Empowering teachers to nurture computational thinking and innovation in K-12

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الجمعية التربوية الدولية
International Education Association IEA

Overview

- IEA learning domains
- The problem
- Why now?
- Children's potential
- What hinders innovation in education?
- The solution
- How does Coder-Maker address this solution?
- Pedagogical underpinning and process
- Teacher professional development
- Preliminary and current research

International Education Association Domains

The Problem

Skills Mismatch

Skills taught in school do not match the demands of the fast paced and ever changing global market.

Ingenuity Gap

"Dangerous gulf between our need for practical, innovative ideas to solve our increasingly difficult problems and our actual supply of those ideas", *Thomas Homer-Dixon*

Emerging Jobs

Almost 65 percent of the jobs elementary school students will be doing in the future do not even exist yet. Both the workforce and our knowledge base are rapidly evolving. Source, World Economic Forum

Why Now?

Skills Shortage

38% Worldwide

The global talent shortage in businesses has been on the increase since 2014. Source Manpower

Proliferation of IoT

70 Billion Things Connected in 2020

Students will have to work in and create intelligent places and smart cities

Innovation is tied to Knowledge Building

The “health and wealth of nations is tied to the innovative capacity of its citizens”, *Drucker*

Prosperity will depend on innovation and the creation of new knowledge *Thomas Homer-Dixon*

.

Children's Potentials

When given the right skillsets all children can grow into tomorrow's

Computational thinkers

Creative team leaders

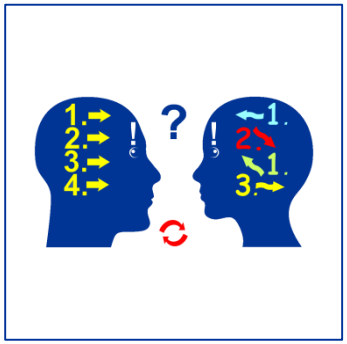
Creative builders

Creative entrepreneurs

What Hinders Innovation in Education?

The complex nature of the educational process which is burdened by:

- Approach
- Disconnect
- Misconceptions



Approach

Learning is too often confined to passive knowledge transfer within classroom walls.

Providing a set of CZ instructions to follow.

The pace of technological advancement occurs faster than innovation in teaching and learning.

Disconnect

Educational agencies and communities fail to coordinate with each other.

Online communities and resources that can enable educators' capacity building is untapped.

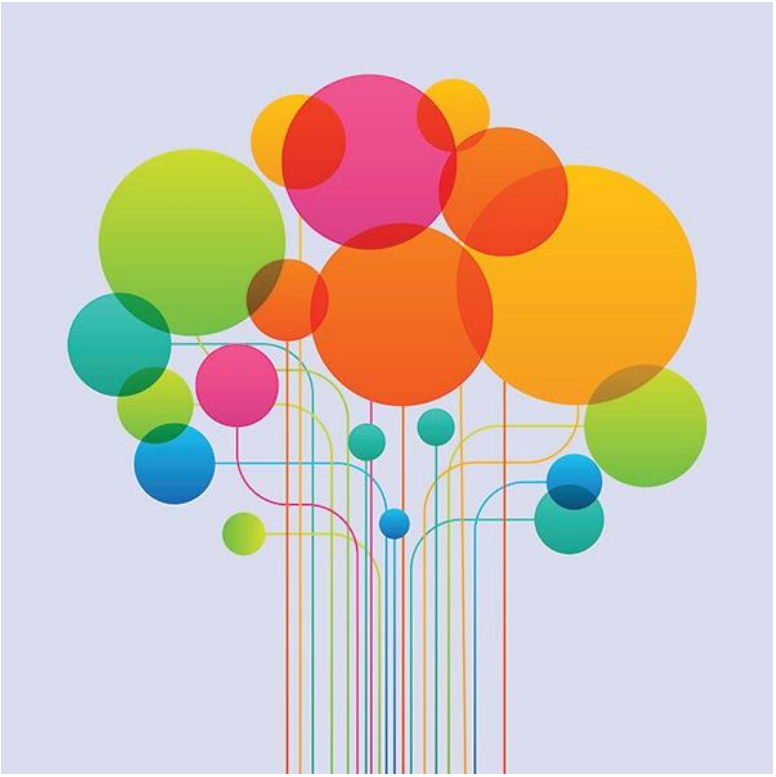
Misconceptions

That technology requires large upfront investment to be effective.
That simply providing access to technology will generate innovation in education.

The "Coding" hype

The Solution

An Integrated Knowledge Building Approach to Education



How does Coder-Maker address this solution?

Coder-Maker
An Integrated Approach

Teacher PD • Pedagogy • Skills • Technology • Partnerships

Teacher PD

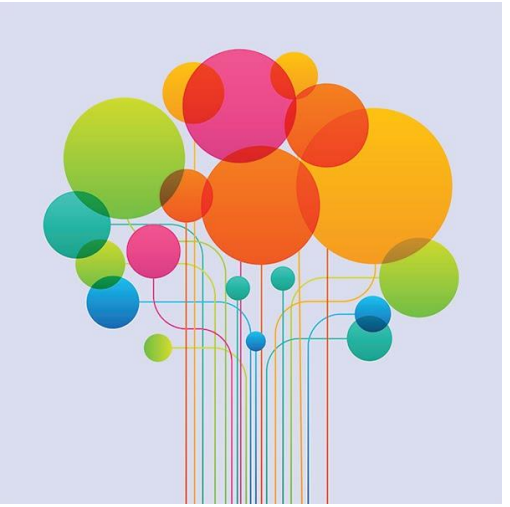
Empowering teacher professional development connecting and reinforcing computational thinking with knowledge building through a problem-oriented learning approach.

Pedagogy

Problem-oriented learning integrated in real life applications, focus on computational thinking and subject integration in Sciences for Middle and High School and thematic learning reinforcing numeracy, literacy and sciences for Primary school.

Skills

STEAM and humanities skills are integrated in design challenges fostering market-relevant skills: collaboration, motivation, creativity, collaboration, problem solving, entrepreneurial thinking.



Technology

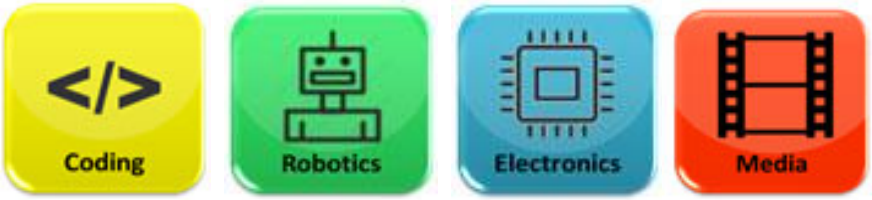
Low cost physical computing with open architecture technologies that enable the interaction with the outside world and the development of computational thinking and innovative prototypes.

Partnerships

Win-win partnerships not only with experts and volunteers but with market-relevant stakeholders, small and medium size enterprises, ministries, universities, and stakeholders in the knowledge economy.

Coder-Maker: What, How, Integration

What



How

Participate in guided inquiry

Complete hands-on applications

Collaborate to solve real-life problems

Integration

Integrating the Coder-Maker Program at school

STEAM Foundations
Science, Technology, Engineering, Arts, Math

Tutorials
Open Source
Ongoing Updates

Equipment
Affordable
Latest Items

Teacher Support
Ongoing
Online

Coder-Maker Foundations: Learn, Apply, Create

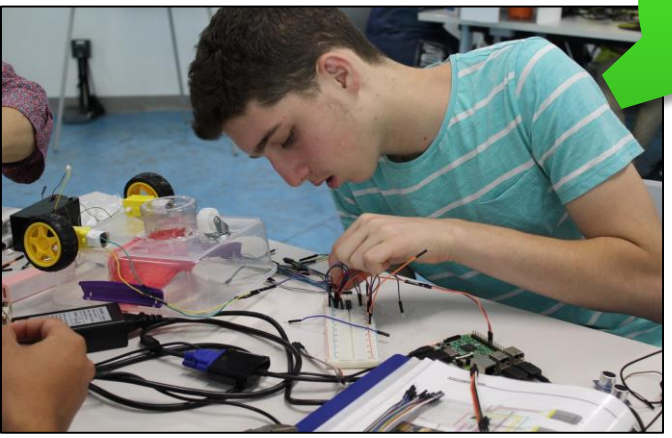
Participate in guided inquiry

Learn

Apply

Create

Engage
In hands-on applications



Physical Computing

Complete
real-life applications

Coder-Maker Pedagogical Underpinning

Rooted with some variations in socio-constructivist learning and knowledge building

- Combines independent and collaborative learning in progressive problem solving
- Connects learning in and out of school
- Iterative and co-creative
- Context driven focusing on learners' reality
- Combines knowledge, self-exploration and the social good
- Enables learners to gain confidence in order to address challenges
- Deep understanding
- Learn through inquiry, testing, questioning, reflecting investigating and hypothesizing in new situation

Coder-Maker Pedagogy
Independent and Collaborative Problem-solving

Traditional Pedagogy

- Problems in the book
- Following instructions
- Providing a problem with one solution
- Requiring students to answer questions
- Providing no space for errors
- Appling the traditional scientific process
- Surface understanding

Coder-Maker Pedagogy

- Real-life problems
- Solving open-ended challenges
- Providing problems with multiple solutions
- Enabling students to raise questions
- Learning from failure
- Learning through inquiry, testing, questioning, reflecting investigating and hypothesizing.
- Deep Understanding

Launch of the Coder-Maker in Partnership with the Ministry of Education and Fondation Mouna Bustros

Coder-Maker Partners and Donors

Patron

Ministry of Education
And Higher Education

Co-founder

Fondation Mouna Bustros

Strategic

Beirut Digital District

Raspberry Pi Competition

UK LEBANON TECH HUB

Education Research Projects

IDRC

FORD FOUNDATION

Raspberry Pi

Innovative Generation Project

BAU

Corporate: 10 Public Schools Project

Microsoft

alfa MANAGED BY ORASCOM TELECOM

HYUNDAI

Supporting Universities

AUB American University of Beirut
الجامعة الأميركية في بيروت

RHU

University of Balamand

USJ

USEK HOLY SPIRIT UNIVERSITY OF KASLIK

BAU

Coder-Maker Equipment
Raspberry Pi 3 Station

Monitor

HDMI to VGA Converter

Mouse

Keyboard

Coder-Maker Equipment
Electronics Explorer Kit

Stepper Motor

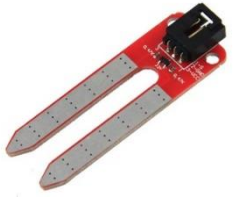
Servo Motor

DC Motor 6V

Gear Motor and Wheel

LED Lamps

Ultrasonic Sensor



Moisture Sensor

Raspberry Pi Camera

Breadboard

Jumper Wires

Resistors

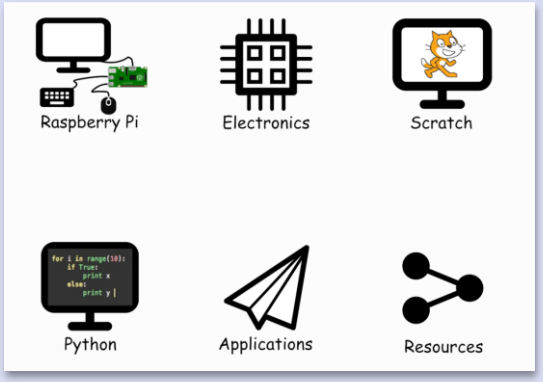
Transistor NPN

Integrated Circuit (IC)

Diode

Coder-Maker Content

Guide



Essentials

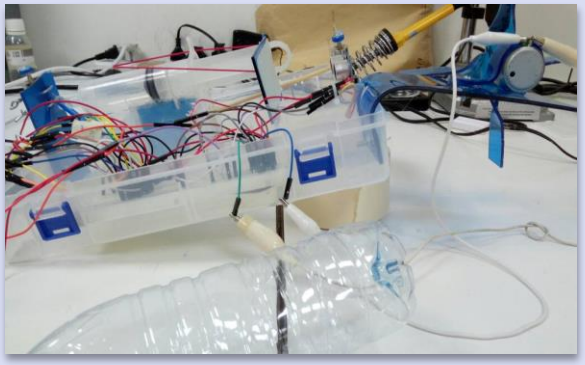
Includes computational thinking basics
Each individual student or teachers can learn and practice
Provides pedagogical cards

Applications

Based on Scratch and Python

Provides examples to develop and put skills in action
Aligned to curriculum
Includes circuitry, electronics and robotics

Design Challenges



Challenges

Provides Design Challenges
Reinforces STEAM concepts and Humanities
Aligned to the curriculum

Coder-Maker Creative Process

Stage	Observe	Research	Imagine	Design	Create	Review
Process Objective	Gain insight into; Self Surrounding Community Natural surrounding Question and explore your community	Identify a problem Formulate the problem Research the cconcept Justify why it is important	Brainstorm designs: Defer judgment Encourage wild ideas Help students to build on the ideas of others and focus on the topic; propose a design	Make a plan (5W) Design your prototype Share your design Adjust your design	Build your prototype based on your design and the problem / solutions proposed Use things around you	Test, verify that the design meets the original problem objectives; Evaluate the prototype ; Analyze and discuss what works what does not; what to improve
Outcome	Concept Map • Ideas • Community • discussion points	Gain insight into your: Self Community Surrounding Articulate a problem that is worth being addressed	Propose a design to address the question	Design a prototype include in It electronics and materials needed	Create the prototype Start adding the circuitry and the code	Test, review and refine, debug if necessary Reflect on the process Identify and improve what works well/ what does not work well
Technology Objective	Learn and apply: Raspberry Pi essentials Basic circuitry: LEDs, resistors, breadboard Self-exploration	Learn and apply : Electronic: ultrasonic sensors, LED(s), combination of LED and ultrasonic sensors	Learn and apply : - Motors: servo and DC - Integrate multiple electronics together	Learn and apply : - Rpi Camera, - Humidity Temperature sensor Decide what electronics to use in your design	Create: Implement what you've learned: - Build your circuitry - Code	- Create: Test your program - Debug your code - Finalize

Communicate and Share

Coder-Maker Activities

Sharing Event

Working Sessions

Hackathons

Raspberry Pi Lebanon Competition

Teacher Professional Development

Lebanon Raspberry Pi Competition

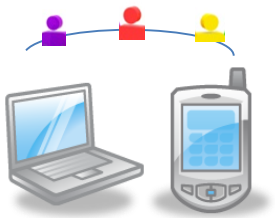
- Video available online:
- Click here to view it
- Or copy and paste this link in your browser:
  https://www.youtube.com/watch?v=tH5hf5iN_KM&feature=youtu.be

Examples of Previous Students' Projects

- Automated Green House
- Automated Watering System
- Smart Stick for the Blind
- Automated Pill Box for the Elderly
- Garbage Sorter
- Green School
- Sorting Garbage: Changing Students' Behavior
- Etc..

Coder-Maker
IEA Teacher Training Model

Learn-as-You-Work



Face-to-Face Workshop

Online Collaborative Learning

Guided Classroom Applications

Working Sessions

Performance Evaluation

Concrete Learning Outcomes

Coder-Maker
Teacher Training Overview

- Professional Development: Learn-As-You-Work Model
  - Six days Face-to-Face spread over the term
  - Sharing and reflections
  - Ongoing coaching by team
  - Support during sessions by IEEE Lebanon Chapter Coder-Maker volunteers
  - Working session with students
  - Additional reflective feedback
  - Online and offline resources supported by text messaging

Coder-Maker
Teacher Training: Pedagogical Underpinning

- Experiential and situated learning
- Teachers become learners
- Learning mirrors how and what they will implement in the classroom
- Context relevant
- Process is determined by practice
- Collaborative
- Professional community

Preliminary Research
M&E Instruments used in Part 1 (Pi4L)

Part 1

Exploring Primary teachers' engagement with CT

- 18 teachers
- Two Rounds of teaching
- 40 hours of instruction per round
- 300 Students

Process

Teachers were given an integrated course

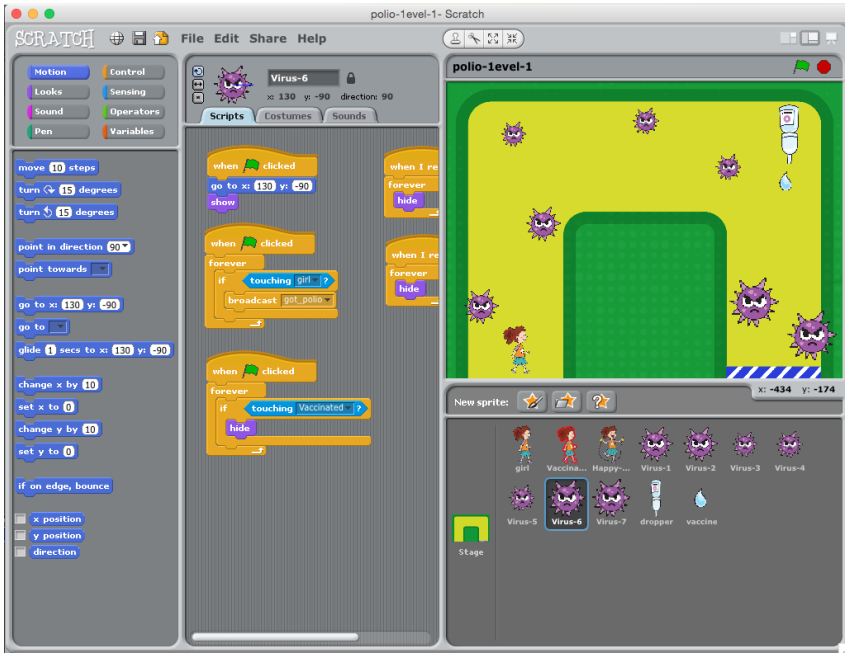
Applied themselves in the same way that their students would. They were also given ready made lesson plans around:

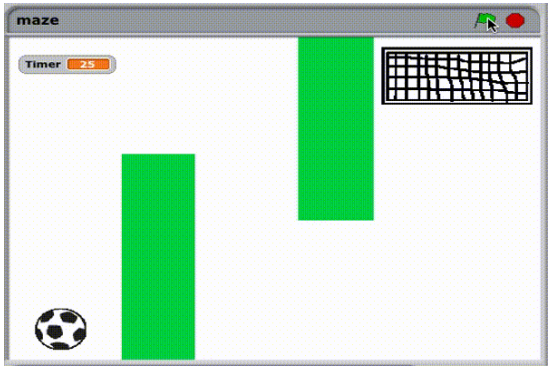
Learning to code with Scratch and how to code to Learn in thematic learning (Math, Literacy, Health) alongside unplugged activities.

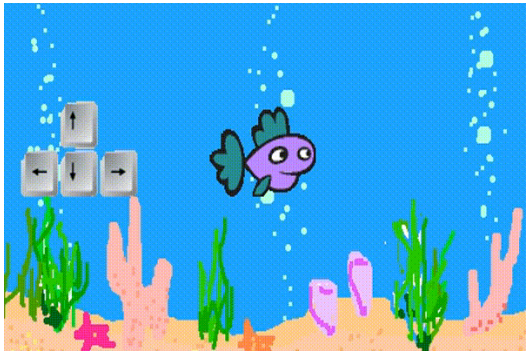
At the end of the process teachers were invited to adapt and develop their own and create lessons plans around new themes

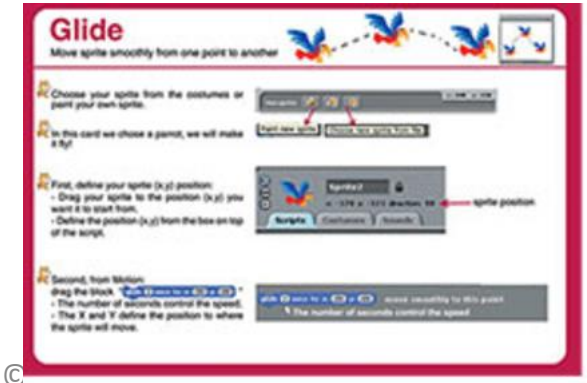
- **Tests** grades
- Numeracy **grades**
- **Rubrics scores** for students artefacts
- **Interviews** (coordinators, teachers, students, parents, coaches)
- **Questionnaires**: Teachers and students
- **Reflections**: Teachers
- **Observations**: External and internal M&E

Preliminary Research
Example of Scratch Thematic Games & Content









Aligned with Learning Goals

Preliminary research
Impact on Teachers Part-1

Direct impact on teachers

Professional Growth, Self-confidence,
Pedagogical Adoption,
Skills, Knowledge, and Attitude.

The impact on teachers extended well beyond their work with these children, and indicates that it has the potential to transform pedagogy on a much wider scale."

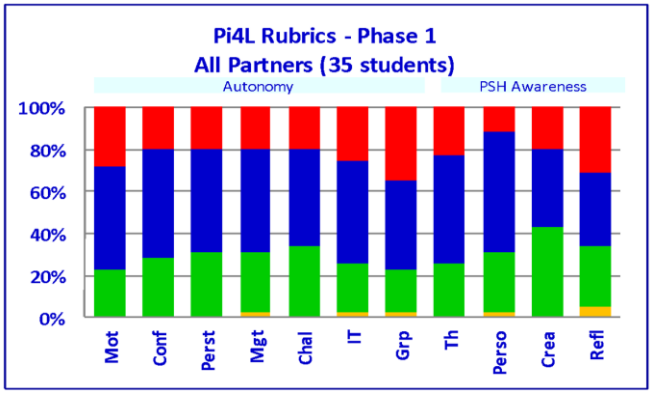
External Evaluation Report, College of Teachers, London

Direct Classroom Benefits

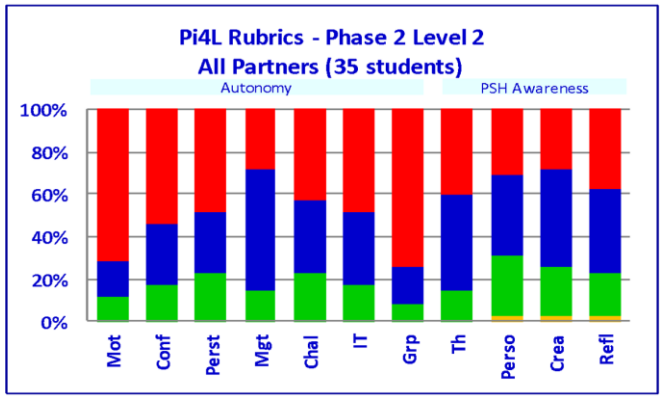
- Accelerated learning
- Better students' grades in numeracy
  - Participants: 70% improved, 21% doubled or more
  - Control Group: 40% improved, 3% doubled or more
- Motivation and self-confidence
- Computational thinking
- Group work
- Creativity
- Task management
- Persistence, and willingness to rise to a challenge
- Enhanced understanding

Preliminary Research Indicators

Graph 29: Pi4L rubrics results, Phase 1



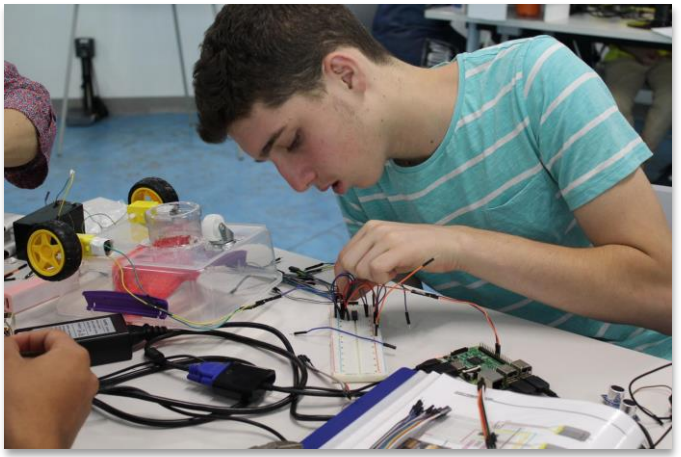
Graph 30: Pi4L rubrics results, Phase 2, Level 2

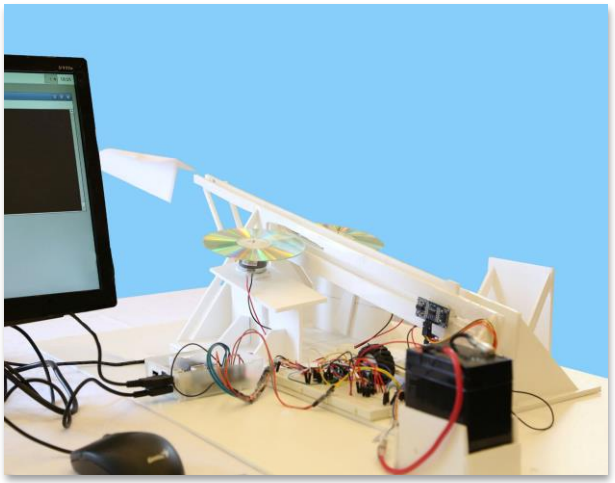


- Motivation: 89% of students reached ratings 4 and 3 (71% scoring 4)
- Group work: 83% of students reached ratings 4 and 3 (74% scoring 4)
- Self-confidence: 83% reached ratings 4 and 3 (54% reaching 4)
- CT: 83% reached ratings 4 and 3 (49% reaching 4)
- Management of their work: 86% reached ratings 4 and 3 (29% reaching 4)
- Persistence: 77% reached ratings 4 and 3 (49% reaching 4)
- Willingness to tackle new challenges: 77% reached ratings 4 and 3 (43% reaching 4)

Coder-Maker Current Research

Research is ongoing in Lebanon with 41 Lebanese (High School, Middle and Primary and Technical school) with 60 teachers in schools where there is a high number of refugees.





Coder-Maker Research Aims

- Digital Learning Innovations research which aims to improve the quality and accessibility of learning in and outside the classroom for children of host communities and refugee in Lebanon and Jordan.
- The project's implementing partners are IEA with Birzeit University as implementing partner in Jordan with funding from the IDRC and Ford Foundation

Specific Objectives

- To develop and test an "Ecology of Digital Educational tools and Resources" in Lebanon and Jordan to effectively address the education challenges proper to the contexts of the host countries and those caused by the influx of Syrian refugees.
- To provide an effective, low-cost model designed to build the capacities of teachers, educators and administrators and counselors
- To deepen our understanding of the relevance and effectiveness of different digital learning innovations in post emergency situation
- To inform digital learning innovation related educational policy-making and action at national and sub-national levels in Lebanon and Jordan.
- To maximize students' career choices and help students transition to higher education

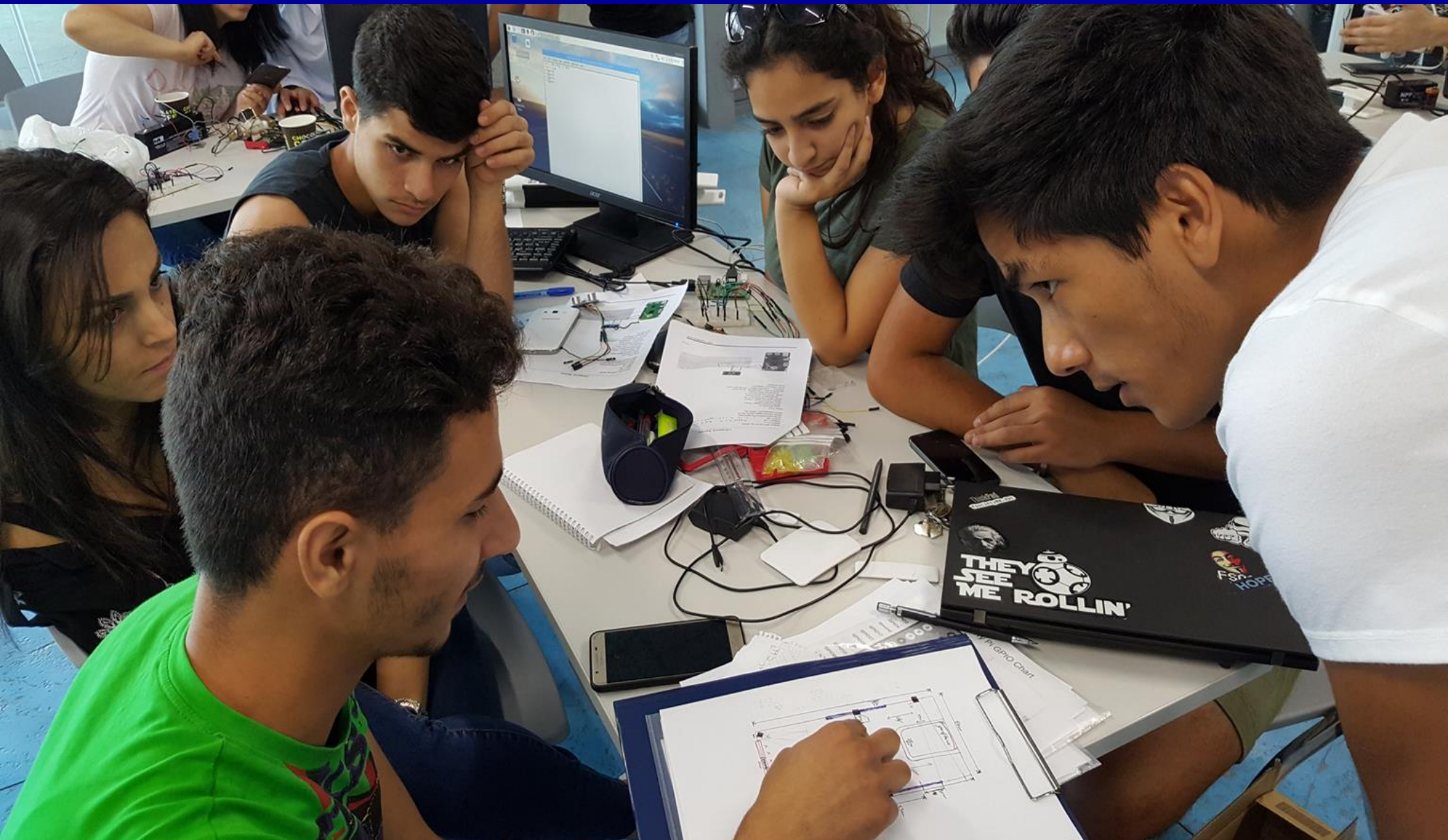
Coder-Maker Research Part 1

- Exploring Lebanese teachers' engagement in a low-cost technology enhanced, problem-solving orientated learning intervention with their students.
- How are teachers experiencing this learning intervention, what is working or not, what tensions are they experiencing and how are they are mitigating them?
- What is teachers' perspective on the learning intervention and how does it relate to their practice?
- What was the process like for students to think and create their artefacts? How does it relate to their learning?
- What value do the artefacts represent to students, teachers and principals?

- Field notes from discussions with teachers during the learning intervention
- Teachers' questions via WhatsApp
- Teachers' reflections, discussions and post-implementation interviews
- Discussions with teachers and students during working sessions
- In-depth post-intervention interviews with principals, teachers and students and examining students' artefacts
- Artefacts rubrics

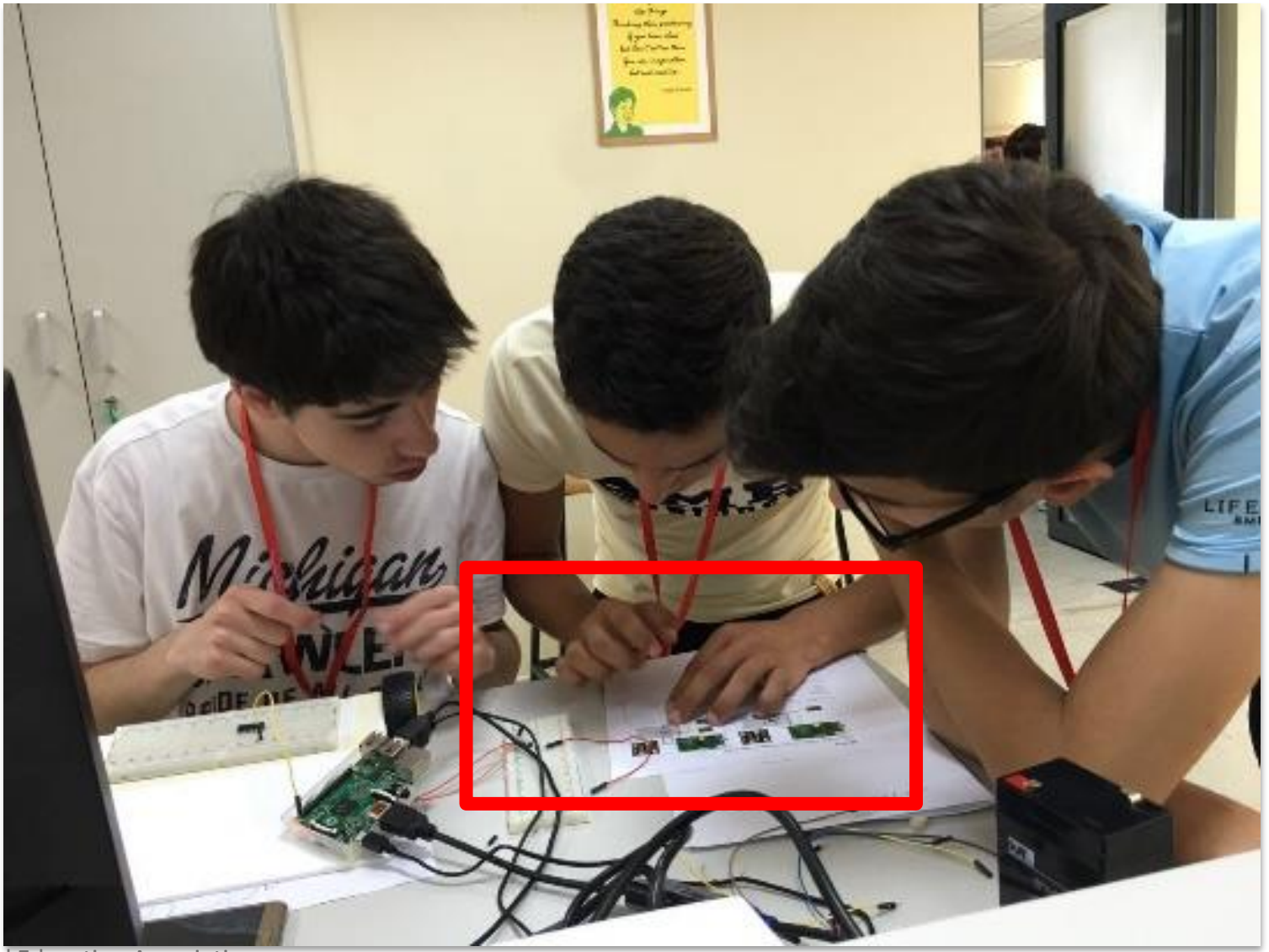
Teacher Workshop

Coder-Maker Working Sessions



Coder-Maker Working Sessions

Coder-Maker Working Sessions



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