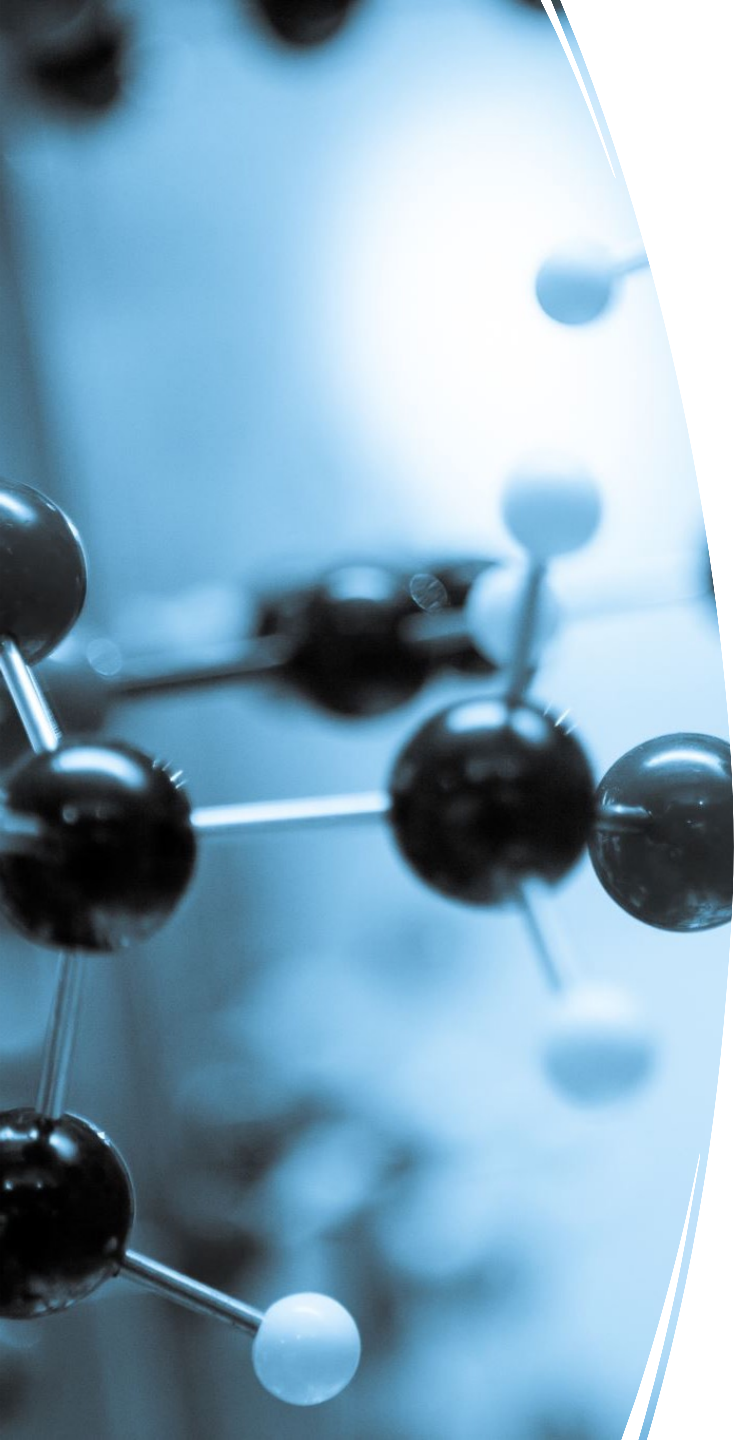

Bridging the Gap between Formal and Informal Science Learning: PBL & Surrounded by Science

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Outline of Talk

1. **Project-Based Learning (PBL) in Science and Technology**

   Summarizing 26-years of PBL in Israel and recommendations about how to scale up

2. **Surrounded by Science An EU Project**

   Conducting research about how iSTEM activities can contribute to school science – and vice versa

1. PBL in STEM
The Israeli Experience

- 1993 – 2019 (26 years)
- Parents as project mentors
- Professional Development of STEM teachers
- Development of materials, guides and digital tools
- PBL school networks – HiTechHigh Community
- Educational research: case studies and longitudinal
- 500+ parents
- 3,000+ teachers
- 50,000+ students
- Schools in Jewish, Arab and Druze communities in Israel

Lessons Learned: How can PBL help advance STEM education?

PBL can:

- provide real-world connections
- increase teacher and student motivation
- integrate STE(A)M disciplines & knowledge
- promote 21st Century Skills
- develop students ready for the "dynamic, knowledge-based economy" (from the Lisbon Strategy)

PBL Promotes 21^{st} Century Skills

Communication

Collaboration

Creativity

Critical thinking

Cultural literacy

Curiosity

Challenges of PBL

For learners: ambiguity & open-endedness, research skills, collaboration skills, self-regulation, motivation, overcoming setbacks and obstacles, time management, self-assessment, etc.

For teachers: content coverage, high-stakes testing, facilitating student autonomy, facilitating skill development, managing group dynamics (e.g., social loafing), access to resources, managing diverse student needs, time management, authentic assessment, etc.

For administrators: providing long-term teacher professional development, shifting the school culture, curriculum alignment, resource allocation, managing logistics, community and parental support, scaling up and sustainability, establishing metrics, assessment and accountability, etc.

Scaling Up PBL

"What would it take to scale up PBL and integrate it into educational systems?"

Chrysa Mitta

Director, Lisbon Council

Kalanswa Arab Village: “The Water We Drink”

Professional Development of Teachers

In this project, 26 teachers from grades 1 to 12 participated in a year-long PD workshop . For the first half of the year, they engaged in their own PBL projects about the topic, on their own levels, and discussed possible student difficulties and pedagogical approaches to address them. In the second half of the workshop, they applied this knowledge to their students, resulting in a projects fair with, by and for over 500 students from the Kalanswa, and other members of the community. In the above photo, the teachers are exploring the Alexander River, located close to the village.

Evolving Model of Professional Development

Teacher as **Learner** in the Workshop
Teacher as **Teacher** in the Classroom
Teacher as **Innovator** in the School

Rosenfeld, S. Scherz, Z. Orion, N. and Eylon, B. (1997). "An Evolving Model for Long-term Teacher Development." In: Vosniadou, S. et al. Conference Proceedings for the 7th European Conference for Research on Learning and Instruction. University of Athens, Greece.

	FOCAL AREAS OF EMPHASIS		
	I. Self Teacher as an active learner	**II. Classroom** Teacher as a reflective teacher	**III. School/System** Teacher as an adaptive innovator
COMMON DEVELOPMENTAL SEQUENCE	**Disequilibrium: Confusion and Excitement** (*What are the goals of this inservice anyway?*)	**Disequilibrium: Confusion and Excitement** (*What is my role in the class? To pour out knowledge or help students learn?*)	**Disequilibrium: Confusion and Excitement** (*The curriculum is going to change but what* ***IS*** *the relationship between science and technology?*)
	Frustration (*I don't know enough. I'm 20 years behind. How can I teach what I don't know?*)	**Frustration** (*How can I implement the changes outside of this inservice? The conditions aren't right to support the change in my classroom*)	**Frustration** (*How can I implement changes without the supervisor's agreement and support, in terms of teaching hours, money, an inflexible curriculum?*)
	Recognition of Need to Change (*I need to change, to learn more and in different ways. I don't have to know everything?*)	**Recognition of Need to Change** (*We need to get the relevant resources and teach the relevant skills.*)	**Recognition of Need to Change** (*The school system needs to change. Someone has to talk with the principal, the other teachers, and the supervisors. The curriculum needs to be changed.*)
	Desire to Change (*I want to change.*)	**Desire to Change** (*I want to change my classroom teaching.*)	**Desire to Change** (*We want to change the schools system. We want to talk with the principal, the other teachers, and the supervisors. We want to change the curriculum.*)
	Will to Change (*I believe that I can change.*)	**Will to Change** (*I believe I can change my classroom teaching.*)	**Will to Change** (*We believe we can change the school system. We believe we change the curriculum.*)
	Fulfillment (*I changed. I know I can change as a person.*)	**Fulfillment** (*I changed my classroom teaching. I know I can change as a classroom teacher.*)	**Fulfillment** (*We changed the school system by involving the principal, the other teachers, and the supervisors. We participated in changing the curriculum.*)

The Evolving Model of Professional Development (PD), is based on an empirical study. The model focuses on three focal areas of emphasis for teachers that all share a common developmental sequence. The key for teachers moving successfully through this sequence is adequate support from the PD leaders and teacher colleagues.

School-Academia Connection

Rethinking Science Education in Europe,
Lisbon Council, May 22, 2023

PBL Guides and Digital Resources: Grades 7-12

Teachers

Students

Digital Guide

School Networks

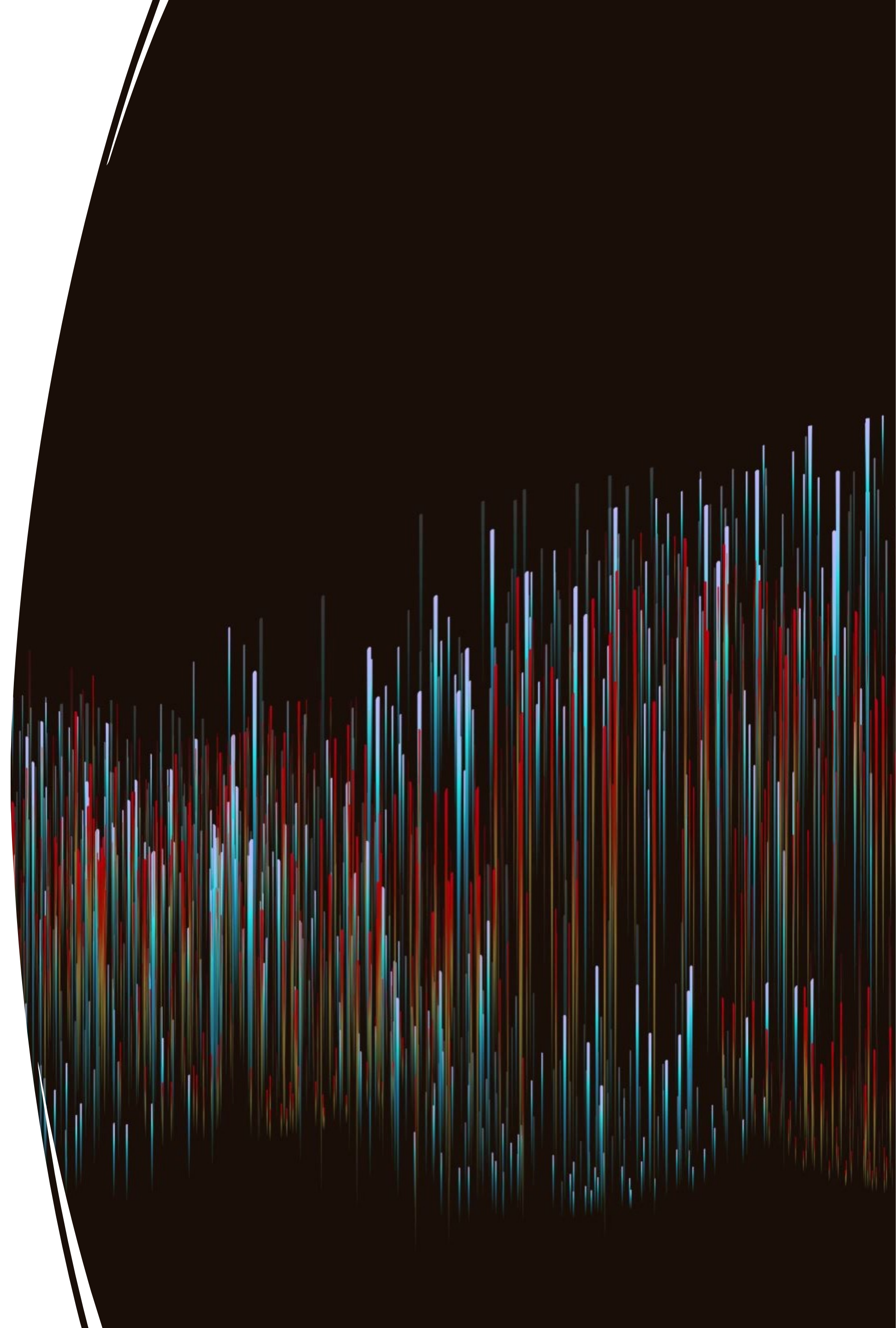
Amal School Network (2012-9)

What is Quality PBL? 10 Essential Aspects
Significant Content
Real-World Connection
Need to Know
Driving Question
In-Depth Inquiry
Authentic Products
21^{st}-Century Skills
Student Voice and Choice
Public Audience
Revision and Reflection

Lessons Learned: How to scale up and integrate PBL into education systems?

In this section of the talk, several approaches were suggested:

- Long-term Professional Development (PD), based on the Evolving Model of PD
- School-Academia Partnerships
- PBL Guides & Digital Resources
- School Networks – Communities of Practice with principals, pedagogical coordinators, teachers, and students
- Focus on Quality PBL



2. Surrounded by Science – An EU project to bridge the gap

The Guiding Research Questions

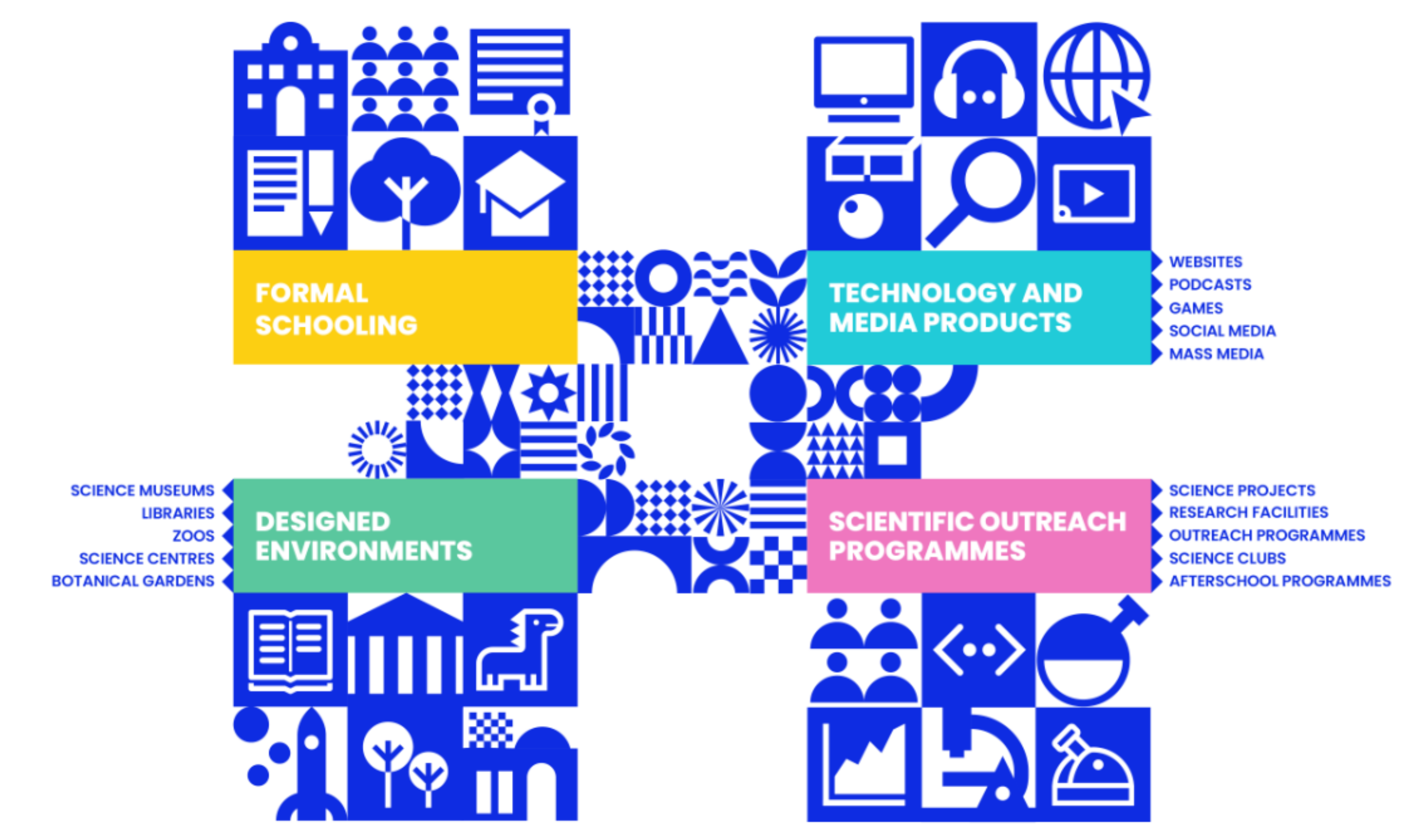
How can informal STEM (iSTEM) learning activities contribute to the development of science learning in formal science settings, and vice versa?

Three sub-questions will also be addressed:

a. What are the outcomes of these iSTEM activities and programmes in terms of science proficiency?

b. What design features of the iSTEM activities and programmes foster science proficiency?

c. How might the iSTEM activities be used to bridge between formal and informal STEM learning?

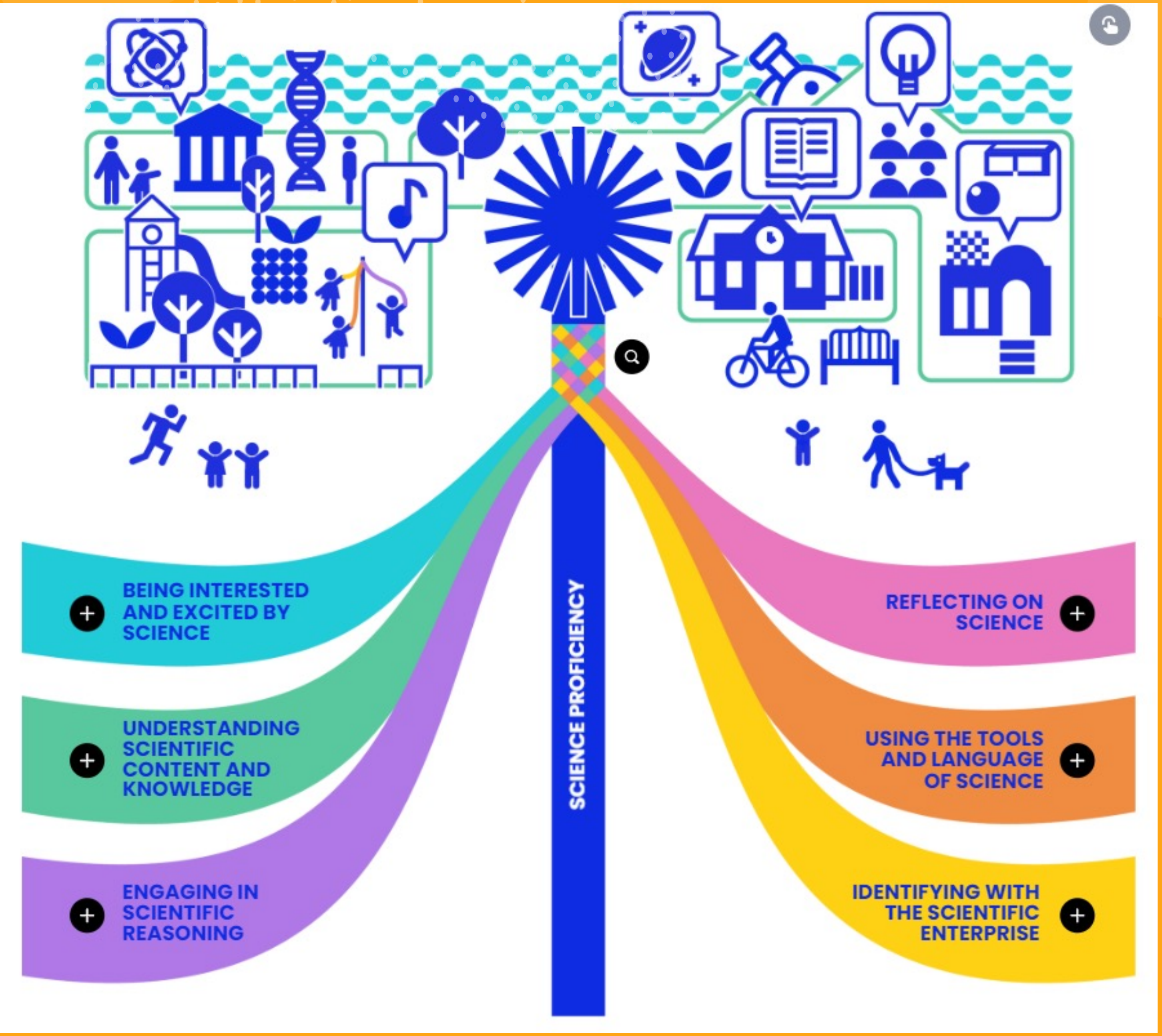


Learning Contexts

Rethinking Science Education in Europe,
Lisbon Council, May 22, 2023

The 6 Strands of Science Proficiency

National Research Council (NRC) 2007, 2009



Strand	NRC Description	Research Concepts
1. Being Interested in and Excited by Science	Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.	Interest Engagement
2. Understanding Scientific Content and Knowledge	Come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science.	Factual knowledge Conceptual knowledge Procedural knowledge
3. Engaging in Scientific Reasoning	Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world.	Understanding explanations and arguments
4. Reflecting on Science	Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.	Nature of Science (NOS): understanding how science knowledge develops
5. Using the Tools and Language of Science	Participate in scientific activities and learning practices with others, using scientific language and tools.	Scientific language Scientific tools Authentic science
6. Identifying with the Scientific Enterprise	Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.	Science identity Self-perception in science

The Research Perspectives

1. **Context-oriented perspective.** Insights regarding the <u>characteristics that trigger attention and interaction</u> in the different contexts, based on *tracking* the behaviour of the users.

2. **Person-in-context perspective.** Insights regarding <u>the interaction and experiences of users</u>, based on *short questionnaires* related to their experiences, their appreciation and accessibility of the activity, perceived learning, and motivation to participate in similar and other science activities.

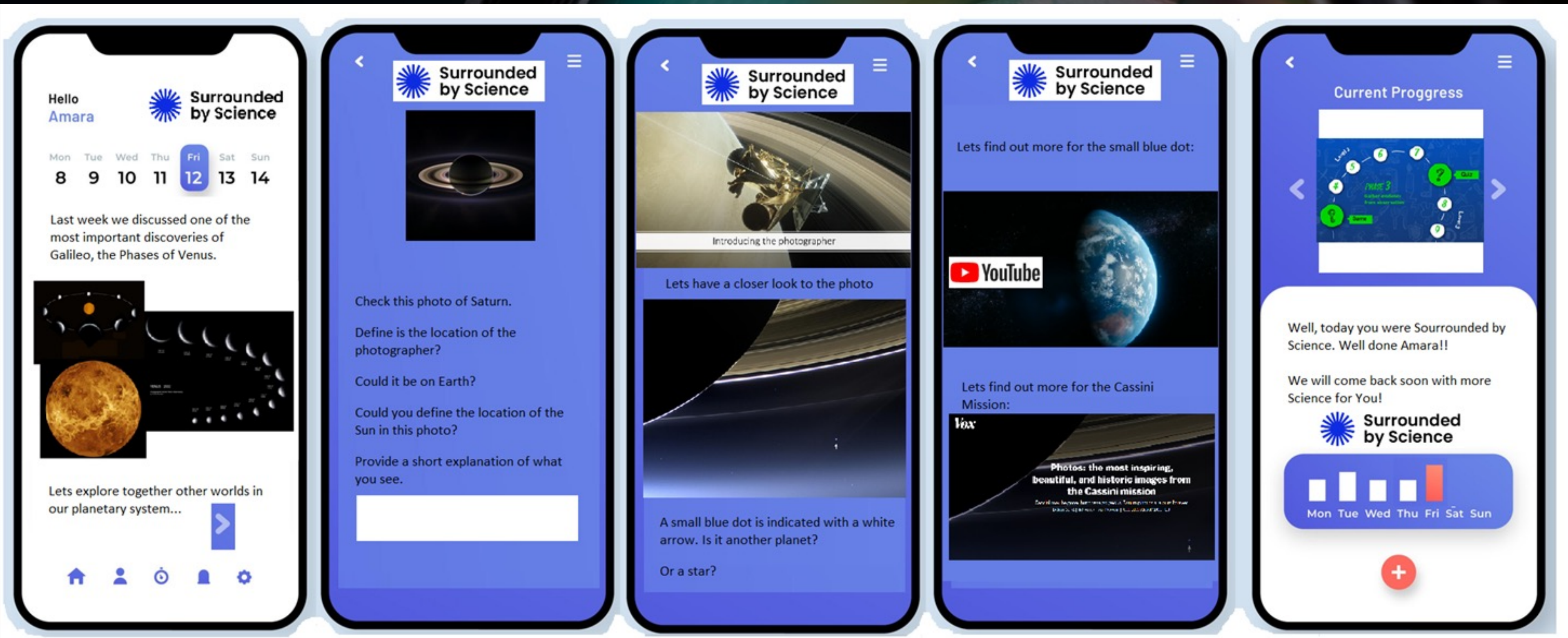
3. **Person-oriented perspective .** Insights about the <u>outcomes that iSTEM learning activities have regarding the six strands of science proficiency</u>, based on *questionnaires and interviews* (e.g., regarding factual, conceptual and procedural knowledge).

4. **Everyday-life perspective.** Insights based on the <u>everyday interests and engagement of users in science activities</u> (e.g., watching a documentary, reading a science magazine, or visiting a science-related website), based on *self-report diaries*.

Research Tools

	Context-Oriented	Person-in-Context Oriented	Person-Oriented
1. Sparking Interest and Excitement	1. Tracking frequency and duration. 2. Participant behavior 3. Participant Discussions	Likert-scale and open-ended questions: "During this activity, what I found interesting was …"	Adapted Questionnaire: Linnenbrink-Garcia, et al. (2010)
2. Understanding Scientific Content and Knowledge		Likert-scale and open-ended questions: "During this activity, I learned that…"	1. Questions to test for specific factual, conceptual and procedural knowledge. 2. Visual representation, e.g., concept maps
3. Engaging in Scientific Reasoning		Likert-scale and open-ended questions: "During this activity, I could explain that …"	1. Questions to test for participants being able to make sense of natural phenomena 2. Visual representation, e.g., concept maps
4. Reflecting on Science (NOS = Nature of Science)		Likert-scale and open-ended questions: During this activity, I understood how scientists found out that…"	1. Nature of Science Questionnaire (Conley, et al., 2004) 2. Visual representation, e.g., concept maps
5. Using the Tools and Language of Science		1. Likert-scale and open-ended questions: "During this activity, I understood how scientists work:…" 2. Analysis of participant discussions (with use of language analyzer app)	The Perceived Authentic Science Questionnaire (Boll, 2013)
6.Identifying with the Scientific Enterprise		Likert-scale and open-ended questions, e.g., "During this activity, I saw myself as a science person."	Science Identity Instruments (Hazari, et al., 2013; Avraamidou, 2022)

Digital Toolbox

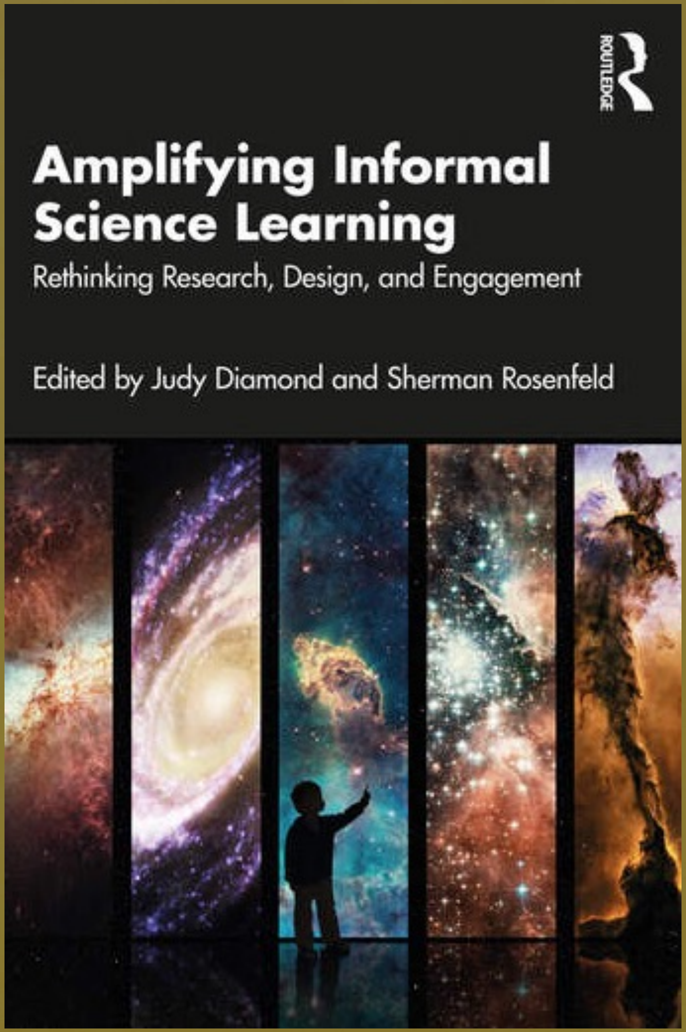


Bridging the Gap between Formal and Informal Science Learning

In this presentation, two approaches to bridging the gap have been presented:

1. Bringing aspects of informal science learning (such as free-choice learning, student interest and science identity) into formal science learning via PBL, and

2. Studying the outcomes of informal learning activities and programs, in order to identify the design features that make a difference, as a basis for bridging this gap.



Scheduled for publication in June 2023, the book presents the state of the art in the field of Informal Science Learning, with 34 essays.

[The book’s page on the publisher’s website]

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PBL

Fallik, O., Eylon, B-S and Rosenfeld, S. (2008). Motivating Teachers to Enact Free-Choice Project-Based Learning: Effects of a Professional Development Model. *Journal of Science Teachers*, 19 (6): 565-591.

PBLWorks (Buck Institute of Education) https://www.pblworks.org/
HiTechHi Schools https://www.hightechhigh.org/student-work/projects/

Surrounded by Science

Project website: https://surroundedby.science/

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Many thanks for listening!

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