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# Taking Citizen Science to School: A mutualistic ecology of science learning

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## Rationale

Research on students' participation in citizen science (CS) projects reveals an increase in knowledge and an intensified understanding of the scientific research process (Ballard, Dixon, & Harris, 2017; Golumbic Baram-Tsabari & Fishbain, 2016). These outcomes are encouraging but evidence is sparse and most projects primarily address the goals of one party e.g. scientists with minimal benefit to citizens or education with little value for science (Andújar et al., 2015; Barron, Martin, Mertl, & Yassine, 2016; Galloway et al., 2015). Sagy et al. (2019) conceptualize CS and its myriad stakeholders as an ecology in which all parties should benefit from their involvement. They proposed the "Mutualistic Ecology of Citizen Science" (MECS) framework for school-based learning around CS projects benefiting all participants. We examine this concept within the notion of Taking Citizen Science to School (TCSS), which, in addition to citizens and scientists, involves students, school-practitioners, education-researchers and policy-makers. Our group harnessed multiple expertise in science-communication, science-education, data-science education, knowledge-building communities and technology-enhanced learning design to put TCSS into practice across a network of schools in Israel. We describe our operationalization of the TCSS notion, present preliminary findings on proof-of-concept and value of the approach, and discuss tentative conclusions.

## Putting TCSS to Practice

To form a community of enthusiasts around the notion of TCSS we invited school-practitioners, scientists, education-researchers, policy-makers, and anyone interested in the idea of taking CS to school to join. The community that formed meets three times per year—twice during school-year, and once for a two-day summer conference. As part of the TCSS meetings, participants share their experience and negotiate the notion of TCSS from their multiple perspectives. The community is updated on relevant events and activities through our website (www.tcss.center) and monthly correspondence.

Trough these activities several strong multi-expertise partnerships were formed. Teachers joined forces with education-researchers and scientists who lead CS projects to co-design classroom activities around these projects. Effectively, we built a network of design-centric research-practice partnerships (DC-RPPs: Hod, Sagy, Kali & TCSS, 2019), where different stakeholders work together in order to advance TCSS (see figure 1). Currently, the community consists of approximately 300 members, some deeply involved while others remain peripheral with about: 100 school-practitioners, 20 scientists, 30 education-researchers, 20 policy-makers, representing various initiatives and organizations that care about environmental and educational issues.

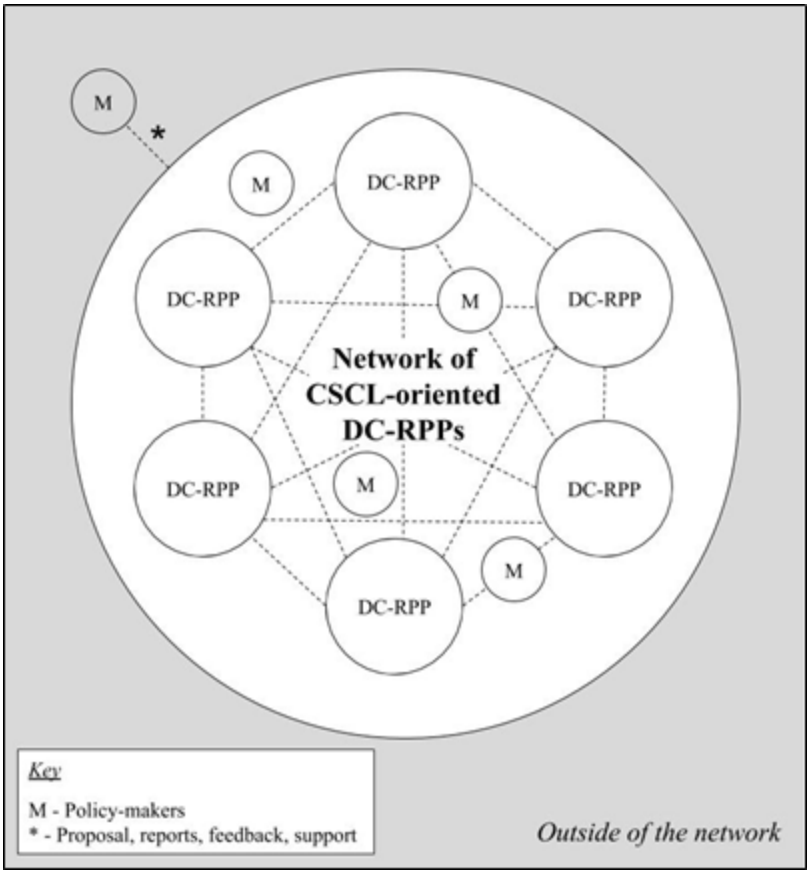


Figure 1. TCSSs community model, taken from Hod et al., 2019.

## Initial findings

**Proof-of-concept**

The community approach, and the infrastructure we provided for participants to take part and interact seems to prove itself. A diverse group (Figure 2) of members voluntarily joined and attended community meetings on the expense of their own time (which is scarce for the type of participants involved). We were particularly encouraged by the interest that scientists and other CS project-leaders expressed in joining the community and collaborating with schools, which enabled us to offer twelve different CS projects to be co-designed and implemented this year in schools, involving areas such as biodiversity (via footprint analysis) geography (through open-mapping and creating routes for the disabled), or sleep research (as related to current life habits). The willingness of educational practitioners to radically revise classroom methods to embrace the required epistemological commitments, and to transform organizational frameworks to enable these partnerships is also impressive.

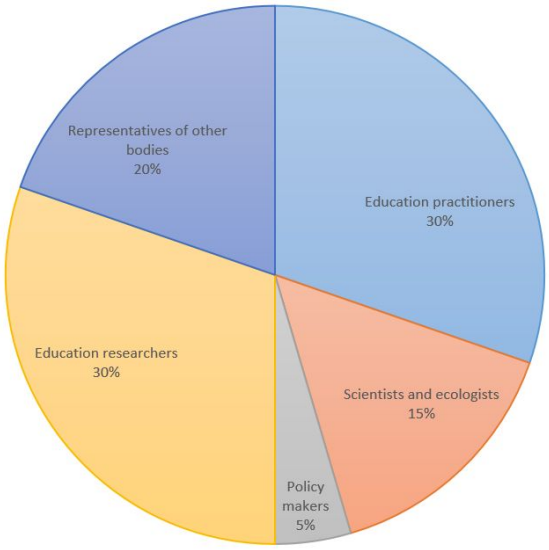


Figure 2. Average stakeholder participation in TCSS community meetings

**New learning opportunities**

Preliminary evidence illustrates that the TCSS approach opens up new learning opportunities, as well as challenges for students, education-practitioners and scientists. **Students** (including typically low achievers, hinting at science-capital social mobility) express interest and engagement with what they view as a different and inspiring way to learn. But they also report on extra effort and responsibility that not all students value. **School-practitioners'** learning indicate impressive professional growth and enthusiasm for those who took up the challenge (Kali, Sagy, Benichou, Atias & Levin-Peled, 2019). However, the pedagogical and organizational transformations required posed many difficulties. **Scientists** have also struggled with difficulties, especially with school requests for frequent visits to guide students through data collection protocols. However, some enjoyed the data collected by students (especially in those schools were the broader community was involved) and see the potential for further collaboration.

**Collective design knowledge**

Another important advance took place in a summer conference workshop, when participants shared their TCSS stories and looked for commonalities between them (Lavie-Alon, Dolev, Sagy, Kali & TCSS, submitted). These discussions led to the identification of guidelines for TCSS implementation relating to breaking of boundaries between classrooms and the outdoors, between students, teachers and scientists, school and community, as well as the recognition and acknowledgement of students' and teachers' contributions to science.

## Tentative Conclusions

Taking into account the initial findings, we understood that system-wide support should complement the network of DC-RPPs consisting of community meetings and intensive partnerships. We identified three main components that contribute to such support, reducing the load of scientists and ecologists and aiding teachers with this "new way" of teaching. These include "off the shelf" student activities around a variety of CS projects, an infrastructure for sharing pedagogical design guidelines for developing such activities, and a dedicated course for school leaders about how to implement such projects in their schools.

TCSS is a promising direction with the potential to realize the notion of MECS. Fulfilling this potential requires organizational transformation and adjustments in all related infrastructures, including scientists, educational institutions, and education policies (Law, Yuen & Lee, 2015). Our initial findings exemplify the potential of taking CS to school as a MECS that can advance science, develop teachers' professional skills, and provide an effective attractive way of learning.

**References**


Andújar, B., Campderrós, G., García, M., Marino, M., Mas, M., et al. (2015). Twenty tips for highschool students engaging in research with scientists. *Frontiers for Young Minds*, *3*, 7.

Barron, B., Martin, C. K., Mertl, V., & Yassine, M. (2016). Citizen science: Connecting to nature through networks. In U. Cress, J. Moskaliuk, & H. Jeong (Eds.), *Mass collaboration and education* (Computer-Supported Collaborative Learning Series) (Vol. 16, pp. 257–284). New York: Springer.

Ballard, H. L., Dixon, C. G., & Harris, E. M. (2017). Youth-focused citizen science: Examining the role of environmental science learning and agency for conservation. *Biological Conservation*, *208*, 65–75.

Galloway, M. A., Willett, K. W., Fortson, L. F., Cardamone, C. N., Schawinski, K., Cheung, E., et al. (2015). Galaxy zoo: The effect of bar-driven fuelling on the presence of an active galactic nucleus in disc galaxies. *Monthly Notices of the Royal Astronomical Society*, *448*(4), 3442–3454.

Golumbic, Y. N., Baram-Tsabari, A., & Fishbain, B. (2016). Increased knowledge and scientific thinking following participation of school students in air-quality research. In *Proceedings of Indoor Air* 2016.

Hod, Y., Sagy, O., Kali, Y. & TCSS (2019). 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, Y. , Sagy, O. , Benichou, M. , Atias, O. and Levin-Peled, R. (2019), Teaching expertise reconsidered: The Technology, Pedagogy, Content and Space (TPeCS) knowledge framework. *British Journal of Educational Technology, 50*: 2162-2177

Law, N., Yuen, J., & Lee, Y. (2015). Precarious School Level Scalability Amid Network Level Resilience : Insights from a multilevel multiscale model of scalability. In AERA (pp. 0–24).

Lavie-Alon N., Ronit D., Sagy O., Kali Y. &, TCSS (submitted). Citizen Science in School - developing design principles in a multi-expertise heterogeneous community of practice

Sagy, O., Golumbic, Y. N., Ben-Horin Abramski, H., Benichou, M., Atias, O., Manor, H., … Baram-tsabari, A. (2019). Citizen Science: An Opportunity for Learning in the Networked Society. In Y. Kali, A. Baram-Tsabari, & A. Schejter (Eds.), *Learning In a Networked Society - Spontaneous and Designed Technology Enhanced Learning Communities* (pp. 97–115). Springer, Cham:Switzerland


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