Engineering Education, Educational Programme, Engineering Registration Systems, Lifelong Learning, Learning Outcomes, Professional Engineer, Qualification, Railway Engineering Education, University

1. Introduction

Currently, engineering education in general and railway engineering training – particularly in many European countries, such as Czechia, Poland, Russia, etc. face a new problem: to set correspondence between the requirements to university graduates in technical professions and the national qualification standards. The grounds of this problem that one should seek in the history of technical education of these countries is that during the course of almost 80 years, a powerful network of specialised technical institutes that were transformed into technical universities in 1990s were developing in these countries. When competency-based education and assessment of graduates in the terms of the competences were introduced in 2010s, it turned out that national educational standards did not fit the professional requirements. Furthermore, there are still no qualification standards for many professions’.

To ensure that engineering graduates occupy a relevant career grade in order to be employed by a respected company and enjoy reciprocal privileges by equivalent professional bodies overseas, European countries need to find ways to tune graduates’ competences with professional requirements and qualification standards. For this purpose, the government authorities and educational bodies must take into account the experience of other countries in engineering education. It is a matter of common knowledge that the most topical list of the requirements to the engineering programmes’ graduates can be found in Washington Accord21. Its ideas were developed in the Sydney Accord and the...
Therefore, there are currently 12 universities in the USA that offer about 20 railway programs as well as courses for undergraduates and graduates. Another 19 universities do not offer courses in this area, but conduct research. The total number of undergraduates and postgraduates studying for the US railway sector, was 150–250 people per year\(^3\). After completing higher education and getting an academic degree, a person can start his/her career in the railway sphere as an engineer in training. In four years he/she should decide whether or not to take licensing exams in order to get the title of Professional Engineer, which gives the right to offer professional services directly to the public. The licensing process includes two written exams, held by state licensing councils on the base of the requirements defined by the National Council of Examiners for Engineering and Surveying (NCEES). Applicants should only be the graduates of accredited universities who completed the accredited programmes and received a bachelor’s degree. Accreditation of engineering programs at the US universities were implemented by the Accreditation Board for Engineering and Technology (ABET). The Board periodically publishes criteria for evaluating educational programs. \textit{ABET’s Engineering Criteria 2000} \comprised eight criteria for evaluating educational programs, among which there are requirements for student learning outcomes\(^9\). These criteria reflect knowledge, skills, and abilities that a bachelor of engineering must possess. These seven student outcomes represent the core competences of a graduate, including the following abilities: (a) to apply knowledge of mathematics, science, and applied science, (b) to design and conduct experiments, as well as to analyse and interpret data, (c) to formulate or design a system, process, or program to meet desired needs, (d) to function in multidisciplinary teams, (e) to identify and solve applied scientific problems, etc.

A number of US universities, such as Iowa State University of Science and Technology accepted these outcomes to be their own criteria. Others, such as California State University at Northridge, added them to the list of their own requirements for learning outcomes or, as done at the College of Engineering at the University of Kentucky, formulated educational goals and objectives, using the Council’s demands to be guidelines. Therefore, the US technical universities include ABET’s student outcomes in their learning process to be a guideline for evaluating a graduate's readiness for professional activity, taking into account the licensing requirements of NCEES.

2. Materials and Methods

The above mentioned problems made us set the main objective of our research to be singling out the most popular procedures of evaluating the graduates’ competences of railway engineering programmes in the systems of technical education in English-speaking countries. Taking into account a complex character of this problem and various approaches existing in different countries, this objective can be gained through a number of the following goals:

a) to analyse the systems of technical education and the work of the corresponding educational bodies in the USA, Great Britain, Australia and Singapore.

b) to find out the level of development of national professional standards and qualification requirements to general engineering professions, and particularly railway engineering.

We used a competence-based approach\(^6\) to be the methodology of our research\(^1\)–\(^3\).

3. Results and Discussion

In the USA, knowledge and skills are required for starting a career in the railway industry, which can be obtained from four sources: private independent consultants, rail industry provided courses, private rail academies, and colleges and universities\(^11\). In order to obtain an academic degree, the majority of undergraduates interested in pursuing rail transportation careers are taught at Engineering Colleges or Civil Engineering Departments of US technical universities. A concentration in the field of railway transport was usually implemented by means of elective credit courses integrated into engineering education programmes with a major in Civil Engineering. Therefore, there are currently 12 universities in the USA

Dublin Accord, which suggest accreditation systems and accredited programs across international boundaries at the Professional Engineer, Engineering Technologist and Engineering Associate levels\(^4\).

To find all of the benefits and pitfalls of introducing the standard requirements to the assessment of professional competencies of railway engineering programmes’ graduates, we made an attempt to analyse and compare the evaluation procedures in railway education in the USA, Great Britain, Australia and Singapore.
Great Britain, having the oldest railway history and being the country where the first locomotives were invented, is famous for its educational traditions. However, there were no universities or technological institutes specialising in railway education in this country. However, there were currently no less than 10 universities that suggested different programmes and courses in railway engineering and construction. Four of them being: Oxford, Cambridge, Birmingham University, and Imperial London College were included into lists of 10 of the world's top-universities with engineering training. This rating was done by the respected authorities: “The Times Higher Education”\(^\text{22}\) and “The Guardian University Guide”\(^\text{19}\).

Sometimes, railway training is included into ‘Unified Engineering Programmes’. The Technical University of Birmingham suggests educational programmes, such as ‘Civil and Railway Engineering’ and ‘Civil and Power Engineering’ for bachelor’s and master’s degrees. The graduates are also able to be employed at various railway companies\(^\text{14}\).

Evaluation procedures of the university graduates' readiness for railway professional activity in Great Britain have a multilevel character. After successful graduation from a university, a young railway engineer gets a tutor for the first year period, whose functions include not only consultation and workplace training, but the final assessment of a young specialist at the end of this probation term. It should be noted that during this period, an engineer is to complete a number of specialised courses and seminars in corporative railway culture, ethics of British railway infrastructure, application of railway standards and rules, new technologies and methods of professional activity. At the end of the probation period, the engineer is to take a number of qualification exams, including viva and case study\(^\text{20}\).

Another body whose functions are to maintain constant control over the professional activity of railway engineers is the Sector Skill Council (these councils are available for every industry). The employees of the largest railway companies are members of the council and make prognoses of market requirements and are concerned with reducing a ‘skill gap’ of the universities' graduates, introducing new technologies, and perfecting professional standards.

The Office of Qualifications and Regulation (Ofqual), together with Qualification Bodies that conduct examinations of the national qualifications and The State Commission for Employment and Skills, constantly supervise the professional qualifications and conduct accreditation of the bodies responsible for applying the qualifications\(^1\).

Therefore, this complex and multilevel system of monitoring and evaluation of British engineers directs its efforts to improve the quality of training at the universities and correspondence of the learning outcomes to the national professional standards.

Although the system of higher education in Australia initially copied the work of British universities, currently, this country may be considered to be the most advanced regarding introducing standardisation and competency-based approaches into the sphere of professional training.

To start with, after the educational reform in the middle of the 1980s, the system of higher education in Australia split into two components: classical universities, which suggest numerous educational programmes as well as bachelor's, master's and doctorate degrees, and a system of technical and postgraduate education, which is called – Technical and Further Education (TAFE). Usually, a person graduating from a classical university and having an interest in technical profession can continue his/her education in specialised educational institutions that have a TAFE license, or they can take these two types of education simultaneously. The professionals working in different industries can also enter TAFE courses if they want to gain formal recognition of existing skills and knowledge through a qualification.

TAFE Certificates at the I (the lowest), II, III and IV levels for short-term courses were usually regarded to be lower than a bachelor's degree. There are also TAFE programmes of a higher level that last 2-3 years. After this period, a Diploma or Advanced Diploma are awarded. These documents allow for occupying the position of a junior manager, a master (at some industrial sites) or to enter the 2\(^{\text{nd}}\)–3\(^{\text{rd}}\) years of university\(^2\).

Besides TAFE courses, there was a system of Registered Training Organisations (RTOs), which are private educational institutions that conduct licensed training on the basis of the supposed 'Training packages', which accumulate theoretical knowledge and intensive working practice\(^\text{18}\) in a number of technical professions\(^\text{15}\). Currently, Rail Innovation Australia Pty Ltd\(^\text{13}\) is the exclusive licensee of rail technologies and organisation of Railway Engineering education in Australia at the basis of a number of RTOs and certain universities, such as Central Queensland University, Queensland University.
of Technology, Monash University and University of Wollongong.

The distinctive feature of Australian higher education is a system of qualifications and a stable interest to support a high level of training. The Australian Qualifications Framework (AQF) was initially adopted on the national level in 1995. The latest edition was approved in 2013. All of the qualifications from each sector of industry, culture, trade, etc. are united in the AQF into a single comprehensive national qualifications framework. It contains a clear system of criteria of qualification achievements and requirements to different professions, which can be taught both in the system of classical and technical education. This document also presents a list of the licensed educational bodies that have the right to conduct education and training.

The following example shows how standardisation in Australian technical education made it possible to evaluate a graduate’s readiness for their professional activity. If a person is going to get a TLI22113 Certificate II in Rail Vehicle Driving, they must get successful assessment outcomes in a total of 17 competencies, which are comprised of 11 Core Units (TLIC2075A Drive and monitor medium/heavy self-propelled on-track equipment, TLIC2076A Establish and operate braking system, TLIC2078A Identify and respond to signals and trackside signs, TLIE1003A Participate in basic workplace communication, TLIF2010A Apply fatigue management strategies, etc.) and any 6 elective competencies from the General Elective units (TLIB1028A Maintain and use hand tools, TLIB2130A Diagnose and rectify minor faults on on-track vehicles, TLIE2008A Process workplace documentation, etc.).

In Singapore, railway training is represented by Singapore Mass Rapid Transit Corporation Institute (SMRT Institute), Institute of Technical Education (ITE), Land Transport Authority Academy (LTA), Nanyang Technological University (NTU), and Workforce Development Agency (WDA). Workforce Development Agency, together with its partners worked out a Competency Card comprising of 12 elements of key competencies that correspond towards broad practice areas of professional engineering performance, which enable students to become highly skilled professionals that are able to design, plan, construct, maintain and operate all areas of the rail industry, as well as to improve the reliability, safety, efficiency and maintainability of transport services and infrastructure. Moreover, there are a number of cross-cultural, professional, educational, and other competences that underpin holistic education and help students succeed in a rapidly changing world and be better prepared for the future. The body supervising and accrediting engineering educational programs or system of labour qualifications certification is Singapore Engineering Accreditation Board (EAB). Almost all of the engineering programmes are accredited by the EAB. Another body that evaluates, prepares, develops and recognises individuals’ key competencies that companies look for in potential employees is the Workforce Skills Qualifications (WSQ) System, which provides training with the aim of improving skills and certifying existing skills and abilities. Accredited training in accordance with recognised standards guarantees the employment of specialists for the railway industry.

4. Conclusion

After analysing different systems of engineering education and procedures of evaluating engineers’ readiness for their professional activity in English-speaking countries, we came to the following conclusions:

- a great potential of private educational bodies can be used in the sphere of engineering education besides technical universities,
- immediate efforts should be taken to set correspondence between educational standards in railway engineering and qualification requirements,
- the system of evaluation of graduates’ readiness and competency assessment should be multilevel, transparent and clear for all participants,
- an assessment of engineer’s competences should be conducted during all of their working career, while being supported by a system of lifelong professional development.

The findings of this research can be used by governmental authorities and the administration of universities in order to improve their systems of engineering education.

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