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Supporting the development of territorial Responsible Research and Innovation

Policy Brief

Enhancing Science Education through Citizen Science: Students' Perceptions and Motivations in STEM/STEAM Learning

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Introduction

Science education plays a crucial role in fostering critical thinking, problem-solving, and curiosity among students. Citizen science (CS), an approach where non-professional individuals actively participate in scientific research, has gained attention as a powerful tool to enhance science education. CS involves students actively participating in real-world scientific projects, providing hands-on experience and promoting a deeper understanding of STEM/STEAM concepts. Assessing students' perceptions of the usefulness of CS in STEM/STEAM education and their related motivations for their future careers is crucial to our understanding of the importance of integrating CS in both secondary and tertiary education. This policy brief uses data from research on measuring students' perceived usefulness and motivations conducted within the framework of the WBC-RRI.NET project by the Macedonian Academy of Sciences and Arts (MASA). The brief draws recommendations from best practices by the University of Novi Sad, Serbia.

Student Perceptions of Citizen Science

MASA conducted research during November and December 2023, through an online questionnaire with high school and university students. 199 responses were received and the final valid sample is 174. 59.8% of the respondents were women, 39.7% men, and 0.5% stated other. The age of the students ranges between 15 and 26 years, where 44.8% were 15-18 years old (high school students) and 55.2% were 19 or more years old (university students). The majority of the represented institutions are located in Skopje - 86.8%, while 13.2% are in other cities/towns in the country.

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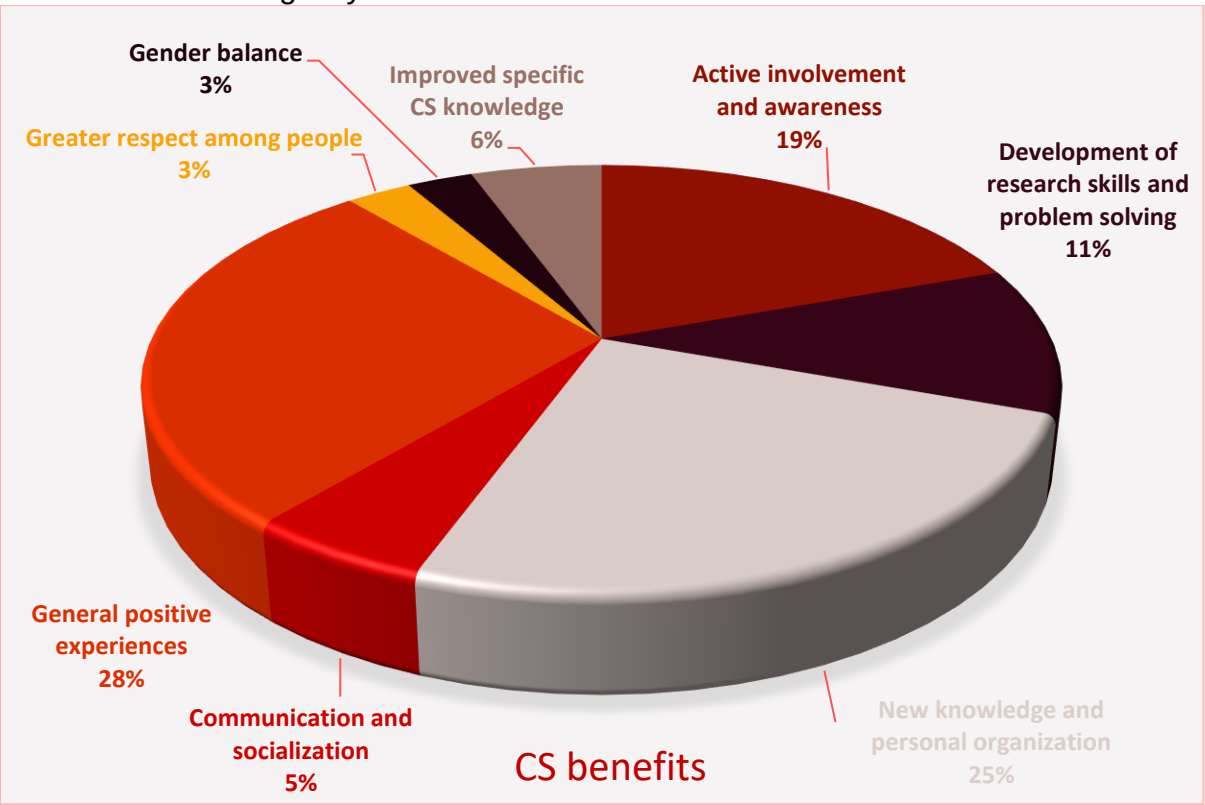
➢ Perceived Usefulness

Based on the results of the research, 78% of the respondents were not aware of the benefits of CS in STEM/STEAM education. However, those that perceive its usefulness, see it in the following way:



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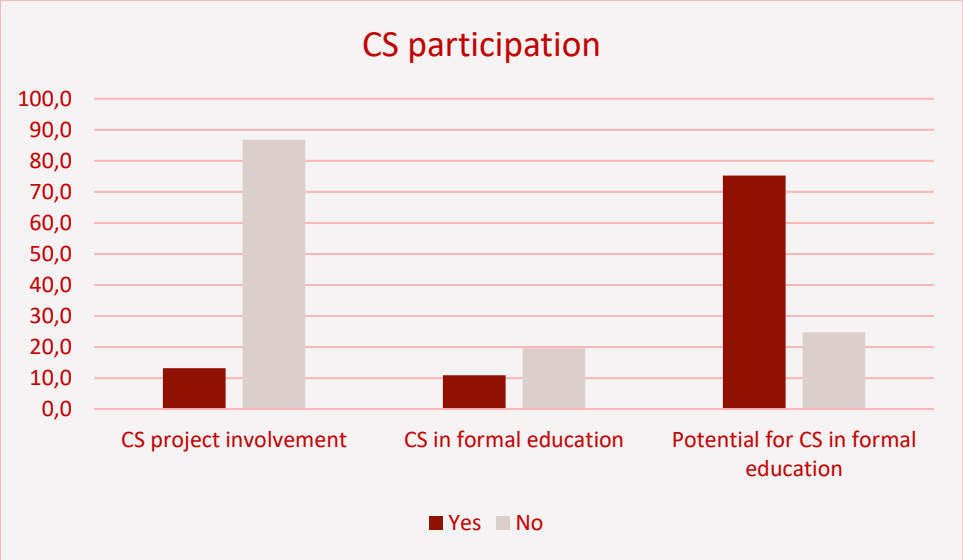
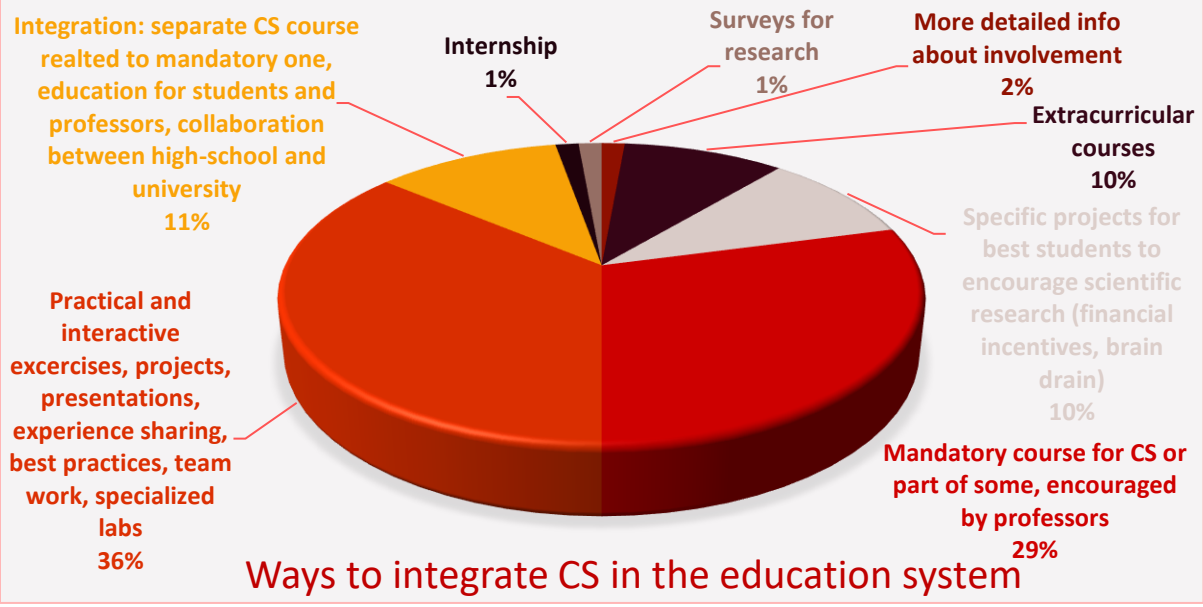
➢ Valued Learning

Students' involvement in CS projects was limited, especially in CS projects, which were part of their formal education. However, students understood CS to be a valuable method of learning, which should be integrated in their curricula.



The way they mainly see the integration of CS in formal education is by:



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➢ Motivation Levels

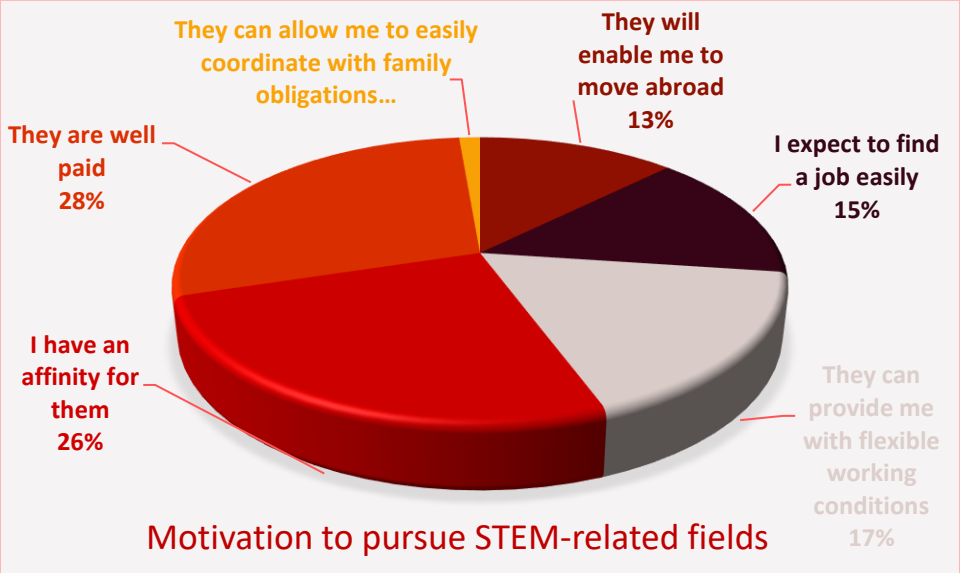
Students saw the following opportunities and incentives in engaging in CS projects:

- Opportunity for active learning of different groups of citizens
- Opinion/experience sharing
- Motivation for learning
- Voluntary activities
- Facilitates the perception of the formal education benefit for CS activities development
- Improvement of critical thinking, problem solving and scientific research skills

➢ University Aspirations

77% of students expressed their intention to pursue STEM/STEAM disciplines, although it cannot be concluded that this intention is due to their experience with CS, provided that only 13.2% of the students (high-school or university) have been involved in CS activities.

Students' motivation to pursue STEM/STEAM-related fields lies in the following perceptions:



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Issues and Challenges

➢ Lack of Awareness

The current landscape of STEM/STEAM education often overlooks the potential benefits of integrating CS in the curricula, leading to a lack of awareness of this approach among both students and educators. CS, while not explicitly mentioned in formal curricula, holds tremendous potential for enhancing STEM/STEAM education in various ways**.** One key challenge is the limited exposure and discussion of CS in the educational context. Students and teachers may not be fully aware of the opportunities it presents for hands-on, real-world applications of STEM/STEAM concepts. To address this issue, it becomes imperative to initiate awareness campaigns, workshops, and professional development sessions aimed at showcasing the advantages of incorporating citizen science into STEM/STEAM education. Additionally, collaborative efforts between educational institutions, science organisations, and citizen science platforms can bridge the awareness gap. By fostering partnerships and integrating citizen science resources into teaching materials, educators can expose students to a broader spectrum of STEM/STEAM applications, fostering a deeper understanding of the real-world implications of their studies.

➢ Resource Constraints

Curriculum Demands: Schools often face tight schedules with limited flexibility. Finding time to integrate citizen science projects into an already packed curriculum can be challenging.
Long-Term Commitment: Many citizen science projects require ongoing participation. Allocating sufficient time for students to engage consistently over an extended period may clash with other academic priorities.
Educator Training: Teachers may need specialised training to effectively integrate citizen science into their teaching methods. Lack of training opportunities can impede successful implementation.
Student Orientation: Students may require guidance on how to participate in citizen science projects, understand project goals, and use relevant tools. Adequate training may be needed to empower students to contribute meaningfully.
Financial Constraints: Funding for materials, equipment, and project-related expenses may be limited. Schools with tight budgets may struggle to allocate resources for citizen science initiatives.
Staffing: Adequate staffing is crucial for supervising and guiding students during citizen science projects. However, schools may face challenges in allocating sufficient human resources.

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Recommendations

➢ Educator Training

- Provide training for teachers to effectively integrate citizen science into their curricula. The first published Guide for citizen science in Serbia as well as translated 10 principles of citizen science in Serbian can be a starting point for introducing this topic when working with students. Additionally, the first Handbook for Open Science in Serbia, published as a result of the BEOPEN project (*Boosting Engagement of Serbian Universities in Open Science*), Could be helpful.

➢ Community Partnerships

- Foster collaborations between schools and local communities, encouraging the active involvement of students in community-based CS projects. The recent call for citizen science projects organised by the Center for Promotion of Science in Belgrade stands out as a prime example of collaborations between schools and local communities. Supported by the Ministry of Science, this initiative encouraged researchers to engage outside the academic setting. The call not only provided a platform for schools to actively participate in CS projects but also emphasised the importance of community engagement in scientific endeavours. Such initiatives serve as a model for future activities, illustrating the positive impact that coordinated efforts between educational institutions and local communities can have on scientific exploration and community development.

➢ Curriculum Integration

- Advocate for the integration of citizen science into official STEM/STEAM curricula at educational institutions. An example of curriculum integration of STEM/STEAM from the UNS team is the creation of promotional videos and tutorials describing technological processes and manufacturing procedures of electronics materials and components for every project they undertake. These promotional materials-tutorials are included in the curricula at postgraduate and PhD study level. Additionally, they incorporate citizen science projects in traditionally non-STEM/STEAM subjects such as biology (example activity: identifying and cataloguing local flora and fauna); chemistry (example activity: sample collection, chemical analysis, and data interpretation); and Psychology (example activity: daily monitoring of individuals).

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➢ Conducting future extensive research into student's perceptions and motivations of CS

- Understanding the factors influencing students' motivation in engaging in CS involves recognizing the dynamic nature of these motivations, particularly among young students. In the context of Novi Sad, certain prevalent motivations, such as curiosity, consistently emerge among students. Beyond curiosity, motivations can be categorized into two overarching groups. The first group comprises students driven by the aspiration to achieve a tangible impact in the realm of science. This underscores a motivation to contribute meaningfully to ongoing research and scientific endeavours. The second group encompasses students motivated by a broader ambition—to effect positive change in their immediate surroundings. This reflects a desire to leverage scientific knowledge and CS initiatives as tools for actively shaping and improving the world around them. It's crucial to acknowledge the evolving nature of these motivations. As students gain a deeper understanding of CS, their motives may shift, crystallizing into a more defined and purposeful drive. Consequently, investigating these motivations should involve a dynamic approach that considers the developmental trajectory of students' engagement with CS and how their motives transform over time.

Suggested further reading:

Dinić, B., Sadiković, S., Oljača, M., Milovanović, I. i Smederevac, S., (2022). *Vodič za građansku nauku*. Novi Sad, RS: Filozofski fakultet u Novom Sadu. https://star.ff.uns.ac.rs/genius/vodic_za_gradjansku_nauku.pdf (in Serbian)

European Citizen Science Association ESCA (2015). 10 principles of citizen science. Translated in Serbian 2022.

European Commission, Joint Research Centre (JRC) (2018): An inventory of citizen science activities for environmental policies. European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/jrc-citsci-10004

Sadiković, S., Branovački, B., Oljača, M., Mitrović, D., Pajić, D., & Smederevac, S. (2020). Daily monitoring of emotional responses to The coronavirus pandemic in Serbia: A citizen science approach. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.02133

Schade, S., Tsinaraki, C., Manzoni, M., Berti Suman, A., Spinelli, F.A., Mitton, I., Kotsev, A., Delipetrev, B. and Fullerton, K.T., Activity Report on Citizen Science – discoveries from a five year journey, EUR 30551 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-28370-6, doi:10.2760/841551, JRC123500.

Smederevac, S., Pajić, D., Radovanović, S., Gilezan, S., Čolović, P., & Milosavljević, B. (2020). Otvorena nauka: praksa i perspektive. Univerzitet u Novom Sadu.

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https://psihologija.ff.uns.ac.rs/viz/BEOPEN%20-%20Otvorena%20nauka.pdf (in Serbian)

Vohland, K, Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R. and Wagenknecht, K. (2021). The Science of Citizen Science. Springer Link. Open Access at: https://link.springer.com/book/10.1007/978-3-030-58278-4

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