FINAL TECHNICAL REPORT / RAPPORT TECHNIQUE FINAL
DIGITAL LEARNING INNOVATIONS FOR SYRIAN REFUGEES AND HOST COMMUNITIES IN LEBANON

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IDRC Grant / Subvention du CRDI: 108376-001-Digital learning innovations for Syrian refugees and host communities
Submitted to IDRC

By

International Education Association

January 2019
### Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMDI Kit</td>
<td>Coder-Maker Digital Innovation Kit</td>
</tr>
<tr>
<td>DOPS</td>
<td>Département d’Orientation Pédagogique Scolaire</td>
</tr>
<tr>
<td>FMB</td>
<td>Fondation Mouna Bustros</td>
</tr>
<tr>
<td>IEA</td>
<td>International Education Association</td>
</tr>
<tr>
<td>LAYW</td>
<td>Learn-As-You-Work</td>
</tr>
<tr>
<td>MEHE</td>
<td>Ministry of Education and Higher Education</td>
</tr>
<tr>
<td>MIT</td>
<td>Massachusetts Institute of Technology</td>
</tr>
<tr>
<td>RPi</td>
<td>Raspberry Pi</td>
</tr>
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</table>
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Abstract

This technical report provides key findings and lessons learned from the Digital Learning Innovations (DLI) project implemented in Lebanon between August 2016 and 2018 with a no-cost extension. The implementation was led by the IEA with its partner Fondation Mouna Bustros (FMB) in close collaboration with the Ministry of Education and Higher Education in twenty-one schools, targeting refugees learning with underserved Lebanese students in morning shift public schools. Additional funding from Ford Foundation contributed to increasing the scope of the project to an additional twenty underserved Lebanese schools which benefited from equipment donated by Fondation Mouna Bustros.

The aim of the Digital Learning Innovations project was to test the potential of pedagogical and technological innovations to improve the quality and accessibility of learning in and outside the classroom for Syrian refugee children and host communities, with a primary focus on children ages 14 to 18. The project reached forty-one schools, spread across 5 locations impacting 61 educators, 41 principals and 1,470 students and beneficiaries included school principals, teachers, parents and students. The implementation included the development of mixed methods research tools, pedagogical training materials, a technological platform, equipment distribution to schools, an intervention with teachers, a career guidance day for students and several community events. The research instruments included focus groups, semi-structured in-depth interviews, observations, questionnaires and assessment of learning outcome.

The implementation provided a holistic intervention, connecting teachers learning to students’ learning outcomes, based on the Coder-Maker Digital Innovations Kit (CMDI Kit) designed with strong foundations of purposeful, situated contextual and authentic pedagogical principles, cost effective hardware, open source software and training materials. The model provided a blended model of teacher training and community engagement following IEA’s Learn-As-You-Work\(^1\) model designed to enable schools and educators to provide an effective learning experience within the challenges of the post-crisis where refugees are learning with host communities. The project was successful in addressing some of the challenges identified in the provision of education in post-crisis and refugee situations such as school violence, a lack of motivation to learn, teaching predominantly focused on content delivery and working students struggling to adapt. With its holistic approach to teaching and learning the intervention revealed that the blend of pedagogical and technological processes provided a transformative experience to teachers and students who developed a deep sense of purpose. Students were clearly motivated beyond the initial excitement of digital technologies, exhibiting commitment to learning and their long-term project goals.

Teachers’ capacities were strengthened, learning outcomes were enhanced, teachers and students gained transferable skills such as complex problem-solving, self-regulated learning, collaboration, critical thinking and creativity, perseverance, self-confidence and more informed decisions towards career choices. In addition to learning, the project initiated more social cohesion, collegiality and collaboration around students’ project at school and girls showed an appetite for STEM activities despite the general societal association of STEM fields with boys. Students were committed to their long term learning goals which is significant in a culture where the norm is for children to work.

The intervention was designed, with specific attention of costs, in view of scalability and maintaining quality; and the CMDI kit hardware, software and content provide open source software packages keeping cost as low as possible. However, it is important to further validate DLI’s long-term sustainability and have a longitudinal study of its impact to evaluate the persistence of observed transformation, the corresponding impact on students’ learning outcomes, and their later

\(^1\) http://iea.org.lb/Sections.php?ID=3
progression in their life and career. In addition, with the increasing importance of STEM in the jobs of the future and knowing that there will be a worldwide shortage of STEM skills in the future job market, it is crucial to address this gap in future DLI interventions in order to have more equitable and inclusive society.

Introduction
Since the beginning of the Syrian crisis, Lebanon is the home of 1.5 million refugees, half of them under the age of 18, thus placing a considerable burden on a fragile education system that needed reform (RACE II report). Despite all the efforts exerted so far, it is estimated that only half of those children are enrolled in schools (United Nations High Commissioner for Refugees, 2016). The Digital Learning Innovations (DLI) project is designed to develop and test innovative educational learning solutions to address the challenges for refugees learning with host communities. The project aims at using technological and pedagogical innovations to improve the quality and accessibility of learning in and outside the classroom for Syrian refugee children and host communities in Lebanon and Jordan, with a primary focus on children aged 14 to 18.

Objectives
The overarching objective of DLI aims to use technological and pedagogical innovations to improve the quality and accessibility of learning in and outside the classroom for Syrian refugee children and host communities in Lebanon, with a primary focus on children aged 14 to 18. The specific objectives of the project were to:

1. 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;
2. Provide an effective, low-cost model designed to build the capacities of teachers, educators and administrators and counsellor;
3. Deepen our understanding of the relevance and effectiveness of different digital learning innovations in a post emergency situation;
4. Inform digital learning innovation related educational policy-making and action at national and sub-national levels in Lebanon and Jordan;
5. Help students transition to higher education and career;

Brief Overview
In Lebanon, the project reached forty-one schools, spread across 5 locations impacting 61 educators, 41 principals and 1,470 students. Beneficiaries include school principals, teachers, parents and all students of the same school. The implementation included the development of research tools, pedagogical training materials, a technological platform, equipment distribution to schools, an intervention with teachers and a career guidance day for students and several community events.

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3 The term “Ecology of Digital Educational Resources” is borrowed from the Ecology of Resources (Luckin et al)
Selection of Schools
The intervention ran in morning shift schools which were selected in close collaboration with MEHE, Ministry of Education and Higher Education and DOPS, Department d’Orientation Pédagogique Scolaire, based on the highest percentage of refugees as per the data available at the time of selection and the willingness of the principals and educators to participate in the project. The selected schools were located in five governorates (Mount Lebanon, North, Beirut, South and Bekaa) with a percentage of refugees ranging between 20% and 60% (with the exception of four schools in which the percentages ranged from 3-18% to increase the geographic diversity of the schools represented in the project). The project description was shared with the schools and all participants were given detailed information along with the requirements for teachers’ participation.

After starting the program, seven schools were replaced for various reasons beyond our control and hence there were two groups of teachers, one that started in February 2017 and one in December 2018; both groups followed exactly the same process. The list of schools is presented on Appendices A and B

Participants
Participants included principals, teachers and students. Schools were asked to invite two teachers (one science and one computer) who were interested, willing, and able to commit to the program. However, few schools did not have a computer teacher or if they had one, their schedules did not allow them to participate in the workshops. In addition, few High Schools had a heavy load on science teachers who could not leave school on the days of the intervention. The intention was for technology teachers to teach coding in their class and subject matter teachers to integrate computational thinking in their teaching to enhance learning and strengthen learner outcomes. However, due to the circumstances mentioned, almost all schools sent only one teacher, either a science or a computer teacher with the exception of a few schools who sent both.

In order to engage participants in the DLI intervention, IEA developed the Coder-Maker Digital Innovation Kit (CMDI Kit) which consists of pedagogical learning material (tutorials, applications and design challenges), digital tools and a platform for learning and exchanging information.

The Coder-Maker Digital Innovations Kit (CMDI Kit)
The CMDI Kit included:
1. An online platform and a web application
2. Digital learning equipment
3. Software Packages
4. Pedagogical content

Online Platform and Web Application
An online password-protected platform was created and enhanced for DLI allowing educators to track newsletters, receive updated content, share the progress of their work and communicate with trainers.
In addition, a web-based application was developed to communicate with teachers and send push notification to teachers. The web application was finalized late into the project and was tested after its completion.

**Digital Learning Equipment**

The equipment consisted of Raspberry Pi (RPI) stations which were selected by virtue of necessity to provide the most affordable, sturdy, and reliable solution. The decision to select the Raspberry Pi was also influenced by IEA’s previous experience with the RPI with refugees which required practically no maintenance. All DLI Schools received RPI stations, those funded by IDRC received 7 stations and those funded by Fondation Mouna Bustros received 2 stations each; the station included:

1. A Raspberry Pi (RPI) board
2. A power supply unit (PSU)
3. A SD memory card (loaded with software to operate the RPI and learning guide)
4. A Screen
5. A Mouse
6. Various electronic tools (adaptor, breadboards, sensors, motors, etc.)

The Raspberry Pi runs on Raspbian, an open source operating system, which enables the use of several open source software packages used in DLI, such as Scratch and Python.
Figure 3: School DLI Electronics Equipment getting ready at IEA offices

Figure 4: DLI Equipment Boxes ready for shipment to schools

Figure 5: DLI equipment installed at a DLI school
Software Packages

Scratch is a visual programming software developed by Massachusetts Institute of Technology (MIT) with a wide range of research literature about computational thinking and cognitive learning in schools (Papert, 1980; Wilensky & Resnick, 1999). However, despite the excitement around Scratch and programming, there seems to be no significant evidence of enhanced learning or skills improvement with programming only (ibid), hence the importance of how it all fits in the overall pedagogy of the CMDI Kit.

Python is a simple yet robust and powerful object-oriented programming language which is well suited for beginners and provides a solid base for learning programming. It is a dynamic language which uses clear and logical language performed at run-time by an interpreter; it highlights the code in different colours and reinforces the importance of accuracy and correct syntax. Furthermore, the software packages Scratch and Python software are open-source, so the learners will not have to incur additional licensing costs and can leverage the power of Python in a wide range of applications as they grow at school, university, and at the workplace.

Each software has a thriving community which provides support and answers questions. To supplement the software taught as part of the CMDI Kit, teachers and students used the Internet, PowerPoint, YouTube, WhatsApp, mind mapping software, word processing, photo and video editing to communicate among each other and to research, design, present and share their projects.

Pedagogical Content

The pedagogical content included an online guide with more than 10 Tutorials and 20 Applications and Learning Designs. The tutorials provide step-by-step guidance from beginner to advanced levels in Scratch, Python, and circuitry. The applications included step-by-step Learning Applications (LA) designed to support and enhance the Lebanese curriculum and thematic learning for primary teachers. All applications are designed based on challenging science concepts which are made easy and integrated in open-ended design challenges with examples, a teacher guide, and a student workbook.

The online guide and applications are also available offline on the RPi’s SD card and can be updated when the user is online.

Figure 5: Learning Design
The process of engaging with the content is integrated to guide teachers and students to learn gradually from simple to more complex computational thinking concepts and tasks. The developed guide includes:

1. Tutorials to get started
2. Unplugged lessons to understand concepts
3. Scratch tutorials ranging from beginner to advanced
4. Scratch applications and design challenges
5. Python tutorials from introduction to intermediary
6. Python learning applications and design challenges
7. Circuitry from passive to more complex electronics tutorials

Figure 1: Coder-Maker Online Guide
The Intervention

The intervention started with a 3-day leadership workshop and was followed by a 6-day teacher professional development workshops spanning over four months. The aim of the leadership workshop was to have them support the digital transformation in their school, understanding the program requirement and providing teachers and teams the support they needed to succeed in the project.

Figure 2: Leadership Workshop

The aim of the teachers’ workshop was to guide them through the digital transformation and teach them how to use the CMDI Kit.

The specific objectives of the teachers’ workshop were to enable teachers to guide their students to:

1. Gain insight into self and community
2. Engage with passive open-ended challenges and themes
3. Explore computational thinking concepts and active instructional methods
4. Learn introductory and intermediary levels of Scratch or Python (depending on grade level)
5. Learn how to use electronic tools and circuitry
6. Apply what they learned in classroom applications
7. Combine elements and connect concepts with learning objectives
8. Experience and simulate the entire cycle of a project that responds to a community need
9. Define the problem, conduct research, imagine solutions, design, construct, code and review their projects
10. Share their projects
The training spanned over a period of four months: from February to May 2017 for the first group and from December 2017 to March 2018 for the second. The workshop for the first round of teachers were held in five regional locations (South, Beirut, Kaslik, Tripoli and Bekaa) and in Beirut for the second group.

The intervention was designed using IEA’s Teacher Professional Development, Learn-As-You-Work (LAYW) methodology which is process and outcome-oriented and guides teachers step-by-step on how to apply the program in their own contexts. The process combines pedagogical and technological skills engaging teachers gradually from simple to more complex concepts and tasks that support and reinforce the learning goals set by the national curriculum. The outcomes are aligned with problem-solving skills and provide training in a blended manner with interpersonal workshops followed by continuous tracking and online support.

The methodology enables teachers to slowly gain confidence as they work with their students and to track the progression of teams as they select a problem to address and develop relevant solutions. The program is designed such that computer teachers support or teach coding in their class and science teachers integrate computational thinking in projects designed to enhance learning. The
program is inheritably flexible and has specificities for primary, intermediary and secondary student to support its integration depending on the subject and grade level of teachers.

The learning process scaffolds concepts and learning blocks, simulations and challenges to meet the objectives of the official curriculum. Reflective exercises were weaved through the process and midway reflections were collected and compared with the post implementation reflections. Teachers were invited to practice what they learnt and to apply the same activities they learned in the workshop the following week with their students at school.

At school, teachers dedicated an hour a week with their students using the same process that they followed during the interpersonal workshops in addition to after school hours to support the final stages of development of students’ projects. In addition to teachers’ workshops, four working sessions were offered by IEA, with support from volunteers providing technical support to teams of students who were working on their projects.

Since this was their first experience, teachers were invited to engage the whole class in activities and to implement a project with one or two groups of up to five students based on students’ interest.

Upon the request of the Minister of Education, the DLI teams of students were invited to present their projects at the MEHE. A list of projects presented by students to Minister HE Marwan Hmadeh, MP Nicolas Sehnaoui, Director General Mr. Fadi Yarak, and officials at the Ministry of Education is provided on the next page.

Figure 5: DLI students explaining their project to HE Minister Hamadeh and HE MP Nicolas Sehnaoui
### List of projects presented by students at MEHE

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Description</th>
<th>School</th>
<th>Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector of Two Persons in a Toilet Cabin</td>
<td>A system that detects two persons in a toilet cabin and operates an alarm at the school’s admin to protect children from sexual harassment.</td>
<td>Jbeil Second Public Middle School</td>
<td>4 Syrian males, 0 Syrian female, 1 Lebanese male, 2 Lebanese females</td>
</tr>
<tr>
<td>Auto-bell</td>
<td>Automatic bell that operates according to the school’s schedule and holidays, the school has three floors and one supervisor.</td>
<td>Baakline Intermediate Official School</td>
<td>1 Syrian male, 0 Syrian female, 3 Lebanese males, 2 Lebanese females</td>
</tr>
<tr>
<td>Blind Aid Stick</td>
<td>A stick that warns the blind about the presence of hurdles in its way through sounds that it emits.</td>
<td>Institut Technique de Batroun</td>
<td>0 Syrian male, 0 Syrian female, 3 Lebanese males, 0 Lebanese females</td>
</tr>
<tr>
<td>Electro Power Station</td>
<td>A clean power station that uses the Raspberry Pi.</td>
<td>Jahlieh Public Middle School</td>
<td>2 Syrian males, 0 Syrian female, 3 Lebanese males, 0 Lebanese females</td>
</tr>
<tr>
<td>Septic Tank Alarm System</td>
<td>An alarm system that warns about the increase of water level in a septic tank.</td>
<td>Yahshoush Mixed Public Middle School</td>
<td>5 Syrian males, 0 Syrian female, 13 Lebanese males, 0 Lebanese females</td>
</tr>
<tr>
<td>Medical Room</td>
<td>A room that provides medical support at home.</td>
<td>Martyr Rafic Hariri Secondary School, Doha Choueifat</td>
<td>1 Syrian male, 1 Syrian female, 2 Lebanese males, 2 Lebanese females</td>
</tr>
<tr>
<td>Door Opening System</td>
<td>A system that opens doors automatically for handicapped in public spaces like supermarkets, hotels, and restaurants.</td>
<td>Hoch El Omara Secondary Public School, Bekaa</td>
<td>1 Syrian male, 0 Syrian female, 3 Lebanese males, 2 Lebanese females</td>
</tr>
<tr>
<td>Raising Awareness About Nature’s Cleanliness</td>
<td>A digital story to raise awareness about the importance of keeping our environment clean.</td>
<td>Kfarmatta Public Middle School</td>
<td>0 Syrian male, 1 Syrian female, 1 Lebanese male, 0 Lebanese female</td>
</tr>
<tr>
<td>Animal Protection System from Cars</td>
<td>A system that protects animals and operates on the Raspberry Pi</td>
<td>Hammana Public School</td>
<td>0 Syrian male, 0 Syrian female, 3 Lebanese males, 4 Lebanese females</td>
</tr>
<tr>
<td>Robot vacuum cleaner</td>
<td>The Robot vacuum cleaner is a fully automated self-operated device for school yards that runs on the Raspberry Pi and programmed using Python</td>
<td>Antelias Public High School</td>
<td>0 Syrian male, 0 Syrian female, 4 Lebanese males, 0 Lebanese female</td>
</tr>
<tr>
<td>Protection of Children in Public Gardens</td>
<td>An alarm system that warns the operators of a public garden if children have approached the fence, it operates a light and an alarm.</td>
<td>Beirut Al Aliah Public Middle School for Girls</td>
<td>2 Syrian males, 2 Syrian females, 2 Lebanese males, 2 Lebanese females</td>
</tr>
</tbody>
</table>

In summary, 72 students presented their projects at the Ministry of Education, 28% of them were Syrian students, with a majority of boys, 75% versus 25% girls. The full list of projects developed by all students follows.
Table 2: presents the list of all projects developed by all students:

<table>
<thead>
<tr>
<th>Number of schools</th>
<th>School Name</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Al Huda School - Saadnayel</td>
<td>School Exit Organizer</td>
</tr>
<tr>
<td>2</td>
<td>Antelias Public School</td>
<td>Robot vacuum cleaner</td>
</tr>
<tr>
<td>3</td>
<td>Baakline Public School</td>
<td>Auto Bell</td>
</tr>
<tr>
<td>4</td>
<td>Bar Elias Official Secondary School</td>
<td>Saving Electricity</td>
</tr>
<tr>
<td>5</td>
<td>Beyrouth Al Aliiah Public School</td>
<td>La serre framboise pi</td>
</tr>
<tr>
<td>6</td>
<td>Beyrouth Al Aliiah Public School</td>
<td>Protection of Children in Public Gardens</td>
</tr>
<tr>
<td>7</td>
<td>Gebran Andrawos Tweini Public School</td>
<td>The Tunnel Trafficmeter</td>
</tr>
<tr>
<td>8</td>
<td>Jahlieh Public Middle School</td>
<td>Electro Power Station</td>
</tr>
<tr>
<td>9</td>
<td>Kfarmatta Public School</td>
<td>Raising Awarness about environment</td>
</tr>
<tr>
<td>10</td>
<td>Rafik Al Hariri Official Secondary School</td>
<td>Medical Room</td>
</tr>
<tr>
<td>11</td>
<td>Saadnayel Secondary Public School</td>
<td>Smart Glasses for Visually Impaired People</td>
</tr>
<tr>
<td>12</td>
<td>Second Public School of Jbeil</td>
<td>Sexual Harassment Prevention</td>
</tr>
<tr>
<td>13</td>
<td>Shehim Official High School</td>
<td>SD-Tr@p</td>
</tr>
<tr>
<td>14</td>
<td>Shehim Third Official school</td>
<td>Accident free</td>
</tr>
<tr>
<td>15</td>
<td>Yahshoush Public School</td>
<td>Septic Tank Alarm System</td>
</tr>
<tr>
<td>16</td>
<td>Zahia Kaddonrah Public School For Girls</td>
<td>Smart Control</td>
</tr>
<tr>
<td>17</td>
<td>Hoch El Omara Secondary Public School</td>
<td>Door Opening System</td>
</tr>
<tr>
<td>18</td>
<td>Al Wafaa Secondary School</td>
<td>Smart Sorting Trash Bin</td>
</tr>
<tr>
<td>19</td>
<td>College Khadja El Kobra - Makassed</td>
<td>Drive me safe</td>
</tr>
<tr>
<td>20</td>
<td>George Frem High School - Jounieh</td>
<td>Smart Car</td>
</tr>
<tr>
<td>21</td>
<td>Hammana Public High School</td>
<td>Système de prévention des accidents pour les animaux</td>
</tr>
<tr>
<td>22</td>
<td>Khorbit Kanafar Public Vocational School</td>
<td>Smart irrigation</td>
</tr>
<tr>
<td>23</td>
<td>Makassed Ali Bin Abi Taleb School</td>
<td>Amazing Color Creator</td>
</tr>
<tr>
<td>24</td>
<td>Makassed Ali Bin Abi Taleb School</td>
<td>Auto-Fire Fight System – Woods Protection</td>
</tr>
<tr>
<td>25</td>
<td>Makassed Ali Bin Abi Taleb School</td>
<td>School Watering System</td>
</tr>
<tr>
<td>26</td>
<td>Makassed Ali Bin Abi Taleb School</td>
<td>Automatic Cure System</td>
</tr>
<tr>
<td>27</td>
<td>Makassed Ali Bin Abi Taleb School</td>
<td>Gas Leakage Security System</td>
</tr>
<tr>
<td>28</td>
<td>Makassed Ali Bin Abi Taleb School</td>
<td>Sea Cleaning System by Eco-Friendly Submarine</td>
</tr>
<tr>
<td>29</td>
<td>Saints-Coeurs - Zahle</td>
<td>School's Kiosk</td>
</tr>
<tr>
<td>30</td>
<td>Shouf High College</td>
<td>Smart watering and Fertigation System</td>
</tr>
<tr>
<td>31</td>
<td>Technical Institute of Batroun</td>
<td>Blind Aid Stick</td>
</tr>
</tbody>
</table>

In addition to workshops and working sessions, 54% male and 46% females between the age of 14 and 18 participated in community events which spanned over the project duration including:

1. A sharing day with twenty-three teams in June 2017
2. Five hackathons with 92 students with 53% boys versus 47% girls
3. A career guidance day with 18 students in August 2017
4. A showcase of students’ projects (12 projects and 72 students) at MEHE in January 2018
Details of these events were promoted in the community beyond the teams participating in the project. The events were informal and aimed to help strengthen sharing, connecting and learning from each other.

Career Guidance Activities
As part of the project implementation, a training program on career guidance was delivered to the most underserved students from the Bekaa: 18 Syrians and Lebanese between 14 and 18 years of age. The one-day career guidance program was promoted via school teachers and out of the 25 students invited, 18 responded. Few girls registered in the program: 28%, compared to 72% boys. The intention of the career guidance program was to understand the students’ perception of their career paths and consider how it may be integrated in the project intervention. The data collected from students through focus groups and questionnaires were analysed and used to inform the detailed design of the CMDI Kit. During the career guidance program, participating students showed a deep appetite to understand and know their career pathways, and a keen interest in exploring their potential options.

Project Timeline
A visual summary of the implementation is provided hereafter:
Methods

The methods used in the research included focus groups, observations, interviews with participants, questionnaires and assessment of students’ project as follows:

1. Pre-intervention focus groups with principals and teachers and post-intervention focus groups with educators and trainers;
2. In-depth semi-structured interviews with principals, teachers, student in nine schools, mid-way and post the implementation;
3. Observations throughout the intervention’s workshops and working sessions;
4. Questionnaires to teachers and students
5. Assessment of students’ project (rubric).

Data Collection

Focus groups
A total of five focus groups were held as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th>Number</th>
<th>Stakeholders</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-intervention</td>
<td>1</td>
<td>Principals</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Teachers group 1</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Teachers group 2</td>
<td>14</td>
</tr>
<tr>
<td>Post-intervention</td>
<td>1</td>
<td>Teachers</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Trainers</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Volunteers</td>
<td>12</td>
</tr>
</tbody>
</table>

Formal invitations were sent to all participants with follow-up phone calls. All focus groups lasted 4 hours, were held in Beirut, and were conducted by the DLI research team. The conversations were recorded, transcribed and organised for coding.

Pre-intervention focus groups included an introduction to the project and an overview of what previous schools had completed. Principals were asked to discuss and share their perceptions about teaching and learning, technology and the impact of Syrians in their school; teachers were asked to describe the approaches that they use in the classrooms, their experience with classroom projects and technology and the impact of refugees in their classes.

Post-intervention focus group included a debrief session and participants were asked to share their perspectives on the experience, the challenges they faced and how they were able to mitigate them.

Interviews
IEA research team conducted nine in-depth semi-structured interviews interim and post-intervention with the same participating principals, teachers and students. The interviews were all conducted in schools starting with the principals in their offices and followed by teachers then students. In few cases (n=3), principals called upon teachers into their office but in most cases interviews with teachers were held in the classroom where students worked on the project. Principals and teachers’ interviews lasted around 45 to 60 minutes each while students generally lasted 30 minutes. Students’ interviews were in all cases held in the presence of teachers with the exception of one group.
Interim Interviews
During the interim intervention interviews, principals were asked mainly how things were going-on with the project, how participants were selected and the type of learning that was happening. Teachers were asked how things were going for them, how they had selected students, the challenges they were facing, and how they were addressing them. Students were asked about their experience, if they enjoyed it or not, what they were learning and what challenges they were facing. It was also a time for principals to inquire about teachers and students’ progression and to express the increasing motivation around school.

Generally, teachers showed the interviewers their project wall (pictured below) with students’ interest, community questions and where they worked with their students. They spoke with enthusiasm and motivation and discussed their projects’ progression. On the other hand, students shared their interest and projects, asked if there could be more working sessions, explained how they created their bulletin board, the ideas they had around the community problem and showed how they were learning and applying the technology. They also shared their designs and project development.

Figure 7: DLI Project Wall

Figure 8: Students' sharing their project
Post intervention interviews

During post intervention interviews, principals were asked about the whole experience in their school and how they saw next steps. Teachers were asked about their experience and its impact on them. Students were asked about their experience and what they learned, if and what did they enjoy and what made it enjoyable.

Consistently, principals took time to describe in details the intervention in their schools. Most of them said that it had impacted their school deeply, well beyond the impact on teachers, and that it had transformed students, they also discussed next steps. As for teachers, they spoke with motivation about their experiences, the benefits for them and their students and how they tackled challenges. Invariably, students spoke about their projects, how they were going to continue and the impact of the project on them. Generally, they had a clear vision, were focused and articulate. Their body language was attentive, they listened and wanted to know about the next steps. They spoke with determination and self-assurance about their projects.

Figure 9: Students’ Interview

Observations

Observations were held by the research team in the various locations of the workshops and working sessions. Discussions were recorded and transcribed, pictures and notes were taken. Workshops went very smoothly with teachers who completed all activities and invariably left workshops with smiles saying they were happy to be able to implement directly activities with their students. During the workshops, they spoke about their students’ reaction to the activities, their enthusiasm and questions particularly about the community research. They also spoke about their students’ projects, their challenges, worries and the things that were going well. Working sessions were held in Beirut and in the regions. The ones held in Beirut hosted a larger number of students reaching-up to twelve teams which meant that the number of people working in the same hall was around eighty-two people with around sixty students, twelve teachers and around eight volunteers and two trainers. The first working session started with a presentation of each school team sharing their project idea(s), attendees exchanged feedback and asked questions; then each group worked on their project. During the sessions, teams worked closely together and often students and teachers circulated to know what other schools were doing. Teams worked interdependently and were responsible for bringing everything they needed to develop their project: drawings, design, and fabrication before writing the code. Although all students had learned the basics of coding, they assigned to each other different responsibilities. Hence, they took different roles and organised themselves depending on what they had inclinations towards, including setting up the equipment.
before working, learning more code, researching the problem, sketching, designing and making, taking pictures and documenting their work. Those more interested in coding went on YouTube and shared videos on WhatsApp. During working session, often they showed the conversations and how they organised their WhatsApp group. The discussions during working sessions were lengthier as there was more time that could be spent with teams, speak to students and teachers and understand what and how they were working on.

At the end of each cycle, teachers and students were asked to reflect on the process. Teachers and students were given reflective prompts which were collected and tabulated in an excel worksheet (total teacher responses, N= 20) and an average of 2 students per school answered in both batches bringing up to eighty-one the number of student responses (total student responses, N=81).

Figure 10: Observations during working sessions

Post Implementation Questionnaires
At the end of the project, teachers were invited to give feedback about the process. Teachers (n=13) responded online or by email (n=20) with a total of N=33 respondents and responses are presented in the data section. Students were also asked to give feedback and (n=24) submitted their responses online. The teacher and student questionnaire presented in the Appendix included a rating scale from 1 to 5 as follows: 1 = Not at all, 2 = Somehow, 3 = Generally, 4 = Mostly, 5 = Extremely.

Assessment of students’ project
In order to assess students’ problem-solving skills and overall performance in the project, a rubric was discussed and given to teachers to complete at the end of the intervention. The objective of the rubric was for teachers to assess, reflect and measure the quality of the problem-solving process rather than the quality of the end product only. The rubric consisted of eight domains with a set of indicators for each domain and three rating levels (1 = Needs Improvement; 2-3 = Good; 4-5 = Exemplary. The domains consisted of: self and community, problem, design, create, analyzing and interpreting results, planning, team work and meta-cognition and assessed with descriptive indicators available for reference in the Appendix.

A total of eighteen educators (N=18) filled the rubric, (n=10) during the last face-to-face meeting and (n=8) returned by email. The team of DLI research evaluated the projects and reviewed the results which were within the same range.
Gender Balance

There was a noticeable difference in the number of females versus males between community activities and those taking place at school, 75% male versus 25% female in school projects, versus 53% male and 39% females in community events. A major difference between both is that almost 50% of teachers selected the students they thought were interested in the project which might be a sign of gender bias in favour of males. To validate the lower interest in the project among girls, hackathons and community events were promoted directly to the community. We observed higher levels of interest among girls. Out of the 92 participants who enrolled, there were 53% boys versus 47% girls, a clear increase in the participation of girls. Through discussions with girls, additional ideas were captured to give wider access to girls, such as organizing a girl only hackathons. In addition, this prompted the IEA to develop prototypes and applications that are less mechanically focused to attract a wider range of interest.
Data

The data was collected systematically providing substantively rich primary data consisting of audio files, videos, meeting notes. The data was methodically transcribed and analysed and case studies which enrich the data were extracted alongside the analysis of the questionnaires and the assessment rubric.

Post Implementation Teachers’ Questionnaire

Teachers filled the post implementation questionnaire at the completion of the project and forms were collected and tabulated in an excel worksheet (total responses, n= 33). There were 20 respondents across the following subjects: computer (9), Sciences (6), Math (4) and English (1) and levels: 8 Secondary and 12 Moutawassita Schools.

Teachers selected their students differently which resulted in 75% boys and 25% girls participating in the project; 15 Teachers proposed to everyone and asked who is interested to join the project and 15 selected those they thought might be interested in the project. Their perceptions of students’ interests varied depending on those that seem motivated; a few teachers (n=2) selected the most performing students which contrasted with others (n=3) who engaged students of mixed abilities with underachievers and with students who had behavioural issues.

Teachers perception of the experience was overwhelmingly positive with an average of 4.75/5. What they enjoyed most was working and guiding students to address a real challenge and having them come up with their own project ideas.

![Image of bar chart showing enjoyment levels of various teaching activities](image.png)

Figure 11: Teachers' Feedback, Question 5

Generally, they enjoyed the overall process and a large number of teachers (n=20) said that there was nothing they did not enjoy. Issues that were challenging included receiving the equipment late, their lack of mastery of the Python language, the distance to come from their villages for the training, more time for learning and implementing a project and for a few teachers support from the school management. All subject teachers showed a higher degree of confidence in the pedagogical process than in technological knowledge with a good level of comfort (4.0) to deal with circuitry,
basic Scratch and the Raspberry Pi. They expressed more confidence to guide their students in solving challenges and addressing a real life challenge (4.25) than in physically creating and coding the project (3.75) and Python (3.6) remained the area which they needed most help with.

All teachers (99%) except one found the workshops relevant to their teaching. Those that found it relevant explained that the project integrates physics and science and it made them introduce analytical and problem solving skills in their subjects. Several teachers mentioned that it helped them to connect their subject with real-life in a scientific process and connect computational thinking with their subjects. With one exception, all teachers mentioned that they could clearly see how the project connects to other disciplines and was relevant to their teaching. They appreciated that it helped students integrate all the concepts they learned in math and sciences in one project.

All teachers appreciated connecting to their students’ reality with an average of (4.45/5) which helped them to know them better, communicate more effectively, and find out their abilities to create and develop a spirit of collaboration and being attentive to each other. Teachers rated their performance in the program as good with an average of (4/5) but felt that further experience and more workshops would help them to do better. To improve their performance to a higher level, teachers (n=15) recommended additional workshops, time to practice and to learn more coding, integrating more complex and relevant codes with Python; but also designing, making, coding and addressing new challenges during the academic year.

Teachers recommended adding an evaluation component for teachers; they also expressed being interested in working on the development of future applications and scientific activities. Another important factor for improving teachers’ performance was setting-up training sessions that do not disrupt school time. Their recommendations, included starting earlier in the academic year, having more working sessions, more time, printed information and practice and avoiding conflicts with school schedules. All respondents were positive 100% to join future workshops.
Post Implementation Students’ Questionnaire

Students were given questions at the end of the project via their teachers. The total number of students who answered in both batches, N=81. Students who filled the questionnaire ranged from primary to secondary school and 5 technical school students; 81 students (18 females and 63 males) filled the post implementation questionnaire at the completion of the project.

The students enjoyed their experience and gave a very positive overall feedback. Working in teams and being with friends was selected by 53% of students as extremely enjoyable and receiving a certificate of completion counted for (54%) of them as enjoyable.

As shown in the next graph, the things that appeared to be enjoyable were finding a real-life problem to solve, coding and making the project with friends and learning new things and in new ways. The analysis of the graph follows.

In their answers to the overall DLI Coder-Maker experience, everyone found the experience enjoyable to different extent, with more than 60% of participants as extremely enjoyable, around 30% very enjoyable and 10% as enjoyable. When answering to what extent each of the elements made it enjoyable, learning in new ways was found as extremely enjoyable by more than 67 % of participants, very enjoyable by 12% and enjoyable by 20% of participants. What participants
seemed to enjoy most was “finding a real-life problem” (with 73% extremely enjoyable, 12% very enjoyable and 14% enjoyable) and coding their project with 72% selecting it as extremely enjoyable, 11% very enjoyable and 14% enjoyable.

What seemed more challenging for participants was “designing a solution” and “solving challenges” which appeared with 64% and 59% respectively as extremely enjoyable versus 16% and 19% as very enjoyable and 16% and 20% as enjoyable which means that despite the challenges that they faced, they thoroughly enjoyed the learning experience.

Furthermore, they thoroughly enjoyed coding and making the project which appears in the respective rating of 72% and 69% as extremely enjoyable, 11% and 10% as very enjoyable and 14% and 18% as enjoyable.

It is worth noting that working in teams was also rated extremely enjoyable (69%), very enjoyable (11%), and enjoyable (23%) which is in line with what participants mentioned about learning with peers in the next graph.

All students except three explained that finding a real-life problem to solve was most enjoyable. They enjoyed coding as much as thinking about the problem; learning new things” such as the science concepts related to their projects and the technological part such as “programming and learning to use electronic sensors, motors”. “The new way of learning, working, thinking, having ideas, solving problems with infinite number of solutions and to think how to choose the better one; “understand how things work” but also “meeting people, being with friends, making friends, working together as a team, gaining confidence and helping each other, meeting teams from other schools, sharing and feeling part of this group always meeting in a nice atmosphere”. “Doing, creating, and achieving our goals, helping to improve things around us in society”. “Having responsibilities and believing that we can and are able to”.

All of them (100%) stated they would like to join future workshop, 86% of students stated that there is nothing they did no enjoy and 30% of students recommended keeping things exactly the same. They encountered difficulties such as receiving the materials late, too little time for the project, time on the road and not having an extensively printed guide.
A few recommendations included providing: an online course “with step-by-step guided learning”, an “online help”, a printed guide, integrating it in the school program and curriculum so it becomes a way of learning but also to add simple and exciting projects with readymade experiments to learn from before starting from the creative process.

Students’ Project Assessment Rubric Results
The results and analysis of the problem-solving rubrics filled by teachers and validated by trainers reveals that students gained significant reflective skills and were able to successfully identify a problem and define a problem which they addressed with exemplary levels of collaboration and communication skills alongside exemplary skills in managing their project tasks. On the other hand, the data shows that most students would further benefit from sharpening their analytical, coding, documentation and data collection skills in order to further enhance their problem solving skills as fewer students reached exemplary rating for those indicators. The analysis follows the graph below:
The following is a summary of the results for each indicator:

**Gaining insight into self and community:** 44% of teachers rated students’ project on this indicator as exemplary, 44% as good and 11% as needing further improvement. Teachers reported that it was generally difficult for students to tackle the concept of community and many were not used to disclosing their feelings as they were not used to talking about themselves. However, this happened gradually as they started working in teams and untangled the concept of community which became clearer as they engaged in observations and discussions.

**Identifying a problem:** 67% of teachers rated students’ project on this indicator as exemplary and 33% as good. All teachers thought that their students had gone through great length to identify a problem and did very well because the problems they identified were all sensed in the community. Teachers reported that students started exploring a wide variety of problems and they needed lot of assistance in order to focus on one problem rather than surface many.

**Defining a question:** 56% of teachers rated students’ project on this indicator as exemplary, 33% as good and 11% as needing further improvement. All teachers reported that the challenges students faced were to express their thoughts into words and to focus on one specific aspect.

**Recognizing perspectives:** 33% of teachers rated students’ project on this indicator as exemplary, 56% as good and 11% as needing further improvement; teachers reported that students had learned...
to look at the problem from all its facets during project work and that connecting with people helped them understand why their proposed solution was not viable.

**Ability to communicate the problem:** 44% of teachers rated students’ project on this indicator as exemplary and 56% as good; teachers reported that the project made them more aware of how challenging it was to help their students to communicate clearly their ideas.

**Research:** 44% of teachers rated students’ project on this indicator as exemplary and 56% as good. Teachers reported that students conducted in-depth inquiry and identified a variety of sources of information, be it online, in books or seeking the help of experts, professionals and people in the community.

**Integrated knowledge and use of information:** 44% of teachers rated students’ project on this indicator as exemplary, 44% as good and 11% as needing further improvement. Teachers reported that students had effectively learned and used new concepts into their project. They also said that they applied what they knew to assist the problem-solving process, yet however, work remains to be done in this area to integrate fully the information in the process.

**Sketch and Design:** 44% of teachers rated students’ project on this indicator as exemplary, 44% as good and 11% as needing further improvement. They thought that it was maybe the first time students learned that designs were important in order to clarify and communicate their ideas to others.

**Empathy:** 44% of teachers rated students’ project on this indicator as exemplary and 56% as good. Teachers reported that students connected deeply with those for whom they are developing the project and understood more deeply various perspectives through those interactions with people.

**Create:** 56% of teachers rated students’ project on this indicator as exemplary, 39% as good and 6% as needing further improvement; those that rated four said that although students were able to create their project, they had got help from the volunteers to be able to code their project. They reported that students reconstructed the code and circuitry several times and that it met the project’s specifications.

**Data collection:** 33% of teachers rated students’ projects on this indicator as exemplary, 67% as good. They reported that the use of tools was not always successful and they would have benefitted from more consistency in data collection.

**Interpretation of data and analysing:** 22% of teachers rated students’ project on this indicator as exemplary and 78% as good. Those that selected exemplary pointed to how students hypothesised and described results and conclusions. The others reported that students were able to draw correct conclusions from results, but had to be guided to relate them well to the original hypothetical solution of the problem.

**Problem-solving process:** 44% of teachers rated students’ project on this indicator as exemplary, 44% as good and 11% as needing improvement. The rating for problem solving was exemplary and good stating that the challenge students had was to think out of the box although they were able to think critically and use problem-solving techniques.

**Review:** 67% of teachers rated students’ project on this indicator as exemplary and 33% as good mentioning that students were invigorated to review their work in order to succeed, they learned from errors and were eager to make it better continuously making changes and learning from them. They learned from their errors and explored new ways to approach problem.
**Managing Tasks:** 44% of teachers rated students’ project on this indicator as exemplary, 44% as good and 11% as needing improvement in order to work independently. Those that did not meet the exemplary rating had a challenge to respect and complete the tasks within the assigned time. Exemplary meant that the team took the initiative to define tasks, set a timeline, match assignments to expertise, share responsibilities, maintain open communication, and develop strategies to enhance group success.

**Documentation:** 33% of teachers rated students’ project on this indicator as exemplary, 56% as good and 11% as needing improvement. The exemplary provided a comprehensive collection of work, written notes, sketch, design, pictures, data is documented and organized in a booklet while good meant that the data was summarized in a booklet but could have been more organized. Those that needed improvement lacked documentation to support their project.

**Collaboration:** 44% of teachers rated students’ project on this indicator as exemplary and 56% as good. All groups were able to develop strategies for success, and demonstrate understanding of how the problem-solving process relates to other activities. Several teachers mentioned that “collaboration helped them to get to know each other better which also helped each one to know themselves. This was important because they knew themselves more, so they communicated better with their community and with each other.”

**Communication:** 44% of teachers rated students’ project on this indicator as exemplary and 56% as good. They gave examples of how students could explain their project, the concepts, principles, and processes with their own words, justifying their answers, and showing their reasoning. Those that selected good stated that students faced challenges to articulate and explain clearly their ideas.

**Sharing knowledge:** 44% of teachers rated students’ project on this indicator as exemplary and 56% as good. The exemplary group team members all worked together to gain knowledge, apply, synthesize and exchange what they learnt as they listened respectfully to the opinions of others. The groups that were rated good did not share knowledge consistently.

**Reflection:** 44% of teachers rated students’ project on this indicator as exemplary and 56% as good. Those that selected exemplary stated that students were able to clearly and concisely articulate what they gained in the process. Teachers reported that students demonstrated metacognitive awareness and ability to reflect on self-knowledge, use productive habits of mind, and reflect on the meaning of the experience. Two teams were able to describe the problem-solving process, but were not able to critically assess how well it was applied to the current problem.
Findings

The data reveals findings worth exploring further in the larger framework of providing education to refugees particularly in fragile socio-economic contexts. The findings that appeared predominantly in the pre-intervention focus groups and the situation analysis revealed the challenges proper to the influx of Syrian refugees and the context of learning contexts in Lebanon. Those are grouped under three main sections and speak about school violence and drop-out and an alarming drop-out rate not only of Syrians but Lebanese students too, a challenge to adapt to a different learning culture and unprepared teachers who lacked skills and had a fixed mind-set about the situation and what they could do about it. The pre-intervention situation analysis prior to starting the intervention is explained hereafter:

Pre-Intervention Situation Analysis

Violence and School Drop-out

Despite all the work exerted on child protection by MEHE (RACE II report) evidence of violence was seen in the vast number of harmful objects confiscated on the school premises. Violence was also reported by principals and educators as a serious problem among Syrian students with negative consequences on the Lebanese population and a high drop-out rate of host community students. Situations that start around small disputes quickly escalate to violent encounters with intensity which is usually not in proportion with the issues that gets children so deeply upset. Even the games they play are violent. A boy, for example, beat his sister really hard just because she had a better grade than him in Math. However, although earlier reports, cite children reporting incidence of violence as the principal reason for dropping out (Jalbout, 2015⁴), the question remains an unresolved challenge, evidence of which is that there are no afternoon shifts for High School students despite the enormous work that is exerted since the start of the crisis.

Adapting to a Different Culture

Syrian parents expect their children to work after school even at an early age, as young as 9 years, to contribute to the family income; they work in the fields, stores, workshops, or restaurants for example. The impact is that they often come to class tired or have not completed their homework but on the other hand, teachers found that this makes them also responsible at a younger age than their peers.

Aside from being working students, Syrian children cultivate deep respect contrasting with fear of teachers and the overall system with a strong sentiment of fright of physical punishment. Teachers reported that, at the beginning of the school year, when they walk in class along the rows of desks, invariably children bend to hide their heads with their arm as if they were going to be slapped. Furthermore, although Syrians and Lebanese are Middle Eastern cultures, the language of instruction is Arabic in Syria while it is either French or English in Lebanon. This made it more challenging on Syrian children who had suffered war, had no home, and had to adapt to a different culture including learning core subjects in a foreign language.

Unprepared Teachers and Lack of Motivation

With the exception of a few teachers who reported using active teaching and learning methodologies most educators referred to teaching as delivering content rather than skills. All fingers were pointed at the old curriculum (dating back to 1998) that encourages teachers to perpetuate rote learning and prepare students to pass exam. Educators felt unprepared to deal with

⁴https://www.brookings.edu/research/will-the-technology-disruption-widen-or-close-the-skills-gap-in-the-middle-east-and-north-africa/
the challenges and repeatedly reported a lack of motivation to learn and being unable to motive and interest learners.

Fixed Mind-Sets

What is a fixed mind-set?
Essentially, a growth mindset as opposed to a fixed mind-set “allows individuals to change and grow through application, effort and experience” (Dweck, 2006⁵). Dweck describes the fixed mindset as “a state where you believe that your qualities are carved in stone” (ibid) which arguably inhibits people from taking risks or venturing out of their comfort zone as they only keep doing what they know how to do. Research show that growth mindset (Dweck & Snyder⁶) perseverance and grit (Duckworth, 2016) are predictors of success not only in education but in one’s professional life” (Duckworth, p34⁷). Hence, the “non-cognitive character trait of grit, is a critical indicator of success and long-term goal achievement and students with a growth mindset are significantly grittier than students with a fixed mindset” (Duckworth, p.180).

Fixed mind-sets of educators and students
Educators and students started the intervention with fixed mind-sets; they did not believe that they were able to engage successfully in the intervention and doubted their capacities and abilities to learn how to use the technology in teaching or learning. In fact, many students thought that they were unable to do anything and expressed this at the beginning of their experience. Although technology was perceived by educators as a motivating tool they found it challenging because of their lack of prior knowledge and capacities. They considered the younger generation of contractual teachers more prone to learning how to use technology while cadre teachers, usually close to the retirement age, being less inclined to adopting and using new technologies. In addition, there was a sentiment of disempowerment which was expressed early on in the pre-intervention focus groups across stakeholders. Actually, the crisis drained schools, increasing the load of administrative work in an extremely top-down bureaucratic system which required additional paper work for anything and everything that needs to be done at school. Across the data, educators, mentioned feeling overwhelmed by classroom violence, the language barrier and the various different levels in their classes which slowed everyone down. Furthermore, students lacked self-esteem and confidence and did not believed they could learn how to use the technology. Those challenges depict the overall fixed mindset of educators and students and the overwhelming situation in which the DLI intervention took place.

⁶ https://www.strategy-business.com/article/ac00047
The Impact of the Intervention

For the intervention, the team used the content developed for the project, selected the adequate technological equipment resources which were coupled with a pedagogical learning process. Teachers received the pedagogical digital resources developed for the project in the forms of guides and tutorials with ongoing support and their pedagogical use is explained in the next goal. In addition to the equipment provided, IEA incorporated a variety of electronic tools alongside several software packages such as WhatsApp that seem like fixtures to the existing mobile phone culture used by teachers and students. The findings in this section contribute to deepen our understanding of the relevance of intervention which had a transformative impact on teachers and students far beyond the tools. Educators reported a transformative dimension in their practices and ways of thinking with motivation to teach and learn, strengthened capacities and a transformation of culture around the project, more social cohesion, commitment of students to learning, more autonomy and self-regulated work, grit and self-confidence. Key insights from the case studies below are used in the sub-sequent section.

Case Study 1: The Smart Glasses for the Visually Impaired

Level: Secondary School, Region: Bekaa

Shafic, the principal of the school in the Bekaa, had first not shown great enthusiasm to participate in the program due to negative past experience with ICT-based initiatives. He followed carefully the progress of the team at school who worked on a smart glasses project created for Alia, a 12 years old girl who squints and has a severely impaired vision. She now plays at school without being ridiculed by her classmates and does not bump into things or people anymore because her Smart Glasses inform her how close she is getting to them; so she stops at the right distance and looks as normal as every child around her!

The Smart Glasses for the Visually Impaired have been designed and built by two Lebanese girls, Mariam (Alia’s sister) and Manal, and their Syrian refugee classmates, Akram, Mahmoud, and Kamal, who are students of Grades 10 and 11 in a public school, in the Bekaa, Lebanon. Akram did everything to be expelled with the intention to work and help his father financially. His parents were divorced, he was failing his subjects and his teachers were desperate asking the principal to do something about it. Shadi described Akram as a thug who was severally ill-behaved beyond anyone’s imagination. Rather than expelling him and letting him go astray through dangerous paths, he assigned him to the DLI Coder-Maker project. Akram became the driving force of the project’s team who distributed the research tasks among themselves once they had identified the research question.

In addition to caring about Alia’s condition, the team was concerned that mechanism of the smart glasses might have a negative impact on her brain. As a result, they conducted extensive research with support from their technology teacher Mohammad who sought support from the Science teacher. The team discussed their plans and ambitions during working sessions and adjusted their goals to be more realistic and achievable. To design, code, and wire the glasses, they often stayed at school in the afternoon till 6 pm and sometimes continued their research and tests in the home of Aysha and her sister Mariam where they were received by their parents. With the help of the team, Akram started studying better and his grades improved, particularly in Sciences (from 20 out of 60 in physics, he earned 56 almost three times better). He was motivated to learn which puzzled his father who visited the school to understand the transformation in behaviour and achievement. He wanted to know what his son was doing and thanked the principal and teacher.

During the interview, Akram articulated a clear mission statement for the team’s project saying with emotion in his voice, “I will only stop when no one is called blind.” He mentioned feeling “happiness inside” when he saw the impact on Alia and her joy to be able to move around independently.
Akram’s vision is to continue working on the project to help visually impaired people to have as normal a life as possible and not be labelled as such. He knows he would like to focus on vision and technology in his future studies.

Today, each team member knows what they want to study: Akram wants to specialise in eye vision, Kamal wants to be an Engineer, Mahmoud wants to study Computer Science and Mariam wants to do Marketing.

During this first stage, the glasses are equipped with a Raspberry Pi computer, an ultrasonic sensor, and a motor that vibrates at different intensities when an obstacle is in front of Alia at 3, 1.5, and 0.5m. In the second stage they will install a lighter sensor, a 3D camera to identify things around her, and electronic components to communicate better with the brain.

In addition, the team participated in the 2nd Lebanon Raspberry Pi Competition and won the first prize in the Secondary School category. They were recognized on the school Facebook page and teachers were startled at the change. The results were beyond their expectations, they had won the students and there was more cohesion at school, even attracting the interest of parents who had their children registered in private schools.
Case Study 2: Detector of Two Persons in School Toilets

Level: Intermediary School, Region: Mount Lebanon

Amira teaches math and sciences in Middle School and Randa teaches social sciences and math in elementary school in a public school in Mount Lebanon. They are both cadre teachers and joined the DLI project in the first round of workshops and developed a project with their students to prevent sexual harassment in school toilets. The second year, they each integrated the project in their classes and Amira taught an additional hour of technology to grade 7. Their principal was very supportive and followed the project closely.

The first year, their students came-up with the idea of preventing sexual harassment in school toilets because one tends to think of the problem after it occurs, so they thought of finding ways to prevent things like that from happening rather than lament when it is too late. Teachers explained: “if such an act happens in a toilet, no one will know about it, and even if anyone knows, it will be too late. So, here is the Coder-Maker to think about as a tool to solve that problem. (Teacher, Coder-Maker Reflective report)

The idea appeared to be extremely challenging, but they felt excited by the encouragement of their peers, teachers and principals during the workshops and working sessions. It stimulated them tremendously. The question they asked themselves was: How might technology be used to detect two persons in the toilet? The seven participating students, four Syrians and three Lebanese, met regularly everyday with their teachers at the break but also on Saturdays. They all had amazing energy and commitment to the project. They learnt Python programming and worked on some design challenges with their teacher.

Early on in the project, one of the Syrian students invited a friend of his: “Join us, I am sure you will love what we are doing”. Indeed, he joined the team and they met regularly despite the fact that two of the Syrian students were working during the weekends and some evenings.

The difficult part of the project was to design a solution. They sketched and imagined various designs as they explored all sorts of sensors thinking that although a camera might detect people in the bathroom, it is not possible to use one. So what type of sensors might detect two persons in a toilet?

They contacted a professor of robotics engineering in Sweden. He said that this project was too complex for grade 8 and 9 students because it required deeper knowledge and higher skills. They took it as a challenge and kept working, visited several electronic stores in Lebanon and explored the Coder-Maker Digital Learning Innovations kit.

The support they got during visits of the Coder-Maker team, discussions and working sessions helped them in many ways, particularly when they felt discouraged after researching and testing all types of sensors. They later realized that they had to think differently and that the project was not just about the sensors. They started by sketching their prototype and discussed their drawing and hypothesis during working sessions with trainers and volunteers. Ideas went back and forth, the problem seemed very complicated and they started to feel desperate again. It is through investigating different hypothesis which they analysed and evaluated with their sketches that the scenarios started to make sense and they found the solution. They built a mock-up of the toilets to scale with a door opening to the outside and not reaching the floor or ceiling. They coded their solutions and got two figurines and tested all sorts of scenarios, where to put them, what and how they might detect someone coming in or the movement of the person(s).

The solution revealed itself to be much simpler than anticipated and they were able to solve it with only two ultrasonic sensors. As the project came to completion, grade 9 students presented and
passed the Brevet National exams and went to a different Secondary school where one of their teachers wanted to do a project around racing cars. Mahmoud, said, “what purpose is there to invest my time on such a project, how is it helping others? ... I prefer to come here and continue working on the project and build a real prototype”. All students still come to their old school to work on the project in order to develop a full prototype. This is done with support from IEA and FMB.

Figure 14: Sexual Harassment Prevention Project Team explaining the project to IDRC Program Director
Case Study 3: Smart Tunnel  
*Secondary School, Region: Beirut*

Leila teaches Science and is technology savvy, a Microsoft Innovative Teacher Fellow, Microsoft Innovative Teacher Expert, British Council Validated Trainer and British Council School Ambassador. She has won several awards and joined Coder-Maker in the second round of teacher training after seeing how her students learned in a hackathon. She worked with a group that had refugees from Syria (n=2) and Sudan (n=1) working on a project with two Lebanese students. They were of mixed abilities, some were ill-behaved students, did not know their own interests or how to express themselves.

Students decided to work on road safety because of the large number of car accidents that occur in front of the school’s gate. They decided to create a smart hump and dived into the project design, development and coding. Through discussions with trainers in working sessions and consultations with community members they realised that the project was not viable. Leila thought they would give-up and discussed it with them. They reflected on the process and explained how they made mistakes, jumped into conclusion and rushed to start coding, to build and to finish the project. They had done very little research and developed an idea “in their heads” which they thought would work. They decided to start again on the right track and investigated other issues. They decided to work on the problem of congestions in the tunnel next to their school and to create a system that would warn people of congestions to avoid that road; there were also additional features to help healthy breathing in the tunnel during congestions. They planned, researched in depth, hypothesised and completed their project consulting experts and checking with community members. In the interviews, her students were focused and explained how this project helped them to think critically, solve problems, reflect and understand concepts, not only code or create and Leila was puzzled how students developed such critical and reflective thinking, which was so difficult to achieve in other projects.

Figure 15: Smart Tunnel Team sharing their DLI project at EdEx 2018
Case Study 4: Protect Our Environment

Level: Elementary School, Region: Shouf

Malak is a 14-year-old Syrian student and Rima is a 10-year-old Lebanese student. Malak and Rima were part of the DLI Coder-Maker group that were using technology to learn English and gain digital skills. Malak lives next to the school and used to watch with envy all students go into it while she was doing her home’s chores. She waited patiently to be admitted, which was particularly challenging because she had missed three years of school when she first arrived to Lebanon from Syria. She also had no friends. During the first interview, she practically said very few words and spoke with a very soft voice.

Malak and Rima’s aim was to create a play using Scratch and involve the school community, parents and students to raise awareness about the environment. On their way to school, they took pictures of their environment which they downloaded on their RPi stations and discussed with teachers. They built their vocabulary which matched the theme of the environment. To write their story, they drew a storyboard on paper, learned how to search the Internet, used the words they had learned and started making short sentences which they checked with their teachers. They kept using Google to translate and practice new words and sentences and slowly they found themselves at ease with the language. The storyboard was sent back and forth to the DLI trainers first as a story with words, then the words were drawn into Scratch blocks with the commands next to them. Their second step was to invite their peers in playing and creating their own games about environmental issues.

In the post interview school visit, Malak, the reserved Syrian student who used to speak with such a low voice, you could hardly hear her, was teaching 5 students how to use Scratch. When asked what they used Scratch for, she said with an assertive voice: “to create a play...about the environment”. She was actually teaching a group of Syrians from the afternoon class how to use Scratch and create their own stories. She was assertive and had a big smile on her face. According to Malak, the project was very beneficial, not only because they gained technological skills, but because the process helped her to learn English and have friends. She found learning fun and enjoyable. Malak’s teachers mentioned the radical and rapid change that they had noticed; her teachers knew her for two years; not only she had gained self-confidence and engaged with others (she was constantly alone) but doing well at school.

Figure 16: Protecting Our Environment Team writing their story
Key findings from the cases and the data show growth mind-sets, a motivation to teach and learn, enhance teachers’ practices, enhanced learning outcomes, school culture and more social cohesion. Those are explained below:

Motivation to Teach and Learn
From a lack of motivation and interest, participants showed a deep motivation to teach and learn. Students like Akram who was a thug showed a profound transformation even beyond the motivation to learn. Students also mentioned that a better understanding of concepts and meaning making “we understand Sciences better, particularly Physics”. Motivation was also reported by teachers in all four cases, Mahmoud for example said, “I am motivated to teach, I have started dreaming again”. Motivation to teach and learn was evident across the data, particularly during observations as all teams showed a very high motivation and commitment to their projects, in teachers and students’ reflections and answers to questions. There was unanimous agreement (100%) that the project was motivating for everyone.

Teachers’ Practices
Although teachers came from different backgrounds, all of them mentioned they had benefited and grown professionally. Evidence of this appears in teachers’ reflection, post-intervention focus group and interviews and the four case studies. Amira, for example, stated she felt “born again” and Leila stated she felt “new”. The four teachers mentioned that they were able to nurture skills that they were not able to instil in other initiatives. Supporting evidence towards this is mentioned by teachers in the four case studies, and include critical, creative, and reflective thinking and solving real-life problems but also additional ones such as computational thinking which are skills that are generally difficult to instil and even more so in such a fragile context.

All teachers mentioned getting to know their students better, how they think and learn. Evidence of this is described by educators in how new conversations were initiated around students’ projects and thus enhanced communication and healthy relationships between all stakeholders (students-students, teachers-students, teachers-students-principal, students-principal, students-parents) including communication between students and teachers. As a result of the intervention, teachers were able in a relatively short while, only six days of training with ongoing support and working sessions, to adopt an open-ended problem-oriented technology-enhanced approach and succeeded to guide their students to create innovative projects surmounting incredible challenges in a highly rigid and bureaucratic school system. In addition, although anecdotal, there is evidence of improved achievements with students such as Akram with grades almost three times higher.

School Culture and Social Cohesion
In addition, educators and principals mentioned transformation around the school culture with more social cohesion, collegiality and collaboration around students’ project, be it between teachers, between students or with the principals which made the bureaucracy around project work seem less overbearing. This was transparent in the case studies with teachers such as Amira, Randa, Leila and Mahmoud referring to their principals’ trust and flexibility as instrumental to mitigate the challenges they faced, particularly transportation to workshops and working sessions and staying at school additional time to work on the project.

From school violence, disruptive behaviour, or students’ feeling inward at the start of the project, teachers mentioned more harmony and social cohesion, between teams and at school. This was noticeable in how Syrians and Lebanese collaborated without a single dispute happening over the span of the project. This was mentioned by educators in the four case studies. All teachers mentioned constructive collaboration but also social learning whereby students cared and contributed to the community showing ethical responsibility towards the people impacted by their project.
Commitment to Learning

In a climate where there is such a high-dropout rate, students’ commitment was noticed across the intervention and noticeable in the four case studies. Akram for example wanted to drop school to help his father, but he felt committed to the team and to learning, from a school thug which could have ended in one more school drop-out he now sees his future in the reality of Science and Technology. The same applies to all students who are committed to learning to improving their future. Students showed a deep commitment to one another, often waiting for those that had work commitment to be able to join. They expressed a mission towards taking action for social good in a context where they had to often work to support their parents and sometimes their existence was at stake.

Self-regulation and Awareness of Learning

Teachers in the four case studies, similarly to Leila, mentioned a shifting paradigm in planning learning. Leila for example, has in-depth experience in project-based learning pedagogy and is a Microsoft Innovate Teachers and a British Council Trainer and Ambassador. From planning alone and telling students what to do, she shifted to including them in the process and students were able to self-regulate, organise themselves and be responsible for completing their project on time. While almost all teachers mentioned that students were able to self-regulate, the four teachers in the case studies stressed students’ metacognitive skills and their ability to reflect on what they had learning.

Transferable Skills

As reported in the rubric, students gained transferable skills such as to various degrees problem-solving, critical thinking, empathy, self-confidence, communication, collaborative, perseverance and self/group management skills. Those skills were reported by all teachers and were reflected throughout the process in how students worked together, organized their work, connected with the community and invested themselves to understand and solve the problem they decided to address as a team. All students showed self-confidence and were more conscious of themselves and the community around them. Evidence of that was noticeable when they presented their projects and explained in details the project purpose and functionalities. This was mentioned by principals and teachers and by officials at MEHE during the exhibition of projects.

Perseverance to solve problems was most frequently mentioned across the data and was stressed by the four teachers saying their students were working tirelessly to achieve their goals and they had discovered a side of their students that they had never imagined. This is remarkable in an environment with such a high drop-out rate, giving them hope to solve any future problem. *Grit is a distinct combination of passion, resilience, determination, and focus that allows a person to maintain the discipline and optimism to persevere in their goals even in the face of discomfort, rejection, and a lack of visible progress for years, or even decades,* (Angela Duckworth, 2016). Duckworth definition of grit is similar to how teachers described their students’ passion as they worked relentlessly to achieve their goals.

Students’ Achievements

Students skills and learning were enhanced; they cared more about their subjects and aimed at performing better. This was reported by most teachers, and stressed by the teachers in the four case studies, saying that they are “better students”. Leila mentioned that her students cared to do well because they did not want to disappoint their teacher; they felt privileged to be part of the team working on the project and hence they studied more. Although the aim of the project was not to assess the impact of the project on students’ grades, exceptional stories such as Akram who was failing his science subject (26/60) but passed them (56/60) were reported so it is worth further exploring
students’ achievement in a longitudinal rigorous study in order to ascertain the long term impact of such an intervention.

Growth Mind-Set
Teachers and students were able to see themselves as able and capable of doing and taking on a task. Students perceived themselves as problem-solvers with the ability to face problems of the future; this was evident in discussions with all students particularly Akram and Mahmoud and was consistent in the discussions with all students. Teachers in the four case studies mentioned being surprised by their students’ abilities not only to learn but mostly to problem-solve, reflect on what was working or not and adjust their project to reach a solution. They mentioned things like “discovering” their students but also “trusting” their abilities and perceiving an aspect of their students which they couldn’t have perceived before. Teachers’ mind-sets and perception of refugee learners changed, seeing a positive impact on them when they collaborated; after the presentation at the Ministry of Education for example, Amira stated for example in her reflection, “who said that Syrian refugees can’t learn with Lebanese” or a teacher in the South saying there was more acceptance of others in the group.

Students’ Considerations of Higher Education
The career camp held as part of the intervention unveiled unexpected areas with a general feeling of disempowerment; findings revealed that 50% of male students considered higher education inaccessible and financially unreachable and were considering vocational or technical fields. None of them knew they could get a scholarship or ever considered learning online as a possibility. Out the 50% who considered higher education their career options were the classic parents’ choices including journalism, engineering, teaching, pilots and doctors. Furthermore, the camp revealed that most of the students lacked knowledge of self and were unable to express their own interests. Based on those findings, and to remedy the low turn-out of girls at the camp, the DLI team integrated those elements by strengthening the component of “self and knowing one’s interest” as part of DLI which was discussed again with teachers at the completion of projects to re-capture where their interest may lead them.

In this manner, career guidance was integrated as part of the DLI intervention thus impacting a much larger portion of students ultimately leading to a higher influence on girls. Across the intervention, students who engaged in the DLI had a very clear option of what they want to become and what they should study to reach it. Students such as Mahmoud and Akram are examples but this applies across the data with girls selecting choices such as marketing, graphic design, photography but also electrical engineering, computers studies and teaching. Amongst boys the majority selected STEM-related career choices including computer science, biomedical and electrical engineers and agribusiness. A comparison between the first 18 students versus the choices of all students showed that by engaging in teams and taking on different responsibilities during the project, students were much more aware of their talents and had much sharper understanding and knowledge of the field where lied their interests and passions with a much wider horizon and a determination to pursue their dream.
Analysis

The research findings show a deep impact on participants with extended impact on society which is considerable taking in consideration the challenges that they were facing, the lack of capacity and their skepticism to engage effectively at the start of the intervention. The analysis discusses the impact on teachers, students and the extended impact on the whole school and community around the project.

Impact on Teachers

Indeed, teachers were able to engage effectively in the intervention and to make learning much more relevant to their students in a problem-oriented pedagogy. Furthermore, they gained skills and were able to engage their students in purposeful and meaningful problem solving, critical thinking and creativity enhancing their metacognitive and self-regulation skills, promoting constructive dialogue, collaborative and peer learning. This is remarkable in a post-conflict situation particularly in a context where learning is, to a large extent, focused on content delivery as explained by teachers at the start of the intervention. In addition, several teachers, such as Leila, mentioned that the intervention helped them to address those skills, some of those being particularly challenging to infuse in teaching such as empathy, metacognitive and self-regulation skills. Arguably, this contributed to students’ growth on multiple axes of social and emotional learning as described in the case studies. Indeed, they developed and expressed empathy, gained confidence, self-esteem and articulated with commitment the mission of their project. Again, while this is important to all students, it is even more so in the case of refugees considering their psycho-social needs, the high-drop out rate and the lack of motivation or interest in learning.

Furthermore, teachers such as Leila, Randa, Amira and Mahmoud, reported transformed conversations around learning and building truly “authentic relationships” (Fullan, 2005) with students, amongst students, between students and parents, between teams and school principals but also all around the school and in the community. As explained by Fullan (2005), this should not be undermined because building relationships has shown to be crucial when engaging students in the learning process. Indeed, effective schooling,

"indicates that the teacher-student relationship is at the heart of the learning process. This is not simply a philosophic proposition emerging from a belief in equity, but a practical contributor to effective schools... and student responds best when the relationship with the teacher is authentic that is both teacher and student see themselves as partners in the learning process, and there is mutual respect and acceptance and reciprocal expectation" (p:117) (Fullan, 2005)

This “authenticity” as explained by Mahmoud’s principal, extended in the school around the project but also in the wider community as mentioned in the findings. This is remarkable considering the challenges that teachers expressed before starting such as disengaged learners, fear from physical punishment, lack of self-esteem or ill-behaved students. Furthermore, the overall motivation to learn was clearly sensed with students’ transformation from disruptive to well behaved learners with a genuine appetite and commitment to learning.

Considering the situation analysis which described a style of teaching predominantly focused on content delivery and a lack of motivation to learn, it is significant that such results were possible with only six days of professional development coupled by working sessions and community events.

8 Michael Fullan; Fundamental Change, International Handbook of Educational Change-Springer (2005)
Indeed, in a relatively short time, DLI has enriched educators enabling them to provide purposeful and authentic learning to students. Teachers gained several skills of the most effective learning strategies (EEF, SIH) which arguably contributed to making them better teachers far beyond learning how to use technology only. Thus, such an intervention brings a much deeper understanding of the transformative potentials of digitally assisted learning particularly in post conflict or protracted situation. What is fantastic, is that those gained skills are transerfable and teachers can apply them, with or without technology, beyond this intervention making this approach available to all their students. With such principles and deep impact on teaching and learning, it is worth considering DLI interventions as part of in-service teacher professional development. It It would not only give teachers hands-on experience but it will accrue their professional growth and skills.

Students’ Learning Outcomes
During the intervention, students as shown in the case studies, developed a sense of purpose which they manifested through-out the project which is remarkable considering the context and the rigorous problem solving indicators used to assess learning outcomes. Most importantly, students gained transferable skills such as self-confidence, perseverance, curiosity, ethical and creative problem-solving, critical and reflective thinking, self-regulation, collaborative team work, entrepreneurial and emphatic skills towards the wider community. All those indicators are indicators of quality learning as defined by UNESCO (Youth and Skills, 2015) and contribute to enhancing learning. As shown in the rubric, teachers (64%) considered their students were exemplary on several of those indicators such as perseverance, learning from their mistakes and reviewing the solutions of the problem they had identified. While work remains to be done to improve students’ analytical skills (only 22% of teachers reported that those skills were exemplary and 78% as good) it is arguable that in the context of this research such learning outcomes are remarkable considering the high drop-out rate and the general lack of interest in learning. Students’ self-perceptions were changed from being demotivated and incapable to be effective problem-solvers, they were more motivated to learn, hopeful and felt confident to face future challenges; they gained self-esteem and contributed meaningfully to the community where they live. With the staggering drop-out rate and lack of interest in learning reported by teachers in the pre-intervention focus groups it is arguable that DLI’s pedagogical approach may increase students’ retention rate and attract them to learning.

Socio-Cultural
The intervention had a socio-cultural impact on the community at large, parents, Syrians and Lebanese which changed deeply anchored frames of mind. In a culture where the norm is for children to work, for example, it truly is significant their children invest themselves in such a project and that students dedicate precious time that could generate income to doing social good; even more significant is the fact that the parents of these working children still encourage them to spend time on the project. In addition, DLI has broken socio-cultural stereotypes and encouraged Syrians to learn alongside Lebanese not only at school but after school to develop a prototype for a meaningful social action.

Furthermore, teachers and students’ appreciation of community events and working session was clearly sensed and mentioned in questionnaires and interviews. It is important to note that throughout the intervention, all sessions ran smoothly even when up to 70 participants joined working session or more than 100 students participated in sharing events. This is remarkable and reinforces the importance of social learning which can grow in the future particularly between participants.

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<sup>9</sup> https://education.gov.scot/improvement/Pages/EEF-Toolkit.aspx
Cost Effectiveness and Scalability

DLI was designed with low cost technologies and a cost effective capacity building program in view of scalability. One of the reasons for selecting the Raspberry Pi (RPi) is IEA’s previous experience which proved it to be sturdy and reinforced its cost effectiveness. The basic concept behind the RPi is to make computing as affordable as possible and it is often used as a replacement to a regular computer. Furthermore, it allows a variety of uses such as tinkering and prototyping but also the possibility of being used like a regular computer. The combination of tools selected in the CMDI Kit bring the most powerful resources at the lowest possible cost. In addition to cost efficiency, the software on the RPi is open source, hence free of charge for schools. RPi runs on Raspbian, a simplified version of Linux and is preloaded with two programming languages, Scratch and Python which are also open source.

One solution can be to have an SD card per student which they can plug in any Raspberry Pi making every child mobile with their own data on a card (the average cost of an SD card is $16) and making every child know that the world is accessible to them through this chip.

In addition, the professional model is based on fundamental guiding principles of cost efficiency with a delivery model that includes only six training days and four working sessions following the “Learn-As-You-Work” model which spreads learning over time to give space for teachers and teams to digest and apply their learning before they progress to more complex concepts. The combination of low cost hardware components, open source software, online and in-person training and support offers an affordable solution that can be further maximized and made scalable if the project was part of the delivery services of the Ministry of Education and Higher Education thus contributing to the massive undertaking to educate millions of refugee children. Currently, IEA estimates the national scaling of DLI at $2 per student per month over 3 years with courses, tutorials, applications and design challenges created for the DLI to be published on the Coder-Maker site under a Creative Commons license. This is coupled with IEA’s efforts to develop, as per the recommendation of teachers, a set of printable Coder-Maker courses and teacher guides for wide dissemination.

In summary, the digital learning innovations intervention was cost effective with potential for wide scalability which should be designed based on the lessons learned from this intervention presented on the next page.
Lessons Learned

Deeper Understanding of DLI: Situated Pedagogical Use of DLI
In itself, the intervention enabled a deeper understanding of the potential of digitally assisted learning in protracted situations particularly to motivate students which can in the future decrease drop-out rates. As opposed to purely instructional and technological solution (such as providing games to learn, how to or a tool to show and tell), it showed that the combination of pedagogy and technology in a situated contextual and authentic process had a much deeper impact on refugees and host communities. While this may be important for all students, it probably is even more so in the case of refugees and is an eye opener on how learning can be enhanced with assisted digital technologies rather than just built around it. From being disengaged in learning, demotivated and having low self esteem, students were developed a sense of purpose and agency and were committed to learning. From violence previously reported in the school, students collaborated harmoniously, pursued their project and took action for social good which contributed positively to the community where they live, thus generating more social cohesion.

Building Capacities: Simple versus Complex Solution
The rhetoric, in a context affected by a refugee crisis, is usually negative around complex solutions presented in silos. The argument is usually surrounding available capacities to deal with the complexity of such a model of STEAM learning in the classroom. Indeed, while at the start, educators feared their lack of capacity and knowledge, all of them, computer and subject matter alike, demonstrated in a relatively short period of time their ability to teach coding and infuse computational thinking in projects which enhanced learning outcomes and was coupled with students’ significant appetite to learn. The lesson learned is to build teachers capacities around principled and effective models that aim to enhance students’ learning outcomes.

Cohesion: Extending STEAM Learning in the Community
The lesson learned is when learning is purposeful, meaningful and relevant to all it may extend in the community, thus creating synergy and cohesion in the way it creates a bridge between schools and the wider community. DLI students’ projects started in class but extended out of class around relevant and important issues to the community, thus, DLI enabled those connections and made learning exciting through this strong sense of purpose making schools digital transformational hubs with tangible and concrete results. Such extension in the community reinforces the importance of making the project accessible to learners in post-conflict situations; participants not only learned together but they developed a sense of purpose and learned to live together and taking action towards social good. In the protracted post-conflict context and in a culture so laden with societal problems resulting from learning and living together, this is significant and is a sign of a wider societal appreciation.

Gender Bias: Girls Have an Appetite for STEM
DLI’s lesson is that girls have an appetite for STEAM activities despite the general societal association of STEAM fields with boys. With the increasing importance of STEAM in the jobs of the future and knowing that there will be a 38% worldwide shortage of STEAM skills in the future job market\(^\text{10}\), one

\(^{10}\) Source: Manpower - https://go.manpowergroup.com/talent-shortage-2018
of the most important lesson learned is that it is crucial to address this gap in future interventions and to encourage girls in STEAM programs in order to have more equitable and inclusiveness learning.

Volunteers: Grow and Structure Volunteerism
The intervention relied on the volunteers to support trainers in technical training. Their involvement was instrumental to the success of the project. An unexpected finding which emerged is the richness the experience provided the volunteers, helping them to grow personally, to enjoy giving to the community and to gain empathy. As a result, several of them gained jobs or internship and said that the experience with Coder-Maker was instrumental in securing their job. The lesson learned is to grow and structure the volunteer program to support a national growth.

Policy: MEHE’s Endorsement
Today, the choice of innovative projects run in parallel to learning in an occasional manner, and the two are disconnected and not properly aligned. MEHE’s endorsement of the project proved to be an important factor in motivating and enabling teachers to walk the extra mile and make innovation a reality within the classroom. MEHE considers the program as providing quality learning and it has further expressed its support to the project, to take it at a national level and to anchor it at the Ministry. Hence, the lesson learned is to align intervention with the delivery services of MEHE so that it can have a life past the initial funding.

Efficiency and Bureaucracy
We have learned that efficiency is reduced by bureaucracy and resources can be put to more productive use with reduced bureaucracy around already formally approved projects by MEHE. If minor decisions, were decentralized with a systematic way of reporting activities, school efficiency would be maximized. A simple example is the lengthy and endless time it takes to get an approve signed when projects schedules have inevitable minor changes.

Conclusion
The overarching objective of DLI was to use technological and pedagogical innovations to improve the quality and accessibility of learning in and outside the classroom for Syrian refugee children and host communities in Lebanon. The findings show that the intervention had a transformative impact on learning with contributed positively to addressing the challenges identified in the context. The digitally assisted experiential intervention provided a deeper understanding of the relevance and effectiveness of digital learning innovations in post emergency situation. The model showed to be an effective and low-cost model that has the potential to transform pedagogy and a longitudinal rigorous research would help to ascertain the research evidence. With the interest of the Ministry of Education to scale the project, it is crucial to include a stronger component towards more inclusive and equitable access to STEAM learning particularly towards girls.
Appendix List

- Appendix A: Table 1: List of the 21 participating schools
- Appendix B: Additional Schools
- Appendix C: Teacher Questionnaire
- Appendix D: Student questionnaire
- Appendix E: Students’ Learning Outcomes, Rubric Indicators
<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
<th>School Name</th>
<th>Percentage of Refugees</th>
<th>Number of Students</th>
<th>Number of Project Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beqaa</td>
<td>1</td>
<td>Haouch Al Oumara Public High School</td>
<td>21%</td>
<td>217</td>
<td>5</td>
</tr>
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<td></td>
<td>2</td>
<td>Public High School Bar Elias</td>
<td>42%</td>
<td>321</td>
<td>5</td>
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<tr>
<td></td>
<td>3</td>
<td>Public High School Saadnayel</td>
<td>15%</td>
<td>655</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Arayish Public School Wadi Al</td>
<td>51%</td>
<td>149</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>School Al Huda**</td>
<td>35%</td>
<td>697</td>
<td>5</td>
</tr>
<tr>
<td>Mount Lebanon</td>
<td>6</td>
<td>Kfarmatta Public School</td>
<td>61%</td>
<td>59</td>
<td>5</td>
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<tr>
<td></td>
<td>7</td>
<td>Baakline Public School</td>
<td>66%</td>
<td>289</td>
<td>6</td>
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<td></td>
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<td>Antelias Public School</td>
<td>29%</td>
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<td></td>
<td>9</td>
<td>Second Jbeil Public School</td>
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<td>275</td>
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<td></td>
<td>10</td>
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<td></td>
<td>12</td>
<td>Haret Sakher Public School</td>
<td>18%</td>
<td>381</td>
<td>5</td>
</tr>
<tr>
<td>North</td>
<td>13</td>
<td>Saba Zreib Public High School for Boys</td>
<td>3%</td>
<td>179</td>
<td>6</td>
</tr>
<tr>
<td>Beirut</td>
<td>14</td>
<td>Rafic Hariri Public High School - Shoueifat</td>
<td>11%</td>
<td>742</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Beirut Al Alia Public School for Girls</td>
<td>28%</td>
<td>137</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Andrawos Tueini Public High School Jubran</td>
<td>10%</td>
<td>282</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Public High School First Basta</td>
<td>33%</td>
<td>214</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Zahia Kaddoura Public School</td>
<td>10%</td>
<td>227</td>
<td>6</td>
</tr>
<tr>
<td>South</td>
<td>19</td>
<td>Jahiliya Public School</td>
<td>40%</td>
<td>211</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>High School Shheim Public</td>
<td>18%</td>
<td>280</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Public School Shheim</td>
<td>57%</td>
<td>381</td>
<td>5</td>
</tr>
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</table>
Appendix B: Additional Schools

Table 2 presents an overview of the additional schools which focus on vulnerable and underserved Lebanese communities.

Table 2: Additional Schools funded by Foundation Mouna Bustros

<table>
<thead>
<tr>
<th>Location</th>
<th>School Number</th>
<th>School Name</th>
<th>% of Refugees</th>
<th>Number of Students</th>
<th>Number of Project Participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beqaa</td>
<td>1</td>
<td>Khorbit Kanafar Public Vocational School</td>
<td>7%</td>
<td>103</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Saint coeurs - Zahle</td>
<td>20%</td>
<td>304</td>
<td>5</td>
</tr>
<tr>
<td>Mount Lebanon</td>
<td>3</td>
<td>George Frem High School - Jounieh</td>
<td>0%</td>
<td>250*</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Hammana Public High School</td>
<td>0%</td>
<td>250*</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Technical Institute of Batroun</td>
<td>5%*</td>
<td>150*</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Father Andeweg Institute for the Deaf</td>
<td>23%</td>
<td>74</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Ihmij Public High School</td>
<td>5%*</td>
<td>75*</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Amshit Public High School</td>
<td>0%</td>
<td>150*</td>
<td>0</td>
</tr>
<tr>
<td>North</td>
<td>9</td>
<td>Rene Mouawad Technical School</td>
<td>0%</td>
<td>150*</td>
<td>0</td>
</tr>
<tr>
<td>Beirut</td>
<td>10</td>
<td>College Khadija El Kobra - Makassed</td>
<td>4%</td>
<td>292</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Makassed Ali Bin Abi Taleb School</td>
<td>10%*</td>
<td>250*</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Makassed Ali Bin Abi Taleb High School</td>
<td>5%*</td>
<td>250*</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Sophia Hagopian College - Bourdj Hammoud</td>
<td>10%</td>
<td>250*</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Aksor Kassarjian School - Bourdj Hammoud</td>
<td>42%</td>
<td>292</td>
<td>5</td>
</tr>
<tr>
<td>South and Shouf</td>
<td>15</td>
<td>Al Wafaa Secondary School</td>
<td>2%</td>
<td>609</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Shouf High College</td>
<td>15%</td>
<td>175*</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Maghdousha Technical Public School</td>
<td>0%</td>
<td>165</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Deir Al Qamar Public technical school</td>
<td>10%</td>
<td>88</td>
<td>0</td>
</tr>
</tbody>
</table>

* approximate numbers
Appendix C: Teacher Questionnaire

Please confirm that you are a teacher, the subject and grade level you teach

I am a __________; Subject: __________________; Grade Level: _________ and answer the questions below to give us your feedback about the overall experience; when rating is applicable, rate from 1 to 5 as follows: 1 = Not at all; 2 = Somehow; 3 = Generally; 4 = Mostly; 5 = Extremely

1. How many students participated in your project? (___ boys and ___ girls)
2. How did you select the students? (Select all what applies)
   1. I proposed to everyone and asked who is interested to join
   2. I selected the most performing students
   3. I selected those I think might be interested in the project
   4. Other, specify: __________________________
3. To what extent did you enjoy the Coder-Maker experience? Rate from 1 to 5
4. To what extent was each one of the following enjoyable? Rate from 1 to 5
   1. Learning with other teachers
   2. The community aspect
   3. Incorporating small challenges in my teaching
   4. Working with students on a real life challenge
   5. Having students come up with their own ideas for their project
   6. Guiding students through the project
   7. Learning how to code and make
5. Is there anything that you did not enjoy? (Yes, No)
6. What I have learned during the workshops is relevant to my teaching: (Yes, No). Tell us briefly why:
7. Now, I can see clearly how this project using STEM connects to other disciplines such as Humanities and Arts. Rate from 1 to 5. Tell us briefly why
8. I appreciate the importance of connecting more closely to my students’ day-to-day realities. Rate from 1 to 5 and tell us briefly why
9. Do you feel confident using Scratch or Python in your teaching? Rate from 1 to 5
10. Do you feel confident using the Raspberry Pi in your teaching? Rate from 1 to 5
11. How confident are you to guide your students during each phase Rate from 1 to 5 for each of the following;
   1. Solving small challenges
   2. Working on a real life challenge
   3. Coming up with an idea that responds to a community need for their project
   4. Researching the problem
   5. Designing a solution
   6. Creating the project
   7. Coding the project
12. How do you rate your performance as a teacher in the Coder-Maker? Rate from 1 to 5 and tell us briefly why.
13. What could we do to improve your performance to a higher level? (Text)
14. What would you like to learn more of? (Tick what is relevant)
   11. The Raspberry Pi
   12. Python
   13. Scratch
   14. Designing
15. Making
16. Connecting coding and making with what I teach
17. Addressing new challenges
18. Handling and programming electronic tools
19. What would you change to improve the Coder-Maker next year? (Text)
20. Would you like to participate in future Coder-Maker workshops? (Yes, No)
Appendix D: Student questionnaire

Please confirm that you are a student, your grade level, age and gender and answer the questions below to give us your feedback about the overall experience; when rating is applicable, rate from 1 to 5 as follows: 1 = Not at all; 2 = Somehow; 3 = Generally; 4 = Mostly; 5 = Extremely

I am a ___________Grade: _____ Age: _____ Gender: _______

1. To what extent did you enjoy the Coder-Maker experience? Rate from 1 to 5; NOT at all (1) and extremely (5)
2. Today, to what extent did you enjoy the following? Rate from 1 to 5; NOT at all (1) and extremely (5)
   1. Being with friends (1 to 5)
   2. Sharing your project (1 to 5)
   3. Seeing the projects of other schools (1 to 5)
   4. Receiving a certificate (1 to 5)

5. What made it enjoyable? Rate from 1 to 5; NOT at all (1) and extremely (5) and tell us briefly why:
   1. Learning in a new way
   2. Solving challenges
   3. Working in teams
   4. Finding a real-life problem to solve
   5. Designing a solution
   6. Making the project
   7. Coding the project

8. Is there anything that you did not enjoy? (Text)
9. What did you use in your project? (Select what is relevant)
   1. Scratch
   2. Python
   3. The Raspberry Pi and electronics tools

4. Would you like to participate in Coder-Maker in the future? (Yes, No)
5. What would you change to improve the program next year? (Text)
Appendix E: Students’ Learning Outcomes, Rubric Indicators

Self and Community:
1. gain insight into themselves
2. articulate their understanding of the concept of community

Problem:
1. identify and define a problem that can be addressed
2. develop perspectives

Design:
1. sketch or visually represent the solution
2. show empathy

Create:
1. implement an initial prototype
2. code it

Analyzing and interpreting results:
1. consistently and systematically collect data
2. describe data clearly
3. explain and relate the results to the problem
4. recognize limitations and propose alternative interpretations
5. problem solve and think critically
6. refine plans and continuously review results
7. learn from errors to keep improving solution

Planning:
1. manage tasks
2. identify tools
3. document their work

Team work
1. collaborative skills
2. communication skills
3. knowledge sharing

Metacognitive skills
1. metacognitive awareness and ability to reflect on self-knowledge
2. use productive habits of mind
3. reflect on the experience