sciendo

Management Systems in Production Engineering

2022, Volume 30, Issue 2, pp. 172-178

Date of submission of the article to the Editor: 12/2021
Date of acceptance of the article by the Editor: 04/2022

DOI 10.2478/mspe-2022-0021

COMPETENCIES OF GRADUATES – AN INDUSTRY EXPECTATION

Agnieszka CZERWIŃSKA-LUBSZCZYK
University of Bielsko-Biala

Michalene GREBSKI
Colorado Mesa University

Dominika JAGODA-SOBALAK
Opole University of Technology

Abstract:
Changes in the environment of industry may affect the expectations related to the competencies of the employees. Changes to the education system and curricula may be required. The main purpose of this research paper was to analyze the expectations of the industries related to competencies of graduates of engineering programs. The paper presents preliminary research. The survey was conducted at twenty-eight companies within the area of technical university in Poland. Based on the survey, data was collected related to the level of preparation of engineering graduates as well as the industry expectations related to the preparation of engineering graduates. This was done for the purpose of determining the gap between industry expectations and the level of preparation of the engineering graduates. Enterprises expect a wide range of competences from engineering graduates. The most important areas of competence included soft competences and practical knowledge and skills. The biggest gap between industry expectation and graduate's preparation are the soft skills. Recommendations were suggested which would be incorporated in the engineering curriculum for the purpose of continuous quality improvement.

Key words: *engineering education, graduate's competences, industry expectations, curriculum*

INTRODUCTION

In the face of economic changes, organization changes may become necessary. These changes may affect the expectations of industry as related to the competencies of the employees [1, 2, 3, 4, 5, 6, 7]. This in turn requires changes in the education system [8, 9] and curricula [10, 11, 12, 13, 14, 15].

In the present economy (21st century), the concept of sustainable development has become important and affects many aspects of our life. Engineering education needs to reflect the topics of sustainable development [16, 17, 18, 19]. Incorporating sustainable development topics is a complex initiative. Sustainable development is a broad concept requiring knowledge, skills and competencies in many areas including ecology, sociology, ethics, security, etc. [20, 21]. Durrans et al. [22] noticed "there is an urgent need for educational institutions to produce graduates with appropriate skills to meet the growing global demand for professionals in the sustainable energy industry". Vargas, et al. [23] pointed that "policy frameworks for sustainable development implementation should include collaboration, partnership, education, outreach, teaching and learning, staff development, curriculum review, research, campus operations and policy". It requires changes in the fields of management, research and development, teacher's education as well as changes in the content of academic programs.

The purpose of this study was to analyze the expectations of the industries related to competencies of graduates of engineering programs. This study has two major aspects. The first aspect is assessment of industry expectations related to the competencies of the engineering graduates. The second aspect focuses on the assessment of the competencies of engineering graduates (from the industry

perspective). Comparing those two aspects helped to determine the necessary changes for the engineering program.
The research paper presents a fragment of international research on the competences of engineering graduates desired by the industry. These are preliminary studies.

LITERATURE REVIEW

Engineers are trained and prepared to work in a variety of positions (industry, research and development, administration as well as education and training [24]. These positions usually require a wide range of engineering competencies. Traditional engineering knowledge gained in university must be supplemented by practical knowledge and skills [25]. These needs include: sustainability, the social aspect, environmental aspect and global connections. What more, the engineering curriculum needs to address and contribute to the development of soft competences.

Width Range of Engineering's Competencies

Universities attempt to develop competences, which are "corresponding to the characteristic of the future professional activities of graduates" [25]. "Competence contains aspects of knowledge, skills and abilities as well as personality characteristics" [26]. Engineering competencies include theoretical knowledge, skills and ability, attitude and soft skills as well as practical experience. Ghonim and Eweda [27] focused on architectural design, but also includes a wide range of other education aspects: writing, theory, built projects, and creative products. Gorshkova [28] concentrated on teaching engineering students how to conduct research. Dubovikova [25] divides competences by: professional competences and universal competences. Balve and Ebert [29] divided competences gained by engineering students into four groups: professional competences (e.g., knowledge of information technology/IT), methodical competences (problem-solving ability, analytical skills), social competences (oral expressiveness, communication ability), self-competences (adapt to changing circumstances, decision-making ability).

Practical knowledge and skills

Industry demands interdisciplinary and also practice-oriented approaches to the education [30, 31]. Ghonim and Eweda [27] highlighted practical aspects and the necessity of real-world projects. Real-world projects are "educational projects by which students work with real clients in real time. They are provided real budgets for socially-engaged projects" Interdisciplinary and practice-oriented approaches in education require various methods [30].
The process of educating highly skilled engineers should include many aspects, such as interactive forms and methods, research carried out using practice-oriented techniques as well as complex and end-to-end research projects. In addition, the educational process should include information technology systems, independent work, self-control, self-assessment of students and extracurricular activities [28]. Syahmaidi et al. [26] noticed: "It is time for graduates of engineering education to carry out upgrading, training and workshops to improve skills, competence and education through continuous online computer-assisted training". Zamaletdinova et al. [32] also focused on solutions related to "information technologies, electronic educational resource, electronic textbooks, webinars, multimedia sites, services, portals, platforms, new smart technologies, wiki technologies, podcasts etc.". Education without information and communication technologies is unimaginable nowadays [33]. It is necessary to consider the readiness of the faculty to improve methods and curricula [28, 31, 34].

Competencies in Sustainability

Graduates' knowledge and skills should consider issues related to the social and environmental aspects related to the activities of the entire industry and the engineers themselves. Bairaktarova and Pilotte [35] stated that "engineering practice is meant to advance the human condition, yet curricula do not appear to fully promote the human-centered philosophy of engineering in implementation". Hoven [36] focused on comprehensive engineering, which implies "ethical coherence, consilience of scientific disciplines, and cooperation between parties". Taebi and Kastenberg [37] worked on teaching engineering ethics to PhD students. Jordan et al. [38] emphasized cultural aspects. They indicated "the necessity to develop culturally responsive engineering curriculum". Gunasekera et al. [39] focused on process safety in equipment design.

Soft Competences

Soft skills are important in the engineering profession. Balve and Ebert [29] as well as Sabirova, et al. [40] confirmed significance of soft skills. Fedoseeva et al. [30] emphasized the role of teamwork skills. The team-building competence could be formed during instruction time as well as extracurricular time (research, internships, sports and other activities at university. Engineering tasks require the cooperation of many participants. Conducting a project requires teamwork. Engineers might need to cooperate with clients, designers, specialists and other engineers to complete a project [27].
For suggestions related to changing engineering curriculum, researchers survey graduates or employers. For example, Castro-Bedriñana et al. [41] interviewed the graduates (up to 20 years after graduation) to assess satisfaction levels related to competences developed in engineering program.

METHODOLOGY OF RESEARCH AND SAMPLE STRUCTURE

The main purpose of this research is: to analyze the expectations of the industries related to competencies of graduates of engineering programs.
The specific goals include:

- Assessment of the importance of various competences to industry.
- Assessment of the level of preparation of graduates of engineering programs.

- Identification of the gap between industry expectations and graduate's preparation.
- Preparation of suggested curricular modifications to be implemented in engineering education programs to eliminate the gap between industry expectations and the graduate's preparation.

The survey was conducted at twenty-eight companies within the area of technical university in Poland. The data was collected in May and June 2020. The survey was available in electronic and paper formats. The respondents could choose the format that they wanted to use.

The two criteria for selecting companies to be surveyed were as follows:

- Willingness of the company to participate,
- Compatibility criterion (the company is hiring engineering graduates).

In the analysis of the collected empirical data arithmetic average was used. Two missing data appeared (indicated as "no data" in Table 1).

Table 1

Characteristics of the companies being surveyed

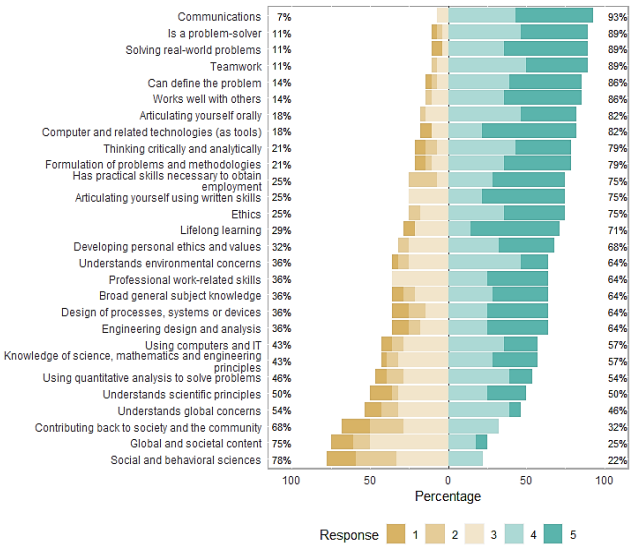
The period of time on the market	Number of companies	Percentage
5-15	5	17.86%
16-25	9	32.14%
26 or more	12	42.86%
No data	2	7.14%
Sum	28	100%
Employment data	**Number of employees**	**Percentage**
Below 9	4	14.29 %
10-49	3	10.71 %
50-249	6	21.43 %
250 or more	13	46.43 %
No data	2	7.14%
Sum	28	100%

Most of the surveyed companies have a well-established position on the market, which is indicated in Table 1. Most of the surveyed companies were operating in the market for over 25 years (42.86%) and were large enterprises (46.43%) with 250 or more employees.

RESULTS OF RESEARCH

The respondents taking the survey were asked to specify the requirements of the company related to the competences of graduates of engineering program. The individual areas of knowledge/skills were assessed on a scale from 1 to 5, where 1 means no value, 5 means very valuable. Subsequently, a request was made to assess the level of preparation of engineering graduates in particular knowledge/skills areas. The same scale from 1 to 5 was also used, (where 1 means not prepared, 5 means very well prepared). The results of the survey are shown in Fig. 1, Fig. 2 and Fig. 3.

The answers related to the importance of skills to industry are shown in Fig. 1. The data are arranged according to the responses: "very valuable" to "no value".



5 – Very valuable; 4 – Valuable; 3 – Somewhat valuable; 2 – Not very valuable; 1 – No value

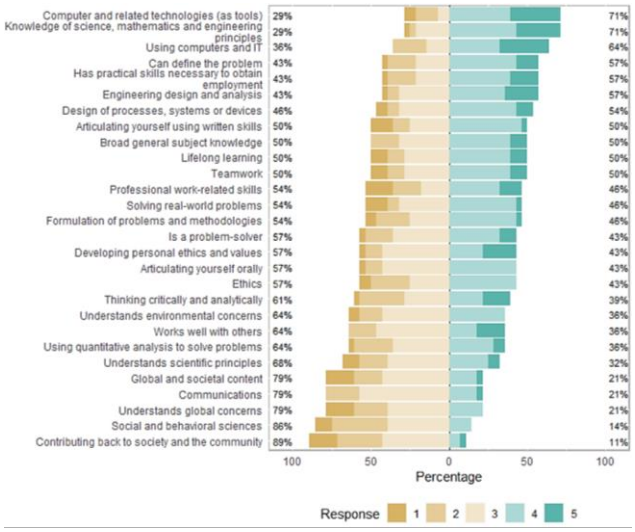
Fig. 1 Results of the survey – importance of skills to industry

The most important areas of knowledge/competence according to the surveyed companies included: communications, being a problem-solver, ability for solving real-world problems, teamwork, ability to define the problem, working well with others, articulating themself orally, computers and related technologies (as tools), thinking critically and analytically, formulating problems and methodologies.

All the individual areas of knowledge/skills were rated rather highly by the respondents. Companies taking the survey expect a very broad range of competences from engineering graduates.

Competencies in sustainability were less important for the surveyed companies: engineering ethics, developing personal ethics and valued, understanding of environmental concerns and understanding of global concerns, contributing back to society and community, global and social content.

The answers related to level of preparation of graduates are shown in Fig. 2. The data are arranged according to the responses from "very well prepared" to "not prepared". The areas where graduates have the best preparations are: computer and related technologies (as tools), knowledge of science, mathematics and engineering principles, using computers and IT. The areas where graduates are poorly prepared for employment are: contributing back to society and the community, social and behavioral sciences, understanding global concerns, communications as well as global and societal content.



5 – Very well prepared; 4 – Prepared; 3 – Somewhat prepared; 2 – Poorly prepared; 1 – Not prepared

Fig. 2 Results of the survey – level of preparation of graduates

A comparison has been made between the mean values of competencies from the perspective of the importance of skills for industry and the level of preparation of engineering graduates (Fig. 3). The competencies above the diagonal dotted line are important to industry, but they are not sufficiently mastered by engineering graduates. Industries hiring engineering graduates have a very wide range of expected competencies.

Comparing the expectations towards graduates and the assessment of the level of preparation of engineering graduates in individual areas of knowledge and skills, it can be noticed that the largest discrepancies exist in the following:

- Communications,
- Articulating yourself using writing skills,
- Working well with others,
- Solving real-world problems,
- Teamwork,
- Is a problem-solver.

It is worth noticing that these are also the most important areas of competence for the surveyed companies. Among the competences in the field of environmental and social issues (competencies in sustainability), there are also competency gaps.

The survey questionnaire included an additional closed-ended question related to articulating yourself using writing skills: Which forms of writing are engineering graduates expected to do as a part of their employment?

This was a multiple-choice question. Summary of the responses was as follows:

- Write a summary (1 page), (24.24% of respondents),
- Write notes with some details (about 2 pages), (21.21% of respondents),
- Write a short report (3 to 5 pages), (15.15% of respondents),

Write an extensive report (more than 5 pages), (39.39% respondents).

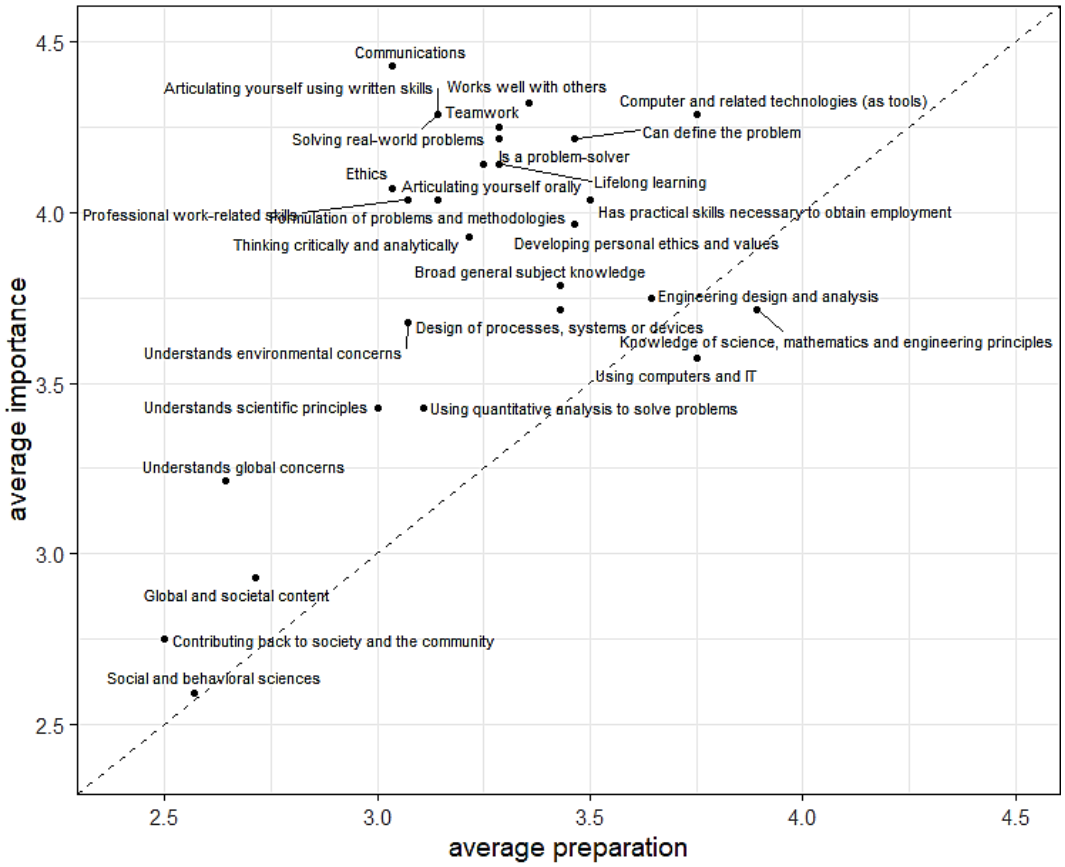


Fig. 3 Results of the survey – importance of skills to industry and level of preparation of graduates

CONCLUSIONS

The modern world establishes not only economic goals for enterprises, but also social and environmental goals. Some of the researchers indicate (Gartner [42], OECD [43], WEF [44]), that many new job categories will appear and replace existing jobs, so the skills required for employment will change fundamentally [45]. This will create changes in the educational system [35, 38, 39, 41, 46]. The curricula must constantly be adapted to changes taking place in the economy from social, environmental and cost-effective perspectives [47].

The conducted research focused on the competences of graduates of engineering programs which are expected by industry. The following conclusions were derived:

- Enterprises expect a wide range of competences from engineering graduates.
- The most important areas of competence included soft competences (communication skills, teamwork, works well with others, articulating yourself orally), practical knowledge and skills (problem-solving, solving real-world problems, defining the problem, computers and related technologies (as tools), thinking critically and analytically, formulating of problems and methodologies).
- The empirical data described in the article confirms good preparation of graduates in the areas of computer and related technologies (as tools), knowledge of science, mathematics and engineering principles, using computers and IT.
- The biggest gap between industry expectation and graduate's preparation are the soft skills.
- Competences in the field of environmental and social issues were of less importance to the surveyed enterprises.
- There are also gap among competencies related to sustainability.

When preparing curricula for engineering studies, attention should be focused on the following:

- Focusing on a wider range of competences.
- Soft skills.
- Skills of articulating yourself using writing skills (preparation for writing of texts of various lengths: summaries-about 1 page, notes covering a few details-about 2 pages as well as short and long reports that are widely used in industry).
- Practical knowledge.

Authors (Grebski, Grebski, Czerwińska-Lubszczyk, Jagoda-Sobalak) [48] compared the curriculum of the Mechanical Engineering Program in Poland (Politechnika Opolska) and the United States (Pennsylvania State University). Both mechanical engineering programs are striving for excellence in preparing students for engineering jobs in industry, but the philosophy of those programs is very different. The main conclusion was that the Mechanical Engineering program at Pennsylvania State University is providing the student with a stronger theoretical background. Graduates from the Politechnika Opolska program are well-trained in application-focus current industry practices. They are not going to require on-the-job training after entering industry. The empirical data described in the article confirmed that engineering graduates are well-prepared in the areas of computer and related technologies (as tools), knowledge of science, mathematics and engineering principles, using computers and IT.

It is important to educate engineers with a practice-oriented approach, that is the use of case studies, visits to enterprises, participation in workshops, hands-on trainings, as well as the organization, attendance and participation at conferences and meetings done in collaboration with industry.

One of the tools to improve the process of updating curricula may be the practice used in the USA – "Partners in Education" (PIE) [49]. It consists of business and education partners. The main goals are ensuring that all students have "academic, technical and employability skills necessary to be successful in the 21st century". The members of PIE are volunteers representing industry as well as educational institutions.

Presently there are many changes in industry regulations related to sustainable development [50, 51]. Those changes are focusing primarily on reducing greenhouse gas emissions. This can be accomplished by reducing the use of coal in electricity production as well as developing technologies for increasing energy efficiency [52, 53]. Engineering education should place more emphasis on developing competences in the field of sustainable development. The direction of these domestic changes requires the training of personnel to implement the goals set by Poland as a member state of the European Union.

The main research limitation was the relatively small research sample. The paper presents preliminary research. The research data which has been collected are interesting. The authors are willing to continue further research. When continuing further research, the sample size should be increased. The authors believe that the study of graduates' competency gaps should be a continuous process that will enable the adaptation of curricula to the changing expectations of the industry. For example, COVID-19 pandemic is affecting industry expectations related to the competencies of the employees. This should be included in future research.

ACKNOWLEDGEMENTS

The article presents a part of international research on the competences of engineering graduates. This project would not have been possible without Professor Wes Grebski (The Pennsylvania State University) and Iwona Łapuńka, PhD (Opole University of Technology). The authors are grateful to Tomasz Owczarek, PhD (Silesian University of Technology) for consultation.

REFERENCES

[1] J. Appelo. *Zarządzanie 3.0. Kierowanie zespołami z wykorzystaniem metodyk Agile*. Gliwice: Helion, 2016.

[2] P.F. Drucker. *Zarządzanie XXI wieku – wyzwania.* Warszawa, New Media 2010.

[3] M. Stoch and J. Gracel. "Inżynierowie przemysłu 4.0: jak ich rozwijać?" *Harvard Business Review Polska*, 2017. Internet: https://www.hbrp.pl, [Apr. 20, 2020].

[4] A. Michna and R. Kmieciak. "Open-mindedness culture, knowledge-sharing, financial performance, and industry 4.0 in SMES". *Sustainability*, vol. 12(21), pp. 1-17, 2020.

[5] K. Beyer. "Współczesna organizacja – organizacja oparta na wiedzy". *Zeszyty Naukowe Uniwersytetu Szczecińskiego*, 736, Finanse, Rynki Finansowe, Ubezpieczenia, vol. 55, pp. 9-25, 2012.

[6] BRICS Skill Development Working Group. *Whitepaper, Skill Development for Industry 4.0*. Roland Berger GmbH, 2016.

[7] P. Hollinger. "Meet the cobots: humans and robots together on the factory floor", *Financial Times*. Internet: https://cobotsguide.com/2016/05/meet-the-cobots-humans-and-robots-together-on-the-factory-floor [Apr. 20, 2020].

[8] J. Bennedsen, S. Rouvrais, J. Roslöf, J. Kontio, F. Georgsson and C.D. McCartan. "Collaborative quality enhancement in engineering education: an overview of operational models at a programme level". *European Journal of Engineering Education*, pp. 1-20, 2018.

[9] J.D. Litster, J.N. Michaels and K.V. Jacob. "Particle technology education in the 21st century – Outcomes from the IFPRI sponsored workshop in Sheffield, April 2017". *Powder Technology*, vol. 366, pp. 144-149, 2020.

[10] H. Stammes, I. Henze, E. Barendsen and M. de Vries. "Bringing design practices to chemistry classrooms: studying teachers' pedagogical ideas in the context of a professional learning community". *International Journal of Science Education*, vol. 42, 4, pp. 526-546, 2020.

[11] J.A. White, D.P. Gaver, JR. Butera, et al. "Core Competencies for Undergraduates in Bioengineering and Biomedical Engineering: Findings, Consequences, and Recommendations". *Annals of Biomedical Engineering*, vol. 48, 3, pp. 905-912, 2020.

[12] I. Cameron and G. Birkett, "Journey Making: Applying PSE Principles to Complex Curriculum Designs". *Processes*, vol. 8, pp. 1-13, 2020.

[13] M.A. Martínez-Prado, J. Rodríguez-Reséndi, R.A. Gómez-Loenzo, K.A. Camarillo-Gómez and G. Herrera-Ruiz. "Short informative title: Towards a new tendency in embedded systems in mechatronics for the engineering curricula". *Computer Applications in Engineering Education*, vol. 27, pp. 603-614, 2018.

[14] M. Epure. "University-business cooperation: adapting the curriculum and educational package to labor market requirements". *Proc. of the International Conference on Business Excellence*, vol. 11(1), pp. 339-349, 2017.

[15] G.C. Rampersad. "Developing university-business cooperation through work-integrated learning". *International Journal of Technology Management*, vol. 68, 3-4, pp. 203-227, 2015.

[16] R. Martínez-Medina and J.C. Arrebola. "Analysis of Sustainability Activities in Spanish Elementary Education Textbooks". *Sustainability*, vol. 1, pp. 1-14, 2019.

[17] F. Sánchez-Carracedo, F.M. Moreno-Pino, B. Sureda, M. Antúnez and I. Gutiérrez. "A Methodology to Analyze the Presence of Sustainability in Engineering Curricula. Case of Study: Ten Spanish Engineering Degree Curricula". *Sustainability*, vol. 11, pp. 1-27, 2019.

[18] T.S. Saraiva, M. Almeida, L. Bragança and M.T. Barbosa. "Verification of the Adequacy of the Portuguese Sustainability Assessment Tool of High School Buildings, SAHSBPT, to the Francisco de Holanda High School, Guimarães". *Sustainability*, vol. 1, pp. 1-21, 2019.

[19] J.J. Salovaara, K. Soini and J. Pietikäine. "Sustainability science in education: analysis of master's programmes' curricula". *Sustainability Science*, vol. 15, pp. 1-15, 2019.

[20] G. Tejedor, J. Segalàs, Á. Barrón, M. Fernández-Morilla, M. Teresa Fuertes, J. Ruiz-Morales, I. Gutiérrez, E. García-González, P. Aramburuzabala and À. Hernández. "Didactic Strategies to Promote Competencies in Sustainability". *Sustainability*, vol. 11, pp. 2-24, 2019.

[21] S-S. Weng, Y. Liu and Y-C. Chuang. "Reform of Chinese Universities in the Context of Sustainable Development: Teacher Evaluation and Improvement Based on Hybrid Multiple Criteria Decision-Making Model". *Sustainability*, vol. 11, pp.1-23, 2019.

[22] B. Durrans, J. Whale and M. Calais. "Benchmarking a Sustainable Energy Engineering Undergraduate Degree against Curriculum Frameworks and Pedagogy Standards from Industry and Academia". *Energies*, vol. 13, pp. 1-32, 2020.

[23] V.R. Vargas, R. Lawthom, A. Prowse, S. Randles and K. Tzoulas. "Implications of Vertical Policy Integration for Sustainable Development Implementation in Higher Education Institutions". *Journal of Cleaner Production*, vol. 235, 20, pp. 733-740, 2019.

[24] N.H. Choe and M. Borrego. "Master's and doctoral engineering students' interest in industry, academia, and government careers". *Journal of Engineering Education*, vol. 109, pp. 325-346, 2020.

[25] E.P. Dubovikova. "Developing professional competences in training construction engineering specialists". *International Conference on Construction, Architecture and Technosphere Safety, Materials Science and Engineering*, vol. 687, 044046, pp. 1-6, 2019.

[26] E. Syahmaidi, H. Hidayat, S. Hartanto and A.F. Rahmadani. "Needs Analysis of Designing Online Computer-Assisted Training to Improve Pedagogical Competencies in Engineering Education". *International Journal of Engineering and Advanced Technology (IJEAT)*, vol. 8(6), pp. 4619-4624, 2019.

[27] M. Ghonim and N. Eweda. "Instructors' perspectives on the pedagogy of architectural graduation projects: A qualitative study". *Frontiers of Architectural Research*, vol. 8, pp. 415-427, 2019.

[28] O.O. Gorshkova. "Technology to form Students' Readiness for Research in Engineering Universities". *International Journal of Engineering and Advanced Technology (IJEAT)*, vol. 9(1), pp. 3881-3887, 2019.

[29] P. Balve and L. Ebert. "Ex Post Evaluation of a Learning Factory – Competence Development Based on Graduates Feedback". *Procedia Manufacturing*, vol. 31, pp. 8-13, 2019.

[30] M.A. Fedoseeva, N.A. Prokudina, N.Yu Fedoseeva, V.S. Evdokimov, A.A. Kapelukhovskaya and V.L. Yusha. "Developing teamwork skills for students trained in compressors and refrigeration programs". *International Conference on Compressors and their Systems. Materials Science and Engineering*, vol. 604, pp. 1-8, 2019.

[31] M.G. Sergeeva, A.V. Vilkova, V.M. Litvishkov, L.V. Kovtunenko, D.V. Lukashenko and E.M. Klimova, "Technology and Innovation in the Development of Cognitive Activity" *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 8(12), pp. 1050-1055, 2019.

[32] G.R. Zamaletdinova, N.V. Konopleva, and N.V. Gorbunova. "Electronic Educational Resources as Means of Formation of the Foreign-Language Professionally Focused Competence of Future Philologists". *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 9(1), pp. 5115-5118, 2019.

[33] F.J. Racero, S. Bueno and M.D. Gallego. "Predicting Students' Behavioral Intention to Use Open Source Software: A Combined View of the Technology Acceptance Model and Self-Determination Theory". *Applied Sciences*, vol. 10, 2711, pp. 1-15, 2020.
[34] Z.V. Smirnova, O. I. Vaganova, E. Y. Konovalova, J.A. Kulagina, N.E. Zhitnikova, N.V. Frolova and V.E. Lukina. "Modern Communication Technologies in Professional Education". *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 8(11), pp. 3751-3756, 2019.
[35] D.N. Bairaktarova and M.K. Pilotte. "Person or thing oriented: A comparative study of individual differences of first-year engineering students and practitioners". *Journal of Engineering Education*, vol. 109, pp. 230-242, 2019.
[36] J. Hoven. "Ethics and the UN Sustainable Development Goals: The Case for Comprehensive Engineering Commentary on "Using Student Engagement to Relocate Ethics to the Core of the Engineering Curriculum". *Science and Engineering Ethics*, vol. 25, pp. 1789-1797, 2019.
[37] B. Taebi and W. Kastenberg. Teaching Engineering Ethics to PhD Students: A Berkeley-Delft Initiative Commentary on "Ethics Across the Curriculum: Prospects for Broader (and Deeper) Teaching and Learning in Research and Engineering Ethics". *Science and Engineering Ethics*, vol. 25, pp. 1763-1770, 2019.
[38] S.S. Jordan, C.H. Foster, I.K. Anderson, C.A. Betoney and T.J.D. Pangan. "Learning from the experiences of Navajo engineers: Looking toward the development of a culturally responsive engineering curriculum". *Journal of Engineering Education*, vol. 108, pp. 355-376, 2019.
[39] M. Gunasekera, S. Ahmed and F. Khan. "Integration of process safety in equipment design: A framework for academic learning activity". *Education for Chemical Engineers*, vol. 30, pp. 32-39, 2019.
[40] U.F. Sabirova, S.V. Gusenina, M.V. Sukhomlinova and V.I. Safyanov. "Humanization as a Sociocultural Component of the Higher Education Quality". *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 9(1), pp. 3209-3218, 2019.
[41] J. Castro-Bedriñana, D. Chirinos-Peinado, F. Zenteno-Vigo and G. Castro-Chirinos. "Satisfaction of Old Graduates of Zootechnical Engineering for Improvement of Educational Quality at the UNCP". *Advances in Science, Technology and Engineering Systems Journal*, vol. 5(2), pp. 166-173, 2020.
[42] Gartner. Internet: http://www.gartner.com/newsroom, [Apr. 20, 2020].
[43] OECD, "OECD Employment Outlook 2019: The Future of Work". OECD Publishing, Paris, Internet: https://doi.org/10.1787/9ee00155-en [Apr. 20, 2020].
[44] World Economic Forum. *The Future of Jobs Report 2018. Insight Report*. Geneva, Switzerland: Centre for the New Economy and Society, 2018.
[45] I. Łapuńka, A. Czerwińska-Lubszczyk, and M. Grebski. "Badanie luk kompetencyjnych inżynierów Przemysłu 4.0", in *Cyfryzacja Produkcji. Aktualności badawcze* 2, R. Knosala, Ed. Warszawa: PWE, 2020, pp. 173-182.
[46] S. Haidi and R. Rabiman. "The Evaluation of Industrial Assisted Classes Program in Vocational Schools in Yogyakarta". *International Conference on Technology and Vocational Teacher, Materials Science and Engineering*, vol. 535, pp. 1-9, 2019.
[47] N.D. Guskova, et al. "The Quality of Education as a Primary Concern of the Sustainable Development", *European Research Studies Journal*, vol. XIX, 3B, pp. 239-257, 2016.
[48] W. Grebski et al. "Comparative Analysis of the Curriculum of Mechanical Engineering Program in Poland and the United States". *Scientific Papers of Silesian University of Technology. Organization and Management Series*, vol. 148, pp. 203-214, 2020.
[49] A. Czerwińska-Lubszczyk, M. Grebski, D. Jagoda-Sobalak. „Partners in Education – Development of Graduates Competencies", *Scientific Papers of Silesian University of Technology. Organization and Management Series*, 2022.
[50] A. Czerwińska-Lubszczyk, M. Grebski, D. Jagoda-Sobalak. "Cooperation of Universities with Business in Poland and the USA-Perspective of Scientific Environment", *Management Systems in Production Engineering,* vol. 28(1), pp. 40-46, 2020.
[51] W. Grebski, M. Grebski. "Keeping Higher Education Aligned with the Requirements and Expectations of the Knowledge-Based Economy". *Production Engineering Archives,* vol. 21(21), pp. 3-7, 2018.
[52] "Krajowy plan na rzecz energii i klimatu na lata 2021-2030. Założenia i cele oraz polityki i działania", Ministerstwo Aktywów Państwowych, 2019.
[53] M. Dacko et al. "Energy Production and Consumption in the European Union – Assessment of Changes in the Aspects of Sustainability and the Energy Self-Sufficiency". *European Research Studies Journal*, vol. XXIII, Special Issue 1, pp. 1100-1112, 2020.

Agnieszka Czerwińska-Lubszczyk
ORCID ID: 0000-0001-8100-8802
University of Bielsko-Biala
Faculty of Management and Transport
Department of Economic and Social Science
ul. Willowa 2, 43-309 Bielsko-Biała, Poland
e-mail: aczerwinska@ath.bielsko.pl

Michalene Grebski
ORCID ID: 0000-0002-3487-4473
Colorado Mesa University
1100 North Avenue
Grand Junction, CO 81501-3122, USA
e-mail: mgrebski@coloradomesa.edu

Dominika Jagoda-Sobalak
ORCID ID: 0000-0003-3085-6603
Opole University of Technology
Faculty of Production Engineering and Logistics
Department of Management and Production Engineering
ul. Ozimska 75, 45-370 Opole, Poland
e-mail: d.jagoda@po.opole.pl