Insights from the implementation of the course “Development of an interdisciplinary STEM project via PBL approach” in an 'Integrative STEM Education' M.Ed. program

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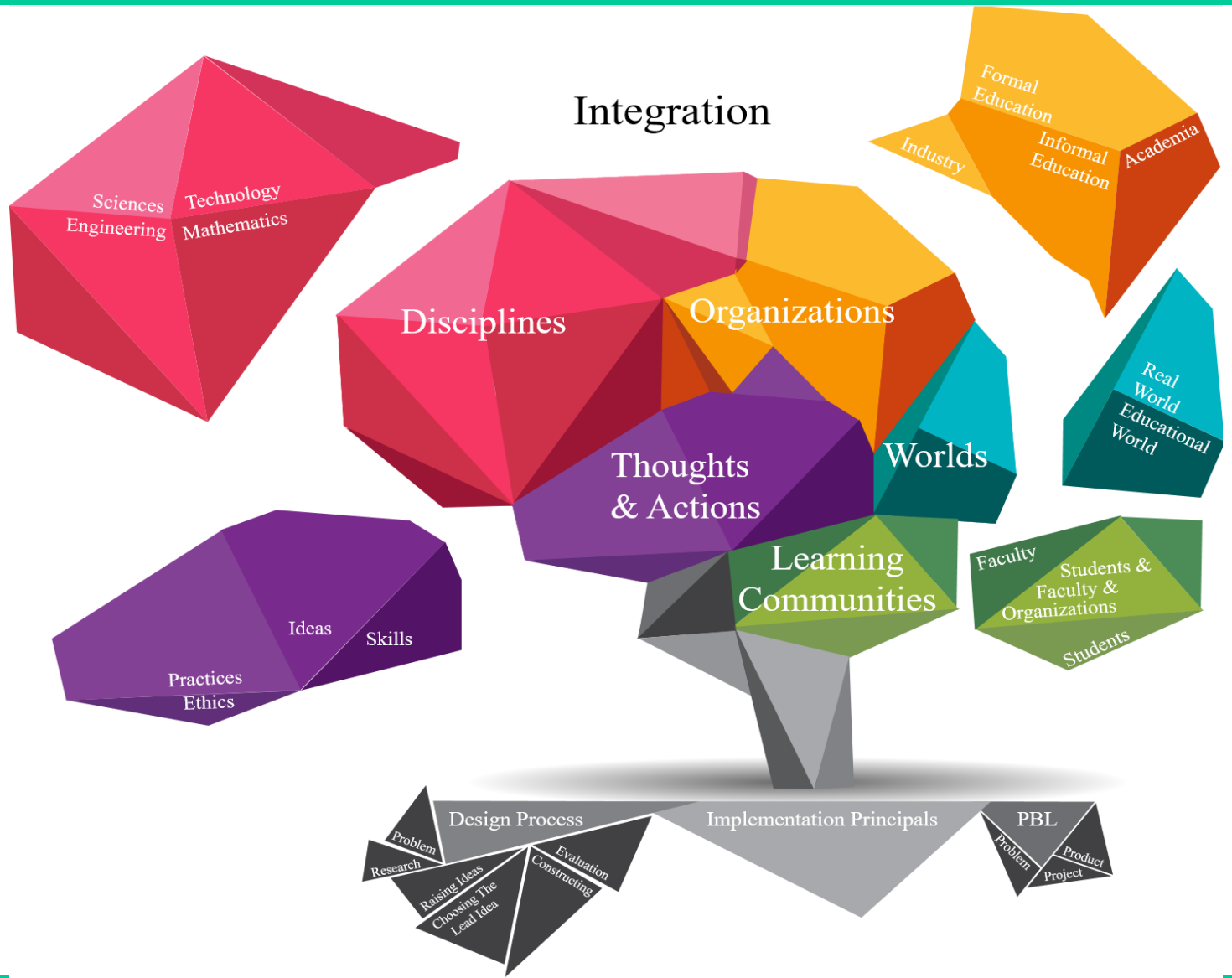
'Integrative STEM Education' M.Ed. program



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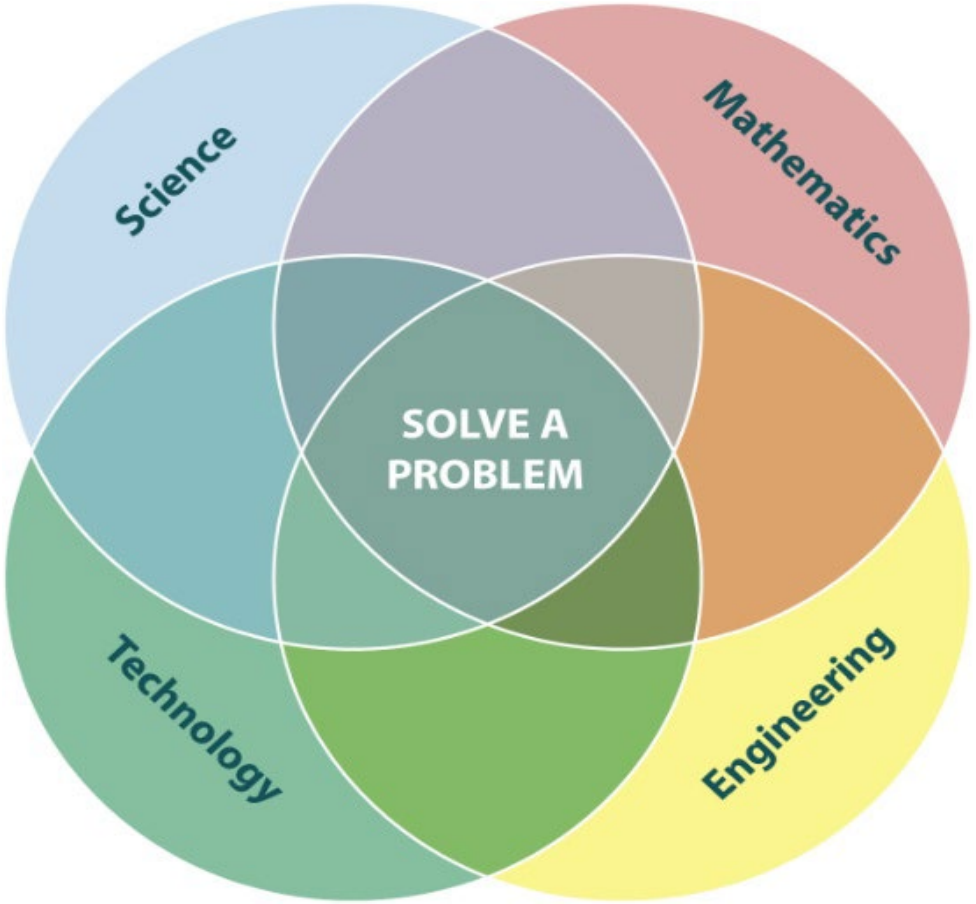
The M.Ed. in Integrative STEM Education:
The Interdisciplinary Approach



The Process
design

Pedagogical approach:
PBL

Bybee, 2013
Tyler, 2020

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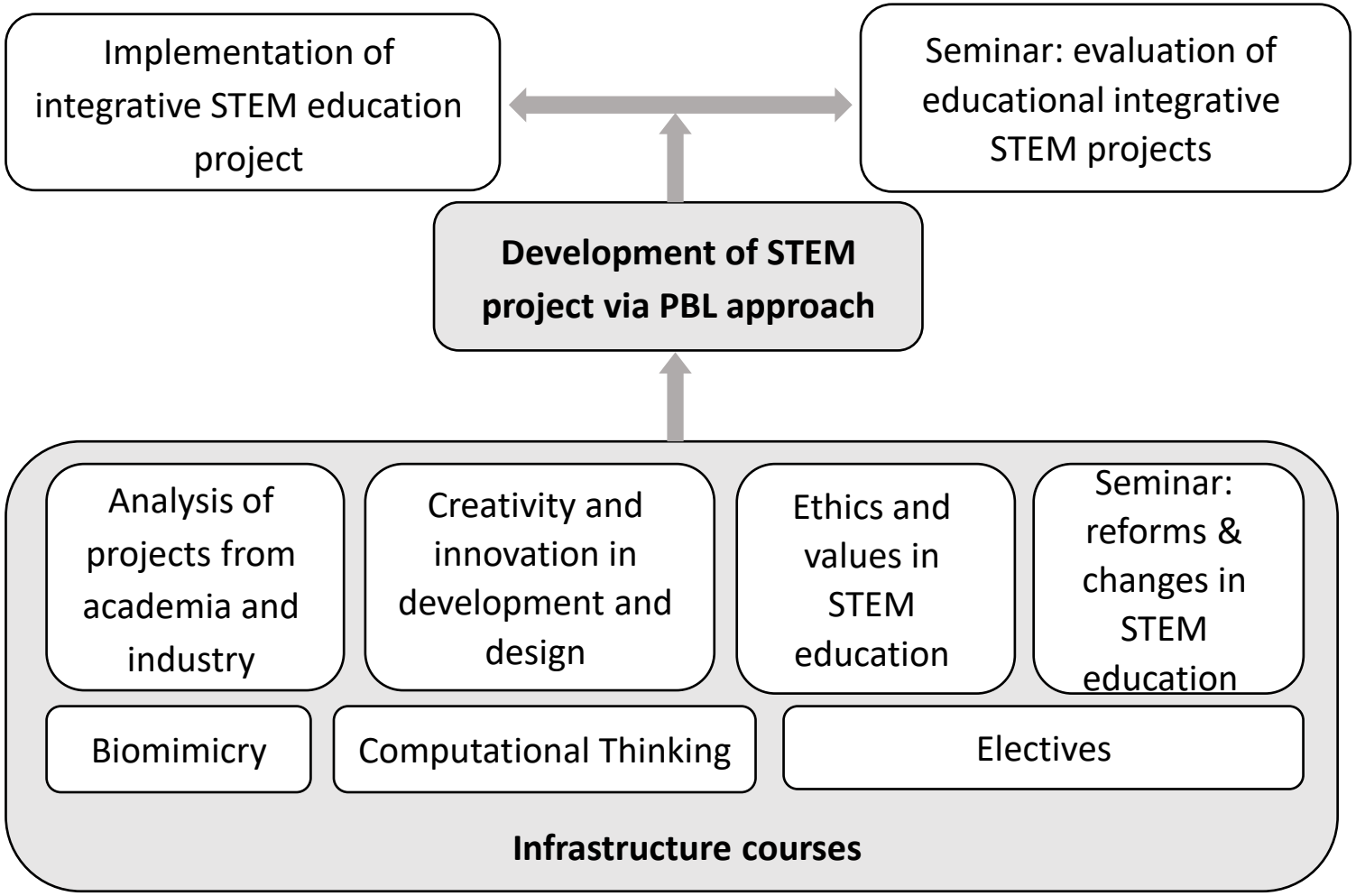
Program Structure & Courses



Project Based Learning Characteristics

1. ***The problem***. Should be "wicked," ill-defined, open-ended, relevant to real-life situations.
2. ***The process***. Iterative. using design tools and design skills.
3. ***The product***. a tangible product.
4. ***The teachers' role***. Facilitator. to guide, assist, support, and mediate the students' learning processes.
5. ***The learners' roles***. Responsibility for the learning process, timetable, teamwork, and assessment.
6. ***Assessment.*** Developing and implementing assessment criteria.

(Dagan, 2023)

Mioduser, 1998

Klappwijk, 2018

These PBL characteristics provide the basis for the course's teaching methods and for the students' individual constructed reflections, which provide the data of this study.

The Course: "Development of an Interdisciplinary STEM Project via PBL approach"

- Course duration : two semesters
- First semester:
  - Problem identification
  - Honing PBL skills: planning schedule, working in a team, planning assessment criteria and their weight, using technology to create an artefact, how to learn about the problem space.
- Second semester:
  - Implementing PBL skills while solving the problem they define.

The STEM-PBL Principles guiding the course

- Select meaningful & relevant **problem**
- Plan the **schedule** of the project
- Employ inquiry and **scientific practices** that are relevant for the problem and sustainability issues.
- **Collaborate** around learning activities
- Using design tools and design skills– **technology**
- Develop and create tangible and measurable **artefact**
- Use STEM knowledge
- Involve **stakeholders** – community, industry and academia
- **Values** – social responsibility, community engagement, equity, leadership
- Identify the **assessment criteria**
- Formative **assessment & reflection** throughout

The Course: The lecturers' and students' role

Lecturers' role	Students' Role
Teaching the skills that are needed	Responsibility for the entire process
Being there for support and guidance when it is needed	Responsibility on the schedule
	Responsibility on the assessment
	Responsibility on the product and the portfolio

Example: the First Students Team Problem

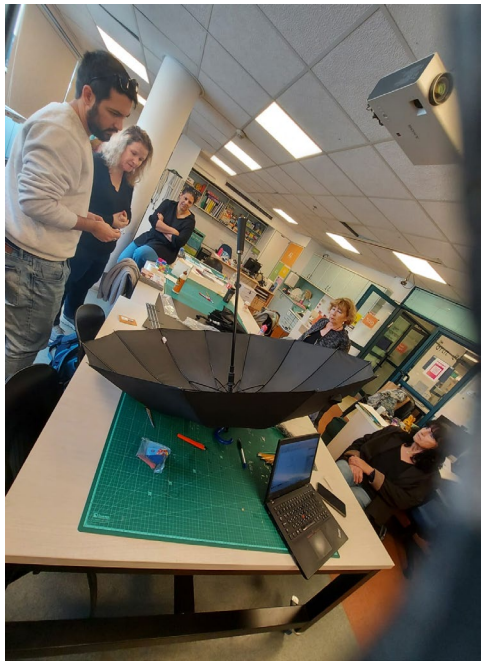
The Brief:

Climate change is making extreme heat events more common and more severe in many areas around the world. More and more of the world population are exposed to a fatal combination of heat and humidity, and models predict increase in such conditions. There are limits to the human body to withstand extreme heat.

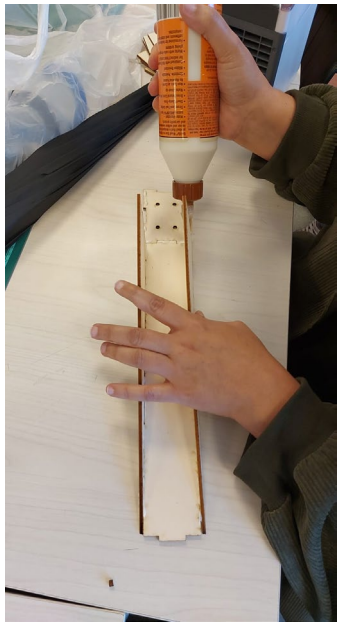
The problem:

How to lower the temperature of the immediate environment surrounding an individual's body when they are outdoors?



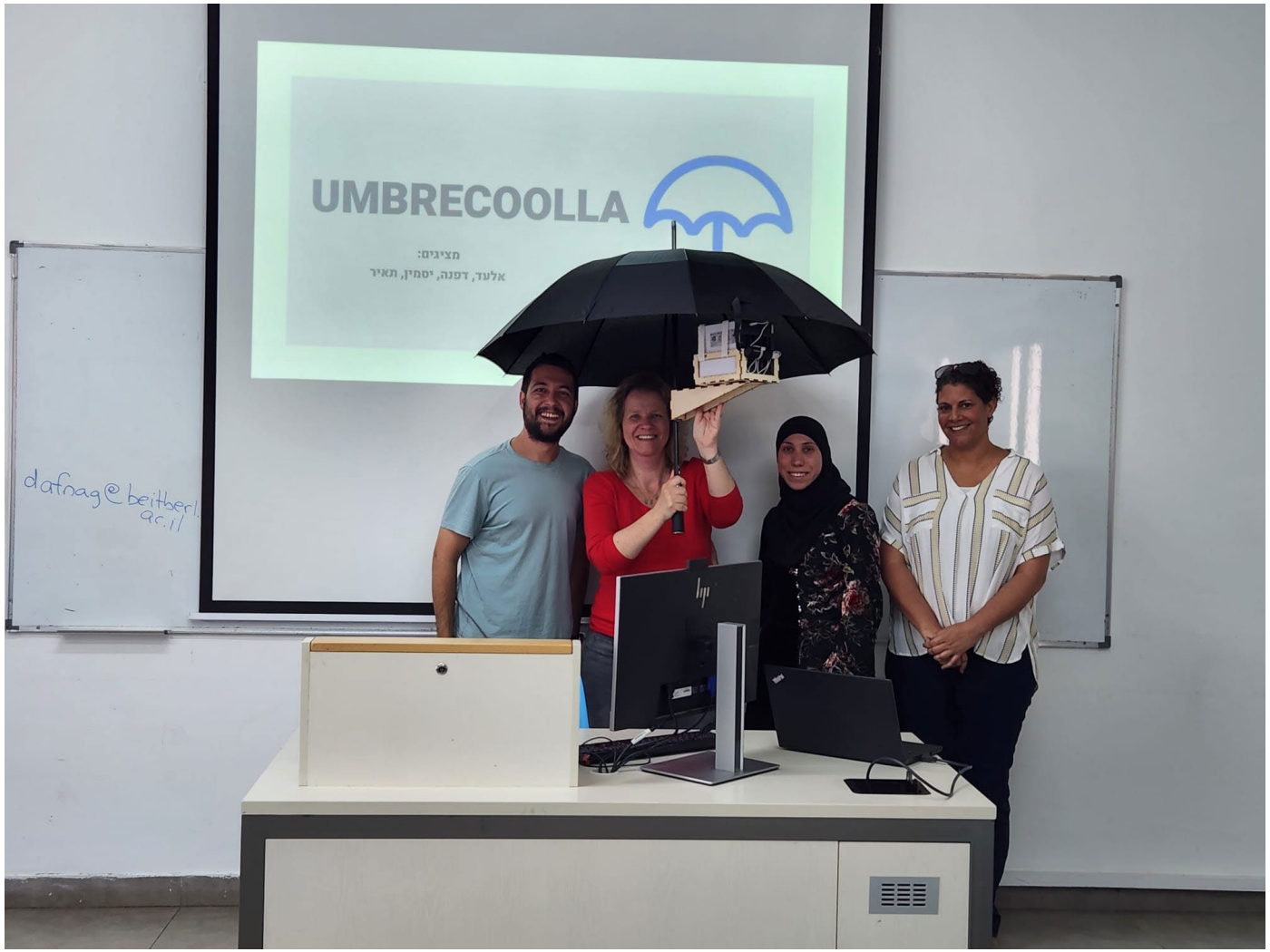





אז איך הכול התחיל?

The solution, The product



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Students' Reflections' Questionnaire

Six PBL aspects, three questions for each

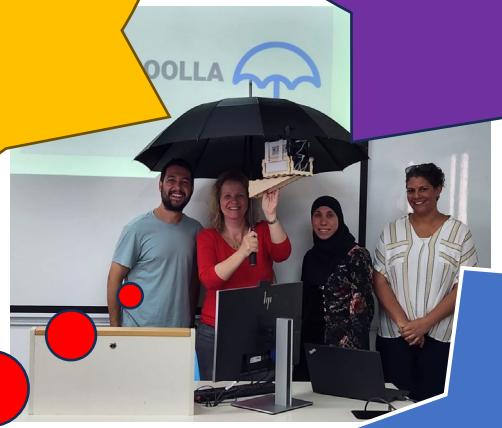
- **Aspect 1:** Finding a topic and identifying the problem.
- **Aspect 2:** The problem-solving process
- **Aspect 3:** Formulating and developing assessment criteria
- **Aspect 4:** Students' role: Determining and managing a schedule.
- **Aspect 5:** Expressing the integrative disciplines in STEM
- **Aspect 6:** Teamwork

1) What were the challenges you confronted?
2) How did you act to meet these challenges?
3) What did you learn from this?

Students Responses

"It opened a new way for me as a teacher to transfer learning responsibility to the students and be a facilitator who directs and monitors the process of making." (YN);

It allows me as a teacher to know where the points of failure are, to know what should be more or less structured, how to assist learners in the process, and above all, how to really implement a PBL project in the best way for all partners in the process." (ES);



"It mainly opens the mind and allows me to think and dream. I don't really know if it can be applied at this point." (DS);

"To understand that the main goal of the PBL process is to develop personal abilities along with empathy, which will increase the chances that he/she will grow up to be a person engaged in improving the world." (TS).

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Finding (1)

- The students experienced all six PBL principles.
- Through their active engagement in the process of PBL, they were able to identify the PBL characteristics and comprehend their significance to the learning process.
- Difficulties and challenges the students encountered:
  - defining a problem such that it will be interesting to solve, with a feasible multi-disciplinary scope.
  - the iterative method which often creates frustration.
  - the positioning of the inquiry component in the process that was determined by the lecturers.
  - the need to be attentive to others' opinions.
  - the need to decide on their own assessment criteria.

Finding (2)

- The students expressed a desire to apply this newfound knowledge in their respective educational fields.
- They overcame challenges they encountered by building on the power of teamwork.
- These strategies reflect 21-century skills central in STEM education that these teachers are expected to cultivate in their students.
- The students' reflections indicate that the course presented herein succeeds in making this move from transmissive to transformative education (Sterling, 2009).

Conclusions

- The course successfully implemented a learner-oriented approach, emphasizing student-centred learning, local ownership of learning, and a constructive learning process.
- This shift aligns with the need for transformative, constructive, and participatory education in the realm of sustainability and STEM education.
- Despite students' frustrations regarding their responsibility for planning the timetable as well as the iterative nature of the design process, this experience developed their PBL skills.
- Teamwork (building on diversity of approaches, dividing roles, trust in mutual support) provided them the solution to the challenges.
- The shift from teacher-oriented transmissive education to learner-oriented transformative education reflects the importance of providing students with ownership of their learning process and the opportunity to engage in constructive and participatory education.

Proceedings on the program:

Ragonis, N., Goldman, D., Dagan, O. (2023, in publication). *Educating the educators: an innovative M.Ed. program in Integrative STEM Education incorporating open schooling principles*. ETE IV: STEM & Open Schooling for Sustainability Education, Educating the Educators.

Dagan, O., Ragonis, N., Wagner, T., & Goldman, D. (2019). Integrative STEM Education -A New M.Ed. Program: Development, Objectives, and Challenges. *Proceedings of Pupils Attitudes Toward Technology - PATT 37 - Developing a knowledge economy through technology and engineering education*, 125-132. Msida, Malta, 03-06, June 2019.

Ragoins, N., Wagner, T., Goldman, D., & Dagan, O. (2019). *Integrative STEM M.Ed. Degree Aligning with Contemporary Perspectives in Academia and Industry*. The 13th Conference of the European Science Education Research Association (ESERA), Bologna, Italy, 26-30 August 2019.

Ragonis, N., Dagan, O., Wagner, T., Goldman, D. (2017). REAL STEAM for Developing the Next Generation Problem Solvers. MASHAV Educational Training Center, May 2017 Booklet STEM.