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Exploring the Educational Efficacy and Potential of 24-Hour Hackathon Programming Marathon – HackEmotion

Abstract

This paper addresses the issue of modern didactics and student motivation for self-learning as well as tackling significant practical challenges. In technical

and STEAM (Science, Technology, Engineering, and Mathematics) education, achieving high levels of motivation is particularly important, as students often become overwhelmed by the vast amount of information and opportunities which lead to diminished interest. At the Institute of Computer Science at the University of Silesia in Katowice, a Hackathon – a 24-hour programming marathon – was organized to enhance student engagement. During this event, students confronted a critical problem in modern society, i.e. emotion recognition. The goal was to develop solutions and help for fostering emotion recognition skills in young people with real-world implementation potential. Additionally, students tested their abilities under time pressure, honed their group work competencies, and faced real-time problem-solving scenarios. This paper presents an evaluation of the event's impact, and analyzes the results of a post-event survey, providing feedback to improve the quality of future Hackathons. The main research questions we posed during the research were: RQ1: At what level of quality was the Hackathon event organized? Werestudents well informed and felt cared for during this event? RQ2: What aspects and properties did motivate students most to take part in events organized at the university like Hackathon? RQ3: What competencies, knowledge and skills were developed by participants in the Hackathon? RQ4: Do students consider issues related to recognizing emotions important and the created applications possible to use in practice? In this paper, we answer these questions using statistical analysis as well as simple machine learning models.

K e y w o r d s: Hackathon, Work in teams, Emotions recognition, STEM education, Programming marathon

Introduction

A very important issue in modern higher education is how to teach young people to take responsibility for their own development, how to motivate them for this development and how to train competences such as teamwork and communication skills. One of the most popular methods is Project-Based Learning that engages students in real-world projects where they have to take ownership of their learning process. They set goals, plan their approach, and evaluate their progress, fostering a sense of responsibility. Assigning group projects encourages teamwork and collaboration. Students learn to communicate effectively, delegate tasks, and resolve conflicts. Another method is Problem-Based Learning that presents students with complex, real-life problems that require critical thinking and problem-solving skills. Students work individually or in groups to analyze the problem, propose solutions, and justify their approaches. In a flipped classroom,

students engage with course materials, such as lectures or readings, outside of class, while class time is dedicated to active learning activities. Students take responsibility for their learning by preparing themselves class independently and come prepared to engage in discussions, group work, or hands-on activities that develop teamwork and communication skills. Other very effective methods are Peer Teaching and Peer Assessment. Assigning students to teach and assess their peers encourages a deeper understanding of the material and enhances communication skills. Students take responsibility for their own learning by preparing themselves to teach a topic to their classmates and providing constructive feedback to their peers.

In the context of particularly STEM education and Computer Science studies, it has now also become a very popular teaching method to organize programming marathons. Hackathons are collaborative events where participants come together to work intensively on solving problems or creating innovative projects within a short period, usually ranging from a few hours to a few days. Specific rules may vary depending on the organizers and the nature of the event. Participants may form teams typically consisting of individuals with diverse skills, such as programmers, designers, and domain experts. Teams may be formed before the event. Hackathons often have a specific theme, challenge, or problem statement provided by the organizers. Participants are expected to develop solutions or projects that address this theme. The theme or challenge is usually announced at the beginning of the event, sometimes with additional details or constraints. Participants must work within time limit to develop their projects. Time management is crucial, and participants are expected to allocate time effectively for ideation, development, testing, and presentation. Hackathon projects often involve creating software, hardware, or another intellectual property. Participants should respect intellectual property rights and avoid infringing on copyrighted material. At the end of the hackathon, teams typically present their projects to a panel of judges or to the entire participant audience. Presentations are usually limited to a set duration, and teams are expected to effectively showcase their project, including its functionality, innovation, and potential impact. Judges evaluate projects based on predefined criteria, which may include factors such as creativity, technical complexity, user experience, and relevance to the theme. Hackathons provide opportunities for participants to network, collaborate, and learn from each other. Participants are encouraged to share knowledge, skills, and resources to support each other's projects. This form of teaching soft competences to students is highly motivating, as it incorporates competition and facing a challenge. In addition, computer science students, who are often quite skeptical of didactic innovations, respond positively to such challenges.

From April 11th 2024 to April 12th 2024, the HackEmotion 24-hour programming marathon was organized at the Institute of Computer Science, University of Silesia in Katowice. The aim of HackEmotion was to prepare an application to help to recognize emotions on the basis of faces and body silhouettes.

This topic was chosen because it is extremely important in today's world. Many people have problems recognizing emotions, especially children who spend a lot of time in front of screens or smartphones have problems recognizing emotions in the real world. In order to help such people, psychologists or pedagogues devote many hours of sessions to teach them how to recognize emotions from photos or other scenes played by actors. Automating this process would be very useful and would be a huge support for professionals. Forty-five students from the University of Silesia in Katowice signed up to take part in the programming marathon, forming groups of two to five people. They mainly included students from computer science, but there were also students from pedagogy and psychology. The prizes for winning the event were financial. Depending on whether it was the first or second place and the number of students in the winning group, this ranged from PLN 2,000 to PLN 400 per person.

The hackathon's goals and tasks encompass various aspects integral to STEM education. Hackathons, like HackEmotion, provide a dynamic and immersive learning environment that integrates various aspects of STEM education. They offer students practical experience in tackling real-world problems, foster essential soft skills, and motivate continuous learning and development. The HackEmotion event specifically focused on software creation that would assist people and train their skills in recognizing emotions. The simplest way to build such an application was to display different emotions in a photo or video and ask the user to recognize the emotion. The user's competence could be determined by measuring the time and correctness of the recognition. The learning can be tailored to the user's needs using appropriate algorithms. However, students inspired by the challenge have created much more elaborate applications - from levelled photos and genre scenes containing emotions to multi-level games containing character creation, challenges, and levels to be gained.

A week after the event, a survey was conducted on the quality of the organized hackathon. The questions covered a variety of topics: an evaluation of the way the hackathon was organized, whether the event contributed to the development of the students and, if so, to what extent, and whether the students considered the topics covered by the hackathon to be relevant. The questionnaire was prepared in a Google Form and the link was sent to the students participating in the Hackathon. Completion of the survey was voluntary and anonymous. The results of the questionnaire in no way influenced the students' grades or treatment by the teachers. The aim of the research is to discuss the results of the survey and the conclusions drawn from it.

The purpose of the article is to address modern didactics and student motivation for self-learning, focusing on significant practical challenges. The main objective is to evaluate the impact of a 24-hour programming marathon (Hackathon) called HackEmotion organized at the Institute of Computer Science at the University of Silesia in Katowice. The article aims to analyze the results of a post-event survey

conducted after the Hackathon to provide feedback for improving the quality of future Hackathons.

The structure of the paper is as follows. The second section provides a review of the literature. The following sections present the experimental methodology, research questions and hypotheses as well as the statistical analysis of the obtained results. This is followed by the presentation of the results obtained using selected machine learning models. The penultimate section contains the discussion. The article ends with conclusions.

Literature Review

Activation teaching methods, also known as active learning strategies, have been extensively studied and implemented in STEM education (Videla et al., 2021). These methods aim to engage students more directly in the learning process, thereby enhancing their understanding and retention of material. Key activation methods include problem-based learning (PBL) (Rehmat and Hartley, 2020), project-based learning (PjBL) (Diana and Sukma, 2021), peer instruction (Prince et al., 2020), and collaborative learning (Salam and Farooq, 2020).

PBL involves presenting students with real-world problems to solve, which helps develop their problem-solving and critical thinking skills. This method has been shown to promote flexible knowledge application, strategic reasoning, intrinsic motivation, and collaboration. Teachers using PBL often report improved student engagement and better learning outcomes, particularly in understanding complex STEM concepts (Attard et al., 2021). Similar to PBL, PjBL requires students to complete projects that often span several weeks. This method encourages deeper learning and the application of interdisciplinary knowledge. PjBL has been effective in promoting teamwork, time management, and practical application of STEM theories (Baran et al., 2021). Collaborative Learning involves students working together in small groups to achieve learning goals. It has been found to improve student attitudes towards learning, increase engagement, and enhance social and cognitive skills. Collaborative learning also helps students develop communication and teamwork skills, which are crucial in professional STEM environments (McCollum, 2020). Peer Instruction strategy involves students teaching each other under the guidance of the instructor. It helps students articulate their understanding and learn from different perspectives, fostering a deeper understanding of the material (Kong and Yang, 2024).

Hackathons, especially in the context of STEM education, serve as intensive, collaborative events where participants work in groups to develop solutions to specific problems within a short timeframe (typically 24-48 hours). These events

are valuable for several reasons (Beretta et al., 2022). Hackathons emphasize practical, hands-on learning. They help students develop technical skills (e.g., coding, engineering design) and soft skills (e.g., teamwork, time management, communication). Participating in hackathons allows students to apply theoretical knowledge in real-world scenarios, which enhances their problem-solving abilities and creativity (Garcia, 2022). The competitive and collaborative nature of hackathons motivates students. The opportunity to work on meaningful, real-world problems in a high-energy environment fosters a sense of accomplishment and enthusiasm for STEM fields. Students are often driven by the challenge and the chance to innovate, which can lead to increased interest in their studies and future careers in STEM (Hacıoğlu and Gülhan, 2021).

Hackathons provide a platform for students to network with peers, mentors, and industry professionals. This interaction can lead to future collaborations, internships, and job opportunities. The collaborative nature of hackathons also teaches students how to work effectively in teams, an essential skill in most STEM careers (Longmeier et al., 2022). Hackathons often include a judging or feedback component, where experts evaluate the projects and provide constructive feedback. This process helps students refine their ideas and improve their projects iteratively, reinforcing the learning cycle of design, feedback, and redesign (Pe-Than et al., 2022).

In conclusion, activation teaching methods and hackathons both play significant roles in enhancing STEM education. Activation methods like PBL and collaborative learning engage students deeply and promote essential skills, while hackathons provide practical, immersive experiences that prepare students for real-world STEM challenges. Both approaches are complementary, fostering a more dynamic and effective learning environment.

Methodology

The research presented in this paper was conducted through a questionnaire survey performed on students from the University of Silesia who participated in the HackEmotion event. The questionnaire was sent to 45 students. However, 30 students completed the questionnaire. Raw survey data is publicly available at http://surl.li/oeqcjd.

The survey was conducted anonymously and on a voluntary basis. It encompassed a range of questions regarding the quality of the organization of the hackathon and the impact of the event on student development. The questionnaire questions were divided into four thematic groups: sociological characteristics, the quality of the event organization, areas of student development and the importance of this topic on the emotions recognition. The segmentation demonstrates thematic cohesiveness

and offers an exhaustive examination of the subject matter. The responses to the majority of inquiries were presented on a 5-point scale, facilitating a broad range of interpretations. Examination of the gathered data involved the utilization of diverse statistical techniques, notably the Kruskal-Wallis test, in addition to various statistical parameters and visual representations, with a specific focus on box-plot diagrams. Depending on the research query being investigated, data was gathered into relevant categories and their attributes were juxtaposed. Additionally, specific machine learning algorithms were utilized to examine latent patterns within the dataset.

The main aim of the research was to find out whether events such as the hackathon are positively perceived by students and whether they motivate them to learn and self-develop. In addition, the research also aimed to find out in which areas participation in a hackathon most influences the development of students' knowledge and competencies. Another aim was to investigate whether students consider the topic of emotion recognition to be important and developmental.

Research Questions and Hypotheses

The following research questions were formulated:

RQ1: At what level of quality was the Hackathon event organized? Were students well informed and cared for during this event?

RQ2: What aspects and properties did motivate students most to take part in events organized at the university like Hackathon?

RQ3: What competencies, knowledge and skills were developed by participants in the Hackathon?

RQ4: Do students consider issues related to recognizing emotions important and the created applications possible to use in practice?

The hypotheses determined based on RQ1–RQ4 are as follows:

H1: Most aspects related to the organization of the Hackathon were at the highest level. The only thing that needs to be improved is the system for justifying the jury's evaluation.

H2: An interesting challenge – a problem to solve and the opportunity to work in groups were the greatest motivation for the students who took part in the event.

H3: Students developed their group work skills the most by participating in the Hackathon.

H4: Students consider issues related to recognizing emotions as important and the created applications as possible to use in practice.

To achieve this, multiple statistical metrics were computed, and the results were visually represented using column graphs and box-plot graphs.

Sociological Metrics

In order to study the relationship between student characteristics and attitude towards educational platforms, the questionnaire included sociological questions. The sociological characteristics questions are presented as follows:

- gender – male, female
- field of study – Computer science, Applied computer science, Art therapy, Psychology, Media cultures
- age – <19–20>, <21–22>, <23–24>, <25–26>, >26
- degree of study – Bachelor degree or Engineering (BorE) 1st year, Bachelor degree or Engineering (BorE) 2nd year, Bachelor degree or Engineering (BorE) 3rd year, Bachelor degree or Engineering (BorE) 4th year, Master's degree (MD) 1st year, Master's degree (MD) 2nd year
- Place of residence – Countryside, Small city (up to 50 000), Medium city (up to 100 000), Large city (over 100,000)

Descriptive statistics on the responses obtained related to the sociological metrics are presented in Table 1. These data are also presented graphically in Figure 1.

Table 1.
Descriptive statistics on responses to sociological questions

Gender	Quantity/ Percentage	Degree of study	Quantity/ Percentage	Age	Quantity/ Percentage	Place of residence	Quantity/ Percentage
Male	27/90	BorE 1st	6/20	<19–20>	9/30	Countryside	5/16.7
Female	3/10	BorE 2nd	11/36.7	<21–22>	12/40	Small city	3/10
		BorE 3rd	11/36.7	<23–24>	7/23.3	Medium	8/26.7
		BorE 4th	1/3.3	<25–26>	2/6.7	Large	14/46.7
		MD 1st	1/3.3	>26	0/0		
		MD 2nd	0/0				

S o u r c e: Own work.

In terms of the field of study, only one respondent was studying Art Therapy, the others were studying Computer Science. There were seven people from Applied Computer Science and 22 students from Computer Science. So the students who took part in the Hackathon and answered the questions were predominantly men in the range of 19 to 22 years old, who live in a large or medium city and are studying in their second or third year of a first-level Computer Science degree. This characterization should not be surprising and is quite predictable considering that the event was targeted at programmers and organized by the Institute of Computer

Science at the University of Silesia. Thus, the information about the event was posted on a public website – it was the students of this particular faculty who were best informed and most motivated to attend the event.

Results and Statistical Tests

In this section, we will present statistical analyses and their outcomes related to the HackEmotion event, categorized into three themes corresponding to the topics listed above.

An important question we will discuss first is through which channel the students found out about the HackEmotion event. We want to intensify the advertising of the event in the future, so it was crucial for us to know which channel was the most effective. The options from which students could choose were as follows: from the teacher, from a poster, from a website, from a friend, from Facebook or another social media channel and other. Students were able to make multiple choices. The number of students who indicated each channel is presented in Figure 1.

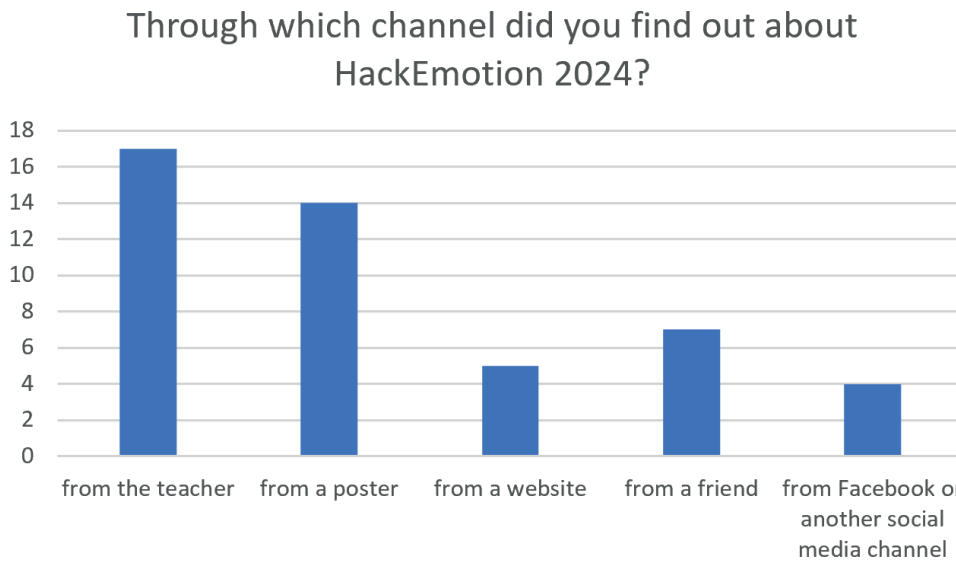

Figure 1. The channel by which students found out about HackEmotion 2024

As can be seen, the most effective channel proved to be the contact with the teacher and the oral communication from the teacher, as well as the posters displayed on the campuses in different cities and Departments of the University of

Silesia. In contrast, the least effective channel proved to be the university website as well as Facebook or another social media channel administered by the university. Perhaps this indicates that students rarely visit the university website and the university social media. However, confirming such a hypothesis requires separate research, which we will not deal with now. For us, the most important information is that when organizing subsequent events of this type, special attention should be paid to verbal advertising by teachers and posters.

Assessment of the Quality of the Organization of the HackEmotion Event

In this part of the questionnaire, we explored how students assess the quality of the organized Hackathon, a 24-hour programming marathon. Could the organizers reliably prepare such a demanding event?To the main questions here the responses were as follows:

Q1. Was communication between the organizers and participants clear?
Q2. Was the proposed challenge (topic, goal) clearly defined?
Q3. Were the organizers able to answer your questions and concerns?
Q4. Do you think the organizers were knowledgeable and experts in the challenge?
Q5. Was the jury's assessment clear to you?
Q6. How likely are you to participate in a future hackathon?
Q7. Do you think the prizes were appropriate for the hackathon?
Q8. Did the organizers meet all deadlines?
Q9. Would you recommend our hackathon to your friends?

Possible answers to all these questions were on a scale of 1 to 5, where 1 – absolutely not, very unclear 5 – absolutely yes, very clear.

Descriptive statistics regarding the responses obtained for these questions are presented in Table 2. In order to better visualize the results, box-plot charts were created for the individual questions (Figure 2). The box-plot partially shows the data from the table. For each question, the mean and the confidence interval (95% confidence interval) for the medians are marked as box. In addition, the whiskers represent deviations from the median plus or minus the standard deviation. These values are also given in Table 2. As can be seen, the students rated communication, the proposed challenge during the hackathon, the knowledge of the organizers as well as answering participants' questions quite highly. Students rated the clarity of the jury's verdict the lowest. Therefore, in the future, the transparency of decisions on awarding prizes to hackathon event participants should be increased. This year, the rubrics were created according to which each jury member assessed the solutions created by the groups in terms of various criteria. These criteria are:

innovation, social utility, business potential, design and functionality, ease of implementation, sophistication. Each member of the jury awarded points from 0 to 3 in each criterion. If any of the projects was outstanding, a jury member was allowed to award 5 points in that category. Therefore, the assessment rules were transparent and reliable. A solution to the problem of students not understanding the basis for making jury decisions may be to present them with the results of the evaluation of their projects and the projects created by the winning teams. Similarly, students rated the likelihood of participating in future events of this type low. Unfortunately, we do not know exactly what the reason for such responses is. However, we see that some students would not participate in an event of this type again. This may be due to the difficulty of physical hardness of constant work and programming for 24 hours or due to time pressure. The remaining questions regarding the prizes in the hackathon, meeting the deadlines by the organizers as well as recommending participation in the event to friends were also rated very highly by the students and provide a satisfactory assessment of the event.

Table 2.
Descriptive statistics on responses to the question related to quality of the organization of the HackEmotion event

Question	Mean	Std dev	Median	Minimum	Maximum
Q1	4.6	0.6	5	3	5
Q2	4.4	0.7	5	3	5
Q3	4.6	0.7	5	3	5
Q4	4.5	0.8	5	3	5
Q5	3.9	0.9	4	2	5
Q6	4.3	0.8	4.5	2	5
Q7	4.5	0.7	5	2	5
Q8	4.5	0.9	5	2	5
Q9	4.6	0.7	5	3	5

S o u r c e: Own work.

To sum up this part of the survey and its results, it can be said that the organization of the event was rated rather highly. However, there is also room for improvement. When organizing subsequent editions of the Hackathon, special attention should be paid to the evaluation of team projects by the jury and ensuring a more transparent presentation of the basis for the awards granted.

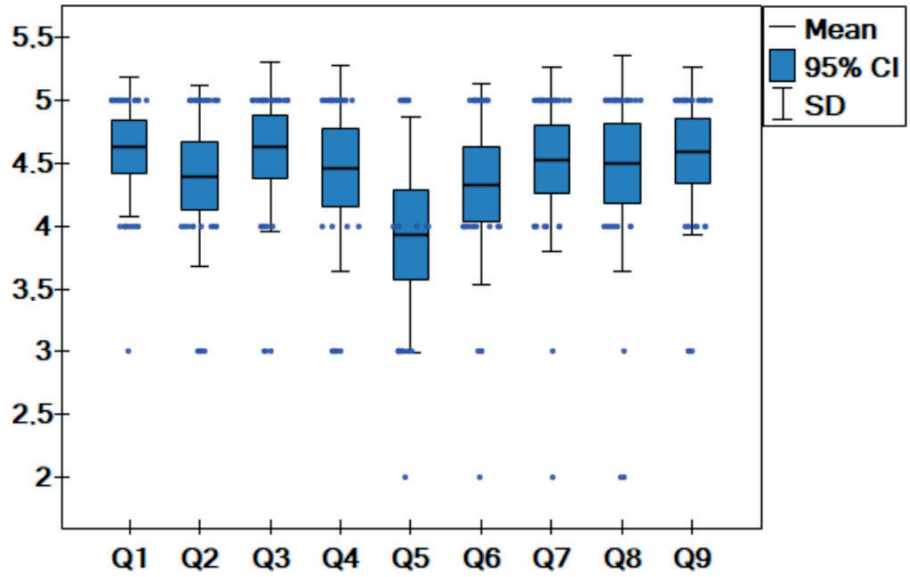

Figure 2. The box-plot charts for questions Q1–Q9

Aspects that Most Motivate Students to Take Part in Events Organized at the University

The second group of questions we asked the students concerned what motivated the students to take part in the Hackathon. We wanted to know which of the features of the event we organize are most important in terms of attracting participants. This issue should receive the greatest attention in the coming years.

The question asked to the students was as follows: What aspects of the event were most important to you? Please provide your answer on a scale of 1 to 5, where 1 – least important, 5 – most important

a) Good atmosphere, integration in the student group
b) Prizes
c) Possibility of further scientific cooperation at the Institute of Computer Science
d) Challenge, testing yourself
e) Competition
f) Working in a group of students in which I feel good

Descriptive statistics regarding the responses obtained for these questions are presented in Table 3. In order to better visualize the results, box-plot charts were created for the individual answers (Figure 3). The box-plot partially shows the data from the table. For each question, the mean and the confidence interval (95%

confidence interval) for the medians are marked as box. In addition, the whiskers represent deviations from the median plus or minus the standard deviation. These values are also given in Table 3. As can be seen, the most important aspects for the students were the good atmosphere, the challenge and working in a group of students in which students feel good. The least important issues for students were awards, competition and the possibility of scientific cooperation with employees of the Institute of Computer Science. Therefore, when organizing future events of this type, the greatest attention should be paid to interesting issues that will pose as a challenge during the Hackathon. We hope that the good atmosphere of the event will be maintained. Working in groups that students create themselves – decide on the composition of teams is a characteristic feature of hackathons.

Table 3.
Descriptive statistics on responses to the question related to motivation and importance of aspects of the event for students

Question	Mean	Std dev	Median	Minimum	Maximum
Good atmosphere	4.5	0.9	5	1	5
Prizes	3.5	1.3	4	1	5
Scientific cooperation	3.6	1.3	3.5	1	5
Challenge	4.6	0.8	5	1	5
Competition	3.5	1.5	4	1	5
Working in a group of students	4.7	0.5	5	4	5

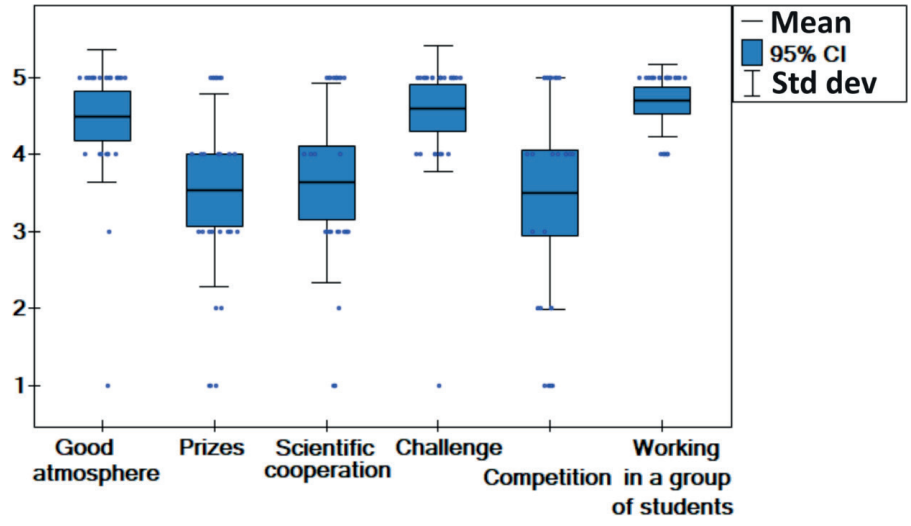

Figure 3. The box-plot charts for question about motivation and importance of aspects of the event for students

S o u r c e: Own work.

Competences and Skills Developed by Participating in the Hackathon

In the next group of questions, we wanted to find out what competences, skills and knowledge of students were positively influenced by participation in the Hackathon. For this purpose, the following question was asked: In what areas did HackEmotion influence the development of your knowledge, skills and competences? Please provide your answer on a scale of 1 to 5, where 1 – I did not notice any development, 5 – it significantly influenced the development

a) Programming
b) Group work
c) Designing the application as a complete and finished product
d) Knowledge of artificial intelligence algorithms
e) Sharing applications in the cloud
f) Managing your own time and that of others
g) Giving feedback to colleagues in the group
h) Your own motivation to act
i) Motivating others to act

Descriptive statistics regarding the responses obtained for these questions are presented in Table 4. In order to better visualize the results, box-plot charts were created for the individual answers (Figure 4). As can be seen, students evaluate that participation in the Hackathon had the greatest impact on their development of group work competences. Only one respondent did not recognize any improvement in this area. Students developed the skills related to Knowledge of artificial intelligence algorithms and Sharing applications in the cloud at a lower level. However, also in these aspects there were students who rated the improvement in their knowledge as 5. The remaining skills were developed at a similar, average level. Therefore, the HackEmotion event had the greatest impact on the development of group work competences. The development of group work competences in IT specialists and programming is crucial for several reasons, given the collaborative nature of most IT projects and the complex, multidisciplinary problems they often address. The key points for which group work skills are important are as follows: enhanced problem-solving capabilities, efficiency and productivity, improved communication and interpersonal skills, increased innovation and creativity, adaptability and flexibility and ,in the end, better project outcomes. Therefore, we believe that this type of event is very important, especially for students of computer science, and it will certainly be organized periodically in the future.

Table 4.
Descriptive statistics on responses to the question related competences, skills and knowledge of students that were positively influenced by participation in the Hackathon

Question	Mean	Std dev	Median	Minimum	Maximum
a) Programming	3.7	1.1	4	1	5
b) Group work	4.5	0.9	5	1	5
c) Designing the application as a complete and finished product	3.9	1.1	4	1	5
d) Knowledge of artificial intelligence algorithms	2.4	1.3	2.5	1	5
e) Sharing applications in the cloud	2.8	1.3	3	1	5
f) Managing your own time and that of others	4.1	1.1	4	1	5
g) Giving feedback to colleagues in the group	4.1	1.0	4	1	5
h) Your own motivation to act	3.9	1.1	4	1	5
i) Motivating others to act	4	1.2	5	1	5

S o u r c e: Own work.

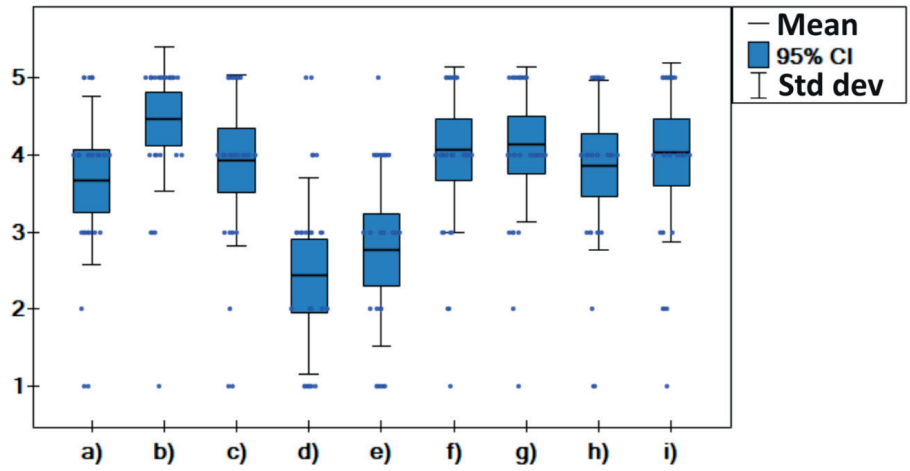

Figure 4. The box-plot charts for question about competences, skills and knowledge of students that were positively influenced by participation in the Hackathon

a) Programming, b) Group work, c) Designing the application as a complete and finished product, d) Knowledge of artificial intelligence algorithms, e) Sharing applications in the cloud, f) Managing your own time and that of others, g) Giving feedback to colleagues in the group, h) Your own motivation to act, i) Motivating others to act.

The Importance of the Issue Related to Recognizing Emotions

The last group of questions concerned students' assessment of the importance of the issue being a challenge for participants in the HackEmotion 2024 event. Two questions related to this aspect were formulated as follows:

Q10. Do you think that the hackathon's topic of emotions is interesting and an important research problem?

Q11. Do you see any possibilities for practical applications of applications created within HackEmotion?

Possible answers to all these questions were on a scale of 1 to 5, where 1 – absolutely not, 5 – absolutely yes.

Descriptive statistics regarding the responses obtained for these questions are presented in Table 5. In order to better visualize the results, box-plot charts were created for the individual answers (Figure 5). As can be seen, most students consider issues related to recognizing emotions to be important. Only two surveyed students rated this issue as not very important. All students stated that the applications created during the Hackathon can be used in practice to develop competences related to recognizing emotions.

Table 5.

Descriptive statistics on responses to the question related competences, skills and knowledge of students that were positively influenced by participation in the Hackathon

Question	Mean	Std dev	Median	Minimum	Maximum
Q10	3.9	0.9	4	2	5
Q11	4.1	0.7	4	3	5

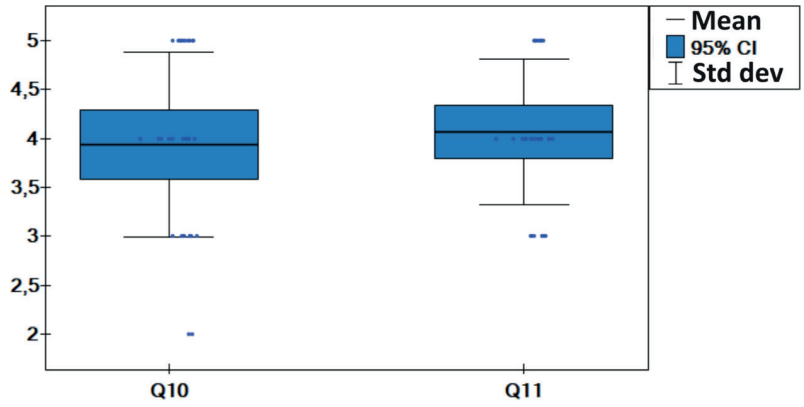

Figure 5. The box-plot charts for question about importance of the issue related to recognizing emotions

S o u r c e: Own work.

Statistical Inference Used for Questionnaire Data

Statistical inference was used to test whether place of residence has a significant impact on differences in perceptions: assessment of the quality of the organization (questions Q1 – Q9 listed earlier in the paper), aspects that most motivate students to take part in events (aspect (a) – aspect (f) also listed earlier in the paper), competences and skills developed by participating in event (competence (a) – competence (i) listed earlier in the paper) and the importance of the issue related to recognizing emotions (Q10 and Q11). For this purpose, we used Kruskal-Wallis ANOVA Tests because we are dealing with more than two comparison groups defined by place of residence (Countryside, Small, Medium and Large City) and we are dealing with an ordinal measurement scale. The results of the tests are shown in Table 6. The table gives the test statistic as well as the p-value. The median in the subgroups is also given. As can be seen, only in some aspects did place of residence have a significant effect on the difference in perceptions of properties regarding the Hackathon (bolded in the table). These were the following competencies:

b) Group work
f) Managing your own time and that of others
g) Giving feedback to colleagues in the group
i) Motivating others to act

Table 6.
The Kruskal-Wallis test results for the questionnaire and groups defined by place of residence

Question	Countryside	Small city	Medium city	Large city
Q1		H(3,30)=1.88; p-value=0.60		
Median	5	5	4,5	5
Q2		H(3,30)=7.34; p-value=0.06		
Median	4	5	5	4,5
Q3		H(3,30)=6.04; p-value=0.11		
Median	5	5	5	5
Q4		H(3,30)=3.65; p-value=0.30		
Median	4	5	5	5
Q5		H(3,30)=0.67; p-value=0.88		
Median	3	3	4	4
Q6		H(3,30)=7.46; p-value=0.06		
Median	5	5	4	5
Q7		H(3,30)=3.19; p-value=0.36		
Median	5	4	4,5	5

Q8		H(3,30)=2.16; p-value=0.54		
Median	5	5	4,5	5
Q9		H(3,30)=7.33; p-value=0.06		
Median	5	5	4	5
aspect (a)		H(3,30)=1.11; p-value=0.77		
Median	5	5	5	5
aspect (b)		H(3,30)=0.20; p-value=0.98		
Median	3	3,5	4	4
aspect (c)		H(3,30)=5.78; p-value=0.12		
Median	5	5	3	3
aspect (d)		H(3,30)=2.59; p-value=0.46		
Median	5	5	4,5	5
aspect (e)		H(3,30)=5.36; p-value=0.15		
Median	5	4	3	4
aspect (f)		H(3,30)=2.96; p-value=0.40		
Median	5	5	4,5	5
competence (a)		H(3,30)=5.14; p-value=0.16		
Median	4	4	3	4
competence (b)		**H(3,30)=14.67; p-value=0.002**		
Median	5	5	4	5
competence (c)		H(3,30)=1.99; p-value=0.57		
Median	4	4	4	4
competence (d)		H(3,30)=4.18; p-value=0.24		
Median	3	3	1,5	2
competence (e)		H(3,30)=2.03; p-value=0.57		
Median	3	4	2,5	2,5
competence (f)		**H(3,30)=8.61; p-value=0.03**		
Median	5	5	4	4
competence (g)		**H(3,30)=8.77; p-value=0.03**		
Median	5	4	3,5	4,5
competence (h)		H(3,30)=5.36; p-value=0.15		
Median	5	5	4	4
competence (i)		**H(3,30)=8.51; p-value=0.04**		
Median	5	4	3	5
Q10		H(3,30)=0.05; p-value=0.997		
Median	4	4	4	4
Q11		H(3,30)=3.62; p-value=0.31		
Median	4	4	3,5	4

For these competences, residents of countryside and small cities definitely rated the development of their competencies higher due to participation in the Hackathon than residents of medium and large cities. Perhaps these people just did not have the opportunity to participate in such time pressure and group work before, which is why they rated their experience growth higher after HackEmotion. Analogous tests of differences in terms of other groups (age, year of study or gender) were not performed because there was insufficient representation in subgroups in the research sample.

Machine Learning Methods Used for Questionnaire Data

Machine learning models were also used to study ability to detect hidden patterns in the questionnaire data. A supervised model – decision tree – was used to classify the place of residence of participants based on the results obtained for all questions except the sociological metric. It was found that the most important attributes that distinguish between participants living in large, medium and small cities and in countryside are:

A1. In what areas did HackEmotion influence the development of your knowledge, skills and competences? Designing the application as a complete and finished product.
A2. Was the proposed challenge (topic, goal) clearly defined?
A3. How likely are you to participate in a future hackathon?
A4. In what areas did HackEmotion influence the development of your knowledge, skills and competences? Managing your own time and that of others.
A5. What aspects of the event were most important to you? Possibility of further scientific cooperation at the Institute of Computer Science.

The exact relations that were found are presented in Figure 6. As we can see, there are six decision rules, namely:

If A1 $\leq$ 2.5 then place of residence = Medium city
If A1 > 2.5 and A2 $\leq$ 4.5 and A4 > 4.5 then place of residence = Countryside
If A1 > 2.5 and A2 $\leq$ 4.5 and A4 $\leq$ 4.5 then place of residence = Large city
If A1 > 2.5 and A2 > 4.5 and A3 > 4.5 and A5 > 4.5 then place of residence = Small city
If A1 > 2.5 and A2 > 4.5 and A3 > 4.5 and A5 $\leq$ 4.5 then place of residence = Large city
If A1 > 2.5 and A2 > 4.5 and A3 $\leq$ 4.5 then place of residence = Medium city

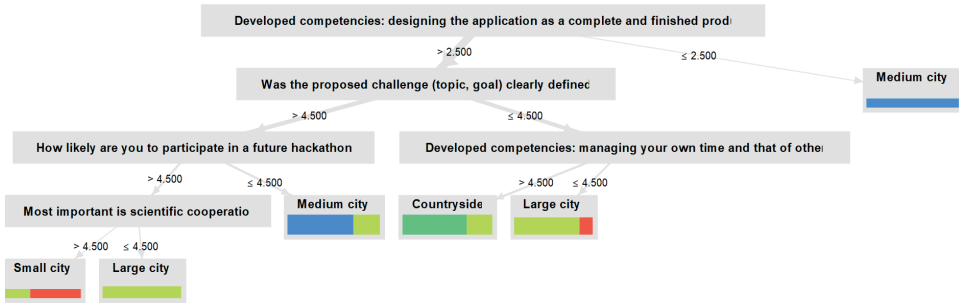

Figure 6. Decision tree obtained for the questionnaire data

The unsupervised k-means clustering algorithm was used to check whether there were groups of similar students in questionnaire participants. Different values of the parameter k (number of groups) were tested, from 2 to 5. It was found that the most consistent groups are formed for k=2. A presentation of the centroids of these groups is shown in Figure 7. The group marked as 0 in the figure contained 28 respondents, while group 1 contained two students. As can be seen, students in group 0 evaluated that through participation in HackEmotion they develop their competences and knowledge. Students from this group, on the other hand, stated that they were unlikely to have developed their knowledge and skills. However, it is important to note the significant disparity between the size of the two groups. Thus, the vast majority of students stated that participation in HackEmotion had positively influenced their development. This information is one of the most important for the event organizers and motivates them to organize events like the 24-hour programming marathon in the future.

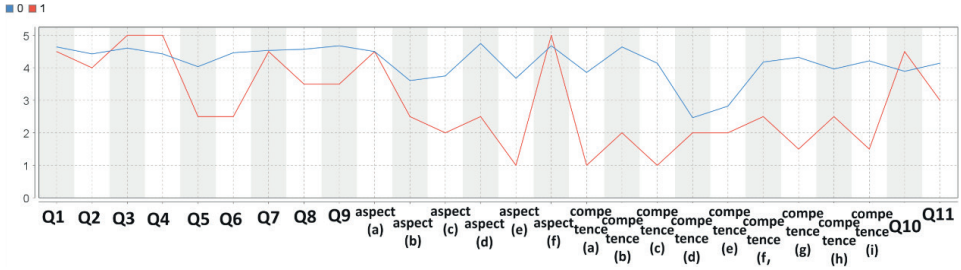

Figure 7. Decision tree obtained for the questionnaire data. Abbreviations used questions Q1–Q9 listed earlier in the paper, aspects that most motivate students to take part in events aspect (a) – aspect (f), competencies and skills developed by participating in event competence (a) – competence (i) and the importance of the issue related to recognizing emotions (Q10 and Q11)

Discussions

Motivating students for their own learning and development in today's world, where distractions with numerous opportunities, information, compete for their attention and work opportunities instead of studying, is increasingly challenging. Students also have more and more requirements in relation to the challenges offered to them. Traditional, outcome-oriented teaching methods have proven less effective than anticipated. Instead, the entire creative process, team collaboration, and the acquisition of knowledge through problem-solving are crucial for meaningful learning experiences.

The analyses presented highlight the necessity and importance of modern learning approaches, such as organizing 24-hour Hackathon programming marathons. This innovative method offers a non-standard learning environment where students work overnight at the university, collaborating in groups to solve significant, real-world problems. This immersive experience fosters creativity, teamwork, and practical problem-solving skills, all of which are vital for students' development in technical and STEAM education.

The evaluations indicate that the Hackathon was organized in a high standard. However, future events could benefit from more transparent allocation of grading criteria to ensure fairness, clarity and understanding the rules for awarding winners. One of the most critical factors influencing students' participation in the Hackathon is the relevance and practicality of the problem they are faced with during this event. For instance, the issue of society's difficulties in recognizing emotions was considered highly pertinent and engaging by the students.

To maintain and enhance student interest and engagement in future Hackathons, it is essential to select problems that are not only significant and real but also implementable. Future Hackathons should continue to address relevant societal challenges that resonate with students, ensuring that the events remain exciting and educationally valuable. By doing so, we can continue to leverage these innovative learning experiences to motivate students effectively and prepare them for real-world challenges.

The research highlights the importance of students being able to work effectively in groups during a hackathon. They appreciate the opportunity to select their own groups in advance, ensuring they collaborate with those they work best with, and they value the positive atmosphere throughout the event. The competences developed most during events like this are closely tied to group work, including time management, providing feedback to peers, and motivating team members. These skills are crucial in today's world, especially when tackling significant challenges involving large data sets or complex applications, where teamwork is essential.

So definitely organizing hackathons in the future is needed and is an important contribution to the development of students' competences and skills.

Conclusions

This paper presents a novel didactic method concerning organizing 24-hour programming marathons. These events, hosted at the university, engage students in creating software to address significant and current problems within a 24-hour period (one day and one night). The paper specifically describes an event organized by the Institute of Computer Science at the University of Silesia in Katowice, and includes results from an evaluation survey conducted after this event.

The main findings confirmed during the studies are as follows. Most aspects related to the organization of the Hackathon were at the highest level. However, the system for justifying the jury's evaluations needs improvement. An interesting challenge and the opportunity to work in groups were the greatest motivators for the participating students. Students significantly developed their group work skills by participating in the hackathon. Students recognized the importance of emotional recognition issues and considered the applications created to be practical.

Future work will focus on identifying appropriate issues for future hackathons and developing clear rubrics to validate the competition results and enhance student understanding of the awarded rankings.

Data Availability Statement

The datasets generated during the current study are available from the corresponding author on reasonable request. None of the data or materials for the experiments reported here is available, and none of the experiments was preregistered.

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Małgorzata Przybyła-Kasperek, Rafał Doroz, Agnieszka Lisowska, Grzegorz Machnik, Arkadiusz Nowakowski, Krzysztof Wróbel, Beata Zielosko

Badanie skuteczności i potencjału edukacyjnego 24-godzinnego maratonu programistycznego – HackEmotion

Streszczenie

Artykuł porusza kwestię nowoczesnej dydaktyki i motywacji uczniów do samodzielnego uczenia się, a także podejmowania istotnych wyzwań praktycznych. W edukacji technicznej i edukacji STEAM osiągnięcie wysokiego poziomu motywacji jest szczególnie ważne, ponieważ uczniowie często są przytłoczeni ogromną ilością informacji i możliwości, co prowadzi do zmniejszenia zainteresowania. W Instytucie Informatyki Uniwersytetu Śląskiego w Katowicach zorganizowano Hackathon – 24-godzinny maraton programistyczny – w celu zwiększenia zaangażowania studentów w proces nauki. Podczas tego wydarzenia studenci zmierzyli się z problemem współczesnego społeczeństwa jakim jest rozpoznawanie emocji. Celem było opracowanie rozwiązań, które miałyby pomóc w rozwijaniu umiejętności rozpoznawania emocji u młodych ludzi. Ważne, aby proponowane rozwiązanie miało potencjał do wdrożenia w świecie rzeczywistym. Dodatkowo, studenci mieli możliwość sprawdzenia swoich umiejętności pod presją czasu, doskonalili swoje kompetencje pracy w grupie i stawiali czoła scenariuszom rozwiązywania problemów w czasie rzeczywistym. Niniejszy artykuł przedstawia ocenę wpływu wydarzenia i analizuje wyniki ankiety przeprowadzonej po wydarzeniu, dostarczając informacji zwrotnych w celu poprawy jakości przyszłych Hackathonów. Głównymi pytaniami badawczymi, które postawiliśmy podczas badania były: RQ1: Na jakim poziomie jakości zorganizowano wydarzenie Hackathon? Czy studenci byli dobrze poinformowani i czuli się zaopiekowani podczas tego wydarzenia? RQ2: Jakie aspekty i właściwości najbardziej motywują studentów do wzięcia udziału w wydarzeniach organizowanych na uniwersytecie, takich jak Hackathon? RQ3: Jakie kompetencje, wiedzę i umiejętności rozwinęli uczestnicy Hackathonu? RQ4: Czy studenci uważają zagadnienia związane z rozpoznawaniem emocji za ważne, a stworzone aplikacje za możliwe do wykorzystania w praktyce? W niniejszym artykule odpowiadamy na te pytania z wykorzystaniem analizy statystycznej oraz prostych modeli uczenia maszynowego.

Słowa kluczowe: Hackathon, Praca w zespołach, Rozpoznawanie emocji, Edukacja STEM, Maraton programowania

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Exploración de la eficacia educativa y el potencial del maratón de programación de 24 horas – HackEmotion

Resumen

Este artículo aborda la cuestión de la didáctica moderna y la motivación de los estudiantes para el autoaprendizaje, además de abordar importantes retos prácticos. En la educación técnica y STEAM, lograr altos niveles de motivación es particularmente importante, ya que los estudiantes a menudo se sienten abrumados por la gran cantidad de información y oportunidades que conducen a la disminución de interés. En el Instituto de Informática de la Universidad de Silesia, en Katowice,

se organizó un Hackathon -maratón de programación de 24 horas- para aumentar el compromiso de los estudiantes. Durante este evento, los estudiantes se enfrentaron a un problema crítico de la sociedad modernae: el reconocimiento de emociones. El objetivo era desarrollar soluciones y ayudas para fomentar las capacidades de reconocimiento de emociones en los jóvenes con potencial de aplicación en el mundo real. Además, los estudiantes pusieron a prueba sus habilidades bajo presión de tiempo, perfeccionaron sus competencias de trabajo en grupo y se enfrentaron a escenarios de resolución de problemas en tiempo real. En este artículo se presenta una evaluación del impacto del evento y se analizan los resultados de una encuesta realizada tras el mismo, con el fin de aportar comentarios para mejorar la calidad de futuros Hackathones. Las principales preguntas que nos planteamos durante la investigación fueron: RQ1: ¿Con qué nivel de calidad se organizó el Hackathon? ¿Si los estudiantes estaban bien informados y se sentían atendidos durante este evento? RQ2: ¿Qué aspectos y propiedades motivan más a los estudiantes a participar en eventos organizados en la universidad como el Hackathon? RQ3: ¿Qué competencias, conocimientos y habilidades desarrollaron los participantes en el Hackathon? RQ4: ¿Consideran los estudiantes importantes las cuestiones relacionadas con el reconocimiento de las emociones y las aplicaciones creadas posibles de utilizar en la práctica? En este artículo, respondemos a estas preguntas utilizando análisis estadísticos y modelos sencillos de aprendizaje automático.

P a l a b r a s c l a v e: Hackathon, Trabajo en equipo, Reconocimiento de emociones, Educación STEM, Maratón de programación

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Исследование образовательной эффективности и потенциала 24-часового марафона по программированию – HackEmotion

А н н о т а ц и я

В данной работе рассматриваются вопросы современной дидактики и мотивации студентов к самообучению, а также решаются важные практические задачи. В техническом и STEAM-образовании достижение высокого уровня мотивации особенно важно, поскольку студенты часто оказываются перегруженными огромным количеством информации и возможностей, что приводит к снижению интереса. В Институте компьютерных наук Силезского университета в Катовице для повышения вовлеченности студентов был организован «Хакатон» – 24-часовой марафон программирования. В ходе этого мероприятия студенты столкнулись с критической для современного общества проблемой – распознаванием эмоций. Цель заключалась в разработке решений и помощи для развития навыков распознавания эмоций у молодых людей с возможностью их применения в реальном мире. Кроме того, студенты проверили свои способности в условиях дефицита времени, отточили навыки работы в группе и столкнулись со сценариями решения проблем в реальном времени. В данной статье представлена оценка воздействия мероприятия и проанализированы результаты опроса, проведенного после мероприятия, что позволяет получить обратную связь для улучшения качества будущих хакатонов. Основными вопросами, которые мы ставили перед собой в ходе исследования, были: RQ1: На каком уровне качества было организовано мероприятие «Хакатон»? Были ли студенты хорошо информированы и чувствовали ли они заботу о себе во время этого мероприятия? RQ2: Какие аспекты и свойства больше всего мотивируют студентов принимать участие в мероприятиях, организованных в университете, таких как Hackathon? RQ3: Какие компетенции,

знания и навыки были развиты у участников Хакатона? RQ4: Считают ли студенты вопросы, связанные с распознаванием эмоций, важными, а созданные приложения - возможными для использования на практике? В данной работе мы отвечаем на эти вопросы с помощью статистического анализа и простых моделей машинного обучения.

К л ю ч е в ы е с л о в а: Хакафон, Работа в команде, Распознавание эмоций, STEM-образование, Марафон программирования