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BADANIE KOMPETENCJI I UMIEJĘTNOŚCI NAUCZYCIELI W DZIEDZINIE BIG DATA

Streszczenie: Badania dotyczą społeczności akademickiej zajmującej się kształceniem studentów uczelni wyższych w celu określenia kompetencji nauczycieli w zakresie Big Data i Data Science. Zadania tego badania miały na celu zbadanie potencjału innowacyjnego nauczycieli szkół wyższych w zakresie Big Data. Omówiono również pytania o to, jak poprawić jakość nauczania dyscyplin opartych na Big Data.

Słowa kluczowe: Big Data, nauczyciele, kompetencje

RESEARCH OF THE COMPETENCIES AND SKILLS OF TEACHERS IN THE FIELD OF BIG DATA

Summary: The research is related to the academic community involved in the teaching of university students to determine the competencies of teachers in the field of Big Data and Data Science. The tasks of this research were aimed at studying the innovative potential of teachers in higher education in the field of Big Data. The questions on how to improve the quality of teaching disciplines based on Big Data were also discussed.

Keywords: Big Data, teachers, competencies

1. Introduction

Lately the development of syllabus in Big Data have been under consideration [1-4]. A lot of attempts have been made in order to offer the corresponding training courses

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[5-16]. The development of competences in the field is related with the studying good practices, including the experience of the teachers. This research was carried out in the context of project no. 2020-1-PL01-KA203-082197 entitled “Innovations for Big Data in a Real World”. The scientists conducted a survey of the academic community involved in the teaching of university students from four partner countries in order to determine the competencies of teachers in the field of Big Data and Data Science.

The survey was performed on-line using Google Forms tools. The survey was performed during a period from the 1’th of September 2020 to 28’th of February 2021. To obtain wide range of data, multiple choice question fields, with additional open question field were offered to overcome the shortcomings of narrowed answers suggestions. The survey contains both open and closed questions. To make a process of data collection un-biased no additional recommendation was added. No events were reported during that time that could influence the result.

The teachers were randomly selected from different universities in Bulgaria, Poland, Serbia, Ukraine. The survey data were presented in a quantitative form. The data was aggregated to the category based on syntactic analysis I.e., the difference in form and not meaning .The open descriptions were analyzed with the help of bar charts of word frequencies, word clouds, and word associates .

Target

This survey is a part of the research within IO1 in connection with the objectives of project 2020-1-PL01-KA203-082197 "Innovations for Big Data in a Real World" (IBigWorld) under the Erasmus+ program. This project aims to join Universities, business and provide innovative solutions to develop Big Data experts. The questions in this research were aimed at study the innovative potential of teachers in vocational higher education in the field of Big Data. It is necessary to reveal that the university teachers who participated in the survey have a high scientific and innovative potential and a willingness to conduct research. It is also advisable to the innovative potential of teachers in vocational higher education in the field of Big Data to determine how to improve the quality of teaching disciplines based on Big Data.

2. Collection and analysis of data

To collect and analysis data on the potential of teachers, 80 teachers from different universities of the four project partner countries were interviewed (Fig. 1, Table 1). The FORM 4 − Survey for Academic (lecturers) questionnaire was offered to teachers of different universities.

The survey questions have been grouped into sections like this:

1. Big Data skills level.
2. Participation in the project iBigData.
3. Participation like a researcher in the project iBigData.
4. Participation like a trainer in the project iBigData.
5. Recommendations.

Data description

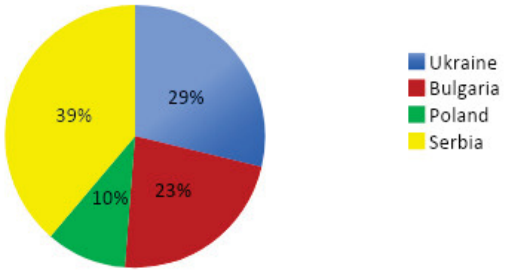

Figure 1. Percentage of teachers' surveyed in comparison with other project partners

Table 1. Percentage of teachers' surveyed in comparison with other project partners

Country	Total	Percentage
Serbia	31	38,75
Ukraine	23	28,75
Bulgaria	18	22,5
Poland	8	10

3. Research of the Innovative Potential of Teachers in Higher Education in the Field of Big Data

3.1. Big Data skills level

The goal of the question was to determine the current level of teachers' skills in Big Data in different countries.

Data description

The survey showed that 31.3% of the interviewed teachers have an intermediate level of skills in the field of Big Data (Figure 2). 18.8% of the surveyed teachers reported an beginner-level skill level. 7.5% of the surveyed teachers consider themselves to be Big Data experts.

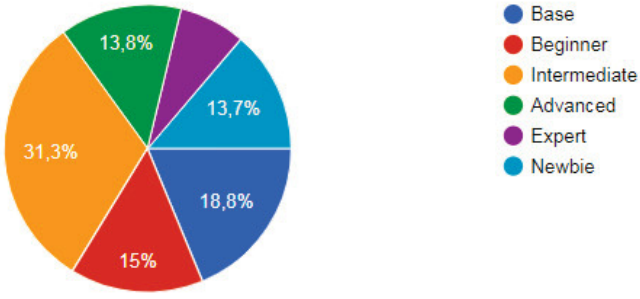

Figure 2. Big Data skills level of the teachers in Ukraine

Discussion

The analysis of the survey results showed that there are teachers with different levels of skills in the field of Big Data in different countries. Most of the teachers have an intermediate level of skills

Conclusion

The results of the survey show that the intellectual potential of the teachers in the field of Big Data needs to be developed. The main problems in the development of the direction of Big Data are the lack of qualified personnel, the lack of sufficient experience in implementations, as well as the high cost of solutions.

3.2. Sources and forms of knowledge and skills acquisition by teachers in the field of Big Data

The goal of the question was to get information where teachers received knowledge and skills in the field of Big Data.

Data description

The results of the survey are given in Table 2 and Figure 3.

Table 2. Sources of obtaining knowledge by teachers in the field of Big Data

Source of knowledge	Number of teachers	Percentage
Self-educated	52	65
University degree	15	18,75
Specialized course	8	10
NA	1	1,25
Only via newspapers	1	1,25
Experience	1	1,25
Projects	1	1,25
Work on industry cooperation projects	1	1,25
Total	80	100

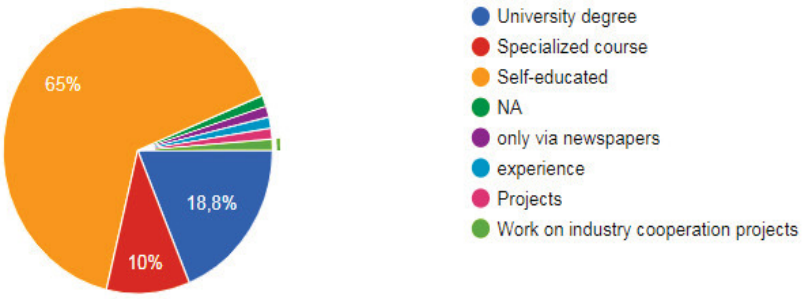

Figure 3. Big Data teachers' knowledge and skills sources

Discussion

65% of teachers are interested in the field of Big Data knowledge, are engaged in self-education and successfully work in this direction. 10% of teachers improve their qualifications in specialized courses. Educational programs on Big Data have been developing in the world. Graduates with a university degree in Big Data have appeared, as evidenced by the figure of 18.8% of the surveyed teachers.

Conclusion

The analysis of the survey results showed that the teachers of the universities of partner-countries are creative people, capable of improving their qualifications and acquiring new knowledge, including the field of Big Data. It is necessary to stimulate and motivate the teachers to improve their competencies in Big Data.

3.3. Experience in conducting Big Data courses

The goal of the question is to determine the presence of experience in conducting Big Data courses, thereby obtaining information about the practical qualifications of teachers.

Data description

The survey results are shown in Table 3 and Figure 4.

Table 3. Experience in conducting Big Data courses

Experience in conducting Big Data courses	Number of teachers	Percentage
No requirement	44	55
Short practice up to one year	13	16,25
From 1 to 3 years	13	16,25
Over 5 years	10	12,5
Total	80	100

Most of the respondents have no experience in conducting Big Data courses (55%). 16.25% of respondents have less than one year of experience. The same number of teachers have one to three years of teaching experience in conducting Big Data courses. 10% of respondents have more than 5 years of experience.

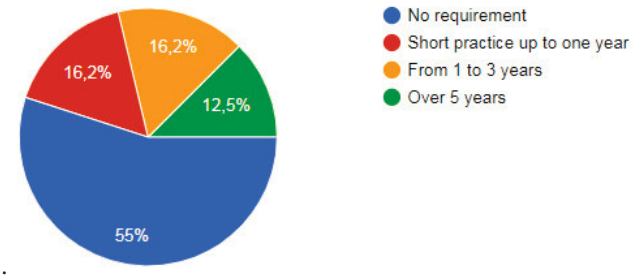

Figure 4. Big Data teachers' experience in conducting Big Data courses

Discussion

The lack of experience in conducting Big Data courses suggests that the relevant disciplines are not widely used in the educational programs of universities. Teachers lack the competencies to offer relevant courses to students.

Conclusion

The analysis of the survey results showed that it is necessary to expand the teaching of Big Data courses at universities and provide an opportunity for teachers to gain experience and improve their knowledge and skills.

3.4. Support of teaching by external experts

The purpose of the survey is to obtain information on the attitude of university professors towards external experts from the IT industry.

Data description

The survey results showed that 92.5% of respondents are positive about the involvement of external experts from the industry in conducting Big Data courses. Only 1.3% of teachers believe that the help of industry professionals is not needed. The survey results is shown in Table 4 and Figure 5.

Table 4. Teachers' opinion on the involvement of external experts to conducting Big Data courses

Teachers' opinion	Number of teachers	Percentage
Disagree	1	1,25
Somewhat disagree	0	0
Neither agree or disagree	5	6,25
Somewhat agree	31	38,75
Agree	43	53,75
Total	80	100

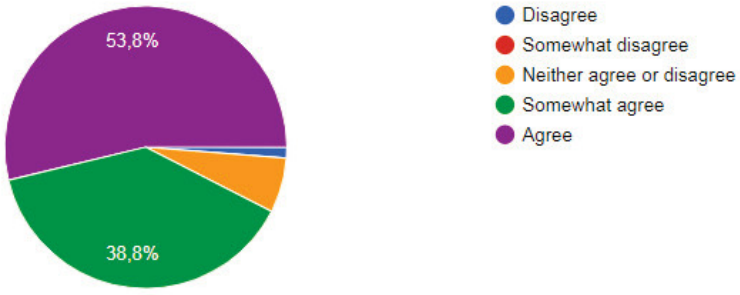

Figure 5. Teachers' opinion on the involvement of external experts to conducting Big Data courses

Discussion

The lack of experience in conducting Big Data courses suggests that the relevant disciplines are not widely used in the educational programs of universities. Teachers lack the competencies to offer relevant courses to students.

Conclusion

A survey of teachers showed that the majority of teachers do not have teaching experience, and the corresponding competencies have not been formed in conducting Big Data courses. The majority of teachers (92.5%) understand that teaching students relevant Big Data courses in accordance with the requirements of the IT market is possible only with the involvement of external experts from the IT industry.

3.5. Ways to improve the teachers' qualifications

The goal of the question is to find out how teachers prefer to expand their knowledge in Big Data

Data description

The survey results showed (Fig. 6) that the majority of surveyed teachers (61%) prefer Thematic courses / seminars / webinars to extend their knowledge in Big Data. To improve their practical skills 55% of teachers want to participate in Projects (commercial part/time job). 52.5% of respondents find it useful to participate in open source projects. For 39% of teachers, participation in conferences is important. Only 33% of the professors surveyed expressed a desire to get to know the results of research conducted at the universities. 2% of teachers prefer to extend your knowledge in Big Data by some kind of free academic access to resources of big cloud providers and focused talks on real-life.

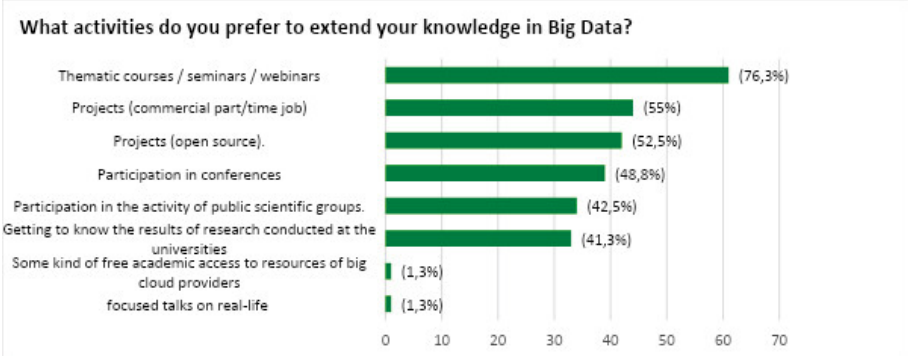

Figure 6. Activities that teachers prefer to extend their knowledge in Big Data

Discussion

Teachers are active in acquiring new knowledge, so thematic courses/seminars/webinars are popular, as they are organized and conducted by IT industry experts. Projects (commercial part/time job) can not only expand knowledge

and practical skills, but also provide an opportunity to receive additional finance. University projects do not inspire confidence among the interviewed teachers due to their inconsistency with modern rapidly changing technological requirements

Conclusion

The analysis of the survey results showed that in the universities it is necessary to expand the possibilities of cooperation with enterprises in order not only to attract experts for teaching disciplines, but also to attract teachers to project work. In addition, universities should create opportunities for teachers to take thematic courses at the request of the teacher.

3.6. Big Data competencies, that are important to include in the program

The purpose of the survey is to determine the directions for improving educational programs with the competence approach.

Data description

The results of the survey (Table 5) showed that from 34% and 38% of respondents consider it high important to include such competencies in the educational program:

1. Ability to process large volumes of data using hierarchical storage, hashing and filtering.
2. Ability to select the efficient algorithm to Big Data, which takes under consideration its scale.

More than 26% of respondents consider it important the competency “Ability to model, analyze, and evaluate organization's business processes”.

More than 25% consider it important such competencies:

1. Ability to select appropriate sampling and filtering method for given Big Data analysed case.
2. Ability to propose concepts, models, create and adapt methods and tools for professional activities using resources from others sciences.

Respondents do not consider such competencies important (27% - 31%):

1. Ability to perform market research and write business plans on information systems, software products, or IS development tasks
2. Graphical user interface analysis and design skills
3. Ability to carry out system reengineering and to analyze legacy databases

Table 5. Competencies that are important for the educational program

Competitions	**Ball of importance Number of teachers surveyed**					**Total**
	1	**2**	**3**	**4**	**5**	
Ability to process large volumes of data using hierarchical storage, hashing and filtering	1	6	11	26	34	78
Ability to select the efficient algorithm to Big Data, which takes under consideration its scale	1	3	8	28	38	78
Ability to select appropriate sampling and filtering method for given Big Data analysed case.	2	3	17	30	25	77

Ability to tackle with concurrency / parallelism problems of Big Data scale	1	7	26	21	22	77
Ability to propose concepts, models, create and adapt methods and tools for professional activities using resources from others sciences	0	4	18	31	25	78
Professional computer and IT usage skills	4	6	23	24	20	77
Ability to model, analyze, and evaluate organization's business processes	2	9	13	27	26	77
Good knowledge of latest information systems modeling languages and standards	2	10	18	32	15	77
Ability to perform market research and write business plans on information systems, software products, or IS development tasks	3	17	31	12	15	78
Graphical user interface analysis and design skills	5	14	27	19	12	77
Ability to carry out system reengineering and to analyze legacy databases	2	9	31	16	18	76

The comparative data analysis is shown in Figure 7.

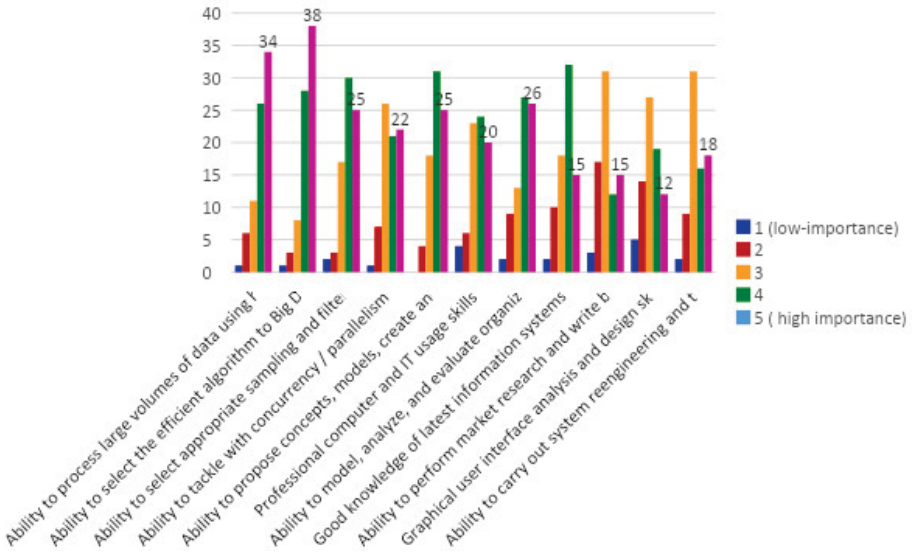

Figure 7. Assessment of Big Data competencies, that are important to include in the program

Discussion

Understanding the importance of developing education in the field of Big Data, teachers note the particular importance of the formation of such competencies that reflect the needs of the job market. Teachers support the following competencies: Ability to process large volumes of data, Ability to select the efficient algorithm to Big Data, Ability to tackle with concurrency / parallelism problems and so on. At the same time, such competencies as Ability to perform market research, Graphical user interface analysis and design skills, Ability to carry out system reengineering do not find support among the interviewed teachers.

Conclusion

The analysis of the survey results showed that it is necessary to improve constantly educational programs at the universities, taking into account the requirements of the IT industry and modern trends in IT development. In general, the interviewed teachers are correctly oriented in matters of modern development of the IT industry, in particular in the field of Big Data.

3.7. Building a website that will present results of Big Data research carried out by the local University

The purpose of the question is to determine the need of teachers for informational support of Big Data research carried out by the local University.

Data description

The results of the survey showed that the opinions of teachers were divided: 26.2% consider the creation of the website very important, 38.8% - Moderately important, 21.2% - Neutral. The result of teachers' survey is shown in Figure 8.

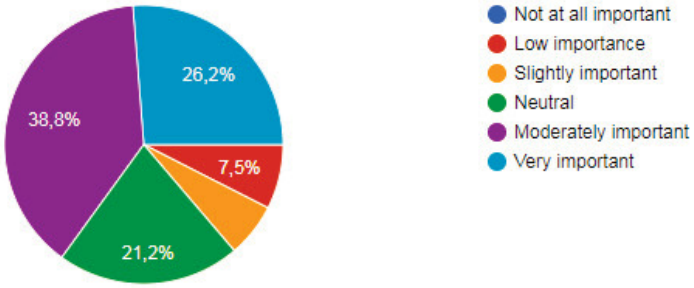

Figure 8. Assessment of the idea of creating a website of Big Data research

Discussion

The issues of presenting the results of Big Data research carried out by the local University are of interest to teachers, as evidenced by the survey results: from 21.2% Neutral to 38.8% Moderately important. Educators welcome reflection on Big Data research findings

Conclusion

Analysis of the survey results showed that teachers would like to have an online platform highlighting the results of work in the field of Big Data carried out by partner companies of universities.

3.8. How do you rate the idea of creating an open-source project, which would be devoted for some Big Data problem?

The purpose of the question is to receive information on desirable ways and methods of obtaining practical skills and experience in the field of Big Data.

Data description

The results of the survey (Fig. 9) shows that 35% of teachers believe that creating an open-source project which would be devoted for some Big Data problem and would be hosted by your university is very important, 45% − moderately important, and 15% − neutral. Only 5% of respondents consider Big Data open-source project, in which university will participates as not important.

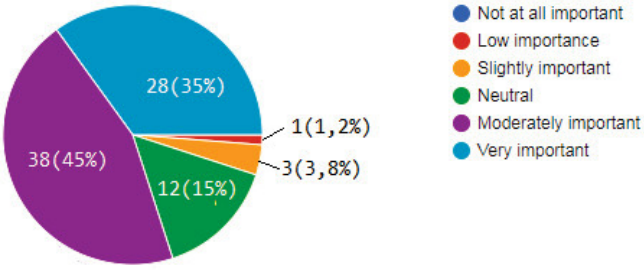

Figure 9. Assessment of the idea of creating Big Data open source project of Big Data

Discussion

Teachers correctly understand that participation in open source projects is an opportunity to improve your skills, while creating something new or improving existing ones. 80% of teachers have a positive attitude towards the idea of the open source project.

Conclusion

The best way to improve your skills is to participate in open source projects. The open source community provides a great opportunity for aspiring programmers to distinguish themselves; and by contributing to various projects, developers can improve their skills and get inspiration and support from like-minded people.

3.9. Participation in Big Data courses sponsored by the employer to extend teachers' knowledge

The purpose of the question is to obtain information on desirable ways and methods of professional development of teachers.

Data description

The survey results showed (Figure 10) that 72.5% of teachers want to participate in the 3rd Part Big Data courses (sponsored by the employer). Yet 25% may have participated. Only 2.5% expressed no interest to iBigData project training.

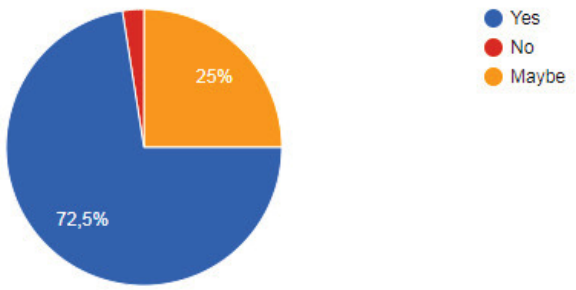

Figure 10. Teaching staff wishing to participate in the iBigData project training

Discussion

Expanding the knowledge of teachers in the field of Big Data and improving their qualifications are very important for the implementation of educational programs and teaching students. The teachers demonstrated an understanding of the need to extend their knowledge and skills. The sponsorship of employers should ensure the high quality of this process.

Conclusion

Analysis of the survey results showed that participation in 3rd Part Big Data courses (sponsored by the employer) to extend teachers' knowledge is very important for teachers.

4. Participation in the research on Big Data

4.1. Familiarity with the newest Big Data trends, technics, solutions

The purpose of the question is to find out the level of readiness of teachers to perceive technologies and solutions in the field of Big Data (Table 6, Fig. 11).

Data description

The results of the survey show that the majority (33.3%) of the surveyed teachers are interested in Big Data novelties from time to time. 23.1% of interviewed teachers are familiar with the newest Big Data trends, technics, solutions at most the basics. Only 25.7% of respondents participate in conferences and systematically read scientific articles.

Table 6 Familiarity with the newest Big Data trends, technics, solutions

#	Questions	No of teacher	Percentage
1	Rather yes, I am occasionally, investigating the area from time to time.	26	33,3
2	No, at most the basics	18	23,1
3	Only knowledge which is required to conduct classes/laboratories with students.	14	17,9

4	Yes, I am reading a lot of articles trying to be up to date in this area.	13	16,7
5	Yes, I am participating in bigdata conferences, projects etc.	7	9
	Total	78	100

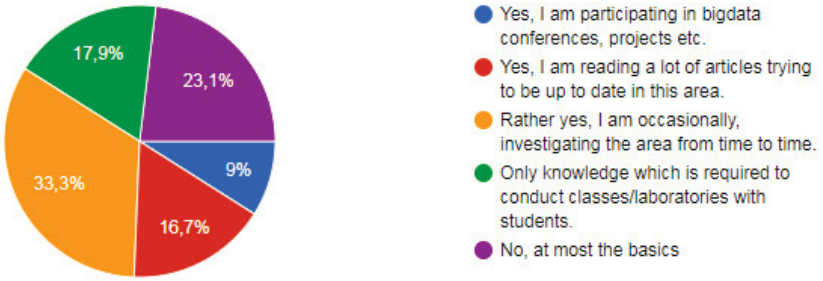

Figure 11. Familiarity of Ukrainian teachers with the newest Big Data trends

Discussion

Training Big Data educators is an urgent task. According to the survey results, only 25% of respondents work systematically in the field of Big Data and improve their scientific and technical level. For 75% of respondents, acquaintance with the newest Big Data trends, technics and solutions has not yet become a top priority.

Conclusion

For systematic work in the field of Big Data, teachers need to create many opportunities for participation in conferences (9% of teachers participating in conferences are very few). To expand knowledge and skills in the field of Big Data, teachers must have the opportunity and need to solve systematically applied problems in this area. For this, it is necessary to involve teachers in scientific and real projects.

4.2. What would you like to do, in the context of Big Data, within your classes as a part of a teaching program?

The purpose of the question is to interest teachers in introducing applied tasks in the field of Big Data into the educational process

Data description

The results of the survey (Fig. 12) showed that “Doping Big Data analytics/machine learning” arouses the greatest interest (78.2%) among teachers. 60.3% of the interviewed teachers are interested in collecting data from different sources. The questions “Presenting distributed processing techniques”, “Application of a full set-in system/software analysis”, “Applying HPC and parallel computing methods and techniques”, “Compare different platforms, tools and techniques, in practical applications” do not arouse the interest of teachers. Only 1.3% of respondents voted for these questions.

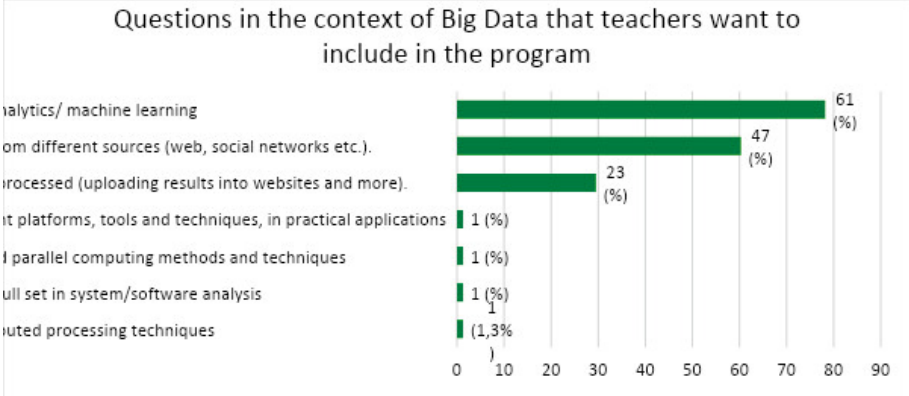

Figure 12. Educators' opinions on the importance of Big Data issues

Discussion

Modern IT trends such as Big Data analytics and machine learning are of interest to teachers and students. Machine learning takes an increasing place in our life every day due to the huge range of its applications.

Conclusion

Analysis of the survey results showed that teachers would like to use Big Data analytics and machine learning algorithms to solve real, everyday problems. The popularity of these areas can provide a breakthrough in the start-up breakthrough, victories in student competitions, student Olympiads, etc.

5. Participation like a researcher in the project iBigData

5.1. Have you participated in projects (commercial or open-source) which were based on Big Data?

The purpose of the question is to reveal that teachers have production experience in the development of projects based on Big Data, to analyze the participation of teachers in Big Data research.

Data description

The result of the survey showed that 59% of interviewed teachers did not participate in commercial projects using Big Data, 30.8% have experience in developing commercial projects. Only 10.3% of teachers participated in more than one project (Figure 13).

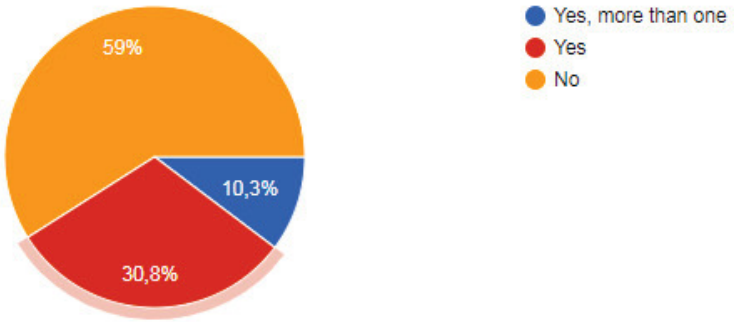

Figure 13. Teacher participation rates in commercial or open-source projects based on Big Data

Discussion

The teacher cannot compete in his KPI with professional programmers, analysts, engineers. That is why there is such a low percentage of teachers, who combine their teaching activities with participation in commercial or open-source projects based on Big Data. The low percentage of teachers who participated in research related to Big Data shows that Big Data is not in the sphere of the majority of teacher's interests. Teachers do not have the necessary knowledge and skills, the ability to participate in real projects, the need to use Big Data analytics in everyday life, etc.

Conclusion

A program is needed to harmonize relations between IT companies and universities in attracting teachers to participate in real commercial projects. It is necessary to popularize the direction of research related to Big Data, to motivate teachers to master Big Data technologies, to create conditions for the participation of teachers in projects and research related to Big Data, to ensure the availability of technical teaching materials on Big Data.

5.2. Have you published any scientific articles on Big Data matters?

The purpose of the question is to identify the publication activities of teachers in the field of Big Data.

Data description

The results of the survey showed (Figure 14) that 60.3% of surveyed teachers do not publish articles on Big Data, 25% have at least one article on this topic, and only 14% have more than one article

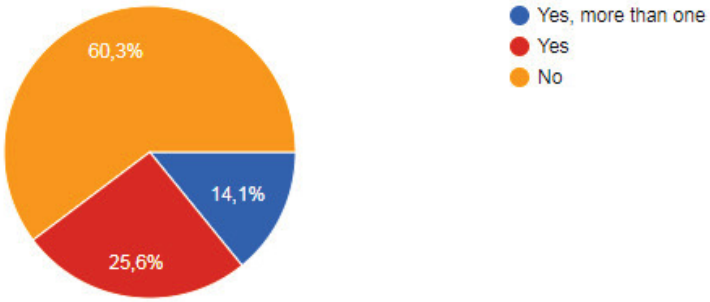

Figure 14. Teachers' publication activities in the field of Big Data

Discussion

The teachers are poorly involved in scientific research in the field of Big Data, mainly due to the lack of funding and the necessary competencies. Most of the interviewed teachers (60.3%) do not have scientific results, which does not allow them to publish scientific articles.

Conclusion

There is a need for a strategy for the development of the teacher's competencies in the field of Big Data, the creation of opportunities and funding for scientific research and testing their results in the real manufacturing sector.

5.3. Have you participated in researches which were based on Big Data?

The purpose of the question is to identify the research activities of teachers in the field of Big Data.

Data description

The results of the survey showed (Fig. 15) that 57.7% (45 teachers from 78) of surveyed teachers do not participate in scientific and technological researches in the field of Big Data. However, 42.3% of surveyed teachers have experience of participating in Big Data researches.

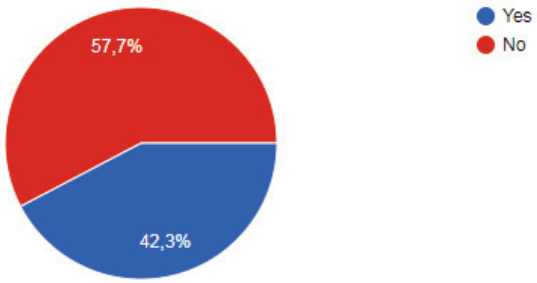

Figure 15. Teachers' research activities in the field of Big Data

Discussion

Lack of experience in scientific and engineering research in the field of Big Data is the reason for the low publication activities. However, almost half of the respondents take part in such studies, which indicates the possibility of the formation of competence teachers.

Conclusion

To enhance the participation of teachers in research based on Big Data, it is necessary to create conditions for motivating and stimulating IT companies to attract teachers to work on projects. For this, the work of part-time teachers in companies should be legalized.

6. Participation like a trainer in the project iBigData

6.1. Would you like to get into Big Data teaching?

The purpose of the survey is to find out the opinion of teachers about their desire to improve their qualifications by teaching a new course based on Big Data.

Data description

The results of the survey showed (Table 7, Fig. 16) that 29.5% of the teachers surveyed said "Maybe", 23.1% know how to use Big Data for teaching courses based on Big Data, 19.2% already reading Big Data courses, 9% would like to start using it.

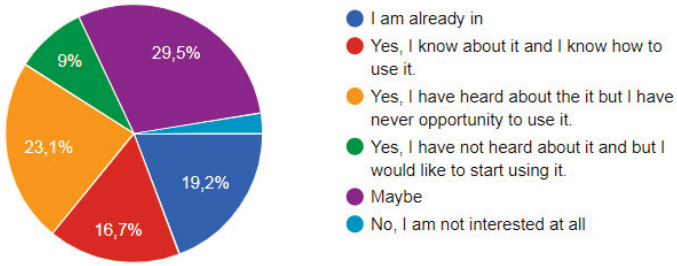

Figure 16. Percentage of teachers willing to teach Big Data courses

Table 7. Percentage of teachers willing to teach Big Data courses

The indicator under analysis	Number of teachers	Percentage
Maybe	23	29,5
Yes, I have heard about the it but I havenever opportunity to use it.	18	23,1
I am already in	15	19,2
Yes, I know about it and I know how touse it	13	16,7
Yes, I have not heard about it and but Iwould like to start using it	7	9
No, I am not interested at all	2	2,6
Total	78	100

Discussion

The teachers are cautious in expressing a desire to teach disciplines in the field of Big Data, as evidenced by 29.5% of teachers who said "Maybe"

Conclusion

The teachers lack faith in their own capabilities in terms of their willingness to teach Big Data. It is necessary to motivate and stimulate the desire of teachers to teach Big Data students. It is necessary to include more questions about Big Data/Machine Learning/AI in educational programs.

7. Recommendations of the teachers regarding Big Data

7.1. What would you propose to implement on your university to better understand Big Data matters?

The purpose of the question is to test the creativity of teachers in introducing Big Data courses into the educational process at universities (Table 8).

Data description

The survey results showed that teachers consider the proposals "Getting into cooperation which some Big Data company, open-source community or experts to speed up the knowledge acquisition" (41/80*100=51.25% high importance) and "Setting up a student's scientific group devoted for Big Data" (25/80*100=31.25% high importance) the most important. The least important teachers consider "Patronizing a Big Data event to gather people, companies involved in this matter" (16.25%). Figure 17 illustrates the distribution of votes between different proposals for the implementation of Big Data courses in the educational process.

Table 8. Teachers' proposition to implement on your university to better understand Big Data matters

#	The indicator under analysis	1-low-importance	2	3	4	5-high importance	Total
1	Organising regular presentations, webinars on Big Data matters	5	7	19	25	24	80
2	Patronizing a Big Data event to gather people, companies involved in this matter.	1	12	26	22	19	80
3	Setting up a students scientific group devoted for Big Data.	4	6	20	25	25	80
4	Getting into cooperation which some Big Data company, open-source community or experts to speed up the knowledge acquisition.	1	0	13	25	41	80

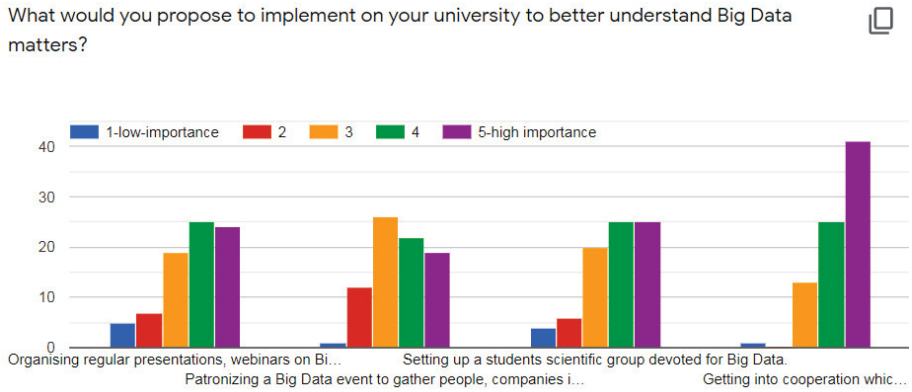

Figure 17. Indicators of the importance of Big Data implementation in the educational process

Discussion

More than 50% of the interviewed teachers believe that cooperation with any Big Data company, open-source community or experts will contribute to the successful implementation of Big Data in the educational process and accelerate the assimilation of knowledge. It will also be useful for teachers to organize regular presentations, webinars on Big Data matters and setting up a student's scientific group devoted for Big Data. More than 30% of teachers supported this proposal.

Conclusion

A modern university should be an educational ecosystem in which the university, companies, in particular, the IT industry, accelerators, business incubators, various funds, etc. interact. In such system, the synergy of interaction between IT education and the IT industry will contribute to the introduction of any modern technologies into the educational process.

7.2. Why is it important to include Big Data subject in the education process?

The goal is to justify the reasons for introducing courses on Big Data into the educational process.

Data description

The survey results show (Table 9) that 35% (28 from 80) of teachers consider "Job market requirements" very important, 43.75% (35) of teachers consider "Provide students with better knowledge on data processing what becomes critical nowadays" and 33,75% (27) of teachers consider "More opportunities for students and teachers to build their scientific skills" as very important (Fig. 18).

Table 9. Teachers' opinion on the importance of including Big Data in the educational process

#	The indicator under analysis	1-low-importance	2	3	4	5-high importance	Total
1	Job market requirements	0	4	16	32	28	80
2	Provide students with better knowledge on data processing what becomes critical nowadays.	0	1	10	34	35	80
3	More opportunities for students and teachers to build their scientific skills	1	5	9	38	27	80

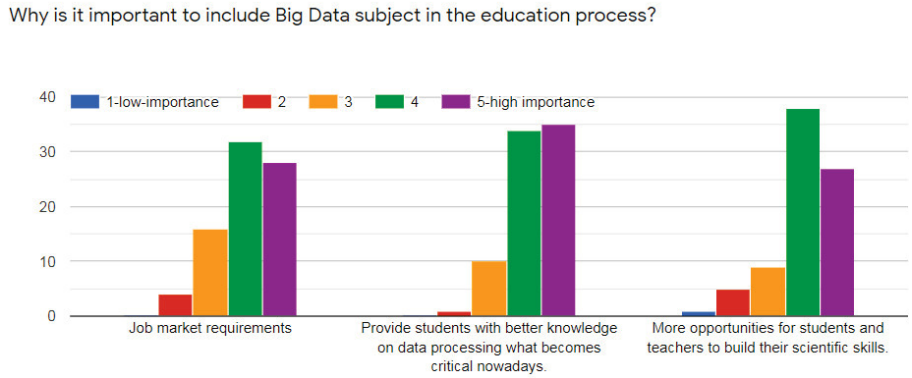

Figure 18. Important factors for including Big Data in the educational process.

Discussion

Teachers determine the importance of the criterion for including Big Data in the educational process in accordance with the requirements of the labour market, opportunities for students and teachers to develop their scientific skills and provide students with the best knowledge about data processing. On average, up to 40% of the teachers surveyed confirmed the importance of these criteria

Conclusion

Practice-oriented training takes into account the requirements of the labour market, where today Big Data solutions dominate in all industries. It is no coincidence, which the professions Data Scientist, Data Engineer and Data Analyst are among the scarcest. The introduction of Big Data courses in the educational process of universities should become one of the priority areas of activity.

7.3. What obstacles/issues do you see in implementing Big Data subject into the teaching programme?

The purpose of the question is to identify obstacles to the introduction of Big Data into the educational process.

Data description

The results of a survey (Table 10, Fig. 19) of teachers determined that 51.2% of teachers consider the biggest obstacle "Limitations resulting from the study program". 46.3% of teachers consider the problem of "Inadequate or maladjusted laboratory/lecture room equipment" to be a significant obstacle. 32.5% of teachers put the problem of "Formal barriers in submitting a new form of classes" in third place in importance. Teachers don't consider issues such as lack of knowledge, lack of appropriate computing resources, lack of strategic and legislative framework in the field of Big Data and Data Science as significant obstacles.

Table 10. Teachers' opinion on the obstacles/issues in implementing Big Data subject into the teaching programme

#	The indicator under analysis	Number of teachers	Percentage
1	Limitations resulting from the study program	41	51,2
2	Inadequate or maladjusted laboratory/lecture room equipment	37	46,3
3	Formal barriers in submitting a new form of classes.	26	32,5
4	Lack of specialists with real-world data science experience	1	1,3
5	I don't see any issue in implementing	1	1,3
6	No, we already have a programme at our department	1	1,3
7	Lack of strategic and legislative framework in the field of Big Data and data science	1	1,3
8	Lack of appropriate computing resources	1	1,3
9	Do not see any bariers	1	1,3
10	Lack of knowledge	1	1,3
11	N/A	1	1,3

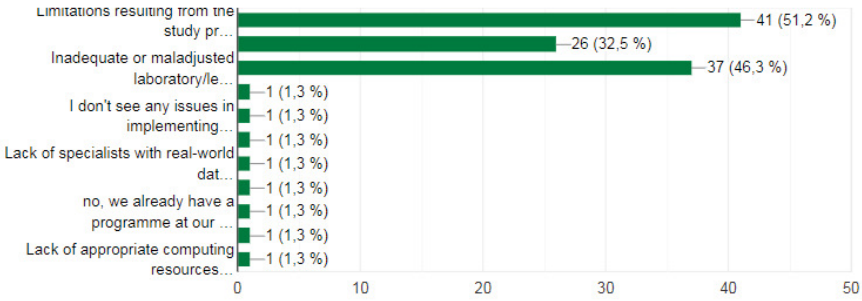

Figure 19. Obstacles/issues in implementing Big Data subject into the teaching programme

Discussion

The problems highlighted by the teachers speak of the conservatism and bureaucracy in universities. The positive thing is that the problem has been identified and the teachers understand what obstacles need to be overcome.

Conclusion

Solving the tasks set for universities requires the pooling of resources and potentials of the academic community (universities, faculties, departments, laboratories), business organizations, government bodies and society. Implementing triple and quadruple helix models, creating knowledge clusters will solve the problems highlighted by respondents.

7.4. How to overcome all shortcomings that would arise potentially when teaching Big Data subject?

The purpose of the question is to get the opinion of teachers on ways to overcome difficulties in teaching Big Data subject.

Data description

The results of a survey of teachers (Table 11, Fig. 20) showed that to overcome the shortcomings that would arise potentially when teaching Big Data subject it is necessary Improve the study program (66.3% of respondents), Develop and implement new form of classes (53,8%) and Improve room equipment (43.8%)

Table 11. Teachers' opinion on the ways and means to overcome obstacles when teaching Big Data subject

#	The indicator under analysis	Number of teachers	Percentage
1	Improve the study program	53	66,3
2	Develop and implement new form of classes	43	53,8
3	Improve room equipment	35	43,8
4	None	2	2,5
5	Introduce student practice in real-life projects	1	1,3
6	To have a better cooperation with Big Data companies and cloud providers	1	1,3
7	Raise funding for professional Data Science and Big Data courses for lecturers	1	1,3

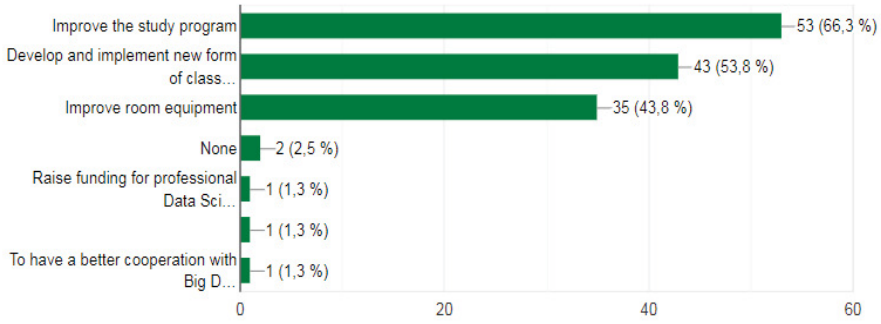

Figure 20. Ways to overcome the complexity of implementing Big Data in the educational process

Discussion

Training specialists in Big Data is problematic due to the high cost for the university, both software and hardware.
However, the problem needs to be addressed. The paths noted by the respondents should become problematic for the leadership of the universities.

Conclusion

In order for the training to be more substantive, students must be involved in the implementation of research projects both with universities and with companies. For this it is necessary to use the unique equipment of the companies. Given the growing demands from potential employers, it is necessary to involve employers in the development and improvement of training programs.

8. Conclusions

The given research of the academic community involved in the teaching of university students was performed with the purpose to determine the competencies of teachers in the field of Big Data and Data Science. For the reasons given, the innovative potential of teachers in higher education in the field of Big Data was studied. The questions on how to improve the quality of teaching disciplines based on Big Data were also discussed.

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