

What (de)motivates one to volunteer in K-12 STEM-C outreach activities?

Tomislav Jaguš, Ana Sović Kržić,
Anamari Nakić, Mislav Grgić
Faculty of Electrical Engineering and Computing,
University of Zagreb
Unska 3, Zagreb, Croatia
e-mail: {tomislav.jagust, ana.sovic, anamari.nakic,
mislav.grgic}@fer.hr

Iva Bojic
SENSEable City Laboratory,
Singapore-MIT Alliance for Research and Technology,
1 Create Way, Singapore, Singapore
e-mail: ivabojoic@mit.edu

Abstract—Today it is already widely accepted that out of school education exceeds formal education in content and knowledge and that it is not a plus, but a necessity. However, unlike formal education, educators working in informal settings are often volunteers or/and they do those activities on top of their daily jobs. The research questions we pose here are (i) what motivates people to volunteer in K-12 Science, Technology, Engineering, Mathematics and Computer Science (STEM-C) informal education, (ii) what could help to motivate people who are currently demotivated, and finally (iii) what we can do not only to attract new volunteers, but also to retain the current ones. We collected and analyzed opinions of faculty staff, students and volunteers involved in K-12 STEM-C outreach activities conducted at University of Zagreb Faculty of Electrical Engineering and Computing, Croatia where five years ago, we started our outreach program named SUZA - From school to science and the academic community. The results of our research study show a wide span of reasons why (and why not) people volunteer in our activities, together with their general attitudes toward K-12 STEM-C outreach activities. Although the results are mostly in line with research in the field, there are some specifics which could relate to specifics of volunteering in K-12 STEM-C fields and could benefit wider community.

Keywords—STEM-C; outreach; out-of-school; education; motivation; volunteering

I. INTRODUCTION

Due to complexity of Science, Technology, Engineering, Mathematics and Computer Science (STEM-C) fields, it is important to combine the strength and knowledge of various institutions in order to achieve successful education of K-12 students [1]. Moreover, time that is planned for formal education in STEM-C fields is too short for K-12 students to learn even basic skills. Luckily, many universities realized that they have to get involved in K-12 education through organizing different out-of-school events [2], [3]. However, educators involved in informal education are often only volunteering and have their daily jobs. The question we pose here is what we can do to keep old volunteers and attract new ones. The importance of outreach activities has been widely acknowledged across different disciplines (e.g. mathematics and computer science [4], biological science [5], ecology [6]) and it can be summarized using the arguments presented in [7]. By

promoting the public understanding of science, not only can we attract new recruits into the scientific community, but also public support for science is closely correlated with their awareness of scientific research outputs. Consequently, research that “makes more sense” for the general public is more likely to be financed. That is why the public understanding of science first and foremost benefits to *science* itself – both financially and in a form of new recruits. The level of penetration of scientific findings into society is also related with national economies and influence and contributes to the democratic society. Namely, citizens who are more interested in science, feel more empowered to influence the science policy-making process. Finally, understanding of science helps the *society as whole* as it can improve the way how *individuals* make decisions in their everyday lives. Five years ago, when we started with our K-12 STEM-C outreach activities at University of Zagreb Faculty of Electrical Engineering and Computing, Croatia, we had huge problems to find educators who were willing to give up on some of their free time and help us to start our outreach program named SUZA - From school to science and the academic community. Today we have “a pool” of volunteers which consists of university professors, researchers and students from the Faculty [8]. Nevertheless, we are constantly struggling to keep our old volunteers happy, but also to find ways how to attract new ones. In this paper we thus present the results of our study in which we investigated what motivates people to volunteer in K-12 STEM-C fields. In addition to our volunteers, we also interviewed people who were in the past not motivated enough to get involved with our outreach efforts, to better understand their main reasons for non-participation. Our study included people of different age, socioeconomic status and gender.

II. RELATED WORK

A recent study from the Royal Society, involving a web survey of 1485 research scientists in higher-education institutes, showed that most scientists agreed that interacting with the public was a worthwhile endeavor as 74% reported having taken part in at least one outreach activity in the past 12 months [9]. It seems like numerous calls for better communication between scientists and the public, which came lately from different professional societies, funding agencies and scientists themselves, helped to get scientists willing to

participate in outreach activities. However, the overwhelming majority of scientists still feel a duty or desire to educate the public about science, rather than willing to involve the public in a two ways conversation [10], [11]. Indeed only 12% of scientists indicated that they are willing to listen or attempt to understand the views of the public [9]. Luckily, this general trend seems to be different when it comes to scientists who are genuinely interested in outreach activities [12]. The focus of our outreach program is mainly on K-12 students and their teachers, while among scientists surveyed by the Royal Society this audience came on the second place after policy makers who were identified as the first target group [9]. On the other side, we try to better understand views, attitudes and interests of exiting volunteers, in an attempt to retain cooperation with them in future outreach projects.

In our study we surveyed volunteers participating in our SUZA outreach program, but also university professors, researchers and students from the Faculty who, in the past, were not motivated enough to get involved. As our program was initially started by a small group of researchers led by at that point our Vice-Dean for Science and today our Dean, we wanted to check if this top-down approach can help to remove peer pressure as a barrier to scientific communication indicated by 3% surveyed scientists in [9]. Moreover, we want to change the perception which seems to exist in the part of the scientific community, that public activity engagement is bad for someone's career and that these activities are for scientists who are not good enough to do a "real science", as well as that outreach activities must be done on one's own time, outside real research [6].

III. METHODOLOGY

This study analyzed the response of faculty students, former students and staff to the online questionnaire about their attitudes and engagement in science outreach activities.

The three main research questions around which the online questionnaire was composed were:

- 1) *What motivates people to volunteer in K-12 Science, Technology, Engineering, Mathematics and Computer Science (STEM-C) informal education?*
- 2) *What could help to motivate people who are currently demotivated?*
- 3) *What we can do not only to attract new volunteers, but also to retain the current ones?*

The questionnaire was created on the Google Forms platform, and consisted of 16 questions, varying from multiple choice and grid questions to the open-ended text fields. The questions were grouped in 4 categories:

- general attitude about science outreach and participation/engagement in outreach programs
- questions for respondents who already volunteered in our outreach activities
- questions for respondents who, until now, did not volunteer in any of our outreach activities

- general statistics (education level or degree, gender, research area/interests etc.)

The email message, containing short explanation and link to the questionnaire was sent out to the staff members and students of the faculty, but also to the members of different student organizations that are active at the faculty.

IV. RESULTS AND DISCUSSION

Overall, 310 responses were collected and analyzed. About three quarters of respondents (74.7%) were male, which roughly corresponds with gender percentages among students and researchers at the faculty. 188 respondents (60%) are students, 87 are faculty members, 23 doctoral students, and the rest includes students from other faculties or faculty graduates. 30% of respondents are members of one or more student/professional associations (more than half of that are members of IEEE).

RQ 1

To answer the question "What motivates people to volunteer in K-12 STEM activities?" we analyzed a subset of 111 responses from participants claiming they were engaged in at least one outreach activity until now.

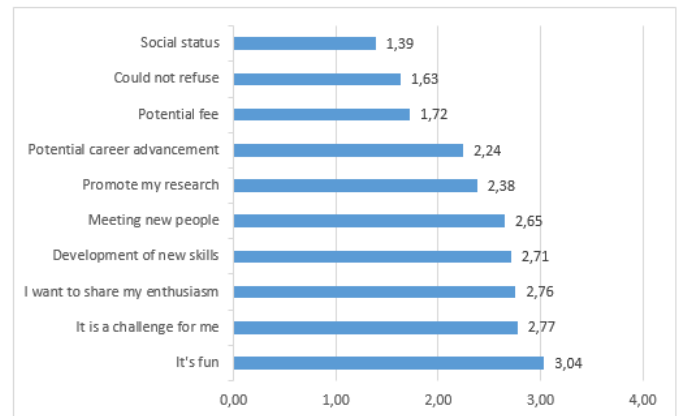


Figure 1. Answers to the question "To what extent did each of these statements affect your participating in STEM-C outreach activities?"

In a question that asked respondents to grade with 1 (did not affect) to 4 (strongly affected) a list of statements that could affect their participating (Figure 1), the most important reason for volunteering was "It is fun", with 43 respondents giving it the top score (4). The second most important reason was "I want to share my enthusiasm towards science with other people", while "Social status and recognition" and "Could not refuse order from my boss/tutor" were the least important reasons, with mean score of 1.39 and 1.63, respectfully.

"Social status and recognition" was graded 1 by 77 respondents, while only three respondents rated it with grade 4. "Could not refuse order from my boss/tutor" received 7 "strongly affected" answers, indicating that a small number of respondents were forced to "volunteer" in some of our programs. Six of these selected "Faculty open day" as one of the activities in which they participated. Open day is a yearly event at our faculty where each department and laboratory have to provide one or more representatives, and some groups have

problems finding volunteers. To avoid further inconveniences, department heads used to order a member (usually, a newcomer) to participate.

RQ 2

The second research question, “What could help to motivate people who are currently demotivated?”, was very important to us, since we always want to increase a number of outreach activities, enrich existing activities with new programs, but also, avoid situations where a person must participate in an activity against her or his will, as stated before. To better understand reasons why someone did not participate in our outreach activities, we asked two questions:

1) *To what extent did each of these statements affect your NOT participating in our STEM-C outreach activities?*

and

2) *Which of these reasons could motivate you to start participating?*



Figure 2. Answers to the question “To what extent each of these statements affected respondent NOT participating in STEM-C outreach activities?”

The first question asked respondents to grade with 1 (did not affect) to 4 (strongly affected) a list of reasons for not participating in our activities (Figure 2).

The most important reason is the lack of time (average rating 2.95 out of 4), followed by lack of information (2.63) and modesty (2.31). More detailed analysis, with grouping participants by educational level, revealed some interesting facts: While the lack of time is still prevalent reason for most groups, undergraduate students rated “I didn’t know that I can participate” as a top reason, while postdoc students and young researchers rated “Tutor/boss is against it” higher than other groups. (Table 1). These answers suggest that we should intensify informing the newcomers about our activities, and also improve communication with senior professors and department heads, in order for them to stimulate, and not discourage their associates to volunteering in outreach activities.

TABLE 1 – TOP REASONS FOR NOT PARTICIPATING IN STEM-C OUTREACH ACTIVITIES BY EDUCATIONAL LEVEL GROUP

	Undergrad. student	Master student	PhD student	Postdoc	Young researcher	Prof.	other
Not enough time	2	1	1	1	1	1	1
I didn't know that I can participate	1	2	2	8	3	3	2
Do not want to stand out	4	4	4	3	2	2	5
Don't know how to do it	3	3	5	11	9	6	4
Fear of public appearance	5	5	2	5	4	4	6
Nobody around me participates	6	6	7	4	12	8	7
Do not want to lose my free time	7	6	5	10	5	4	3
I do not like to work with children	8	8	11	12	9	11	12
Doesn't have impact on career	9	9	9	2	6	9	11
My research is too complicated	11	10	8	7	6	7	8
My research is not interesting	10	11	10	8	6	9	8
Tutor/boss is against it	12	12	12	5	9	12	10

Here, a small gender difference in answers was noticed: male participants prevalently chose “Not enough time”, while female participants chose “I didn’t know that I can participate”.

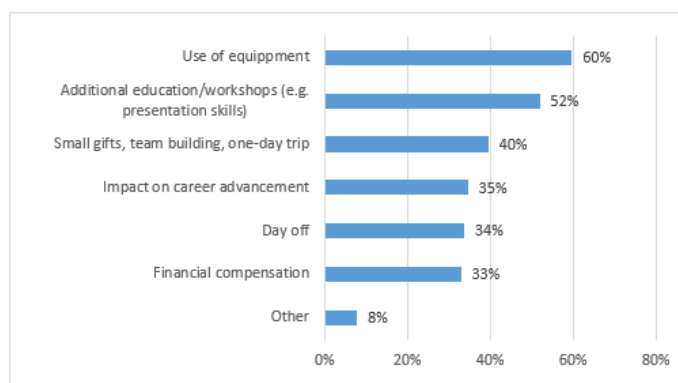


Figure 3. Key motivation factors for getting involved into STEM-C outreach activities

Second question (given to all the respondents, and not only to the “demotivated” group) contained a list of reasons that could motivate one to participate (Figure 3).

Almost 60 percent of respondents chose “Use of equipment (like LEGO Mindstorms, Arduino or LittleBits sets)”. More than half of respondents chose also additional trainings as one of the reasons that could encourage them to engage with some of our outreach activities. While use of equipment was chosen mostly by students (including PhD students), additional trainings and workshops were equally chosen by all respondents. The least important factor was financial compensation.

RQ 3

The third research question, “What we can do not only to attract new volunteers, but also to retain the current ones” required deeper insight into the attitudes and interests of respondents. For this purpose, a number of general questions about outreach activities was asked.

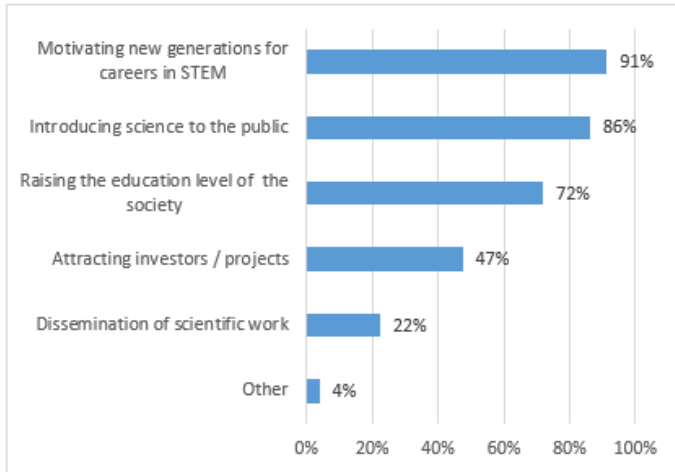


Figure 4. Answers to the question “What is, in your opinion STEM outreach / Science popularization?”

The great majority of respondents agrees that main focus of STEM outreach activities should be motivation of younger students for STEM careers (91%), and in general, introduction of science into the society (Figure 4).

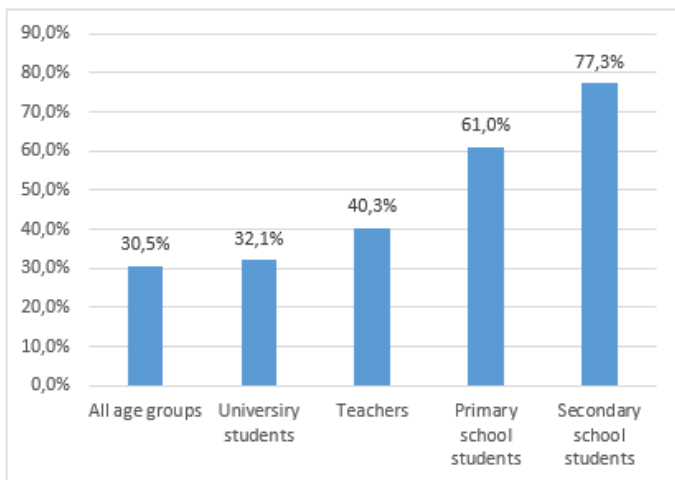


Figure 5. What age groups should be the main focus of our outreach activities?

When asked to grade with 1 (did not affect) to 4 (strongly affected) a list of general statements about Science popularization, respondents gave average 3.51 to both, “A means with which we can publicize the importance of the STEM area” and “Great tool for motivating society in STEM fields”, while giving low score of 1.42 to “Just a passing trend” and 1.48 to “Good for PR, but useless otherwise”. This

question also yielded some gender differences, while top rates statement for men was “Great tool for motivating society in STEM fields”, top rated statement for women was “great tool to fight prejudices (not for girls; you are not clever enough...)”.

Most of the respondents believe that the main age groups we should approach are primary (61%) and secondary (77.3%) school students (Figure 5).

V. CONCLUSION REMARKS

In this study we conducted and analyzed the results of a STEM outreach program survey at University of Zagreb Faculty of Electrical Engineering and Computing.

The overall response was very positive, with more than 300 people filling in the questionnaire and expressing interest to be more actively involved in our future activities. Most of the existing volunteers are involved into the outreach activities simply because “it is fun to do it” and want to share their enthusiasm for STEM with others. On the other hand, the top reasons for not participating in activities are “Lack of time” and “Not knowing how to get involved”. While there is no easy solution for lack of time (decreasing the teaching load?), we definitely should improve our own PR, especially toward undergraduate students. We should also more actively work on continuous improvement of our and our volunteers’ oratory and presentational skills, as well as continue to maintain existing “positive climate” towards STEM outreach activities on the faculty. Considerable number of respondents chose “Possibility to use and test different equipment” as a key factor to engage in STEM-C outreach activities, which provoked a little discussion among authors of this paper about starting a Makerspace (Hackerspace) or a Hands-on old computer museum within the faculty venues. Although the questionnaire was anonymous, respondents could have left their contact information and more than 50 respondents wrote their email address, so this questionnaire may have brought us 50 new volunteers and in a way, solved a problem of bad communication with undergraduate students.

While these reflections are based on our survey, most of them with small modifications can be applied more generally. Perhaps it is time for us, and everybody else “in the business” to take a more scientific approach when trying to improve the number of people volunteering and the effectiveness of outreach activities, as suggested in [5].

ACKNOWLEDGMENT

This work has been fully supported by University of Zagreb Faculty of Electrical Engineering and Computing.

REFERENCES

- [1] M. Honey et al., *STEM integration in K-12 education: Status, prospects, and an agenda for research*. National Academies Press, 2014.
- [2] I. Bojic and J. F. Arratia, "Teaching K-12 students STEM-C related topics through playing and conducting research," in *Proceedings of 45th IEEE Frontiers in Education Conference*, 2015, pp. 1–8.
- [3] I. Bojic, V. Podobnik, J. F. Arratia, and M. Grgic, "Supporting economically disadvantaged students from Nicaragua in STEM-C fields," in *Proceedings of 46th IEEE Frontiers in Education Conference*, 2016, pp. 1–4.
- [4] T. Bell, F. Rosamond, and N. Casey, "Computer science unplugged and related projects in math and computer science popularization," *The multivariate algorithmic revolution and beyond*, pp. 398–456, 2012.
- [5] J. Varner, "Scientific outreach: Toward effective public engagement with biological science," *BioScience*, pp. 333–340, 2014.
- [6] R. Salguero-Gomez, M. D. Whiteside, and J. M. Talbot, "After" eco" comes" service";," *Frontiers in Ecology and the Environment*, vol. 7, no. 5, pp. 277–278, 2009.
- [7] G. Thomas and J. Durant, "Why should we promote the public understanding of science" *Scientific literacy papers*, vol. 1, pp. 1–14, 1987.
- [8] I. Bojic, T. Jagust, and A. Sovic, "Selected examples of cooperation between universities and schools in STEM education," in *Proceedings of 5th IEEE Integrated STEM Education Conference*, 2015, pp. 189–194.
- [9] R. Society", "Science communication: Survey of factors affecting science communication by scientists and engineers," Royal Society, Tech. Rep., 2006.
- [10] S. R. Davies, "Constructing communication: Talking to scientists about talking to the public," *Science Communication*, 2008.
- [11] J. C. Besley and M. Nisbet, "How scientists view the public, the media and the political process," *Public Understanding of Science*, vol. 22, no. 6, pp. 644–659, 2013.
- [12] M. J. Martin-Sempere, B. Garzon-Garcia, and J. Rey-Rocha, "Scientists' motivation to communicate science and technology to the public: Surveying participants at the Madrid Science Fair," *Public Understanding of Science*, 2008.