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The Project-Based Approach in Organizing Cooperation Between Business Institutions and Technical Universities in Digitalization Conditions

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Digital revolution has dramatically influenced modern job market that consequently has new requests to higher education. Universities look for ways to improve their partnership with companies so that not only respond to employers' requirements but even try to be a step ahead foreseeing the competences

highly needed in coming years. In this article we identified the main barriers to fruitful cooperation between universities and business in conditions of global digitalization. Using the case of Course on basic skills in project work for the 2nd year bachelor students of Peter the Great St. Petersburg Polytechnic University (SPbPU) we reviewed the role of project-based approach in overcoming these barriers. In frame of the Course business institutions are involved in project work with students. Annually more than 4,000 students of all specialties take the Course. We analyzed project-oriented Course of SPbPU in terms of organizational structure and managing the process, promotion among the companies and meeting their needs, students' involvement and motivation, effect on students' skills and teachers' engagement. The article presents the analysis of data that was collected in 2018–2021 and the results of survey carried out among students attending the Course. This data is systemized according to the aspects mentioned above. We found out that project-based approach in education is a rather promising instrument for designing fruitful interaction between university, students and companies. As one of detected challenges for practical based collaboration with companies we regard the involvement of teachers in cooperation with the companies.

Keywords: digitalization, project activity, engineering education, business, motivation, students, soft skills, interaction.

Introduction

The modern stage of technological development is characterized by embedding information technologies particularly cyber-physical systems in different areas of life. Such basic technologies for cyber-physical systems, including artificial intelligence, robotics, Internet of things, 3D printing, etc. are considered as megatrends that determine the fourth industrial revolution [*Schwab*, 2017, p. 17].

Scientists from various fields are widely discussing the possibilities and prospects of such rapid technological development. Some of them highlight positive features in technological progress, suggesting that it will allow humanity to reach new heights in science, increase the duration and quality of life, achieve economic growth while others underline the threats posed by the new technogenic civilization [*Fasoli*, 2021, p. 245]. Anyway, researchers agree that the ongoing transformations require new skills and knowledge, a new way of thinking that meets the challenges of the times.

In this regard the experts at the highest level review the lack of competent human resources for digital society as well as for the oncoming epoque of convergent NBIC-technologies [*Schummer*, 2009].

Every year since 2016 World Economic Forum analysts list top 10 competences required by employees. One of the stable trend for more than 5 years claimed in the Forum reports is the high importance of soft skills in different professional areas. However, the components of "soft skills" vary from year to year. Thus, in 2020 skills in self-management such as active learning, resilience, stress tolerance and flexibility were newly included in the top 10 list [*The Future of Jobs Report*, 2020].

Such evolution in skills relevance is associated with a variety of economic and social reasons such as digitalisation, COVID-19 consequences, emergence and fall of industries and others [*Pauceanu et al.*, 2020; *Gill*, 2020; *Daniel*, 2020]. Many analysts and researchers talk about the influence of Industry 4.0. on the nearest future employment situation. It is predicted that in the perspective of 5–10 years many today's professions will disappear. On the other hand, a range of new jobs will appear due to the entrance of smart technologies in business, industry and social life. So the demand for the skills of specialists will also be

different [*Pauceanu et al.*, 2020; *Brougham, Haar*, 2018]. COVID-19 is now pushing forward this trend as pandemic caused transformation of the working processes in different organizations as well as recession in some economic sectors and rapid growth in others [*Gill*, 2020].

Anyway experts agree that in order to be competitive in a future job market the professionals have to possess flexible competences closely corresponding to employers' vision and needs. However, despite all the efforts that are undertaken by employers, universities and governments of different countries there is still a gap between graduates' skills and professional world requirements [*Abelha et al.*, 2020; *Moore, Morton*, 2017].

Considering this, universities look for ways to improve their educational process so that they would be able not only respond to employers' demands but even attempting to be a step ahead foreseeing the competences highly needed in coming years. This seems to be possible only in close cooperation between universities and companies in the education process.

In this article we propose to consider the experience of Peter the Great St. Petersburg Polytechnic University in organizing a Project-Based Course for the 2nd year bachelor students in collaboration with employers.

Literature overview

1. Education and digital revolution 4.0

Ideologist of the concept and creator of the term Revolution 4.0. K. Schwab describes the processes taking place in society under the influence of digitalization and notes the upcoming changes in the labor market, the growing problems of employment and gender inequality [*Schwab*, 2017, p. 17]. Revolutionary changes require a new level of adaptive abilities from a person [*Ibid.*, p. 36]. Education is considered by the researcher as a tool that should help a person to be aware of the transformations, accept them and find his or her place in the new world. Concerning the role of education in a new technological formation it is important to address Schwab's views on intelligence as a force capable of resisting the negative consequences of the rapid innovations. According to Schwab's concept the intelligence includes 4 elements: contextual (mind) — the ability to understand trends and consider a problem as a complex entity; emotional (heart) — self-awareness, self-control, motivation, empathy and social skills; inspirational (soul) — a creative impulse to search for meaning and purpose; physical (body) — the ability to keep yourself in good shape and maintain self-control [*Ibid.*, p. 84]. Such concept of intelligence corresponds well to the increasing role of soft skills development in education.

Russian researcher S. Khaprov [*Khaprov*, 2012] also pays great attention to education in the era of global digitalization. He notes that the technological changes have led to a significant reduction of professional competence life cycle, which is now not longer than five years. Thus, the competencies included in the educational programs when first-year students start their education lose their relevance when students graduate from the university. As a solution Khaprov suggests setting up continuous interaction of higher education with industry throughout the entire study period. Such interaction should be carried out in electronic environment in real-time mode with minimal time delays to maintain the cooperation of a large number of corporations and a university with a variety of disciplinary areas. At the same time, the core of this collaboration is a joint investigation of technological issues conducted by scientists and students of the university together with practitioners of enterprises.

2. Project-based approach to education

For the last several decades project-based learning (PBL) became a very popular approach to education in different spheres and a topic of high research interest. William N. Bender defines PBL as "an instructional model based on having students confront real-world issues and problems that they find meaningful, determine how to address them, and then act in a collaborative way" [*Bender*, 2012]. Various studies articulate the effect of PBL in improving students professional [*Fortelius et al.*, 2015; *Chua et al.*, 2014; *Kwon et al.*, 2021] and soft skills [*Rohm et al.*, 2021]. In this regard project-based approach has a positive impact on developing a set of soft competences such as communication skills, creativity, team work, ability to find information [*Wurdinger, Rudolph*, 2009, *Vogler et al.*, 2018] etc. Discussion about the role of PBL in upgrading students' skills also includes a range of researches dedicated to improving employability skills through developing projects [*Pauceanu et al.*, 2020; *Ornellas et al.*, 2019], that is considered to be a group of meta competences highly needed to get a job [*Fraser et al.*, 2019] and that require regular updating according to labour market demands [*Yorke*, 2005].

In addition, a large number of reviews underline that project-based approach opens a wide perspective for individually oriented education, since in such format student becomes a key actor and the subject of education [*Dilekli*, 2020]. While generating the idea, analyzing context, and developing the product of the project the students inevitably meet the lack of knowledge and skills that they have to improve, so such challenges engage students' motivation for studying and searching for additional knowledge on their own. Thus, PBL provides opportunities to implement individual educational routes considering personal characteristics of each student. Besides, while conducting the real projects students "learn how to learn" and become more flexible to adopting changes in their professional area.

3. Analysis of cooperation between universities and companies

Cooperation with companies in recent years has become a crucial issue for universities in different countries. It has been proved by a large number of publications [*Asmara, Wu*, 2020; *Fonseca et al.*, 2020; *Basit et al.*, 2015; *Isakov et al.*, 2020]. Universities undertake different efforts to establish fruitful and long term cooperation with business. The most popular among them are the forms of real-life problem-based learning, internships for students, employers' participation in courses and seminars, cooperation with career centers and others [*Pereira et al.*, 2020, p. 6–7].

However, there is still a gap between higher education and the business world in various aspects. As one of such challenges researchers articulate the lack of interest from the side of companies in expanding cooperation with university to something more than internship [*Jonbekova et al.*, 2020, p. 6]. At the same time even when organizations invite students as interns, the tasks that students get from the company often differ a lot from the future profession as they do not go beyond simple administrative operations like copying documents or answering the phone.

Another issue related to the first one is that universities in many cases do not have enough competence or creativity to effectively promote their proposals to the business market [*Basit et al.*, 2015]. This can be caused by several factors such as the university intracorporate culture, organization structure etc.

Thus, we can see the situation, when universities and companies speak different languages. There is a mismatch between employers` and academic needs and perception of coopera-

tion. Higher education institutions are not sufficiently involved in the world of real business, so the university curricula lacks relevance to the labor market [*Pereira et al.*, 2020, p. 8].

As for the management and administrative aspects the cases of different universities state that in some of them there is still no department or administrative position responsible for systematic university-business cooperation [*Jonbekova et al.*, 2020, p. 7].

Regarding creating a project-based curriculum in collaboration with companies, that as we discussed are quite effective, universities meet the problem of staff competence in developing such courses. To design a project-based program the university staff should possess not only subject knowledge but project skills as well [*Basit et al.*, 2015].

In this research we are trying to find out how PBL in multidisciplinary university should be organized in order to enhance cooperation with companies and solve the problems mentioned above. To do this we consider the experience of Peter the Great St. Petersburg Polytechnic University in organizing a Project-Based Course for the 2nd year bachelor students in collaboration with employers. We pay attention to the following aspects: organization structure and managing the process, promotion to companies and meeting their needs, students' involvement and motivation, effect on students' skills and faculty engagement.

Methodology

Data for this review was collected between 2018 and 2021 in the frame of three academic semesters of a project-based course "Fundamentals of Project-Based Activities" conducted by Peter the Great St. Petersburg Polytechnic University [*Redko et al.*, 2020, p. 646].

Peter the Great St. Petersburg Polytechnic University (SPbPU) was chosen for this research for several reasons. First of all SPbPU is one of the largest universities in Russia and provides education for more than 30 000 students in more than 60 areas, including engineering, natural science, humanities and economics. Such scale ensured the representativeness of the data analyzed in research. The university has large experience in establishing cooperation with Russian and foreign companies, so the case of SPbPU can be regarded as one of the best practices in Russian education.

In 2017 SPbPU, first among Russian universities, launched a unified project-based course "Fundamentals of Project-Based Activities" that all students attend in the 2nd year of education. Since 2019 university invites the customers from among industry and business to take part in the course by proposing project tasks for students. This course is organized as Massive Open Online Course (MOOC) on digital platform *project.spbstu.ru* that collects statistical data about the students, projects and customers. These data became the main source for the research. Collected data were reviewed by defining the topics that correspond to the research goals.

To detect motivation of students we asked 1798 students attending the course "Fundamentals of Project-Based Activities" at SPbPU about the reasons for choosing the project.

Conducting research and results

1. Course organization

Course "Fundamentals of Project-Based Activities" (course) has been held in SPbPU since 2017 [*Redko et al.*, 2020]. All second year students of all areas of training attend the course. Every year it is more than 4,000 students annually who carry out 600–700 projects in teams under the guidance of about 90 teachers.

The theoretical part of the course takes place online on the MOOC platform. Stages of projects performance, practical tasks are also recorded on the MOOC platform. Each team and its teacher are registered on the platform. Each team gets a "project page" where they upload all completed tasks related to the planning and implementation of the project. So the platform collects digital trail of each student concerning the course.

In the practical part of the course, student teams pass through the all stages of the project from an idea to a practical result such as a prototype of a device, a program, an event, etc. They present the results to the customer, experts and the course teacher.

An obligatory part of the course is participation of customers represented by future employers of students (business, public sector organizations, SPbPU divisions, etc.). It helps students to achieve a real practice-oriented result and develop social interaction skills. As the topic of the project, the customer proposes to students their real problems or tasks.

Customer topics shall meet the following requirements:

— to be aimed at solving a concrete problem or task of the company;
— to be feasible within 2–2.5 months by second year students;
— to have a tangible result (prototype, program, event, research, material object, modernization, etc.);
— to require teamwork;
— to require external communications with customers, university staff, students, focus groups, etc.;
— the customer should provide the resources to achieve the project goal (materials, administrative resources within the customer, etc.) if necessary;
— the customer supervisor should be ready to communicate with the student team during the work on the project (if necessary, communicate with them online or offline at least once in a 2 weeks).

Thus, the course develops social interaction skills of students not only in the usual conditions of communication with the teacher and classmates, but also with external participants — customers from business.

Organizing the work of 4000 students on 600–700 projects is a complicated task. The course administrative team is responsible for its implementation. This area of responsibility includes methodological and administrative support of the course, support of the database with project topics, inviting customers and communication with them.

The work of student teams is supervised by about 90 teachers, who undergo special training in project activity and mentoring. Teachers are responsible for students' educational outcomes and they are also involved in work with customers.

The customer supervisors play an important role in the course. They consult students on the topic of the project as well as on technical issues.

In order to succeed during the course students shall take a proactive position. They should form the project team on their own and they can choose topics based on their preferences. They also have the opportunity to invite customers themselves and suggest an initiative instead of the themes proposed in the database. The team is led by a student, one of its members. Students communicate with companies directly, the teacher or course administrative team are involved in this process only when problems arise.

2. Promotion to companies and meeting their needs

It is obvious that the customers play an essential role in the course. What motivates them to work with students? In a form for submitting a project topic we asked companies to answer a question "What is your goal for participating in the course?"

The following Table 1 shows the customers' responses.

Table 1. Responses of the companies about their expectation of participating in the course

Response	2019 (%)	2020 (%)	2021 (%)
to get a prototype	10	34	33
to get fresh and perspective ideas	34	30	26
to find employees	9	19	22
to get to know the university, its stuff and the younger generation	42	14	17
another answer	5	3	2

In 2019 the largest number of customers had the cooperation with university before joining the course. As we can see, their expectations were mostly to receive new ideas and acquaintances with students. Later when a large number of new customers joined the course, their goals were associated more with obtaining a concrete practical result: prototypes of solutions and personnel for employment.

In Table 2 the distribution of external customers' topics by areas (IT, technical, economic, organizational, creative) shows that IT topics lead from year to year. Obviously this is influenced by the global trend of digitalization of the economy. We also noticed that the number of technical topics has risen in the last two years. This can be caused by an increasing confidence of customer in capabilities of students to achieve real results. This fact also confirms the interest of companies in obtaining concrete practical results.

Table 2. The share of topics from external customers in the course database

The topic areas	2019 (%)	2020 (%)	2021 (%)
IT	34	47	36
Technical	17	23	28
Economic and marketing	22	9	17
Organizational	22	14	8
Creative	5	7	11

Table 3 demonstrates that the number of regular customers on the course has increased from year to year, that also validates their satisfaction and interest in cooperation.

Table 3. Number of customers in 2019–2021

	2019	2020	2021
Total registered external customers on the course, and students	48	87	82
Number of external customers, invited by course administrative team, faculty and participating in the course for the first time	21	49	34
Number of re-enrolled customers invited by the course administrative team and faculty	0	9	17
Number of external customers, invited by students and participating in the course for the first time	27	29	31
Number of re-enrolled customers registered by students	0	0	0

It took three years to ensure systematic work with customers within the course. In 2018, when the course was launched for the first time, the teachers offered their topics as the customers. A pilot work with external customers started in 2019, when 21 companies from among the current partners of the university offered 41 topics. Since 2020 SPbPU has launched systematic approach to inviting external (business) and internal (university departments) customers. This process is led by course administrative team in cooperation with the Career Development Department. Teachers are also involved in this work. They attend special training on working with customers.

Table 4 represents the composition of the course database by years.

Table 4. Composition of the course database

	2018	2019	2020	2021
Total number of topics in the database	443	214	324	344
Number of external customers topics	0	41	128	173
Number of topics from SPbPU divisions	443	173	196	171

In 2018, when the course was launched for the first time, the teachers offered students a large number of topics — 443. Then practice has shown that there is no need to have such a large number of internal topics to organize the course so in 2019 the number of internal topics dropped to 173 and has remained stable in subsequent years.

At the same time the number of external topics has risen from year to year, which can indicate the growing interest of companies in this type of cooperation as well as the productivity of SPbPU's approach to attracting external customers.

The work is carried out by the course administrative team all year round. It includes designing presentation materials, maintenance of website and social networks, participation in events attended by potential customers, cooperation with infrastructure partners, communication with potential customers, promotion within the university, training of teachers.

The teachers join this work a few months before the course starts. They receive the presentation materials and guidelines from the administrative team.

In Table 5 we reviewed data on the number of external customers engaged by administrative team and teachers.

Table 5. Number of external customers invited by administrative team and teachers for the course

	2019	2020	2021
Total number of external customers registered in the database (invited by administrative team and teachers)	21	58	48
Number of external customers registered in the database invited by administrative team	14	39	36
Percentage	66,6%	67,2%	75%
Number of external customers registered in the database invited by teachers	7	19	12
Percentage	33,3%	32,8%	25%

Table 6 shows that some teachers make a certain contribution to the number of customers. However, the share of teachers engaging the customers has persistently remained

low. Thus, every year the same teachers invite the customers while training of other teachers doesn`t not give the desired effect.

Table 6. Number of teachers in the course

	2019	2020	2021
Total number of teachers on the course	86	95	98
Number of teachers who invited external customers	4	8	7
Percentage	5%	8%	7%

3. Students motivation

Fig. 1. shows that in the first 2 years, when the topics were proposed by the internal customers (teachers and university departments), almost half of the students (46% and 48%) preferred to develop their own (initiative) topics. In the last 2 years, when the largest number of topics were proposed by external customers, only a third of students preferred initiative topics, that seems to be a stable trend.

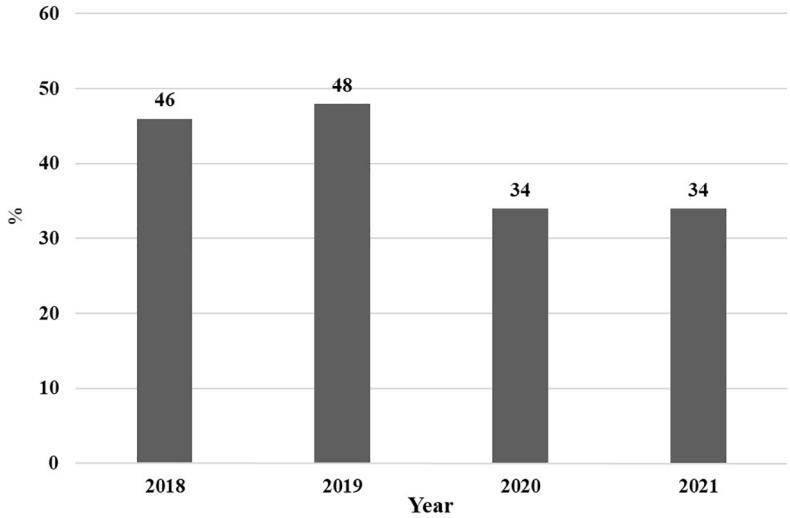

Fig. 1. Share of initiative projects in the total number of projects

At the stage of team building and choosing project topics students are not obliged to choose a topic among the proposed. They are able to suggest their own topic and invite customer company themselves (Table 7).

Table 7. The share of companies invited by students in total number of external customers

	2019	2020	2021
Total number of external customers	48	87	82
The number of external customers invited by students	27	29	31
Percentage	56%	33%	38%

Table 8 indicates, that more than a third of new customers are engaged by students. So student activity is an effective resource for developing a partner network of the course. But

as we determined in Table 3, the customers invited by students do not continue cooperation with the course. It means that course team needs to develop special instruments to establish direct contact with the customers engaged by students in order to maintain cooperation with them after the students' projects are completed.

Table 8. The share of student teams engaged external customer themselves in a total number of student teams

	2019	2020	2021
Total number of student teams	586	613	703
Number of student teams engaged external customer themselves	27	31	34
Percentage	5%	5%	5%

Fig. 2 illustrates the reasons for choosing the project topic by students. The majority of students (30%) chose the topic in order to know something new and contribute to future portfolio, 17% of the respondents chose the topic, because they consider it socially significant, and 14% of students are excited by the topic.

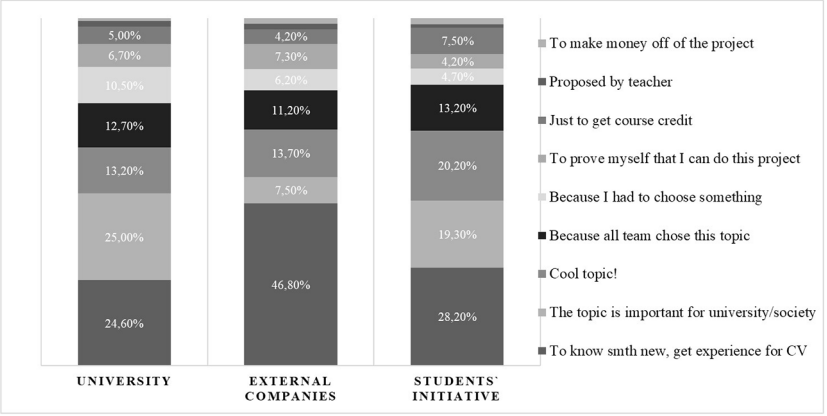

Fig. 2. Reasons for choosing the project topic by students

The diagram (Fig. 2) also shows the distribution of student preferences by categories of project topics (a topic from university departments, from an external customer or an initiative topic of students). Almost a half of the students (46,8%), who worked with external customers, chose the topic in order to know something new and contribute to the portfolio. A quarter of students, who preferred university topics, pay attention to social role of the project (25%), while almost the same number of them (24,6%) think about their CV. As for teams, who proposed topics themselves, 28,2% of them mentioned experience and CV, 20,2% emphasized that their topics are just cool and 19,3% underlined the social role of the project.

In addition, to analyze the self-assessment of employability skills by the students regarding their CVs, we prepared a questionnaire for the students and asked them the following question: "How great is the chance to find a job of interest with such a CV as yours?" We suggested them to rate their CVs in points from 0 to 4, where 0 meant "there is no CV yet", and 4 meant "as soon as I publish my CV, the employer will immediately reply and

offer me an interview". Fig. 3. shows distribution of the responses depending on to the type of project customer.

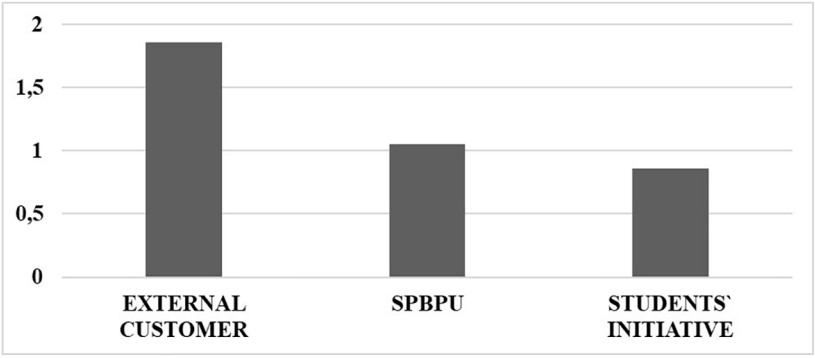

Fig. 3. Students' esteem of their CVs depending on the type of project customer

As we can see, the students, who had worked with external customers, rated their CVs and possible job success higher than the others.

Discussion

In our research we illustrated that project-based method is a good way to organize joint work between a large number of students with different education profiles and various companies from a range of professional spheres. On the one hand, practical project work matches a goal relevant for some companies such as getting prototypes or new ideas, finding employees and establishing business contacts with university. This study proves that companies are interested in project format and we identified the range of their main goals. As further step we plan to determine the satisfaction level according to each of the goal that can show the weak points in university strategy of designing interaction with business.

On the other hand, project based format gives extra motivation to the students in getting experience and improving their employability, also the self-assessment of employability skills by the students is higher when they cooperate with the customer.

Moreover, project collaboration with companies has a positive influence on students' self-managing skills and their opportunities for future employment, that as we discussed in the beginning of this article becomes more and more important in the age of digital revolution. Student teams have a number of areas of responsibilities that they should cover themselves starting from choosing the topic or even inviting the companies to take part in the course up to delivering the final result to the customer. The results of this research correspond the idea of positive effect that PBL and interaction with companies have on matching students' skills with market and society demands. In this article we reviewed organizational skills, in the future it is interesting to investigate a range of specific competencies, for example, engineering skills.

Another problem worth studying is attracting companies by students. We found out that every year stable 5% of students teams attract business tasks themselves and it is curious what can be done to increase this activity among students.

Positive effect is supported by organizational structure and promotional activities of university that we also considered in this review. The stable growth in the number of unique companies participating in the course is ensured by administrative team, who facilitate organizational issues and implement marketing instruments.

As one of detected challenges for practical based collaboration with companies we regard the engagement of teachers in inviting the companies. The engagement of teachers remains low despite the special measures for developing teachers` competence in organizing partnership with potential customers, undertaken by the course administrative team. So it is important to look for the reasons for such lack of involvement to fill the gap.

The debatable question is whether it is necessary to engage teachers in collecting tasks from customers or it is more sensible to leave this functionality for trained administrators. Quantitative data alone are not enough to answer this question. It is important to compare the qualitative characteristics of the projects ordered by customers invited by administrative team and those performed for companies invited by the teachers. It can be assumed that the teacher, who invited the customer, is more interested in the successful implementation of the project, but this remains to be verified in further research.

The obtained results can be applied by other universities to set interaction with companies. However, when interpreting and applying the results, it is important to take into account the specific features of each university. So, for example, the expectations of companies can vary significantly depending on the educational and research focus of the university, while the level of teacher involvement can depend on teacher's workload and the number of students per teacher.

Conclusion

The case of Peter the Great St. Petersburg Polytechnic University demonstrates complex approach to organizing project based learning with focus on interactions with business. The main features of this approach are the following:

- involving all students of the university in project work with customers;
- online platform for studying and practical work on the project;
- a single administrative team that manages the course and supports cooperation with companies;
- a pool of teachers specifically trained for project work and interaction with companies. This complex project-based approach is a rather promising instrument for enhancing fruitful interaction between university, students and employers. It helps to overcome widespread problems that concern organization and managing issues of university-business interactions, promoting university initiatives to companies, students' skills, engagement and their motivation for working with customers.

Further research can be dedicated to the topic of teachers' involvement in more close cooperation with business as well as detailed study of matching university and business goals and development of specific student's skills.

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Проектный подход в организации сотрудничества институтов бизнеса и технических университетов в условиях цифровизации

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Цифровая революция кардинально повлияла на современный рынок труда, который, как следствие, имеет новые запросы к высшему образованию. Университеты ищут способы улучшить партнерские отношения с компаниями, чтобы не только реагировать на требования работодателей, но и стараться быть на шаг впереди, предвидя компетенции, крайне необходимые в ближайшие годы. В статье выявлены основные барьеры, препятствующие формированию взаимовыгодного сотрудничества университетов и бизнеса в условиях глобальной цифровизации. На примере курса по основам проектной деятельности Санкт-Петербургского политехнического университета Петра Великого (СПбПУ) для второкурсников бакалавриата рассматривается роль проектного подхода в преодолении выявленных барьеров. Этот курс реализуется с привлечением институтов бизнеса к проектной работе студентов; ежегодно на нем обучаются более 4 000 студентов всех направлений подготовки. Проектный курс СПбПУ проанализирован в разрезе организационной структуры и управления процессом, продвижения среди компаний и удовлетворения их потребностей, вовлеченности и мотивации студентов, влияния на навыки студентов и вовлеченности преподавателей. В статье представлен анализ данных о курсе, собранных за период с 2018 по 2021 г., а также результаты опроса студентов, обучавшихся на курсе, которые систематизированы в соответствии с вышеуказанными аспектами. Обосновано, что комплексный подход к организации проектного обучения с упором на кооперацию с бизнесом является достаточно перспективным инструментом для построения плодотворного взаимодействия технического вуза, студентов и компаний. В качестве одной из труднопреодолимых проблем для практического сотрудничества с институтами бизнеса артикулируется вовлеченность преподавателей в работу с компаниями.

Ключевые слова: цифровизация, проектная деятельность, инженерное образование, бизнес, мотивация, студенты, гибкие компетенции, взаимодействие.