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

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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

- Professional Development
- Creative Learning
- Education Networks
- Conferences & Events
- Research & Development
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

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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.

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Coder-Maker: What, How, Integration

**What**
- Coding
- Robotics
- Electronics
- Media

**How**
- Participate in guided inquiry
- Complete hands-on applications
- Collaborate to solve real-life problems
- Learn
- Apply
- Create

**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

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Coder-Maker Foundations: Learn, Apply, Create

Engage
In hands-on applications

Learn
Participate in guided inquiry

Apply
In hands-on applications

Create
Complete real-life applications

Physical Computing
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
• Applying 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
- Mouna Bustros Foundation
- Beirut Digital District
- UK Lebanon Tech Hub

## Co-founder

- Raspberry Pi Co-founder

## Strategic

- IDRC
- FORD FOUNDATION
- Raspberry Pi
- BAU

## Raspberry Pi Competition

- Microsoft
- alfa
- HYUNDAI

## Education Research Projects

- Innovative Generation Project

## Corporate: 10 Public Schools Project

- Supporting Universities

  - AUB (American University of Beirut)
  - RHU
  - University of Balamand
  - USEK
  - BAU

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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

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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

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Coder-Maker Activities

- Sharing Event
- Hackathons
- Working Sessions
- Teacher Professional Development
- Raspberry Pi Lebanon Competition

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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..
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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

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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

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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

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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
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

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Graph 29: Pi4L rubrics results, Phase 1

- 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)

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