A Survey on COSMIC Students Estimation Challenge

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Abstract

Software project management is a significant software engineering practice that is highly related to achieving software-specific project goals. This study aims to share students' perceptions of incorporating an international software estimation challenge called "COSMIC Students' Estimation Challenge" into a software project management course. For this aim, students were taught the COSMIC Functional Size Measurement method and entered the competition. After the competition, a questionnaire asking for the students' opinions was collected. The objective of the research is to get an insight into to what extent incorporating this type of competition activity -a challenge- can contribute to students' learning perceptions. In the long run, the findings can contribute to creating a foresight about making the necessary curriculum arrangements to form a more up-to-date and dynamic education plan by including the methods applied in the software industry in Software Engineering education. The results suggest that this kind of competition experience and preparation is helpful for students to learn the COSMIC method.

Keywords

project management education, software engineering education, COSMIC, challenge, gamification

1. Introduction

Software project management is one of the drivers of developing high-quality software products on time and on budget. Software projects often exceed the anticipated budget and generally result in time delays. To raise awareness of the importance of this concept, nowadays, many software engineering departments worldwide have already incorporated a standalone software project management course into their curriculum. In addition, several recent studies have been found in software engineering literature on teaching software measurement processes by exploring different ways, such as using gamification [1, 2].

In this respect, software size stands out as an important input to consistently making project related estimations. In addition to various methods for size measurement, there is a method called COSMIC Functional Measurement (FSM), which ISO also recognizes as a standard [3]. COSMIC Consortium organizes various international activities for the dissemination of the method. One of these activities is the COSMIC Student Challenge 2022, which was held for the third time this year on April 9th, 2022. Students participated in this competition in teams and applied the steps of finding the size of a software project using the COSMIC FSM method. Utilizing the approximation techniques suggested by the method, if the requirements do not contain sufficient details, they estimated the effort using the size that they have measured.

Within the scope of the "Software Project Management and Economics" course in the Software Engineering Department of a university in Turkey, the COSMIC FSM method was presented to students as a part of the project estimation topic. In addition to the materials described in the course content,

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presentations and videos prepared by the COSMIC Consortium were also offered to the students. The students then participated in the "COSMIC Students' Estimation Challenge" and tried themselves in the competition.

After the challenge, we organized a survey to investigate the students' feedback regarding the contribution of the education given during the lectures and the experience after an international measurement competition. In this article, we present the results of the survey in several dimensions, such as prior knowledge about the method, preparation for the challenge, the challenge experience, team scores, and suggestion for improvement suggestions from the students' perspectives.

The remainder of this paper is organized as follows. Section 2 reviews related research regarding software project management and software engineering education. In Section 3, our research methodology for the survey is explained. In Section 4, the results of the survey are presented. Section 5 discusses the survey findings. The main conclusions, limitations, and future work are presented in Section 6.

2. Background

In the literature, various studies are proposed to enhance software engineering (SE) education. Based on a recent study presented in [7,] engaging students is among the main challenges regarding software engineering education, and designing practical activities is also mentioned as one of the difficult tasks. To improve the teaching activities in SE, several approaches are adopted, including gamification techniques, problem-based learning, role-playing, flipped classroom, serious game, etc. [7].

A handful of studies on improving teaching software size measurement were presented in the literature. For example, in [1], the authors proposed a serious game for students to practice the COSMIC FSM measurement. Based on their study, the authors found that the most of the participant students think that the game proposed helped them learn how to use COSMIC for estimation.

Later authors in [2] presented another study in which they presented a proposal using gamification with a serious game to instruct the software measurement process. The authors concluded that this type of methods were beneficial for teaching software measurement due to gamification's competitive and collaborative characteristics.

One of the main properties of a software in terms of measurement is its size. Software size can be described in three core attributes: length, complexity, and functionality [4]. Measuring size in terms of functionality has many benefits over using the other attributes, where early estimation is one of them. Functional size measurement-related studies originate from Albrecht's Function points in 1979. Many other methods, such as IFPUG, Mark II, NESMA have been published afterwards [5].

COSMIC FSM method was officially introduced in 2001 as a second generation FSM method which attracted attention by being applicable to a wide range of software applications such as business applications, service-oriented systems, real-time systems, etc., and by being independent of tools and technologies [6]. COSMIC FSM method is based on counting data movements. The data movements are described as Entry (E), Exit (X), Read (R), and Write (W). The method suggests that a functional user requirement comprises one to many functional processes. These functional processes include a set of data movements. The size of a functional process is the sum of its data movements. Accordingly, the size of a given functional requirement is the sum of the size of its functional process. Consequently, a software system's functional size is the sum of the size of its functional requirements [3].

The method is perfectly applicable when functional requirements contain required details. In addition, the COSMIC FSM method also has some approximation techniques when the given requirement set does not contain sufficient details in the requirement set. It has also a guideline for measuring non-functional requirements.

The COSMIC Consortium provides a set of manuals and materials, including case studies, to instruct the measurement method. All these materials can be accessed for free on the WEB page of COSMIC[2].

[2] https://cosmic-sizing.org/

3. Research Methodology

In this study, the survey is used as the research methodology. The main goal of this survey is to explore the contribution of this type of competition to the students' perception about how much they have learned software size measurement and estimation, and how much this competition raised their awareness of this topic. We accordingly derived the following research questions:

• RQ1. Does COSMIC Students' Challenge contribute to learning size measurement and estimation concept?
• RQ2. Does COSMIC Students' Challenge raise awareness about the utilization of size measurement in software project management?

As for our sampling method, we chose third-year software engineering students taking the "Software Project Management and Economics" course at a university in Turkey. Other student groups could be used, but since software estimation is one of the topics of software project management course, this student sample was the most appropriate one to teach the COSMIC FSM method.

Considering the number of questions, we decided to divide the survey into sections to make it clear and understandable. The survey consisted of four main sections:

• Participant Information
• Prior Knowledge
• Preparation for the Challenge
• COSMIC Challenge Experience

The survey was offered to students after the challenge. It was offered online and using the Google Forms survey platform. Approval from the Institutional Review Board was also taken for applying the survey. Participation of the survey was voluntary but to engage the student interest, two points were offered as a bonus point for the overall course grade.

4. Results

In the challenge, we had 22 participating teams, including a total of 65 students with a team size of 3. Participation in the survey was voluntary. Accordingly, 56 students from 22 groups participated in our survey. The survey comprises six sections: content approval, participant information, prior knowledge, preparation for the challenge, challenge experience, and additional comments. The results of each section are summarized in the following sections.

4.1. Prior Knowledge

We first asked about the participants' prior knowledge of the COSMIC method based on Bloom's taxonomy (see Figure 1). 5.4% of the participants have applied, 10.7% know, and 19.6% have previously heard of the COSMIC method. The majority (64.3%) of the participants have no prior knowledge about the COSMIC method.

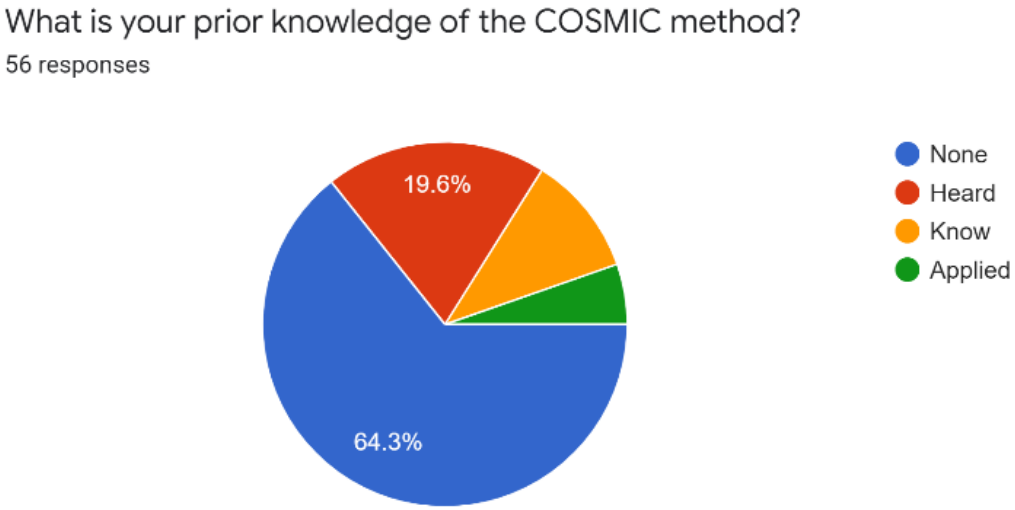

Figure 1: Prior knowledge of the COSMIC method

In the second question, we asked a more generic question about the prior knowledge of software size measurement. The results show that the prior knowledge of software size measurement is more than the COSMIC method (see Fig. 2). 8.9% of the participants have applied, 17.9% know, and 28.6% have no prior knowledge where 44.6% of the participants have previously heard of the COSMIC software size measurement method.

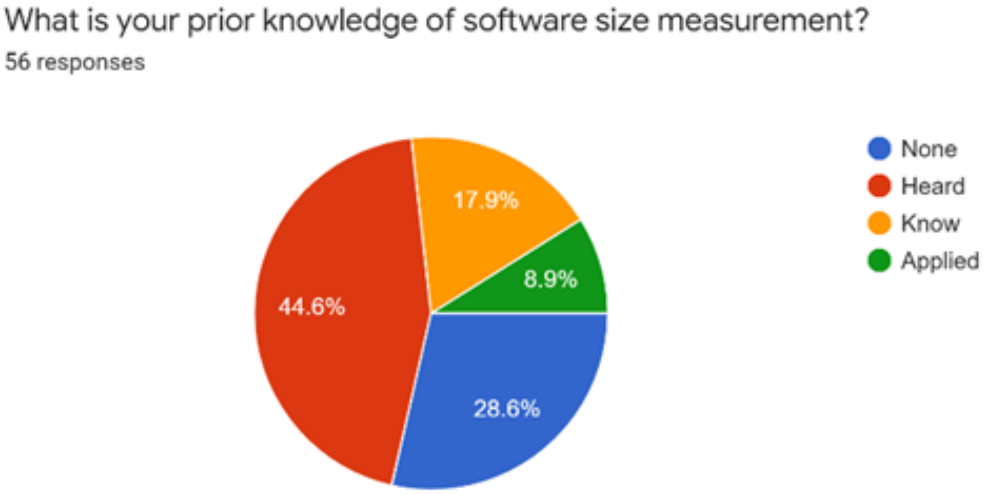

Figure 2: Prior knowledge of the software size measurement

4.2. Preparation for the Challenge

The first question asks whether the participant has attended the challenge preparation lectures or not (see Figure 3). Similar to our observation from the lecture, most students (91.1%) participated in the lecture, while 8.9% did not attend.

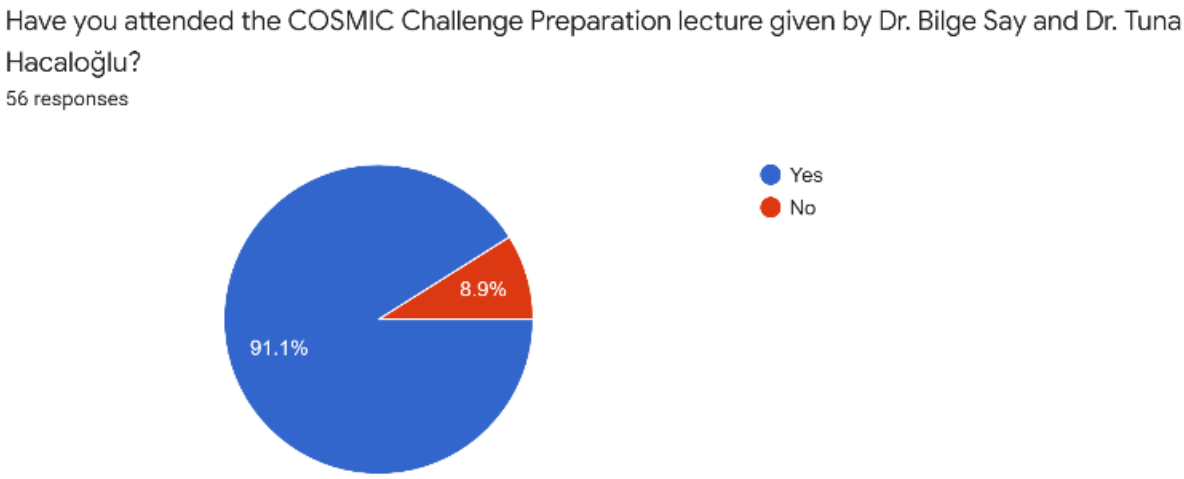

Figure 3: Attendance of the COSMIC Challenge Preparation Lecture

Secondly, we asked how they prepared for the challenge (see Figure 4). 62.5% of the participants read given COSMIC manuals, 62.5% read challenge slides provided by COSMIC, 50% measured sample projects, and 42.9% watched challenge videos available online provided by COSMIC.

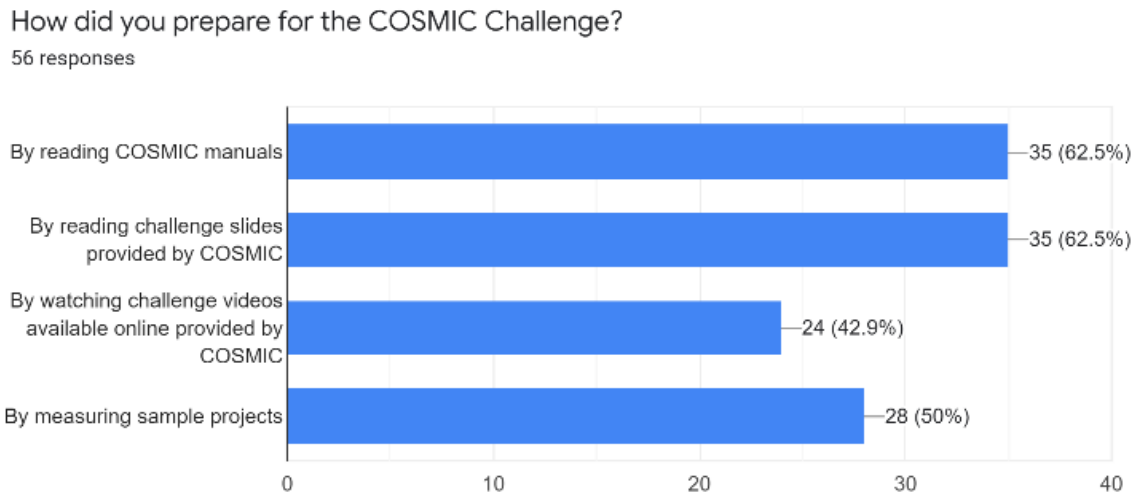

Figure 4: Preparation for the challenge

Thirdly, we asked to explore the time spent preparing for the challenge (see Figure 5). 50% spent 1-3 hours, 30.4% spent 4-6 hours, and 19.6% spent less than one hour. None of the students spent more than 6 hours preparing for the challenge.

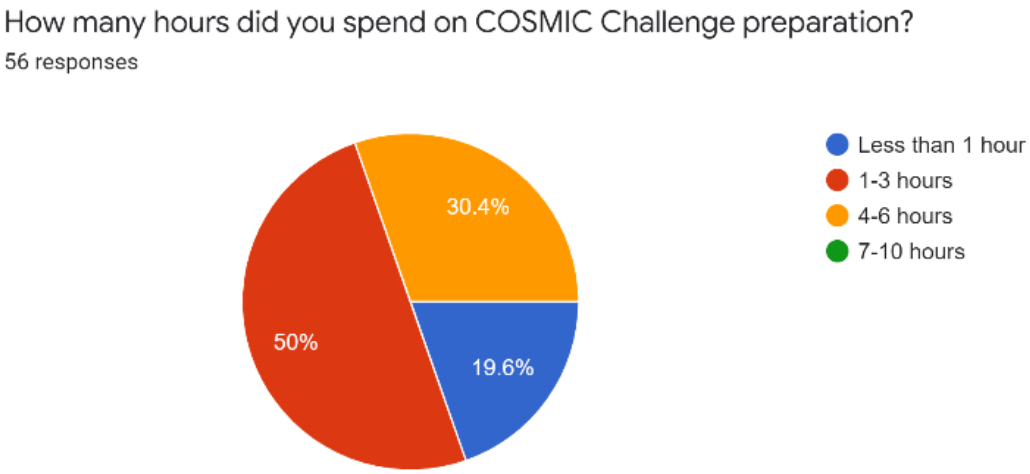

Figure 5: Time spent preparing for the challenge

Lastly, we asked about the satisfaction level of the students' preparation for the challenge (see Figure 6). 35.7% of the participants are neutrally satisfied, 30.4% are satisfied, 17.9% are unsatisfied, 10.7% are very satisfied, and 5.4% are very unsatisfied.

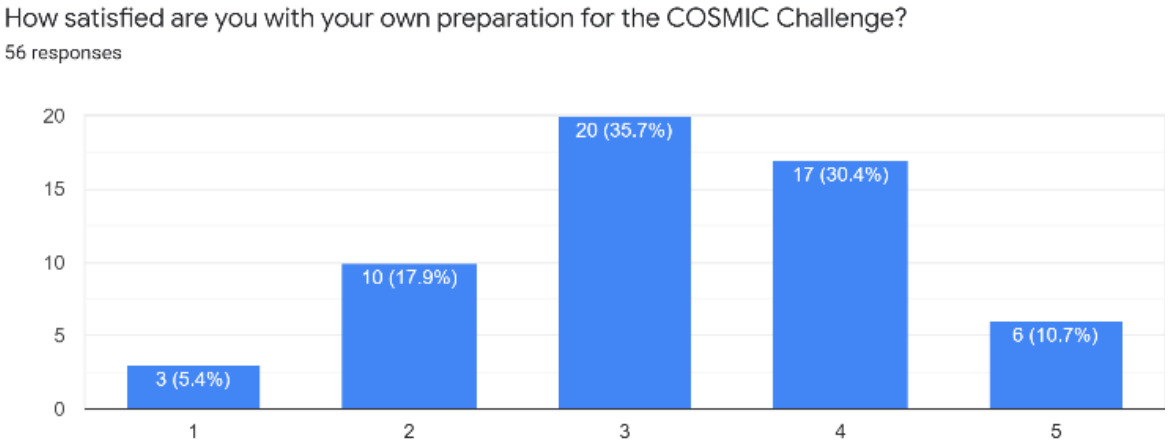

Figure 6: Participants' preparation satisfaction

4.3. COSMIC Challenge Experience

In this section, we asked questions about their experience with the challenge. Firstly, we asked them to rate the difficulty of the challenge (see Figure 7). 33.9% of the participants voted neutral, 32.1% found the challenge difficult, and 26.8% found it very difficult. A small group of participants found the challenge as easy.

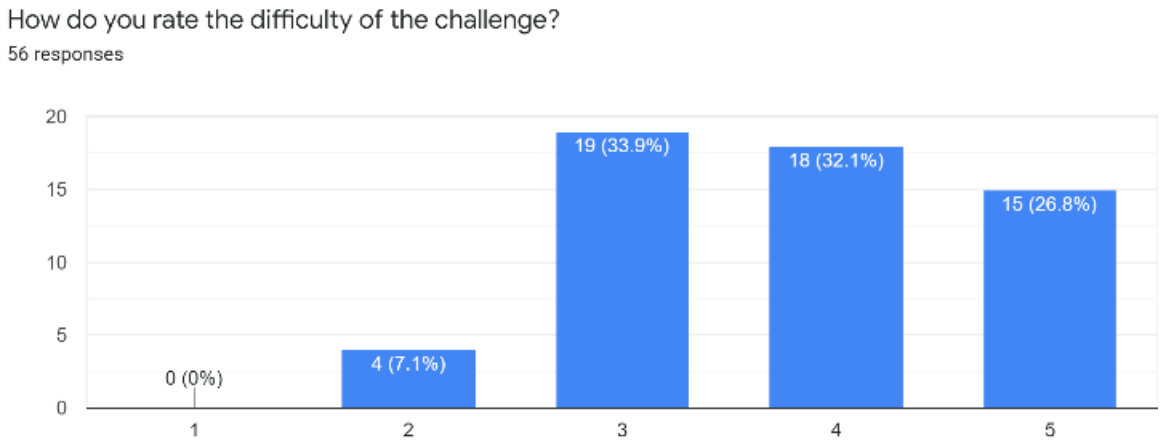

Figure 7: The difficulty of the challenge (1: very easy; 5: very difficult)

Secondly, we asked them to rate the given time for the challenge (see Figure 8). 37.5% found it insufficient, 7.1% found it very insufficient, while 17.9% found it sufficient, and 5.4% found it very sufficient. The percentage of neutral participants is 32.1%.

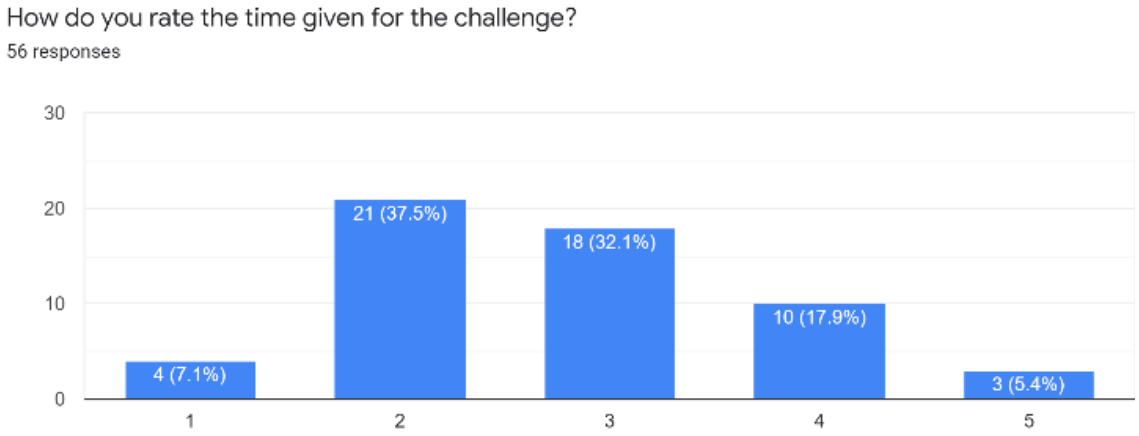

Figure 8: The sufficiency of the given time in the Challenge (1: very insufficient; 5: very sufficient)

Thirdly, we asked which part of the challenge was the most difficult (see Figure 9). Although there is no weight on a specific part, the results are as follows: sizing the detailed functional requirements (28.6%), sizing the non-functional requirements (25%), estimating the effort to develop both functional and non-functional requirements (19.6%), developing an estimation model from the historical data (19.6%) and approximating the size of the requirements (12.5%).

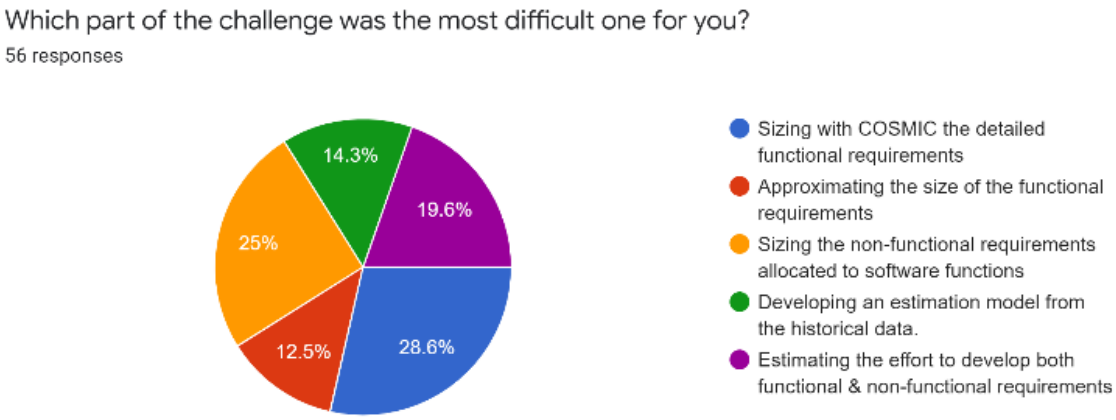

Figure 9: The most difficult part of the challenge

Fourthly, we asked whether the challenge helped them learn the COSMIC method or not (see Figure 10). The results show that most participants found the challenge helpful (41.1%) or extremely helpful (25%). Accordingly, 25% voted neutral, and 8.9% of the participants found it not helpful.

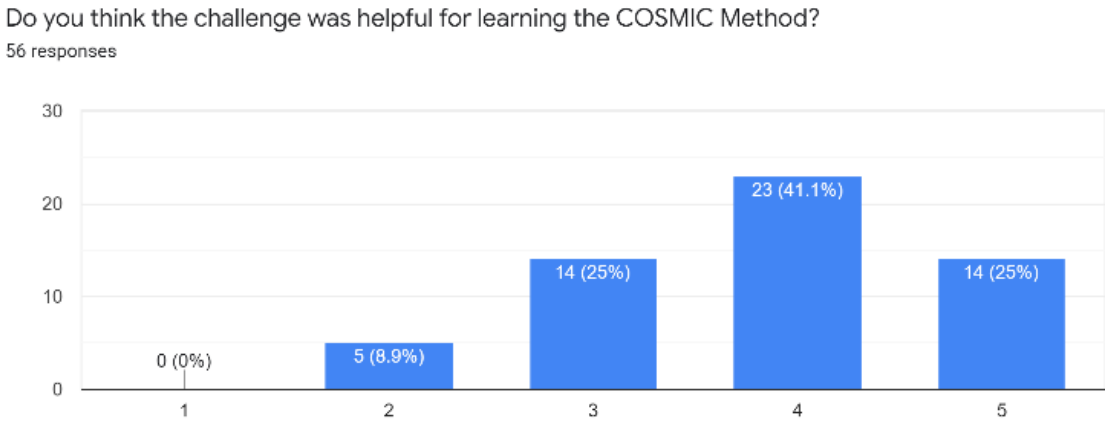

Figure 10: The helpfulness of the challenge (1: not at all helpful; 5: extremely helpful)

Fifthly, we asked the participants' opinions on the usefulness of the COSMIC method in real-life projects (see Fig. 11). 28.6% found it very useful, 25% found it useful, while 28.6% voted neutral.

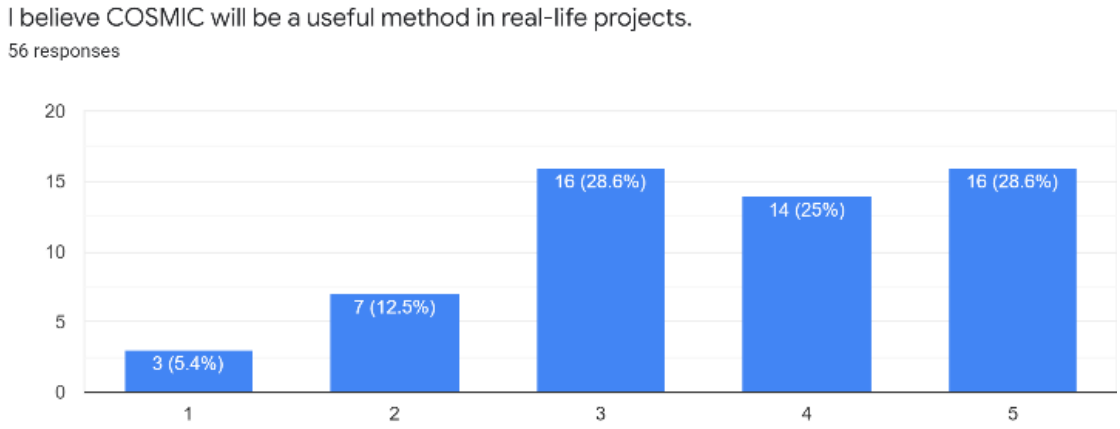

Figure 11: The usefulness of the COSMIC method (1: strongly disagree; 5: strongly agree)

Lastly, we asked participants whether the challenge has changed their perception of the usability of the COSMIC method in real-life software projects (see Fig. 12). 35.7% of the participants agree, 28.6% are neutral, 19.6% strongly agree, 8.9% disagree, and 7.1% strongly disagree.

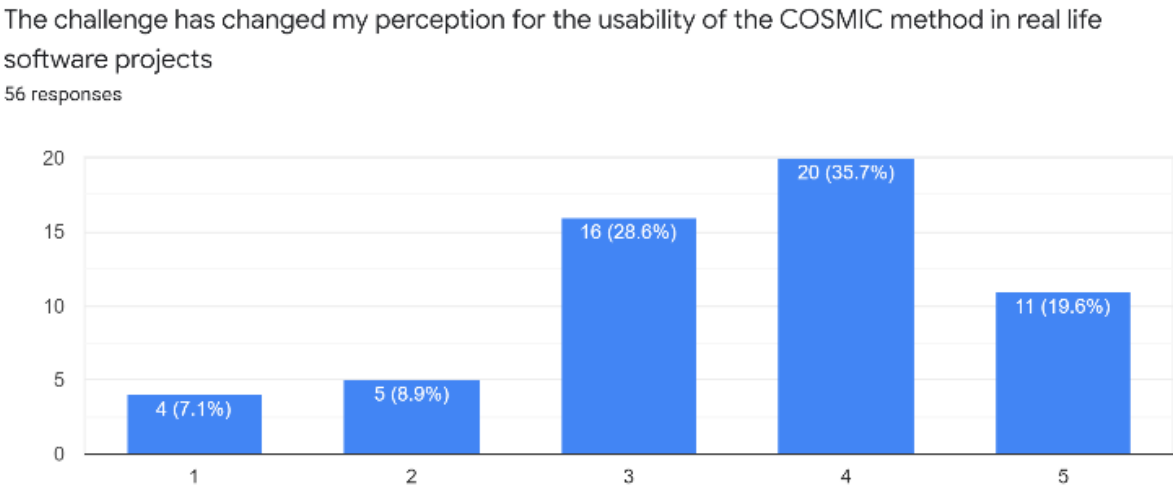

Figure 12: Perception of the usability of the COSMIC method (1: strongly disagree; 5: strongly agree)

4.4. Team Scores

As we mentioned, 22 teams participated in the challenge; however, one team did not submit their work. Thus, 21 teams remained. The statistical summary of the team scores is presented in Table 1.

Table 1
The statistical summary of team scores

Number of teams	Avg. score	Max. score	Min. score	Standard deviation
21	42.24	84	9	18.23

5. Discussions

We will discuss our findings based on participants' comments and suggestions in three sections: recommendations for improvement of the challenge, suggestions for improvement of the study material, and additional comments of the participants.

5.1. Suggestions for Improvement of the Challenge

We asked an open-ended question to the participants about their suggestions for improvement of the challenge. The participant suggestions are listed as follows:

• In parallel to survey results, many participants found the duration of the challenge not sufficient. They expressed that the duration could be longer as there are many tasks.

• Another common suggestion was about the number of tasks in the challenge. As the time was insufficient for the participants, they suggested that the number of tasks could be less.

• Another suggestion was about team size. The participants suggested that all teams should have a fixed size for equality.

• Some participants found preparing a presentation quite unnecessary. They suggested submitting a report instead of a presentation which suits the answers better.

• Participants also suggested that there should be a better explanation for the tasks. Similarly, some participants found the introduction presentation at the beginning of the competition not sufficient. They suggested that the challenge should be explained in more detail.

• The last suggestion was about the date of the challenge. They suggested locating the challenge at the end of the semester as they can have more time to focus on the challenge.

5.2. Suggestions for Improvement of Study Materials

Similarly, we also asked an open-ended question to the participants about their suggestions for improvement of the study materials. The participant suggestions are listed as follows:

• A common comment about the study materials was about including concrete examples in the materials. They suggested including examples similar to the challenge in study materials. They found the challenge much more complex than the examples in the study materials.

• Another suggestion was about the release date of the study materials. They suggested that study materials should be released earlier to provide them more time to be prepared.

In order to improve software project management courses in software engineering curriculums, we infer that the syllabus can be updated in accordance with the challenge components such as sizing functional requirements, making the approximation, sizing non-functional requirements, and performing the estimation.

5.3. Additional Comments

The additional comments of the participants show that COSMIC Challenge reached its goal. Some other comments of the participants are given as follows:

• "Thank you for giving us this chance. If I specialize in project management in the future, I'll be able to say, "I've joined COSMIC."

• "It is beneficial to understand estimating project size."

• "This was an extraordinary experience for me. It was an instructive and entertaining activity and reinforcing work; thank you very much."

• "For the students who will participate in the challenge, I strongly recommend that you do not solve each step together since the duration is really limited, do each part separately and decide the work assignment according to the performance of your team members."

• “It was fun working together with friends.”
• “It was a fun event.”
• “It was a different and unique experience.”
• “Thanks to our professors, we became aware of this COSMIC challenge and participated in the challenge. It was beneficial for us. I think we will use these things we learned in our future business life, and I would like to thank our professors.”
• “It was both a fun and instructive challenge. I am happy to participate and experience.”
• “I like the challenge; I hope I will join the challenge again.”
• “It was a decent challenge.”
• “The challenge was perfect; it added a lot to me, especially about project management.”

6. Conclusion

This year, COSMIC Consortium organized the third Students Estimation Challenge on April 9th, 2022. Apart from the last two challenges, the consortium provided study materials (slides and videos) for the participants this year. 53 teams participated in the challenge, including 234 students from Turkey, Canada, Egypt, Cameroun, and Mexico.

We supervised 22 teams from Turkey. After the challenge, we organized a survey to explore the feedback of participants from Turkey about the challenge. One of our supervised teams won the second prize. In this paper, we presented the survey results and findings.

Considering RQ1, we can say that COSMIC Challenge reached its goal. Participants commented that they improved their knowledge and skills in software estimation. The incorporation of this practical experience to a software project management course made the subject more understandable and excited the attention of the students. Regarding RQ2, the results suggest that the challenge increased the awareness of the students about size measurement and estimation. Moreover, the findings suggest that study materials can be improved by incorporating concrete examples. A potential future study can include statistical analyses such as correlation analysis to investigate the relationship between the students’ preparation, students’ opinions, and the scores they get.

With this article, we aimed to gather the students’ opinions regarding the challenge. COSMIC Consortium improves the challenge each year. We believe that the results of this survey will be an essential input and can give insights to improve the challenge next year.

7. Acknowledgment

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