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COMPARATIVE INTERNATIONAL RESEARCH IN THE AREA OF EDUCATIONAL PLATFORMS AND MOOCs: AN OPINION OF IT STUDENTS USING DATA MINING ANALYSIS

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Abstract: *In the paper, a study was conducted using data mining methods such as decision tree, Naïve Bayes classifier and the Generalized linear model to detect patterns in data obtained from a questionnaire on educational platforms. The questionnaire was conducted among students from three countries Poland, Kazakhstan and Ukraine. Questions on the frequency of use of educational platforms, various platforms that are most popular among students, the most popular topics of courses on educational platforms and the use of Git systems, and the Stack Overflow platform were analysed and some interesting relations were identified in the paper.*

Keywords: educational platform, data mining, visualization, student survey, decision tree, correlation

INTRODUCTION

Knowledge in Computer Science (CS) is essential, and companies have increased their demands for CS professionals. Despite this, many jobs remain unfilled (Spieler, Grandl, Ebner, & Slany, 2019). Thus, they may never understand the fundamental concepts of CS, have unrealistic expectations or preconceptions, and are influenced by stereotype-based expectations. Consequently, many teenagers exclude computing as a career path. (Spieler et al., 2019). In the scope of Higher Education, students face many barriers arising from different causes, as insufficient prerequisites, socioeconomic factors or lack of interest and motivation. Usually, these factors can lead to high dropout rates in some specific careers, as it happens in Information Technology (IT)-related courses. (da Silva, et al., 2020)

1. RESEARCH BACKGROUND

Scholars from different countries are conducting research and presenting results related to the use of educational platforms by students to enhance their programming competences and skills as well as using the MOOCs and e-learning courses to improve their skills in coding and self-educational competences.

The research (Glazunova, et al., 2018) deals with theoretical and practical aspects of self-educational competence formation of IT students. It determines the concept and structure of self-educational competence, analyzes the information resources and services that are used to develop it. The study, conducted by Ukrainian scholars, offers the system of ICT-tools for the formation of self-educational competence of future IT specialists: the resources of the University educational portal, the online academy, massive open professionally-oriented online courses, computer-aided code verification systems, practical programming courses, cloud platforms for the development of software systems, the environment for implementing collective projects. (Glazunova, et al., 2018). Theoretical and methodological aspects of the future IT specialists' self-educational competence formation by means of using resources and services of the information and educational environment of the higher educational institution are substantiated. (Glazunova, et al., 2018)

Educators in massive open online courses (MOOCs) face the challenge of interacting with tens of thousands of students, many of whom are new to online learning. The study (Ferguson, & Whitelock, 2014) investigates the different ways in which lead educators position themselves within MOOCs, and the various roles that they adopt in their messages to learners. (Ferguson, & Whitelock, 2014). Elaborated typology can be used to explore relationships between educator stance and variables such as learner engagement, learner test results and learner retention. (Ferguson, & Whitelock, 2014). The Aim of this study **(**Hsueh, Daramsenge, & Lai, 2022) was twofold: first, to examine how learners' behavioral engagement

types affect their final grades in an online programming course; and second, to explore which factors most strongly affect student performance in an online programming course and their connection to the types of cognitive engagement. Findings Our results demonstrate that: (1) online time and video-watching constructs had significant effects on the self-assessment construct, self-assessment and video -watching constructs had significant effects on the final grade construct, and online document reading was not a significant factor in both self-assessments and final grades; (2) video watching had a most significant effect than other behavioral constructs in an online programming course; (3) cognitive engagement types are inextricably linked to the development of a behavioral engagement framework for online programming learning. The mediation analysis and the importance-performance map analysis supported the importance of cognitive engagement. **(**Hsueh, Daramsenge, & Lai, 2022).

Under the continuous impact of the epidemic, online learning methods represented by MOOC have developed rapidly. The study, described in (Li, Ge, Zhao, & An, 2022) constructs an emotional and behavioral analysis model based on online forum texts, obtains forum data from the "Python Language Programming" course on the Chinese University MOOC platform, uses domain dictionary emotion classification method to analyze learning emotions, and based on the method of cognitive behavior coding table and knowledge construction behavior coding table analyzes learners' cognitive behavior and knowledge construction behavior. (Li, Ge, Zhao, & An, 2022) It can dynamically analyze learners' emotions, behavior changes, and evolutionary trends. This research provides opinions and suggestions on the improvement of platform interactive functions for teachers' online teaching, students' online learning, and platform management, which can effectively improve the efficiency and effectiveness of online learning. (Li, Ge, Zhao, & An, 2022)

The interesting project was described in (Spieler et al., 2019). In 2018, a voluntary lecture "Design your own app" at the University of Graz for students of all degree programs was introduced. In total, 202 students participated. Was applied a Game Development-Based Learning (GDBL) approach with the visual coding tool Pocket Code, a mobile app developed at Graz University of Technology. For exercises and the final submission, the students need to apply game design strategies by using Pocket Code. The MOOC has several target groups – not only young gentelmen as well as young women who have little to no previous knowledge in CS. (Spieler et al., 2019). Additionally, it should help all teenagers to get a more realistic picture of CS to its basic concepts. As well as, teachers can use the course materials to lead high school classes (Open Educational Resources). Finally, the MOOC can be accessed by everyone interested in this topic, thus students of other majors can acquire CS skills. (Spieler et al., 2019).

Some recent studies point out that the adoption of non-conventional teaching practices and attitudes, especially in the first semesters, can collaborate to change not the best scenario. The goal of the research (da Silva, et al, 2020) was to present a 2D educational game for learning fundamental concepts of programming, whose narrative is based on a battle among robots and humans. Students are supposed to

interact with characters through console instructions - in the virtual world, there are characters and items like robot enemies and electromechanical structures (as automated doors, moving platforms, lasers emitters and sensors), which are meant to be manipulated by programming codes. (da Silva, et al., 2020). The model MEEGA+ was applied together with a 5-level Likert-like scale survey. Results shown as very positive - the goal of offering a motivating educational game was achieved, according to students' evaluation; during the gameplay, bosschallenge tests, mixed with choice questions about programming were presented to students, which were meant to correctly answer at least 60% of them in order to finish levels. Regarding to the perception of learning, according to the same survey, Python Domination achieved the objective of being a tool that assists in the learning process of programming fundamentals. (da Silva, et al., 2020).

The research (Valverde-Berrocoso, 2020) contains an overview of literary sources on MOOC. Aldahdouh, Osório (2016) and McAuley, Stewart, Siemens, Cormier (2010) provide theoretical and practical aspects of using MOES in higher education. The study Bennett, & Kent, (2017), Fair, Harris, León-Urrutia (2019); de Jong, et al. (2019) provide comparative characteristics of the use of open online courses, statistical data on the distribution of courses between scientific fields, the number of students, registered for the course, the percentages of those who completed the course, those who completed it partially, and those who simply enrolled in the course without active activity are compared. The number of open online courses on global MOE platforms is constantly increasing (Dhawal, 2020, 2021).

The use of MOOC in the educational process in Ukrainian higher education institutions is the most relevant for students studying in the field of "Information Technologies", because it is information technologies that are changing the most rapidly, and therefore an IT specialist must constantly be in line with these changes, quickly to respond to them, to constantly deepen their professional competences, to engage in self-improvement and self-development.

Prometheus, EdEra, and the Maidan Open University should be singled out among the Ukrainian platforms on which MOOC are hosted. The article presents the results of a comparative analysis conducted by scientists of the most popular global platforms of mass open online courses (Y. Ramskyi, Tverdokhlib, Yashchyk, A. Ramskyi, 2021). Most of them contain courses in English (many have subtitles in other languages), the opportunity to get a free certificate is not provided (except some courses on the Coursera platform), the duration of the courses is from several weeks to several months.

2. METHODOLOGY

The research in this paper was based on a questionnaire survey that was done simultaneously at three universities in three different countries: Poland, Kazakhstan and Ukraine. The survey was anonymous and voluntary. The questionnaire (elaborated and available via Google Form online) was distributed to students in

computer science and included a variety of questions about educational platforms.

Data mining tools such as data visualization and supervised learning algorithms such as decision tree algorithms, Naïve Bayes classifier and the Generalized linear model (Bramer, 2020, Kubat, 2021, Rokach, & Maimon, 2014) were used in the study. In order to detect patterns in the data, the possibility of correct classification/recognition of various examined features was checked based on the characteristics of students participating in the questionnaire. The analyzes were performed using tools such as Rapid Miner (https://rapidminer.com/) and Orange (https://orangedatamining.com/).

2.1. Questionnaire, purpose and research questions

Our focus was on exploring students' attitudes toward a variety of educational platforms, recognizing which platforms are most frequently used, and what elements provided on the platforms are most valuable to students. The survey was conducted in June 2023. Students of computer science from the University of Silesia in Katowice, Poland, the Faculty of Science and Technology, the Borys Grinchenko Kyiv University, Ukraine and the West Kazakhstan agrarian-technical university named after Zhangir khan, Kazakhstan were asked to respond. A total of 158 responses were received from randomly selected respondents. Emails were sent to students at different years of studies, asking them to fill out the survey, and participation was voluntary.

Sociological metrics

In order to study the relationship between student characteristics and attitude toward educational platforms, the questionnaire included sociological questions. The sociological characteristics ~~questions~~ and possible responses in the questionnaire are presented below:

- gender – male, female
- degree of study – Engineer's Degree, Master's Degree
- age – <19-20>, <21-22>, <23-24>, <25-26>, <27-28>, <29-30>, >30

Descriptive statistics on the responses ~~obtained~~ related to the sociological metrics are presented in Table 1.

Table 1.

Descriptive statistics on responses to sociological questions

Gender	Quantity/ Percentage	Degree of study	Quantity/ Percentage	Age	Quantity/ Percentage
Male	117/74.05	Engineer's Degree	114/72.15	<19-20>	18/11.39
Female	41/25.95	Master's Degree	44/27.85	<21-22>	70/44.30
				<23-24>	33/20.89
				<25-26>	8/5.06
				<27-28>	4/2.53

<29-30>	5/3.16
>30	20/12.66

Source: Own work

Based on the results obtained, it can be concluded that the majority of respondents were male engineering students, with the largest group aged 21 to 24 years old, constituting 65% of the respondents. As for the participation in the questionnaire of students from different countries, the largest group consisted of students from Poland (81 students), followed by 40 students from Kazakhstan and 37 students from Ukraine.

As part of our work on the survey results, we aimed to go beyond standard statistics and look for less obvious correlations in the data, discovering differences in the use of learning support platforms between countries. Accordingly, this article focuses on methods from the field of data mining, including data visualization and machine learning. The article omits standard statistical methods under the assumption that they would duplicate the information obtained by data mining methods. The authors also assumed that the use of methods from the field of data mining offers the possibility of detecting relationships that are difficult to prove with statistical methods. The research conducted aims to answer whether there are any significant relationships between the use of e-learning platforms and the country from which the surveyed students came. The comparison was also made by analyzing the age of the respondents, their level of study, and gender. As part of the article, selected results obtained are presented.

Of the methods used derived from data mining, data visualization, decision trees were used, and machine learning algorithms were employed.

The main Research questions were contained to questionnaire and were are:

RQ1: How often do you use educational platforms to learn about programming/IT issues?

RQ2: How often students from Poland, Kazakhstan and Ukraine use an educational platforms to learn about programming/IT issues?

RQ3: Which topics of the courses students from Poland, Kazakhstan and Ukraine use on educational platforms?

RQ4: Do are students from Poland, Kazakhstan and Ukraine use code sharing platforms/tools - specifically Git systems (GitHub, GitLab, Bitbucket, etc.) - as part of expanding their knowledge?

RQ5: Do are students from Poland, Kazakhstan and Ukraine use code sharing platforms/tools - specifically Stack Overflow systems - as part of expanding their knowledge?

For questions 2 to 5 in Research Questionnaire online the possible responses in the second question were defined using 5-point scale; 1 means I do not use and 5 means I use very often.

3. RESULTS OF SURVEY ANALYSES

This section of the article presents the results obtained through data mining methods, the first part presents the overall distributions of survey data to illustrate the distribution of the population participating in the survey.

3.1. Data set description

The first section shows the general distribution of respondents, by country, age, gender and level of study. Figure 1 illustrates the distribution of surveyed students, by gender, country, age and level of study.

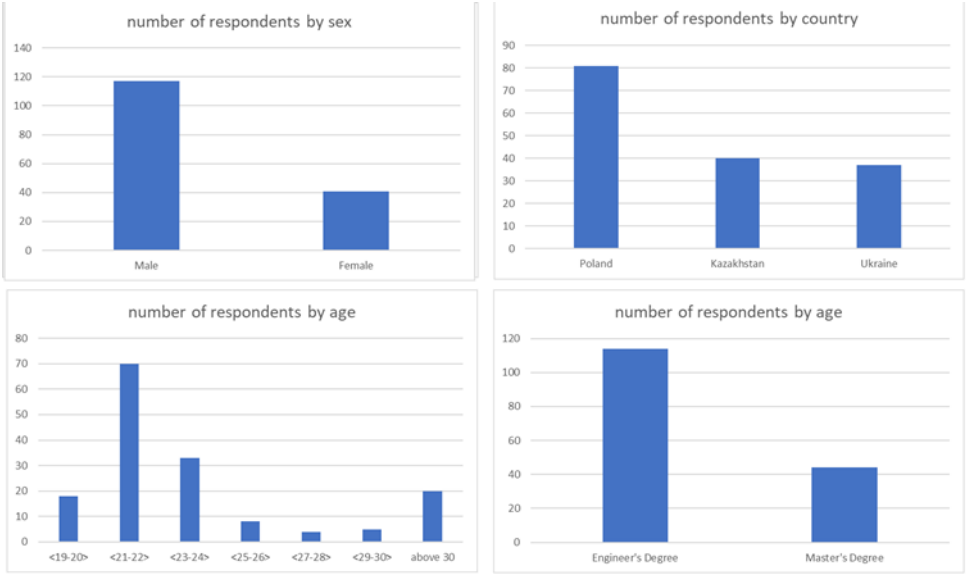

Figure 1 Distribution of survey students by gender, country, age and level of study

Source: Own work

Based on the graphs in Figure 1, it can be seen that, in terms of the gender of the respondents, the majority of students were male. Concerning the country of origin, the largest group were students from Poland. Regarding age the largest number were students at the beginning of the study period aged up to 24 years old, pursuing an engineering level of study.

Figure 2 shows how often students use e-learning platforms by gender and country of origin of students.

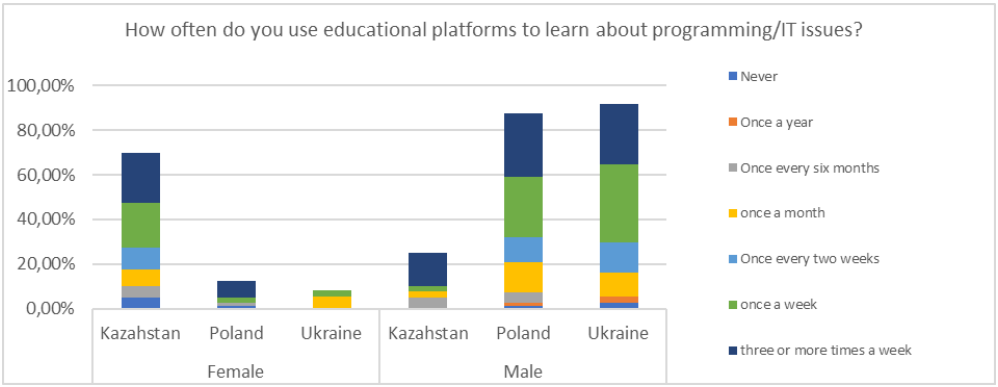

Figure 2 Frequency of using learning platforms by students by gender and age
Source: Own work

Based on Figure 2, it can be observed that students, regardless of their country and gender, readily use. The majority of respondents use such platforms at least once a week.

3.2. Exploratory analysis of survey data

The subsection presents the results of ~~the~~ analyses conducted using data mining techniques.

The first element used in the data mining of survey data was to test machine learning algorithms to verify whether survey respondents can be separated into groups by parameters that characterize students. The parameters focused on were age, gender, country and level of study. The frequency of use of e-learning platforms, satisfaction with using them, and the field of computer science from which students seek courses were used as targets for prediction. In the case of machine learning methods, no satisfactory results could be obtained in any combination of parameters. This implies that there are no significant differences between countries, levels of study and genders concerning the use and evaluation of the usefulness of self-learning platforms. For all samples, a very high level of classification error was obtained with very low classification quality. Tables 1 and 2 show sample results for the Naive Bayes classifier and Generalized Linear model for a sample of classification by gender, age and country for the frequency of use of self-study platforms.

Table 1
Quality score of machine learning using Naive Bayes classifier

Criterion	Values	SD
Accuracy	32.4%	10.1
Classification Error	67.6%	10.1

Source: Own work

Table 2
Quality score of machine learning using Generalized linear model

Criterion	Values	SD
Accuracy	36.9%	12.6
Classification Error	63.1%	12.6

Source: Own work

The results obtained with the Naïve Bayes classifier and the Generalized linear model presented in Tables 1 and 2 were the best results achieved from all samples and parameter combinations. They are presented as exemplary results and confirmation of the thesis that there are no significant differences in the use of e-learning platforms by students from different countries. For most cases of using machine learning algorithms, the obtained classification error was about 80%. For the Naïve Bayes classifier in the case in question (Table 1), an error of 67.6% was achieved, with low classification quality. For the Generalized linear model (Table 2), the classification error was 63.1%. After verifying the models based on different parameters and for different types of parameters for classification and obtaining similar results for all samples, the authors concluded that there were no significant enough differences in the responses of students to classify and divide into groups of students according to the criteria collected in the surveys. This means that students from different countries, of different genders, and at different levels of study use e-learning platforms equally eagerly, and for them, they are a popular source of supplementing the knowledge acquired during their studies.

Also, the popularity of individual self-learning platforms is at a similar level in the surveyed countries, Figure 3 shows the average rating of the usefulness of self-learning platforms (each platform was rated on a scale of 1-5).

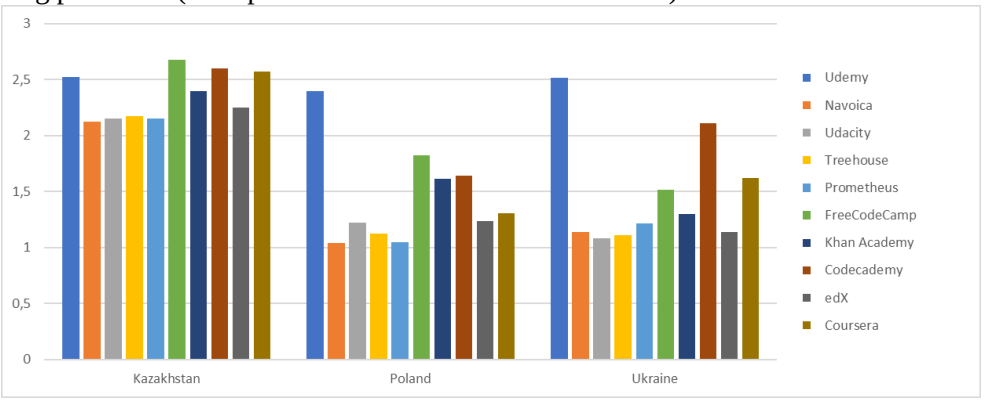

Figure 3 Assessing the usefulness of educational platforms in each country
Source: Own work

Based on Figure 3, it can be noted that regardless of the country, the most popular and highly-rated self-study platform is Udemy. It can also be observed

~~noted~~ that in the case of Kazakhstan, higher ratings were achieved for the usefulness and quality of courses on other platforms than in the case of Ukraine and Poland.

Since machine learning methods failed to classify groups of students concerning selected parameters for evaluating the usefulness and quality of educational platforms, the authors decided to use decision trees as a method that usually achieves good results even for small dependencies.

Figure 4 shows a classification tree of the frequency of use of educational platforms according to gender, country, and level of study. The CHAID algorithm was used to build the tree. In the figure, we have two colored leaves (nodes in the tree that have no descendants) – one red and the other one blue. The red color denotes the pure partition, i.e. the set of respondents who gave the same answer. The blue color denotes the group of respondents for whom the answer written in the leaf was given by more than half of this group. In each leaf, the percentage of ~~an~~ answers that occur in the group of respondents whose characteristics are consistent with the characteristics contained in the path from the root to this leaf is also given.

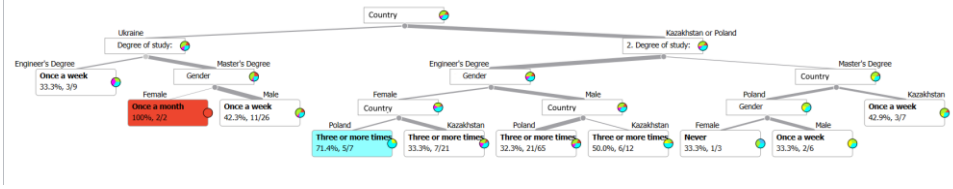

Figure 4. Classification tree of frequency of use of educational platforms
Source: Own work

Based on the tree in Figure 4, several correlations can be seen, for example, in master's studies there are more responses about less frequent use of educational platforms. Women in Ukraine use them once a month, while women in Poland never do. In the case of engineering studies, answers several times a week prevail. It is possible that such results are due to the fact that engineering students are at the beginning of their career path, before taking their first job and therefore seek additional knowledge of new technologies, driven by their own interests, and the requirements of future potential employers. Graduate students, on the other hand, are often working individuals, already using specific technologies daily, hence their lesser desire and need to learn new things.

Figure 5 shows a classification tree for the frequency of use of educational platforms by country and gender. The colors on the leaves of the tree represent the frequency of use of learning platforms, blue - once a week, blue - three or more times, green - once a two weeks, light green - once a month, orange - once every six months, red - never.

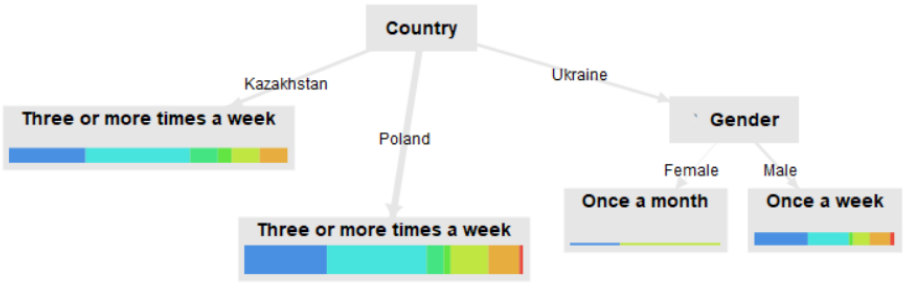

Figure 5 Classification tree for frequency of use of educational platforms by country and gender

Source: Own work

Based on Figure 5, it can be observed that gender mattered in the frequency of use of self-learning platforms only in the case of Ukraine, where women are less likely to use such tools. Also in the case of Ukraine, a lower frequency of use of learning platforms can be observed than in the case of students from Poland and Kazakhstan.

Figure 6 shows a decision tree in which the starting point is the level of study, with additional parameters taken into account being the country of origin and gender of the students.

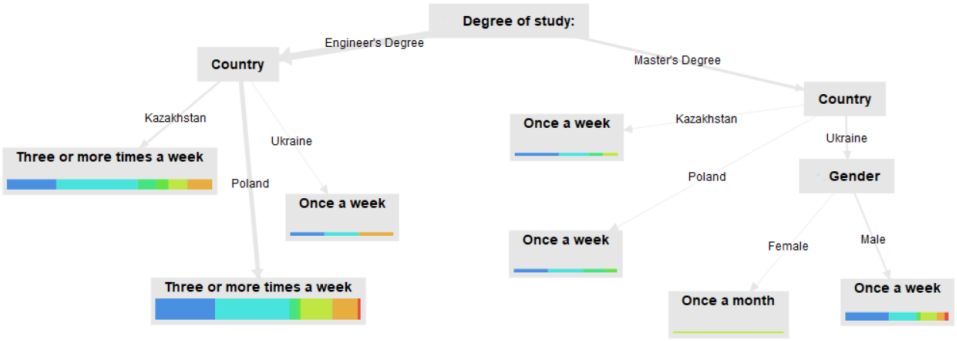

Figure 6 Decision tree of the frequency of use of educational platforms according to the level of study

Source: Own work

Based on the tree in Figure 6, it is possible to confirm the earlier conclusion that engineering students are more likely to use self-study platforms than graduate students.

Due to the greatest popularity of the Udemy platform across all student groups, it was decided to assess the quality and usefulness of the platform.

Figure 7 Assessing Udemy's usefulness according to students' age
Source: Own work

Based on the tree in Figure 7, it can be seen that the only significant parameter by which the Udemy platform frequency of use can be separated is age. It is challenging to discern any trend in the data, such younger people using this platform more or less often. In the figure, the group of students who used the Udemy platform most often is indicated in blue – these are students aged 27 and 28.

Another interesting question is what types of courses students are looking for on educational platforms, and whether there is a difference between students from different countries, genders, and levels of study. The charts in Figures 8-10 show the topics of courses chosen by gender, level of study, and country.

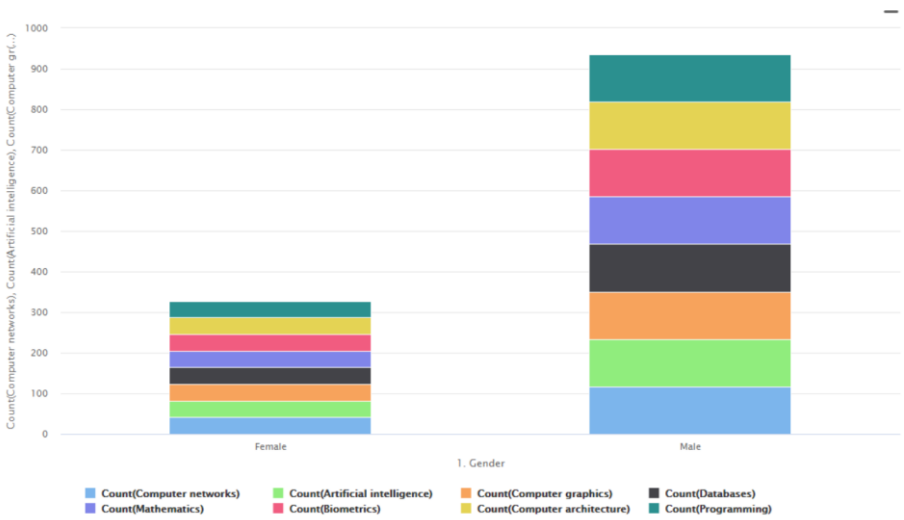

Figure 8. Selected course categories based on gender
Source: Own work

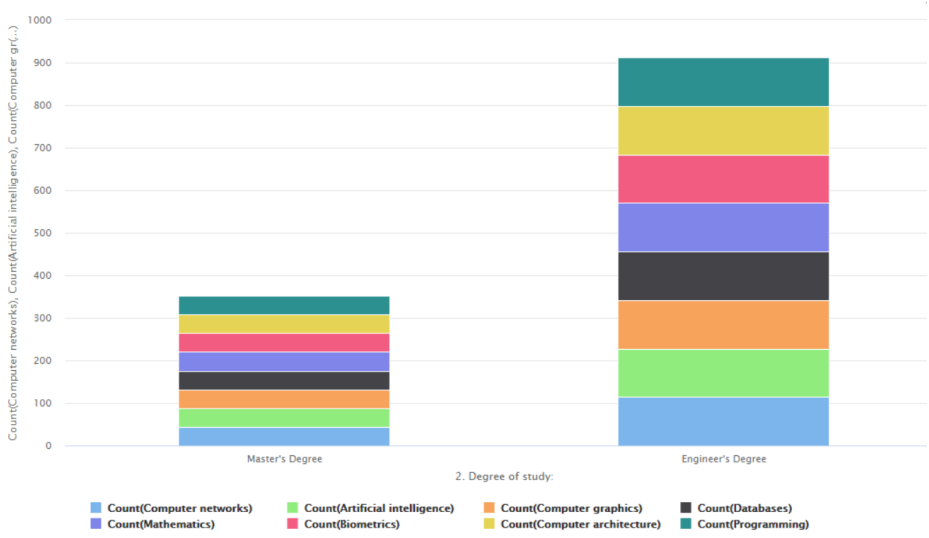

Figure 9 Selected course categories based on study level
Source: Own work

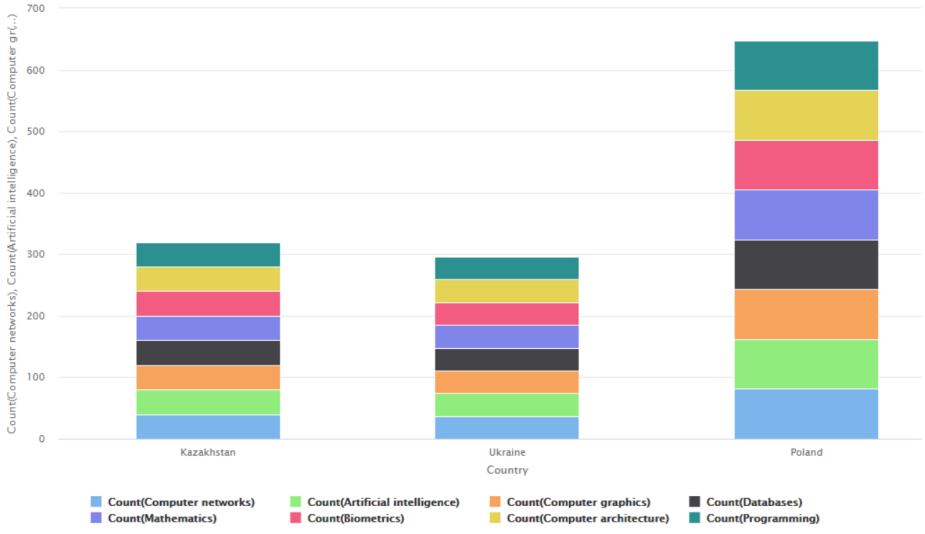

Figure 10 Selected course categories based on country
Source: Own work

Based on the charts in Figures 8-10, it can be seen that the topics of courses that students choose are more or less equal in each category of courses, with no single category being more popular relative to the others. Also, no significant differences can be observed when it comes to the choice of course topics by men and women, engineering and graduate students, and for individual countries.

Another verified element, as no significant differences were detected in the use of educational platforms by students from different groups, was the calculation of correlations. Table 3 shows an excerpt from the correlation matrix.

Table 3
Correlation matrix for selected parameters

	Gender	Degree of study	How valuable are course on platforms	Do you use Git systems	Do you use Stack Overflow
Gender	1	0,019	0,13	0,074	0,251
Degree of study	0,019	1	-0,132	-0,144	-0,149
How valuable are course on platforms	0,13	-0,132	1	0,332	0,415
Do you use Git systems	0,074	-0,144	0,332	1	0,616
Do you use Stack Overflow	0,251	-0,149	0,415	0,616	1

Source: Own work

Based on Table 3, one can only observe the relationship between the use of Git systems, and the Stack Overflow platform, which seems to be quite obvious, especially for programmers.

4. Discussion

As evident from the specialties in ~~the~~ engineering studies at the University of Silesia, a considerable emphasis is placed on programming and the design of information systems. The motivation of students to enroll in courses on educational platforms, expanding topics covered in university classes, can ~~also~~ be attributed to the high popularity of educational platforms among Polish students. There are no regulations at the University of Silesia to provide grades or exemptions from exams based on ~~a~~ courses completed on educational platforms. Therefore, it should be assumed that students do not receive any grades or benefits based on such courses. Academic teachers at the University of Silesia do not include this in the module credit; students are obliged to take regular exams. However, the knowledge and practical skills gained through completing courses on educational platforms enhance students' competencies, potentially boosting their confidence and better preparing them for exams. It would be necessary to investigate whether this also affects the achievement of higher grades, but such a study requires separate questionnaires and is planned in the future research.

Additionally, designing digital analytical educational systems involves training students in the processes of developing and creating tools and technologies for collecting, processing and analyzing large amounts of data to identify patterns and trends and predict future events. Career opportunities for specialists in the design of digital analytical systems are vast, spanning various industries such as finance, marketing, healthcare, telecommunications, information technology centres,

research institutes, computer testing centres, educational institutions, and various private organizations. This educational program is exclusively available at the Kazakh National Women's Teacher Training University.

5. Conclusion

The paper presents an analysis of the results obtained from a questionnaire on courses on educational platforms, conducted among computer science students from three different countries: Poland, Ukraine and Kazakhstan. The assessment included the frequency of platform use, specific platforms used most by students the most popular course topics, and whether students use code-sharing platforms.

Based on the data mining analysis conducted on the data collected from student surveys it can be concluded that the level of use of educational platforms does not differ significantly among the analyzed groups of students. Another interesting observation is that master's students use educational platforms less frequently than engineering students. In the case of Ukraine, a lower frequency of use of learning platforms can be observed compared to students from Poland and Kazakhstan. Data mining techniques could not identify a leading course topic chosen by students in all countries. There is a positive correlation between the use of Git systems and Stack Overflow; students who use one of these platforms often use the other.

Future work plans include expanding the study to other countries and examining the impact of using educational platforms on academic progress and grades in higher education. Additionally other data mining models, such as neural networks or clustering algorithms, will be employed to detect patterns in the results obtained.

REFERENCES

Aldahdouh, A. A., & Osório, A. J. (2016) Planning to Design MOOC? Think First! *The Online Journal of Distance Education and E-Learning*, 4(2), 47 – 57, Retrieved from https://files.eric.ed.gov/fulltext/ED572897.pdf.

Bennett, R., & Kent, M. (eds.) (2017) *Massive Open Online Courses and Higher Education: What Went Right, What Went Wrong and Where to Next?* London: Routledge. ISBN(print) 978-1-4724-8198-6, eISBN 978-1-315-59424-8 Retrieved from https://www.routledge.com/Massive-Open-Online-Courses-and-Higher-Education-What-Went-Right-What/Bennett-Kent/p/book/9780367349202#

Bramer, M. (2020) Principles of Data Mining. Springer, 2020, ISBN: 978-144-7148-83-8

da Silva, J.P., Guimaraes, G., Teixeira, L. & Silveira, I. (2020) Python Domination: An Open Educational Game For Learning Programming Fundamentals In *14th International Technology, Education and Development Conference (INTED)* (pp. 9004-9013)

de Jong, P.G. M., Pickering, J. D., Hendriks, R, A., Swinnerton, B.

J., Goshtasbpour, F. & Reinders, M.E.J. (2019) Twelve tips for integrating massive open online course content into classroom teaching, *Medical Teacher*, 42(4), 393 – 397, http://doi.org/10.1080/0142159X.2019.1571569

Dhawal, S. (2021) *By The Numbers: MOOCs in 2020*. Retrieved from https://www.classcentral.com/report/mooc-stats-2020/

Dhawal, S. (2022) *By The Numbers: MOOCs in 2021*. Retrieved from https://www.classcentral.com/report/mooc-stats-2021/

Fair, N., Harris, L., & León-Urrutia, M. (2019). Enhancing the Student Experience: Integrating MOOCs into Campus-Based Modules, *Trends and Good Practices in Research and Teaching*, 1, https://doi.org/10.36006/16184-08.

Ferguson, R., & Whitelock, D. (2014). Taking on Different Roles: How Educators Position Themselves in MOOCs. In: Rensing, C., de Freitas, S., Ley, T., Muñoz-Merino, P.J. (eds) *Open Learning and Teaching in Educational Communities*. EC-TEL 2014. Lecture Notes in Computer Science, vol 8719. Springer, Cham. https://doi.org/10.1007/978-3-319-11200-8_70 Print ISBN 978-3-319-11199-5, Online ISBN 978-3-319-11200-8

Glazunova, O. G., Voloshyna, T. V. & Starychenko, Y. M. (2018) Formation of Self-Educational Competence Of Future IT Specialists, *Information Technologies and Learning Tools*, 66(4), 122–138 ISSN: 2076-8184, https://doi.org/10.33407/itlt.v66i4.2124

Hsueh, N-L., Daramsenge, B., & Lai, L-C. (2022). Exploring the influence of students' modes of behavioral engagement in an online programming course using the partial least squares structural equation modeling approach. *Journal of Information Technology Education: Research*, 21, 403-423. https://doi.org/10.28945/5010

Kubat, M. (2021) *An Introduction to Machine Learning*, Springer, ISBN: 978-303-0819-34-7

Li, M., Ge, M., Zhao, H.G. & An, Z.Y. (2022) Modeling and Analysis of Learners' Emotions and Behaviors Based on Online Forum Texts. *Hindaw. Computational Intelligence and Neuroscience* https://doi.org/10.1155/2022/9696422

McAuley, A., Stewart, B., Siemens, G., & Cormier, D. (2010). *The MOOC Model for Digital Practice*, University of Prince Edward Island. Retrieved from https://www.oerknowledgecloud.org/archive/MOOC_Final.pdf

Orange, Retrieved from https://orangedatamining.com/

Ramskyi, Y. S., Tverdokhlib, I. A., Yashchyk, O. B., & Ramskyi. A.Y. (2021) Use of Open Online Courses in Conditions of Mixed Education Of Future Specialists. *Information technologies and teaching aids*, 84(4). http://doi.org/10.33407/itlt.v84i4.4431, ISSN: 2076-8184,

Rapid Miner, Retrieved from https://rapidminer.com/

Rokach, L., & Maimon, O. (2014) *Data Mining with Decision Trees*, World Scientific, ISBN: 978-981-4590-08-2

Spieler, B., Grandl, M., Ebner, M., & Slany, W. (2019). *Computer science for all: Concepts to engage teenagers and non-CS students in technology*. Reading: Academic Conferences International Limited. https://doi.org/10.34190/GBL.19.057

Valverde-Berrocoso, J., Garrido-Arroyo, M. del C., Burgos-Videla, C. & M.B. Morales-Cevallos, (2020). Trends in Educational Research about E-Learning: A Systematic Literature Review (2009–2018), *Sustainability*, 12(12), 51 – 73, https://doi.org/10.3390/su12125153