Report for Policy Makers at the Ministry Of Education

Taking Citizen Science to School Center

Meaningful Learning - Center of Excellence

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Taking Citizen Science To School: Breaking Boundaries Between School and Society

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Report content

A. Research Findings
B. Implications for Educational Policy
C. Pedagogical Resources

דו"ח לקובעי מדיניות במשרד החינוך – נובמבר 2023

המרכז לקידום מדע אזרחי בבית הספר

מרכז מצוינות מחקרית ללמידה משמעותית

במימון משרד החינוך והקרן הלאומית למדע

מענק # 2678/17

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1. Introduction

Since the inception of the Taking Citizen Science to School (TCSS) research center, three interim scientific reports and a final scientific report have been written for the Israel Science Foundation (ISF). These reports can be found at the TCSS website (https://www.tcss.center/scientific-reports). In addition to the scientific reports, this report is geared towards policy makers within the Israeli Ministry of Education.

In TCSS, university scientists partner with students, teachers and their communities to advance scientific research while impacting society. This community engagement initiative provides equitable quality science education through school students' participation in various stages of ongoing scientific research. The collaboration serves not only to advance research, and to promote school students' learning but also to democratize science and contribute to a more equitable society.

Over the past five years, we have initiated and cultivated a community of about 800 members including educational practitioners (e.g., teachers, principals, techno-pedagogical coordinators), scientists and leaders of citizen science projects, and educational researchers. More than 100 schools, 180 teachers and 5,000 students have already experienced learning through citizen science in 10 projects. In addition, over 150 outreach events for educators, policy-makers and the public were held, and over 200 university education students have been exposed to citizen science as a pedagogy.

2. Research Findings

In this section we present a general finding, followed by more specific results divided according to our research foci: 1) students; 2) teachers; and 3) networks of research-practice partnerships.

An important finding that spans across the three research foci highlights a major contribution of school participation in citizen science. It often fosters *expansive framing,* that is a sense of meaning and responsibility among the various stakeholders beyond the context and scope of their typical activities (Figure 1).

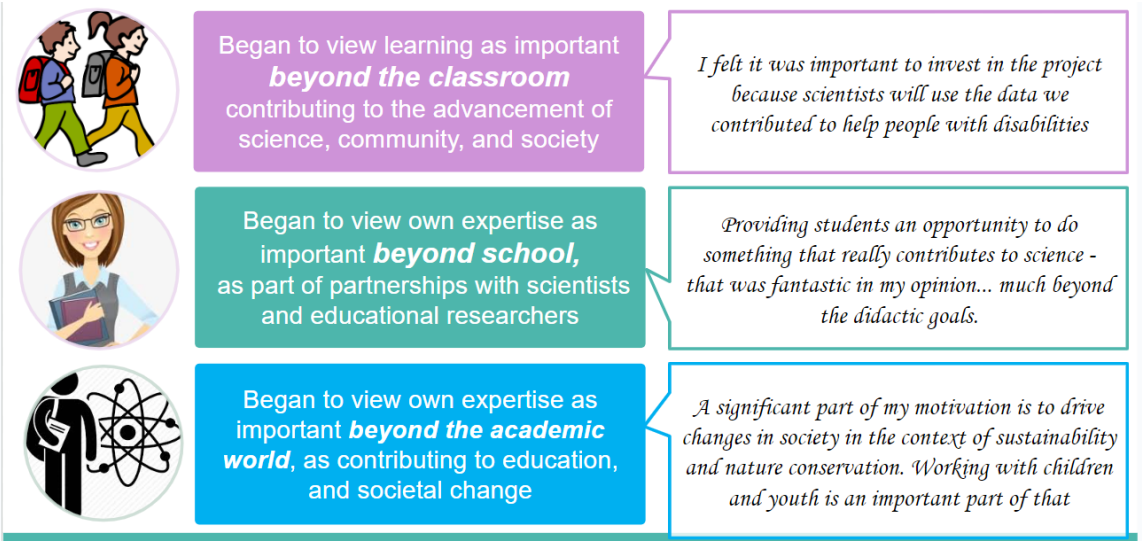

Figure 1: Expansive framing of various stakeholders

References to studies with regard to expansive framing

Benichou, M., Kali, Y., & Hod, Y. (2022). Teachers' expansive framing in school-based citizen science partnerships. In A. Castro Superfine, S. R. Goldman, M-L Ko (Eds.). Teacher learning in changing contexts: Perspectives from the learning sciences (pp. 256-276). Routledge.

Atias, O., Baram-Tsabari, A., Kali, Y., & Shavit, A. (2023). In pursuit of mutual benefits in school-based citizen science: Who wins what in a win-win situation? Instructional Science.

2.1.Students

Some findings, in regards to students, were found in specific contexts, such as:

- Acquired knowledge and 21st century skills (e.g. handling and making sense of big-data)
- Understood what it means to do scientific research
- Developed positive attitudes towards science

Some findings were found across all our studies, such as:

- Enjoyed participating in citizen science and tended to recommend it to their friends
- Felt they developed important skills and knowledge, while also advancing science

References with regard to students' learning

Atias O., Benichou M., Sagy O., Ben-David, A., Kali Y., Baram-Tsabari A. (2020, February). "Sometimes you're not wrong, you're just not right": The impact of an in-school citizen science program on students' epistemic thinking about science, Paper presentation at the 15th Chais Conference on the Study of Innovation and Learning Technologies, Ra'anana

Dvir, M., & Ben-Zvi, D. (2022). Students' actual purposes when engaging with a computerized simulation in the context of citizen science. British Journal of Educational Technology

Oren, L., Tal, T., Lavie Alon, N. (2022). The contribution of citizen science in an outdoor environment to improving achievements and attitudes towards science of students from low socio-economic status. 13th conference of European Researchers In Didactics of Biology (ERIDOB), University of Cyprus, Nicosia, Cyprus

Shefet, H., Lavie Alon, N. & Tal, T. (2020). Do the Irises still flower? Learning authentic science through citizen science. The Israel Society of Ecology & Environmental Sciences annual conference, Israel, June. Poster presentation.

Tal, T., Shefet, H., Lavie Alon, N. (2020). Why don't the Irises make seeds? Protecting rare endangered species in our community. The Annual Meeting of the National Association for Research in Science Teaching (NARST), Portland, OR

2.2.Teachers

By working in multi-expertise teams as part of the network:

- Teachers advanced their professional skills including co-designing sequences of activities tailored for their students' needs and schools' agenda as well as teaching diverse classes with diverse requirements.
- Teachers were able to implement contemporary education, such as place-based instruction, even with low achieving students.
- Teachers developed the perception that participating in citizen science projects has the potential to promote 21st century learning objectives, community involvement and sustainability education goals.

References with regard to the teacher learning and professional growth

Atias O., Benichou M., Levin-Peled, R., Sagy O., Hod Y., Baram-Tsabari A., Kali Y. (2018, February). Citizen Science in Schools: Fostering Mutualism Between Citizen Science and Science Education, Poster presented at the 13th Chais Conference for the Study of Innovation and Learning Technologies, Raanana, Israel

Benichou, M., Kali, Y., & Hod, Y. (2022). Teachers' expansive framing in school-based citizen science partnerships. In A. Castro Superfine, S. R. Goldman, M-L Ko (Eds.). Teacher learning in changing contexts: Perspectives from the learning sciences (pp. 256-276). Routledge.

Kali, Y., Sagy, O., Benichou, M., Atias, O., & Levin-Peled, R. (2019). Teaching expertise reconsidered: The technology, pedagogy, content and space (TPeCS) knowledge framework. British Journal of Educational Technology, 50(5), 2162-2177.

2.3.Networks of Partnerships

We have evidence of an exceptional potential of our modus operandi to:

- Enable any school interested, including those in socio-geographical-periphery, to lead quality educational innovation in tandem with academics
- Promote learning from multiple expertise within and between network partnerships
- Develop unique knowledge within the network on how to incorporate citizen science at school, and disseminating it to the world

Fulfilling this potential requires:

- Entrepreneurial school teams and scientists
- Appreciation and respect of teachers' and scientists' expertise in co-design partnerships
- Acknowledgement of the various stakeholders' agendas
- All stakeholders should be meaningfully involved in the initiation and design of a citizen (CS) science project at school
- Socio-environmental aspects should be explicitly addressed in a CS project's learning activities in order to promote learning outcomes in that area

References with regard to the network of partnerships

Aridor, K., Dulev-Shaham, R., Lavie-Alon, N., Valin, G., Sagy, O., Kali Y. (2022). Coalescing Knowledge Within Networks of Research Practice Partnerships: The Case of a School-Based Citizen Science Network. International Conference of the Learning Sciences (ICLS). Hiroshima, Japan

Atias, O., Baram-Tsabari, A., Kali, Y., & Shavit, A. (2022, March). Motivations of Scientists and Teachers to Collaborate in School-Based Citizen Science Projects. 2022 NARST Annual International Conference, Vancouver, BC, Canada.

Hod, Y., Sagy, O., Kali, Y., & Taking Citizen Science to School (2018). The opportunities of networks of research-practice partnerships and why CSCL should not give up on large-scale educational change. International Journal of Computer-Supported Collaborative Learning, 13(4), 457-466.

Kali, Sagy, Lavie-Alon, Dolev, & TCSS (2020). From a network of research-practice partnerships to a multi-expertise learning and design community. In Gresalfi, & I., Horn (Eds.). The interdisciplinarity of the learning sciences, 14th International Conference of the Learning Sciences (ICLS). Nashville, Tennessee

Sagy, O., Kali, Y., Baram-Tsabari, A., Tal, T., & Ben-Zvi, D. (2020). Taking citizen science to school: A mutualistic ecology of science learning. Paper presented at the online conference for citizen and participatory science 2020. Trieste, Italy

3. Implications for Educational Policy

TCSS aimed to address several practical challenges:

1. How to maintain the voluntary nature and excitement of contributing to CS in school environments where participation is obligatory?
2. How to cultivate the development of a learning ecology that fosters mutual benefits for students, school practitioners, scientists, and sometimes the community when their agendas and ways of working are different and often competing ?
3. How to support teachers in adapting the CS materials, that are not part of the national curriculum, to suit their specific educational context?

To face these challenges we established a modus operandi with four main components:

1. We operate as a Network of research-practice partnerships.
2. We offer a set of citizen science projects that were co-designed within our network.
3. We provide a modular support system for teachers.
4. We have developed the Insights platform, for co-creating design knowledge within our network.

In the rest of this section, we will elaborate on each one of these components.

3.1.Network of research-practice partnerships

Network description

Our center operates as a network of research-practice partnerships, which currently includes more than 100 schools, 180 teachers and 10 scientist teams (each offering a particular CS project).

If we zoom-in to a particular partnership within the network, it includes:

- A team of educational practitioners (such as teachers, principals, subject matter coordinators)
- A scientist, or team of scientists

- An education researcher, usually a graduate student who often acts as a “broker” or “boundary crosser” to help bridge between the world of school and the world of the scientists.

In each of these partnerships, we typically implement one citizen science project, according to the interest of the schools, and availability of scientists. Since most teachers and principals in Israel are not familiar with CS, we couldn’t jump into long term partnerships without enabling some less committing encounters. To do so, we developed a model of participation that includes multiple levels of engagement (Figure 2).

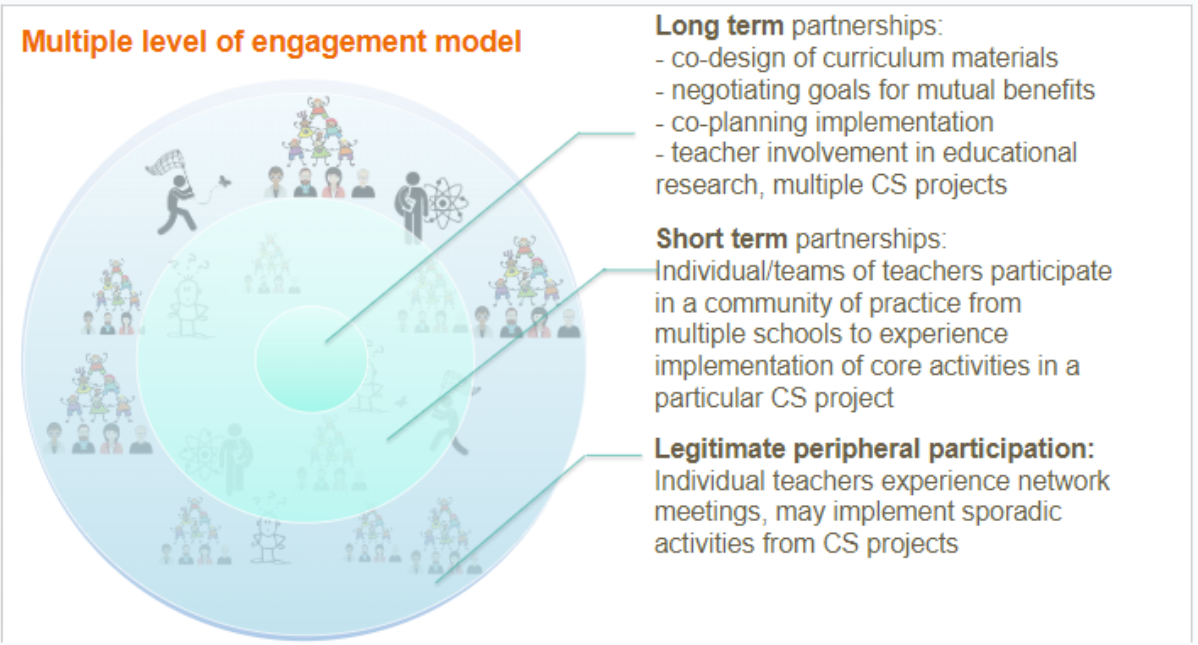

Figure 2: Engagement levels within the TCSS network

Network workshops

We hold two or three whole-network workshops a year that attract varying amounts and compositions of participants. These workshops are a great opportunity for:

- Showcasing best practices

- Sharing research findings
- Discussing implementation challenges
- Getting acquainted with relevant educational policies
- Learning about state-of-the-art research in the CS projects

3.2. A set of co-designed citizen science projects

The second component of our modus operandi is a set of citizen science projects, which we offer schools as an opportunity to collaborate with their scientists. All projects were co-designed within the network, and are openly accessible to the public (see the projects in Figure 3 for example).

Figure 3: Projects offered through a digital platform available in Hebrew (tcss.center/learning-environments)

An example of one of these projects is the ‘Sleep - one third of life’ project. In this project, students partner with sleep scientists to take part in a scientific research on the effects of teenagers' lifestyles on their sleeping patterns. For each of the projects, we have developed a platform that provides all the information and curriculum materials teachers need inorder to

implement the project in their classrooms, and tools for customizing these materials for their specific educational context. More details are provided in Section 4.1.

CS project lifecycle

Based on the implementation of the various projects conducted in different schools and with different educational practitioners, we have devised a recommended implementation sequence comprising five stages. In the first three stages only teachers passionate to integrate CS in their teaching are invited, in the fourth and fifth any teacher may join. The stages are:

Stage 1: Initiation

- Identify a project lead, scientists, educational researchers, and school teams for the project development
- In-depth learning of the scientific and pedagogical challenge
- Co-designing modular pedagogical resources that can be adapted for different contexts
- Initial trial of activities in the classroom
- Preparations towards implementation in stage 2, forming a research and support team

Stage 2: Substantiation

- Implementation in experimental schools with three teachers
- Revising pedagogical resources
- Constructing audio-visual teaching materials together with the scientists (in order to reduce their involvement later on)
- Uploading implementation stories from different perspectives to the Insights platform (to enable learning across schools and projects)
- Preparation towards the expansion of the project's operation
- Starting to identify CS expert teachers amongst the teachers that had participated in the experiments.

Stage 3: Preparing for independence

- Wider implementation of the project
- Project lead works with the CS expert teachers in team teaching and with the scientist as preparation for independence of the project in stage 4.
- CS expert teachers lead the implementation at their school and train at least one more teacher at each school
- Each teacher works with one or two classes

Stage 4: Scaling & Fading I

- TCSS center provides system-wide support and facilitates contact with the scientists.
- Project lead works with a community of 10 CS expert teachers, each guiding two teachers at their school (altogether about 30 classes per project)

Stage 5: Scaling & Fading II

- TCSS center keeps providing system-wide support and facilitating contact with the scientists when needed.
- Project lead keeps working with the same CS teacher experts who continue to work at their schools with the same number of classes

3.3.Modular support system for teachers

We provide a modular support system for teachers, to enable a specific and on-demand response for implementation in classes (Figure 4).

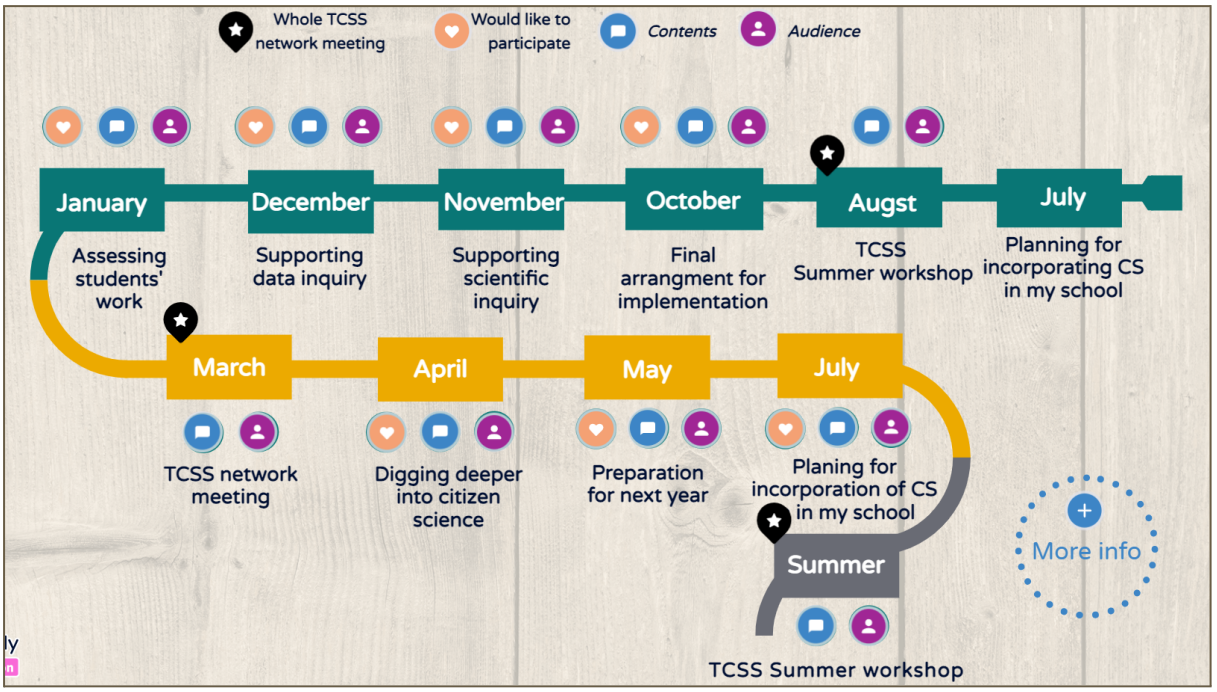

Figure 4: Suggested sequence for implementing a CS project at school

For instance, many teachers had asked for assistance in supporting their students' scientific inquiry process; They had been grappling with the question of how to address both the scientist research, while also encouraging students to explore their own research questions on the topic. This was an opportunity to discuss the Harris et al. approach of using "Nested data in citizen science" (Figure 5).

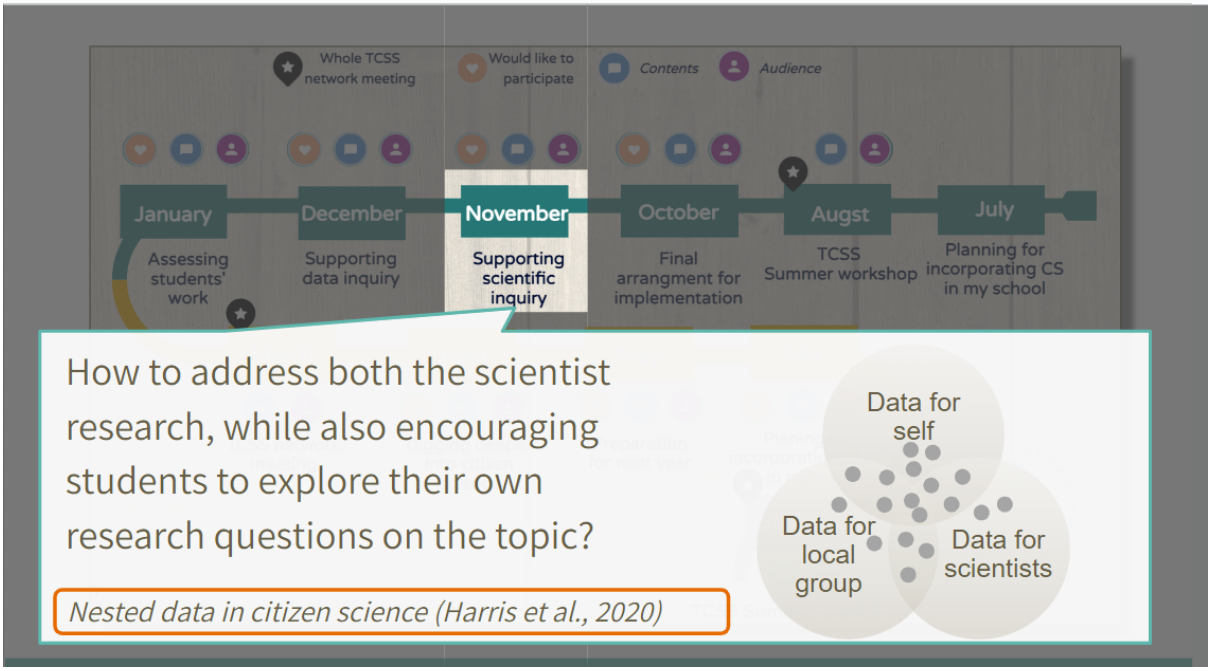

Figure 5: Nested data in citizen science

This nested approach makes a distinction between three types of data; When students collect and contribute multiple pieces of data for a citizen science project, they can collect “Data for self” – to answer their own research questions. Yet, some of this data can also serve to answer scientists' research questions as well, while other pieces of data can support exploring the interests of local groups, such as the whole classroom, or the community. In this way the database serves as a shared space for the collaboration between the students, teachers and scientists. We worked with the teachers to apply this model to the various projects they were involved with, thus providing on-demand support to their specific needs.

3.4. The Insights platform for co-creating design knowledge

The purpose for developing this platform

One of the greatest challenges we face is that each of the partnerships revolves around a specific citizen science project, customized for a specific school context. For instance, one

partnership may focus on implementing the Radon project with 9th grade science majors, and another partnership may focus on implementing the Collaborative Street Mapping project with 10th grade geography majors. This diversity raises the following questions:

- How to bring together the wisdom that has been developed in each of the partnerships?
- How to develop cross-project insights?
- How to integrate practical insights with existing learning theory?

Based on research on pedagogical design principles that bridge theory and practice, the Insights platform was developed in order to address this issue.

The basic component of Insights is an implementation story. Figure 6 presents three stories that were contributed by different teams of practitioners. Stories can also be written by students, scientists, or multi-expertise teams.

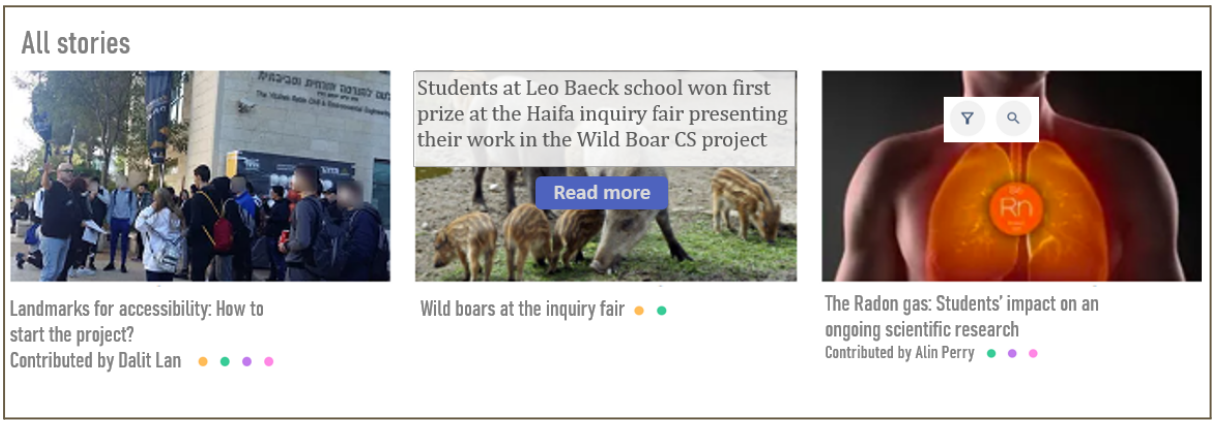

Figure 6: Three implementation stories on the Insights platform (https://insights.edu.haifa.ac.il/)

Contributors are invited to upload their story and images to the platform. In addition, they are also requested to link their story to relevant design principles, chosen from a given repository (Figure 7).

Figure 7: Connecting the story 'Wild boars at the inquiry fair' to relevant design principles

When connecting a story to design principles, contributors may also suggest new principles, which they feel are missing from the current repository. In this way, participants within the network co-create design knowledge that connects practical insights with learning theory.

An example for one of the principles that had emerged from this process and been added to the collective repository, is the importance of accountability; students often develop a sense of accountability when realizing that their input to a CS project will actually be used by the scientists.

4. Pedagogical resources

Different resources have been developed for educational practitioners, some of which were already mentioned in this document. In this section we have gathered all available resources.

4.1.Specific implementation support for the Citizen Science projects

We have developed a platform that provides implementation support for the projects. For each project, as depicted in Figure 8, the platform provides: 1) an overview of the project, including a recommended sequence of activities; 2) downloadable curricular materials to be used in the classroom; 3) tools for planning the implementation, thus enabling customization to a specific educational context; and 4) materials for inspiration, shared by other teachers.

Figure 8: Platform support for each of the projects

In order to demonstrate some of these components, we will return to the project ‘Sleep - a third of our life’. Figure 9 shows a suggestion for an activity sequence for the sleep project. It consists of nine basic lessons (represented by the numbered circles).

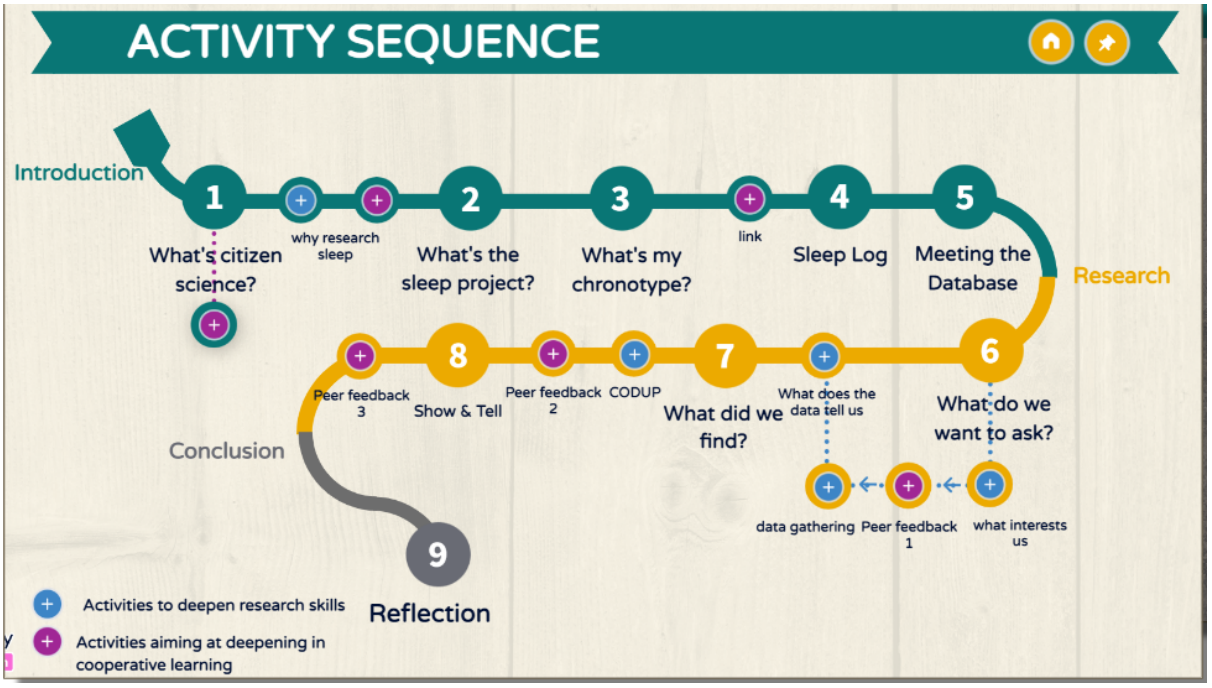

Figure 9: Suggested activity sequence for the 'Sleep - a third of our life' project (tcss.center/learning-environments)

4.2.Publications

Title	More details	link
Publications in digital media	E.g.: lectures, interviews and articles	tcss.center/media
Professional literature	in manuscripts, conferences, and professional books	tcss.center/publications
Citizen science research	fruits of research done at TCSS	tcss.center/cs-research
Scientific reports	Describe the progress and scientific achievement of TCSS	tcss.center/scientific-reports

4.3.Additional resources

Title	More details	link
The insights platform	1) Implementation stories 2) Repository of pedagogical design principles, that connect between practical insights and learning theory	https://insights.edu.haifa.ac.il/
List of CS projects	Projects that are operated by TCSS or collaborate with the center	tcss.center/partner-projects
A list of available CS projects on the net	With no affiliation to TCSS	tcss.center/cs-projects
Principles of CS	CS in general, not specifically for projects implemented at schools	tcss.center/cs-principles
More resources for learning about CS and TCSS		tcss.center/more-resources