Unlocking Learning

The co-creation and effectiveness
of a digital language learning course
for refugees and migrants in Greece

**Despina Karamperidou, Nikoletta Theodorou, Thomas Dreesen,
Matt Brossard, Akito Kamei and Javier Santiago Ortiz Correa**

December 2020

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Cover photo: © ELIX/Koulaxis
Students exploring the Akelius digital language course with their teacher in a Greek-as-a-second-language class.

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Context

Since 2015, more than five million refugees and migrants have crossed into Europe, with over a million arriving on Greek shores. As of early 2020, around 42,500 refugee and migrant children resided in the country. Learning remains out of reach for many refugee and migrant children, due in large part to language barriers. To address this challenge, UNICEF Greece supports Greek language learning for refugees and migrants in formal and non-formal education (NFE) learning centres which are run by local NGOs. Greek as a Second Language (GSL) teachers must navigate teaching children from various linguistic and academic backgrounds in a single classroom. In this setting, education technology holds the promise to support teachers, providing a pedagogical tool to personalize learning for students, allowing children at different levels to learn at their own pace.

This research investigates the development, implementation and effectiveness of the Greek Akelius Digital Language Learning Course. The course aims to support refugee and migrant children to acquire Greek language skills. It is implemented through a blended approach, whereby the use of the digital course on tablets is integrated by teachers within face-to-face classroom teaching. The digital course is developed by Akelius, using a co-creation approach informed by frequent feedback and collaboration between implementing teachers and UNICEF education specialists.

Key findings and related recommendations

Learning outcomes

■ **The use of the Akelius digital language learning is associated with positive results on students' Greek language skills.** The course's associations with improvement in learning outcomes, by comparison with similar students in similar GSL classes but without the Akelius course, vary across language skills domains. There was an 8 per cent improvement in listening, 9 per cent in reading, an impressive 25 per cent in improvement in speaking and 34 per cent in writing skills. Qualitative evidence from learning centres' directors, teachers and students has confirmed these positive outcomes and provided additional information on the reasons behind these outcomes and how they vary across different age-groups.

■ **Implementation of the digital language course in classes encouraged attendance and improved other classroom outcomes for both students and teachers.** A lack of confidence and motivation to learn often result in student withdrawing from class and dropping out of education. Qualitative evidence finds that, due to the course, students are more confident and motivated to learn, attend class (both at the learning centre and in Greek public schools) and less likely to drop out. The interactive nature of the course, with games and instant feedback after lessons, increased student engagement in the learning process, promoted mutual support amongst students and improved their self-esteem. While teachers reported that integrating technology was initially challenging, observations from pedagogic advisors illustrate that the digital language course has been a useful tool to help structure and organize their lessons.

■ **Using technology in a blended approach (i.e. with the teacher in face-to-face classes) and integrated within a pedagogical approach have benefits, especially in classrooms with learners from various levels.** Refugee and migrant Greek language classes frequently consist of students from various linguistic backgrounds and learning levels and feature frequent turnover of students and new arrivals. Research indicates that students, especially those at lower

learning levels benefit from the personalized and self-paced use of the digital language course. Also, through splitting the class into learning groups, teachers can provide tailored attention to certain students, while others work independently using the tablets and headphones. For further improvement of writing skills teachers recommended the use of digital pens and the addition of exercises that would require students to make use of their writing skills in a notebook.

Co-creation of a digital learning tool for humanitarian settings

- **Co-creation requires flexibility and embracing adaptations informed by the experience of users.** The Akelius Digital Language Learning Course was developed through a team of software engineers, academics and linguists from Akelius. Adaptations to the course were informed by continuous feedback from implementing teachers, which included feedback from students when using the course in the classroom. Feedback from UNICEF education specialists, based on their regular visits to the learning centres, also informed adaptations. This process of co-creation enabled the gradual improvement of the course's content, structure and user experience. It helped ensure that the tool was fit for the educational needs of migrant and refugee children in Greece and that it was aligned with the national curriculum.

- **Continuous feedback from implementation (implementation research) improved the digital language course – leading to increased integration in classes.** With each new version of the digital course, teachers reported higher rates of satisfaction and increased duration of use in their classes. The way teachers used the course also changed over time. While the initial version of the digital course was used in class, mainly as recreation and reward, teachers reported integrating subsequent versions of the course into their lesson plans and using it to review key concepts and as a tool to introduce a new lesson.

- **The process of co-development is not always smooth.** In the early stages of implementation communication between software developers and implementing educators was unsystematic. Setting up an improved process of regular communication and implementation feedback protocols helped strike a balance between teachers' expectations and designers' timelines, ultimately increasing teacher satisfaction with the digital course and expanding its use in the classroom.

Implementation of digital technology in humanitarian settings

- **Designing Education Technology (Ed Tech) for the most marginalized requires tools which work effectively in low connectivity settings.** Even in high-income countries in order to reach marginalized groups organizations developing Ed Tech solutions should design and test their tools in low connectivity settings. In Greece, making the course downloadable and usable offline allowed for its rapid expansion to refugee camps and accommodation with poor connectivity. Continual refinement of content to reduce and optimize file sizes will further improve the use coverage. Globally, in order for digital tools to be useful in humanitarian contexts the right balance should be found between high-quality interactive content and optimizing applications to be sufficiently lightweight to adequately function with low connectivity.

- **Continuous teacher training approaches are essential, in particular in humanitarian settings.** The use of technology in the classroom is more than learning how to use a software. It should be closely linked to the academic goals and contextually appropriate methods of teaching. Evidence from Greece shows that adapting to blended learning can be challenging for some teachers. High teacher turnover is a challenge when training teachers, particularly in humanitarian situations where many are volunteers. An online training and a teacher guidance manual on how to integrate the technology within lessons were provided to respond to these needs. Globally, with the expansion of remote learning due to the COVID-19 pandemic it is more important than ever to develop innovative ways to improve teachers´ skills in the use of digital learning.

- **Building monitoring and research into implementation of Ed Tech programmes is crucial to improve their design, delivery and use.** Integrating technology into a learning process comes with challenges. Thus, it is key to invest in monitoring and evaluation, learning assessments and research to understand what works and how.

- **Further research on the Akelius digital learning course is needed to further inform its continued development.** As the UNICEF-Akelius partnership expands, additional mixed-methods (quantitative and qualitative) implementation research will be needed, particularly to cover topics beyond the scope of this report, including:

  - Sustainability of effects of digital learning over time and in new contexts– exploring the longer-term effects of the course (including on the integration of students into formal public schools), and its effectiveness for different languages, new subjects and across multiple implementation settings.

  - Different use cases for digital learning – examining the process and effectiveness of using digital course for various modalities of blended and self-learning, including adaptations for remote implementation during COVID-19.

  - Co-creation as the programme scales – exploring how the co-creation and implementation of the course changes as the course expands to include new languages and to face the challenges of its introduction in new contexts.

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Independent learning

1. Introduction

The world faces a learning crisis. Fifty-three per cent children in low- and middle-income countries are unable to read a simple story by the age of ten (World Bank, 2019). While access to primary education has increased dramatically around the world this has not led to an equivalent increase in learning for children. For refugees and migrant children, the challenges are even more acute. Around half of all refugee school-age children are out of school, only 31 per cent of refugees attend secondary school, and just three per cent access tertiary education (UNHCR, 2020).

As digital technologies have proliferated in recent years, so too have investments in their use to improve, expand and accelerate learning. A recent report that tracks investment in digital education technologies (Ed Tech) in 126 countries found that in 2019 over US$18 billion was invested globally, around double the amount invested in 2017 (Adkins, 2020). How these investments in Ed Tech translate into outcomes for children remains unclear. Globally, school closures due to the COVID-19 pandemic have highlighted how great inequities in access to digital technologies, connectivity and electricity remain widespread. Vulnerable populations are the least likely to have access (Dreesen et al., 2020; UNICEF, 2020; Unwin et al., 2020). To reduce the digital divide and ensure equity, the testing of digital technologies should shift from locations where they are most likely to succeed, to more challenging areas (Unwin et al., 2020). As education systems increasingly invest in Ed Tech for use during and post COVID-19, the need to understand how to efficiently deliver digital learning solutions for vulnerable children has never been more urgent.

The introduction of digital technologies in an educational environment has potential to improve student outcomes through several pathways. Software can be designed to encourage self-paced learning that is typically difficult to achieve in group instruction (Koedinger et al.,1997; Roschelle et al., 2000). Similarly, education content may be individualized to the strengths and weaknesses of the student, through computer assisted learning (CAL) (Muralidharan et al., 2018). Mobile technologies are key to enabling access to learning opportunities during times of emergency when education systems are disrupted (Tauson and Stannard, 2018; De Hoop et al., 2019). The use of technology in education may also enhance digital skills that could enhance economic returns on education, as economies transform and jobs increasingly require digital skills (Flack et al., 2020).

Digital technologies show promise for use in education but a review of literature on their impact shows "mixed evidence with a pattern of null results" (Bulman and Fairlie, 2016, p.1). Evidence increasingly shows that the simple provision of hardware for education systems seems to have no impact on learning. However, integrating technology into a clear pedagogical approach has shown promise especially when the technology is able to personalize learning (Muralidharan et al., 2019). In a review of 29 experimental studies of Computer-Assisted Learning (CAL) programmes, Escuta et al., (2018) find great promise for programmes that offer personalized learning. Of the 29 studies reviewed, only eight report no effect, and one turned up negative effects, but the remaining majority found positive effects, primarily on improving math outcomes.

How technology is implemented within a learning system is an important determinant on outcomes (Bulman and Fairlie, 2016). Comi et al., (2017) explore the use of technology in Italian secondary schools, finding that the effectiveness of technologies depends on the teachers' practice and their ability to integrate ICT into their teaching. Investigating the large-scale introduction of computers and teacher training for technology use in Colombia, Barrera-Osorio and Linden (2009) found little effect on test scores. The authors suggest that the main reason seems to be the failure to incorporate computers into the education process. Survey results from both teachers and students suggest that teachers did not incorporate computers into the curriculum.

While most studies to date focus on outcomes in high-income countries, there is a growing base of evidence in low- and middle-income country settings. Muralidharan et al., (2019) find large impacts of an afterschool CAL programme in India on Hindi and math outcomes, particularly so for academically weaker students. This confirms earlier research results that introducing computer resources may benefit lower performing students more than the highest performing (Banerjee et al., 2007; Barrow et al., 2009). Even as the promise for Ed Tech may be great in low-income and humanitarian settings, where class sizes may be large, and learning levels low, such contexts are also the most likely to lack the technology and human resources to implement Ed Tech effectively and at scale. More research is needed to understand how to effectively implement educational technology for marginalized children.

This report investigates the development of a digital language learning course, and its introduction into language classes for refugees and migrants in Greece. The digital course is implemented through a blended approach, where the use of the digital course on tablets is integrated by teachers within face-to-face classroom teaching. This research contributes to the limited literature on the use of education technology for refugee populations, investigating both the effectiveness of the programme, along with the process of developing and using the digital course. As the research was carried out in tandem with implementation of the programme, the research aims to provide insight on how the digital tool was integrated into the educational process and how its use evolved over time.

Box 1. The UNICEF-Akelius Innovation in Education Partnership

Prompted to act due to the European migrant crisis in 2015, the initial Akelius digital language course was developed as an open source tool for refugees and migrants in Sweden. In 2017, UNICEF Sweden and the Akelius foundation engaged in a partnership to support UNICEF education in emergencies programmes, particularly to create the Akelius digital language course in multiple languages so as to provide language learning for refugees, migrants, and those from linguistic minorities around the world through the support and engagement of UNICEF country offices.

The UNICEF-Akelius partnership embarked on the co-creation of the Greek Akelius Digital Language Learning Course with local implementing educators. The course aims to help marginalized children including refugees and migrants learn languages in order to facilitate their inclusion into schools and society more broadly. Within the UNICEF-Akelius partnership there is a strong emphasis on evidence generation to track progress, learn, inform and improve implementation. In each context, resources are invested to understanding how implementation of the digital learning course works towards improving learning for the most marginalized.

This report focuses on the Greek language version of the Akelius digital language learning course and its use in Greek as a second language (GSL) classes for refugee and migrant children in non-formal education (NFE) learning centres across Greece.

1.1. Refugee and migrant education in Greece

Greece is a major entry point for refugees and migrants into Europe. Since January 2015, over a million have entered and crossed through the country. As of early 2020, around 42,500 refugee and migrant minors resided in the country (UNICEF, 2020a). Today, around half of the refugee and migrant children reside in camps and informal settlements and one-third in apartments with their parents (UNICEF, 2020a). Meanwhile, the places of residency of the remaining sixth are unknown (UNICEF, 2020a).[1] In 2017, the Greek government committed to mainstreaming all refugee and migrant children into the formal education system. An estimated, 13,000 refugee and migrant children of school age (4–17 years old) were enrolled in Greek public education in the 2019-2020 school year (UNICEF, 2020a).

For these children, learning in school is often constrained by their lack of knowledge of the Greek language[2] (Skleparis, 2018; UNHCR, 2019).[3] Refugee and migrant students cannot understand the curriculum, unless they have reached a high level of proficiency in Greek. Schools have limited capacity to provide additional support in classes, consequently non-native speakers often do not enrol or drop out early. To respond to this specific need of refugee and migrant children, UNICEF Greece's education programme has prioritized language learning and psychosocial support (PSS) programmes for refugees and migrant children. UNICEF supported the Ministry of Education, Institute for Education Policy (IEP) and Greek Language Center in the development and implementation of a GSL curriculum to harmonize GSL teaching practices across non-governmental (NGO) partners. Local NGOs in many cases switched focus to education after the initial emergency response, which focused on health and protection services, wound down. To assist with this transition, UNICEF Greece continually supports both the formal and non-formal sector in pedagogical services for GSL classes. An example is child-centered pedagogy teacher training delivered by the Ana Aqra Association, implementing partners for the Akelius course in Lebanon.

1.2. Course design and development in Greece

In 2018, the Akelius Foundation and UNICEF began developing the Greek Akelius Digital Language Learning Course. Initial implementation and testing began in classes of the ELIX[4] organization using a blended approach, mixing face-to-face teaching with class time spent on tablets using the digital language course. The course was first introduced into classes in early 2018. By year-end, it had reached an estimated 347 students in two learning centres in urban Athens. By the end of 2019 it had reached 4,623 children in 17 learning centres for refugees and migrants across the mainland and islands (*see Figure 2*).[5] COVID-19 has further triggered expansion and by July 2020 the Akelius digital language course was being used in 36 sites (refugee camps / learning centres) and reaching a total of 6,412 learners across the country.

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1   Information about where the remaining one-sixth of refugee and migrant students reside is missing.

2   Additional barriers to formal school enrolment and attendance persist including logistical bottlenecks, such as a lack of necessary documentation; slow administrative processes; changing rules, and negative reactions from local communities (UNCHR/UNICEF/IOM, 2019).

3   Unaccompanied minors appear to benefit the least from educational initiatives, as they are still in need of long-term accommodation and do not meet basic criteria for registering in Greek public schools.
      UNESCO. (2018). Global education monitoring report 2019: migration, displacement and education: building bridges, not walls. UNHCR. (2019, September). Greece sea arrivals dashboard.

4   ELIX is a non-governmental organization that designs and implements social programmes in Athens that aim to strengthen social inclusion and protect the rights of socially vulnerable groups.

5   Learning centres provide non-formal education and homework support to refugee and migrant children, as well as their parents, so as to facilitate integration into the formal education system.

1.2.1. The Akelius language learning approach

The goal of the Akelius digital language course, in Greece and other countries, is to provide students and teachers with a tool to accelerate host country language learning. It is free, includes no advertising and requires no prior user information to access. Its main features are simplicity, flexibility, agility and fun. The content has been tailored to be used for a variety of learning levels, including absolute beginners. The methodology has been tailored to the specific needs of refugee and migrant students through consistent feedback from UNICEF Greece, local implementing teachers and Greek language learning experts (*see more details on the co-creation in section 1.2.2*). The four principles underpinning the Akelius digital language course are:

Figure 1: Akelius approach to learning languages

1. Incremental and iterative progression through micro-steps: introduction of few words/concepts at each step and their repetition in the following steps	**2. Freedom of choice and learning speed:** the learner can decide to start the course at any step and progress at their own pace	**3. Focus on verbal communication** rather than written communication	**4. Importance of music (songs)** and games in the learning process

Content within the course is flexible and offers a rich collection of thematic unit series for use in Greek language learning. It contains thousands of micro steps to individualize learning and help learners of any level to progress. The application also features quizzes at the end of each unit to provide instant feedback to students on their progress and areas for improvement. The application can be accessed online through a web browser or on any Android device (tablet or mobile phone), both online and offline. The design of the course content allows for self-paced and individualized learning of the Greek language, through interactive exercises, games, quizzes, and additional content such as Greek language books and songs (*see Images 1 and 2*).

Image 1. Game teaching words for foods.
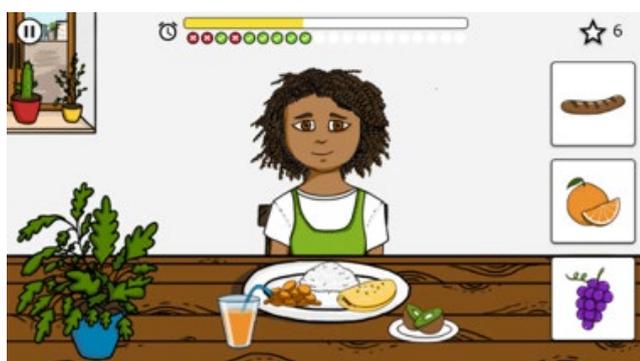
Image 2. Lesson teaching words for emotions.
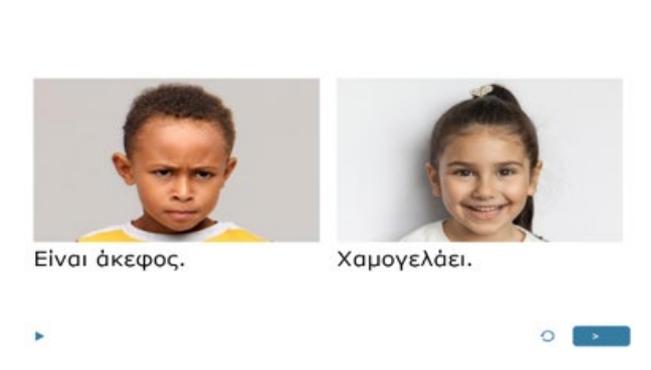
Source: Screenshots from the Akelius Digital Language Course

1.2.2. The co-creation of the Greek Akelius Digital Language Learning Course

To ensure that the digital course is fit for purpose and incorporated into a clear pedagogical framework, the partnership developed the course with frequent communication between GSL teachers, UNICEF education specialists and Akelius software developers. Implementing teachers have the freedom to use the tool in their classrooms as they see fit, in accordance with their teaching goals and lesson plans. Teachers provide continuous feedback based on their use of the digital language course with refugee and migrant children. UNICEF Greece education specialists coordinate feedback from implementing teachers and provide additional feedback based on implementation across a variety of contexts around the country. Feedback from teachers documents how they used the digital language course within classes, their perceptions of the benefits of the digital tool, and challenges that they or their students faced with software, hardware (tablets) and connectivity. Teachers and education specialists from UNICEF Greece provided feedback on course content and suggestions for improvement of both the content and the user interface. The software development team regularly visited Greece as did staff from UNICEF Headquarters, the Europe and Central Asia Regional Office in Geneva, the UNICEF Office of Research-Innocenti in Italy, the Akelius Foundation and the global partnership manager from the UNICEF Sweden National Committee. These visits allowed the various stakeholders to observe implementation and to discuss and learn from implementing teachers, students and UNICEF Greece, in order to adjust plans for software development, implementation and partnership strategy based on implementation realities.

Box 2. The use of the digital language course within GSL classes

GSL classes where the course was initially introduced (in the centres run by ELIX) are two hours long and take place twice a week. The course is implemented in GSL classes using a blended approach,[1] with students spending time on tablets in combination with face-to-face teaching. Teachers were given the freedom to use the course in ways and frequencies that fit their lesson plans and the specific needs of their students. In general, use of the digital language course within classes takes two forms:

■ **Independent learning:** Each student with a tablet and headphones learns at their own pace, reviewing concepts and practicing material covered in the lesson.

■ **Collaborative learning:** Students in pairs work together using one tablet, promoting teamwork, and discussions between students on the content of the digital language course.

The course can be utilized by the whole class together or by rotation in smaller groups. In the whole class approach, specific time is given for all students to use the course on tablets, while teachers circle the room and provide one-on-one support. In the rotating learning stations approach, students are placed into smaller groups and rotate between using the course (with headphones) and receiving face-to-face instruction from their teachers. This approach allows teachers to group students by learning levels and needs, and to provide more tailored instruction, while the rest of the class continues to learn using the digital course.

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6   More information on the learning approach can be found in the blended learning teacher guidance manual (UNICEF, Ana Aqra, ELIX, 2019). The manual describes strategies to effectively incorporate the Akelius digital language course into second language classrooms.

1.2.3. Timeline of implementation and content development in Greece

Initial implementation in Athens: The development of the digital course in Greece started after an initial feasibility and needs assessment in November 2017. The prototype of the course (Version 0) was adapted from the initial Swedish version of the course and was introduced to the Greek implementing partner (ELIX) in February 2018. ELIX teachers gave initial feedback that the software development team used to refine the software before its first launch in GSL classes. ELIX teachers began testing Version 1.1. of the course in one class in May 2018 and continued to provide regular feedback. After the delivery of an updated version in June 2018 (Version 1.2) the course expanded to an additional class.

Expansion within Athens: In October 2018, the course content was restructured based on feedback from implementing teachers based on their use in classes. A user-friendly layout was introduced (Version 1.3). Implementation was expanded to two additional ELIX learning centres and GSL classes in urban Athens.

Scaling up to low connectivity camps and centres across Greece: The introduction of an offline functionality in February 2019, allowed for the expansion of the course to more implementing partners and learning centres beyond Athens. By June 2019, Version 2.0 was being used in multiple low connectivity settings across Greece, including six refugee camps on the mainland (Southern, Central and Western Greece) and four on the island of Lesbos.

© ELIX/Koulaxis
Collaborative learning

Expansion of use during COVID-19: From April 2020, when all regular educational activities were suspended in Greece due to the pandemic, the offline and the digital course continued to be used by unaccompanied children in eight centres. By July the course was used in more than 36 locations. In May 2020, the Greek Ministry of Education's Institute of Educational Policy added the course as a recommended tool for refugee and migrant children on their official remote learning web portal. New tablets were delivered for use by unaccompanied minors in 18 shelters, one safe zone and one safe area on a remote island as well as to Supported Independent Living houses in urban Thessaloniki. An online training tool on the use of the blended learning approach was developed by the UNICEF-Akelius partnership and provided to educators.

Figure 2: Timeline for the co-creation and expansion of the Greek Digital Language Learning Course (February 2018 – July 2019)
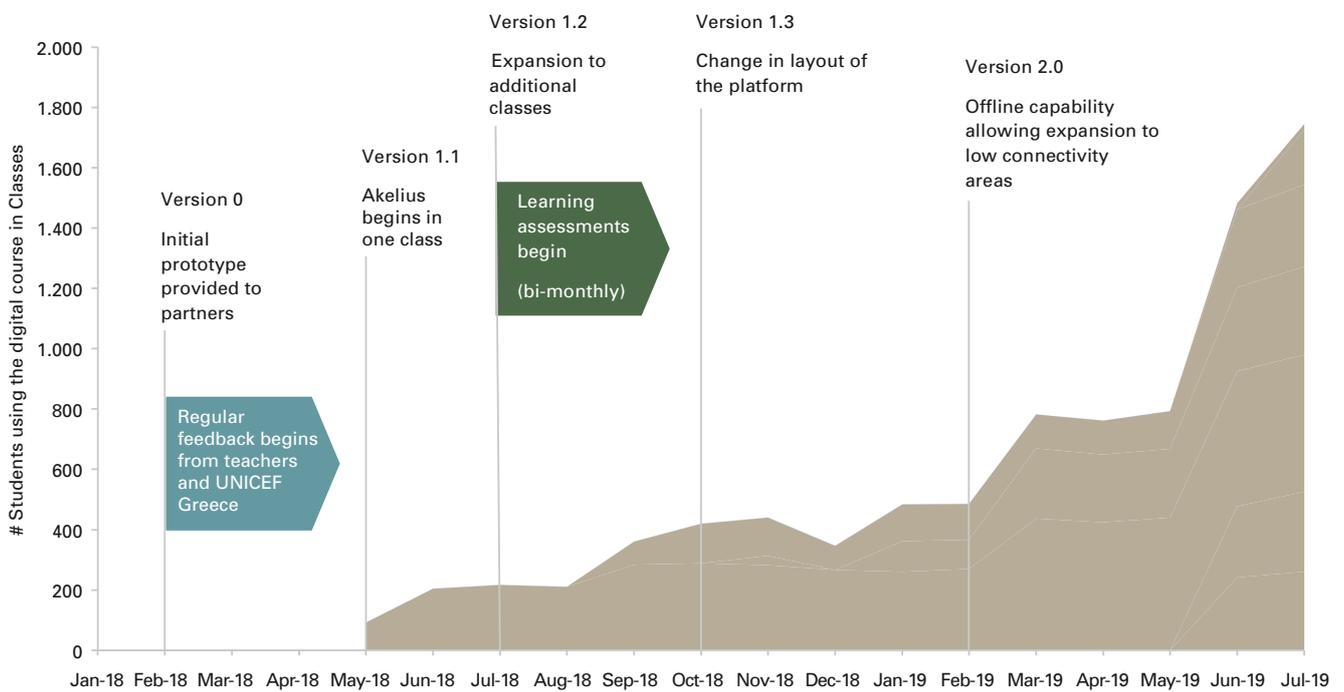
2. Research objectives, methods, data and design

In line with the ambitions of the UNICEF-Akelius partnership to develop and implement evidence-informed quality language learning programmes for vulnerable groups, this study aims to:

1. Understand the co-creation, use and journey to scale of the Akelius Digital Language Learning Course in Greece and identify implementation challenges;

2. Estimate the effectiveness of the Akelius Digital Language Learning Course in improving Greek language learning outcomes;

3. Inform improvements in programme development and implementation, both in Greece and elsewhere;

4. Inform the global evidence base on the use of technology in education, particularly for marginalized children in development/humanitarian settings.

This research uses mixed methods, combining quantitative and qualitative analysis to understand the process of implementation, effectiveness of the programme and to identify key challenges and enablers of success (*see Figure 3*). Quantitative data includes information on students' demographics, attendance to Greek classes in non-formal education (NFE) learning centres, and language learning assessments gathered from administrative datasets of implementing partners. Primary qualitative data was collected through interviews and focus group discussions (FGDs) with multiple stakeholder groups, including teachers and students, and structured classroom observations. Teacher feedback data was gathered over the course of implementation and is used to understand the development and use of the course in classes over time.

Figure 3: List of data sources collected and utilized within the framework of the study

Data source	Use
1. Learning and monitoring data from implementing partners include demographic data (age, gender, nationality, mother-tongue, Greek school registration status), attendance data (attendance of GSL class) and learning assessments data.	**Understanding how the programme influences education outcomes including learning**
2. Primary qualitative data collection – classroom observations, Focus Group Discussions (FGDs) and Key Informant Interviews.	**Understanding context, co-creation, process, sustainability, scale**
3. Teacher feedback data – regularly collected data on how teachers use the Akelius digital language course in their classes.	

2.1. Quantitative methods and sample composition

The quantitative sample was comprised of 969 students who attended GSL classes offered by ELIX, the first implementing partner in Greece, from January 2018 to November 2019. The sample was restricted to students under the age of 21. Forty-three (43) nationalities were represented within ELIX classes during that period (*see Map 1, below*), the majority of students were from Afghanistan (50.2%), Syria (18.3%) and Iraq (12.7%). To estimate the effectiveness of the course, a propensity score matching (PSM) technique was used to compare the learning outcomes of students using the digital language course (treatment group) with students in similar GSL classes not using the digital language course (comparison group).[7] A total of 594 students were able to be matched (across treatment and comparison groups) and used in the analysis, investigating the association between the use of the course and learning outcomes in the four language skills domains (speaking, reading, listening, writing) (*see Section 3.2.1. and Annex 1 for more details*).

Map 1: Countries of origin of students attending GSL classes in ELIX learning centres (January 2018-November 2019)

Students

1   486

This map does not reflect a position by UNICEF on the legal status of any country or territory or the delimitation of any frontiers. Source: Author's design, on the basis of their dataset
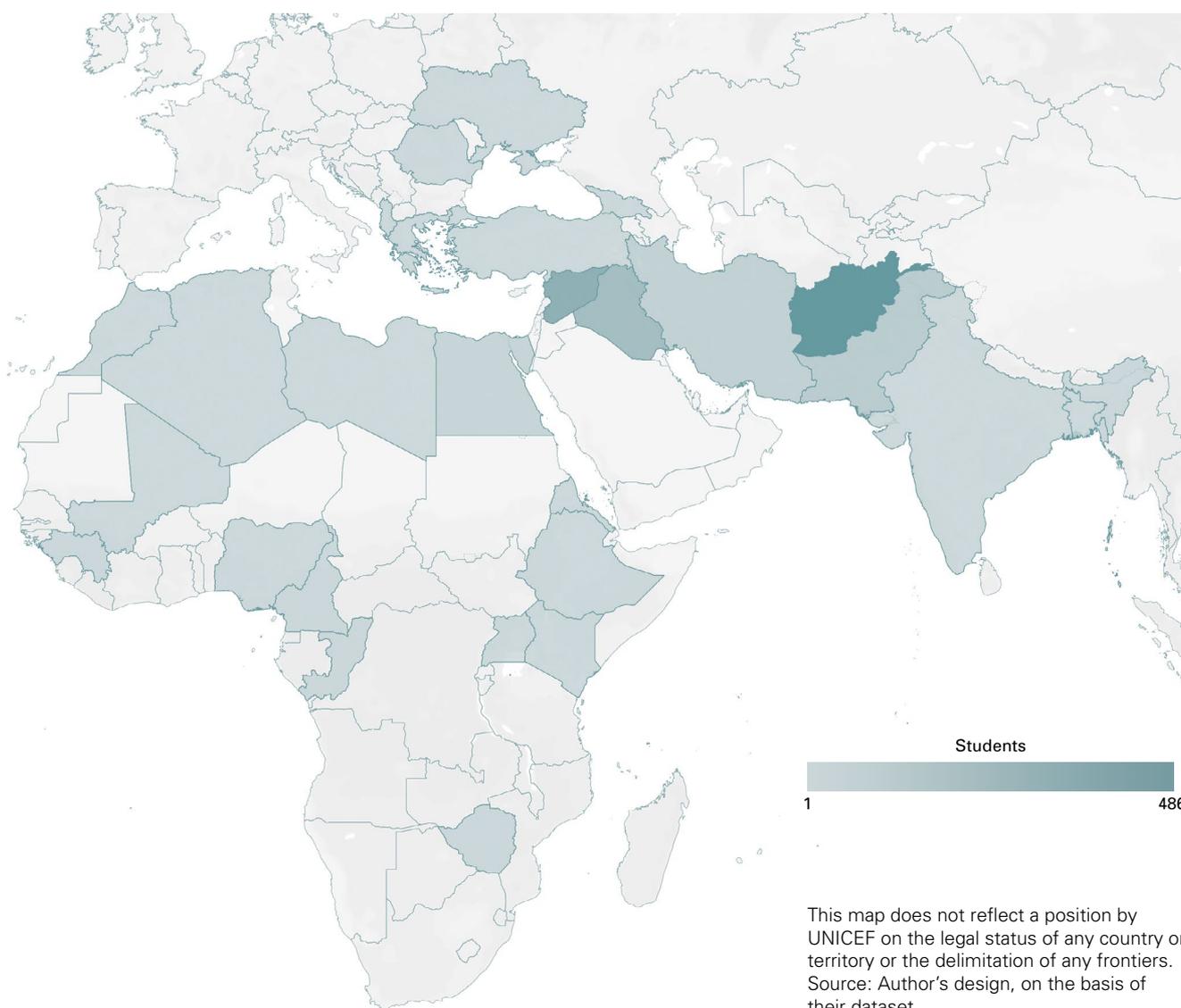
7   (*see Section 3.2 and Annex 1*)

2.2. Qualitative methods and sample composition

Thematic Content Analysis (TCA) was employed to code and analyse transcribed interviews, FGDs and observational data. Qualitative sampling involved the purposive selection of five NFE learning centres based on three criteria: 1) geography (region); 2) location (rural/urban/camp), and; 3) implementing partner (*see Annex 2*).[8] Between December 2019 and January 2020 at each learning centre there were semi-structured in-depth interviews[9] with the director, an FGD with teachers, and two FGDs with students and managers of implementing partners, Akelius designers, and national and subnational education officers (refugee education coordinators)[10] were also interviewed.[11] In total, 85 individuals participated in the qualitative data collection (*see Annex 2*). Evidence generation, storage and management conformed with the UNICEF *Procedure for Ethical Standards in Research, Evaluation and Data Collection and Analysis* (*see Box 3*).

A structured observation tool was used to record enumerators' observations on the use of the digital course in the classroom and teacher-student interactions during visits to selected learning centres.[12] Observational data were used for validation and triangulation purposes.

Box 3. Note on research ethics

The UNICEF Office of Research – Innocenti applied for ethical clearance for qualitative data collection study to both the Health Media Lab (HML) and the Institutional Review Board of the Office for Human Research Protections in the United States of America Department of Health and Human Services, both located in Washington, D.C. Ethical clearance was granted in November 2019, prior to the fieldwork (December 2019-January 2020).

To ensure the safe, fair and dignified treatment of participants, all data collectors were extensively trained in research ethics and abided by the UNICEF *Procedure for Ethical Standards in Research, Evaluation and Data Collection and Analysis* (Document number: CF/PD/DRP/2015-001, Division of Data, Research and Policy, 2015).

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8   The learning centres were selected across four regions in Greece. They had to: be run by different implementing partners; be geographically dispearsed; and have been using the digital course for at least six months prior to data collection.

9   In all semi-structured in-depth interviews, the interviewers had a checklist of topic areas or questions. The intention was to get the informants to talk in their own terms. Thus, questions were phrased in a way that allowed for a range of possible responses. The average duration of interviews and FGDs was 60 minutes.

10   The Ministry of Education, following formation of the Working Group on the Management, Coordination and Monitoring of Refugee Children has appointed several Refugee Education Coordinators (RECs) in all reception accommodation centres where refugees and migrants are housed across Greece. RECs were responsible for the formal education of refugee children. Depending on the size of the centres and the number of children, each centre is staffed with between one and three RECs (Ministry of Education Research and Religious Affairs, 2017).

11   The criteria for selecting participants included: 1) intimate knowledge of all stages of project implementation; 2) personal experience in the use of the platform, and; 3) ability to share insights on its practicality/usefulness and implementation challenges. Students participating in FGDs were selected based on their age (9-18 years old), gender and nationality.

12   The tool was modelled after the World Bank's TEACH classroom observation instrument and was used to capture: 1) the learning environment; 2) the time teachers spent on traditional and platform learning and the extent to which students were on task, and; 3) the quality of traditional and blended teaching practices. To avoid observer bias, two observers used the tool independently and then compared their notes to assign an overall combined score to each element.

3. Findings

3.1. Programme implementation and challenges

3.1.1. Co-creation, content development and in-class use

Developing a process for co-creation

The Greek version of the digital language course was iteratively improved through feedback on its use by teachers, and frequent consultation between each stakeholder. Feedback from teachers was based on their interaction and use of the course with students in classes. The feedback from teachers, learning centre administrators and UNICEF education specialists was especially vital in early implementation.

Figure 4: Reported share of teacher challenges over time
(March 2018–February 2020)
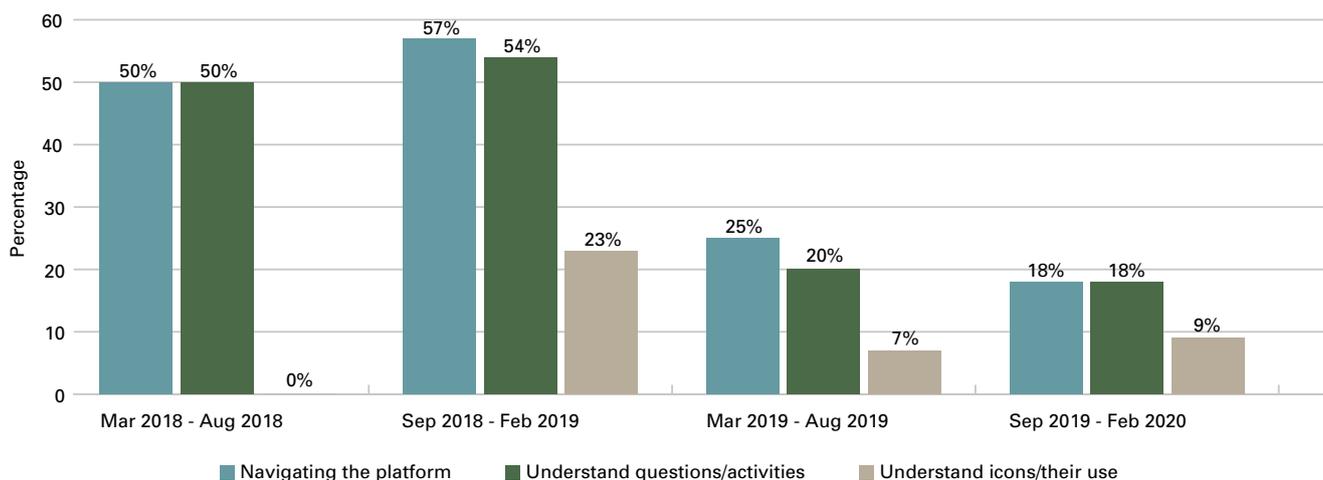
Source: Teacher feedback data
Notes: A total of 123 challenges were reported in feedback from 226 teachers.

When the course was first introduced to implementing partners in February 2018, teachers spent time navigating its content and incorporating the tool in their lesson plans.

In early stages of implementation, teachers reported various challenges for students regarding navigation, understanding questions and the icons within the software. Interviewed teachers attributed the initial limitations in understanding the user interface to its adaptation from the first initial version of the course designed in Swedish. Figure 4 indicates how as the course development progressed, the share of teachers providing feedback on challenges related to user interface decreased substantially.

Co-creation of the course for the Greek context, building on feedback from implementation to software developers was not always straightforward. Respondents described how at the beginning providing feedback was time consuming, and communication between partners was not always clear. For instance, teachers used various communication channels (e-mails, phone calls and reports) to provide their feedback and with varying frequency. Teachers also reported having a lack of clarity on whether their suggestions had been received and taken into consideration. This sometimes resulted in repetitive feedback. Akelius designers confirmed that the early process for feedback collection made collating and responding to teachers' suggestions difficult and slow.

Improving communication to improve implementation

All stakeholders took key steps to improve the co-creation process. Akelius and UNICEF also invested time and resources to make adaptations. To improve the two-way communication, a standardized teacher feedback form was developed by UNICEF, through close consultation with teachers, with a design based on what would be useful to improve implementation. The Akelius software team, together with the global partnership manager, officials from the Akelius foundation, and UNICEF Headquarters, and Office of Research staff visited Greece to observe implementation and discuss with teachers and students when launching major updates to the software. These visits allowed stakeholders from each organization to learn about implementation and adjust the software development strategy and the partnership. A team collaboration software (Trello) was introduced to facilitate direct communication between the software team, teachers and UNICEF so as to provide real time visibility on what changes were being made based on feedback, which adjustments required additional time, and which were not possible. UNICEF Greece also brought onboard a local project manager whose role was critical to consolidate and coordinate feedback between the various stakeholders.

Adaptations leading to improved integration of technology in classes

As a result of feedback from implementation, several content-related updates (such as an enhanced user interface, additional visual cues and sounds), additional games and activities and offline capability were gradually incorporated into the course throughout 2018 and in early 2019. With each new version, GSL teachers reported higher rates of student satisfaction and increased duration of use within their classes (*see Figure 5*). Only five per cent of teachers who provided feedback reported using the course for 30 to 45 minutes within their two-hour classes between March and August 2019. This percentage increased markedly over the September 2019-February 2020 period (42 percent),[13] suggesting further integration of the tool into their teaching practices.

Figure 5: Duration of use reported by teachers within their 2-hour class and changes over time (March 2019–February 2020)
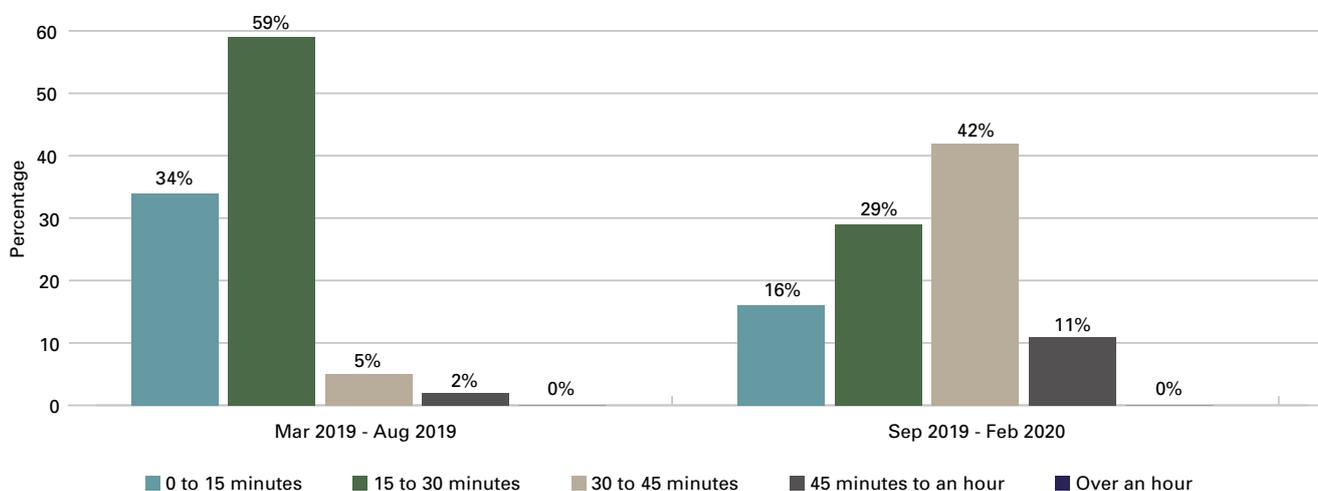
Source: Teacher feedback data, March 2019–February 2020

The way teachers used the course in their classrooms also changed over time. While the first version of the digital course was used in classes mainly as recreation and a reward for students, subsequent iterations of the course were used for more substantial teaching purposes. These included: as a tool for reviewing concepts, introducing students to lessons and as main focus for a lesson (*see Figure 6*). This change in use of the course in classes corresponds to major updates and improvements to the content and user interface, indicating that changes based on feedback from implementation helped teachers integrate the course within their lesson plans and students to use the course.

13 According to teacher feedback forms collected between March 2019 and Feb 2020, 91 per cent of teachers used the digital course once per week and nine per cent used it twice a week. This finding confirms teacher testimonies and classroom observations. In learning centres visited between December 2019 and January 2020, the course was used once per week, at all educational levels (including adults) for approximately 30 to 45 minutes.

Figure 6: Use in classes reported by teachers over time (May 2018–April 2020)
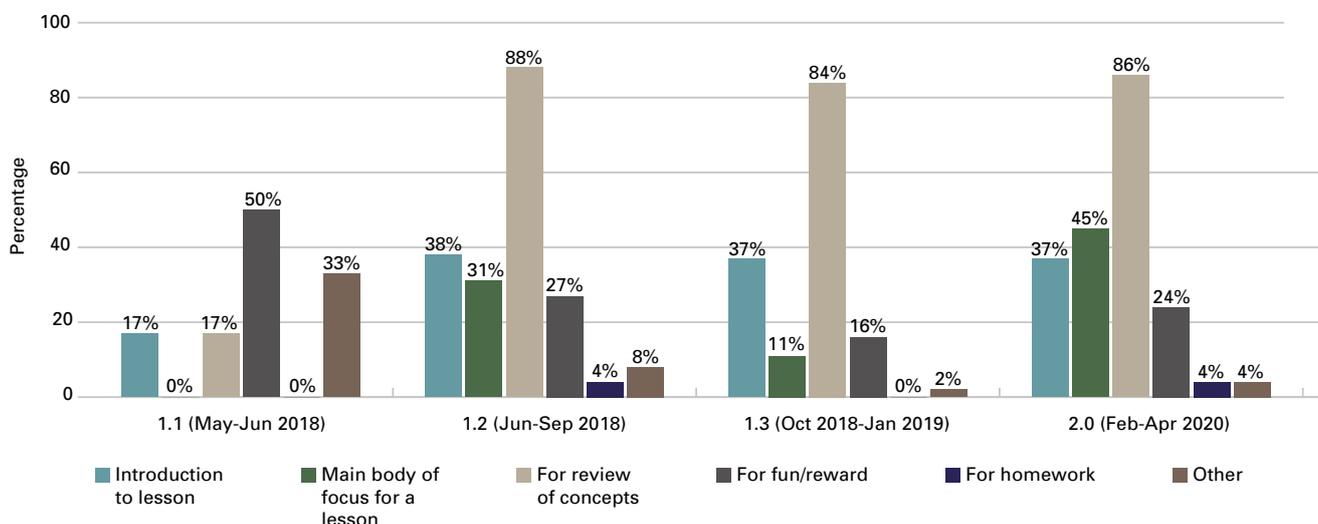
Source: Teacher Feedback Data, May 2018–April 2020

Interviewed teachers at the five selected learning centres[14] confirmed that the course content has been constantly improving based on their feedback. Yet, at the time of fieldwork they also identified further areas requiring additional attention, including:

- The need for an increased focus on grammar;

- increased content for both absolute beginners and more advanced students (B level);[15]

- more content aimed at adolescent students, who found some activities too juvenile and whose continued engagement remained limited as a result, and;

- additional content from a wide range of subjects, such as mathematics and geography, which would further increase possible uses in the classroom, and consequently, the frequency and duration of in-class use.

It is noteworthy that additional content is continually being developed with the goal of addressing the needs listed above and to further improve course use by learners of different levels and ages.

> "I have older students who are quite advanced. They have done the exercises on the tablet a hundred times and they know all the answers already. It would be useful to have constant updates to keep those students interested in using it. It is a pity because they really enjoy it. On many occasions, though, they find it to be quite child-like. Dialogues and images have to correspond to adult life too."
>
> –Teacher, March 2019

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14   All teacher FGDs were conducted between December 2019 and January 2020.

15   The Common European Framework of Reference for Languages is a guideline to describe language learning achievement across Europe. They are 6 levels: A1 – breakthrough or beginner, A2 elementary, B1 intermediate, B2 upper intermediate, C1 advanced, C2 mastery – A0 is used to described content for absolute beginners. At the time of the fieldwork, A0 content was restricted to a few images or single letters (instead of grouped letters). Teachers stated that additional A0 content was needed to effectively address the educational needs of the absolute beginner students. B-level content was under development.

3.1.2. Hardware, software and connectivity

Hardware and connectivity limitations are important obstacles to the effective use of the digital learning course in classes. Dedicated IT staff are not available at most learning centres, so responsibilities for providing technical assistance and storing devices fall largely on centre directors. Centre directors, and teachers often have varied levels of knowledge of IT when it comes to troubleshooting issues.

With the introduction of offline capability in February 2019, the course was able to be used in low-connectivity contexts. UNICEF Greece worked to scale the course to learning centres across Greece, by both direct partners and other education actors interested in using the tool for their classes. Even offline, a stable internet connection is needed initially to download the software onto the tablets and for software updates. This process can be time-consuming. Interviewed teachers stated that ensuring that the offline version is up-to-date is one of the biggest issues they face. Updates are not always successful so on some occasions students in the same classroom used different versions. While addressing these issues has been relatively straightforward in higher connectivity areas, such as urban Athens, they have been more taxing in rural and camp sites with lower connectivity (*see Figure 7*). To address connectivity challenges, teachers have come up with creative solutions, such as moving the tablets outside of the learning centres into higher connectivity areas in order to facilitate software updates. Responding to this challenge, the Akelius development team added a functionality called 'Mesh Net' in early 2020 that allows tablets to synchronize from one another without an internet connection. To use this function an update needs to be downloaded to only one tablet per centre, as the rest can be updated locally without connectivity.

Figure 7: Technical challenges reported by teachers, by location (2020)
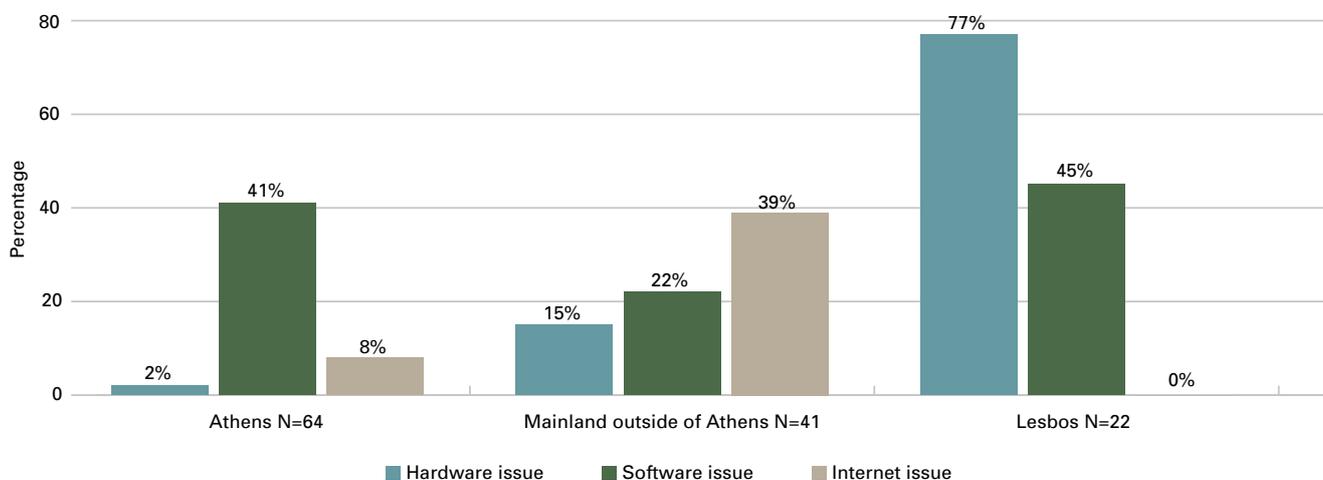
Source: Teacher feedback data, March 2018–February 2020
Notes: Camps in Athens (Eleonas, Skaramagkas) are included in Athens. Lesbos includes three different camp locations (Tapuat, Gekko Kids, and Kara Tepe).

> "Sometimes it [the course] works, sometimes it doesn't. Updating is the hardest and very time-consuming. We have very low connectivity here at the Learning Center. Sometimes I take them at my home to update them all, one by one, 40 tablets... so they can be operational the next day for the students."
>
> – Learning centre officer, February 2019

Storing the tablets securely is also a challenge in Greek refugee and migrant settings, where tablets represent a high-value item. Hardware storage protocols have been developed but need to be further adapted to the specific context of each implementation site. Storage of tablets in camp sites can be unsafe due to risk of theft. Some learning centre directors reported having to move the tablets daily into the locked main offices or to their homes.

3.1.3. Teacher training

A one-day training was provided by the UNICEF and ELIX teams to all new implementing partners that introduced the digital language learning course into their GSL classes from February 2019 onwards. The aim was to introduce teachers to the software and help them to develop strategies to integrate it into their lessons. Multiple on-site visits and provision of support by UNICEF education specialists increased teachers' confidence in using the technology and strengthened the partnership with new implementing partners. However, there is a high turn-over of teachers in locations where the programme is being implemented. As a result, some recently recruited teachers that participated in the FGDs reported that they had not yet received training on the course and its use.[16] Teachers who had received the induction training, stressed the need for refresher courses, especially after the deployment of new versions with major updates to content or user interface.

Interviewed educators recognized the value added of the digital language course, stating that incorporating the course in their pedagogical plans encourages them to think creatively about making the best use of its various thematic elements, a process that they generally perceive as fruitful.

However, GSL teachers also identified initial challenges in engaging effectively with the technology to blend it into their classes. Hence, a comprehensive teacher guidance manual was developed by partner Ana Aqra[17] in collaboration with UNICEF and ELIX, and an online tutorial was also developed by UNICEF in Greek.[18] The current version of the manual[19] is informed by teacher experiences in Greece and Lebanon and highlights promising practices that have emerged from use of the course. The manual aims to enable teachers to prepare the classroom environment and provides pedagogical strategies for blended learning, including techniques for small group activities and for adjusting their teaching style to classrooms with various learning levels.

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16   Five out of the fourteen teachers that participated in the FGDs had not received training at the time of the fieldwork.

17   An implementing partner in Lebanon, where the Akelius digital language course (in French and English) is also implemented.

18   However, at the time of data collection not all educators were aware of these resources. Official translation of the manual to Greek was completed in December 2019.

19   https://www.teach4integration.gr/wp-content/uploads/2020/03/AkeliusENG-1.pdf

3.2. Programme effectiveness

3.2.1. Association of the Greek Akelius Digital Language Learning Course with learning outcomes

The use of the Akelius digital language course is associated with improvement of students' Greek language skills. Quantitative and qualitative analysis suggest that the use of the course is the most useful for speaking (vocabulary, pronunciation and familiarity with new words), writing and listening skills. The association between course use and reading skills is statistically significant but at a lower level and varies more according to the students' level of language proficiency and age.

Empirical results on learning outcomes

The association between course use and learning outcomes was estimated using Propensity Score Matching (PSM). The PSM method matched students in GSL classes using the digital course (treatment group) with those not using the digital course but with similar demographic characteristics (comparison group) in order to create two comparable groups and estimate learning outcomes differences between them.[20]

Learning assessments in GSL classes were conducted across four domains of language learning (speaking, listening, writing and reading). Table 1 shows the average assessment scores in the PSM sample across the learning domains by gender and age group. There is no significant difference in scores between girls and boys. Meanwhile, as expected, older children perform better, in general, than their younger peers.[21]

Table 1: Learning assessment scores (average, on a scale of 10) by gender and age-group (PSM sample of 594 students)

Variable	Listening	Speaking	Reading	Writing
Girls	8.6	7.6	7.3	5.6
Boys	8.8	7.7	7.7	6.1
Less than 8 years old	7.9	5.8	4.4	2.9
8 to 11 years old	8.5	8.0	7.2	5.7
12 to 15 years	8.9	7.8	8.0	6.3
16 years and older	8.9	7.5	8.3	6.9

20 Observable characteristics used in matching were: age, gender, mother tongue, nationality, number of calendar days enrolled in the learning centre, enrollment status in public education and number of tests taken. See Annex for more information on the PSM estimation.

21 Across the domains of writing, reading, and speaking children aged 8-11 score higher than those aged below eight (significant at the 1 per cent level). Students aged 12 to 15 score higher than those aged 8-11 on reading (significant at the 1 per cent level), listening (significant at the 5 per cent level) and writing (significant at the 10 per cent level). Students aged 16 and older score higher in writing than those aged 12-15 significant at the 10 per cent level.

Table 2 presents the main findings from the PSM: the use of the digital course is associated with, on average, an increased score (on a scale of 10 points) in writing of 1.66 points, in speaking of 1.65 points, in reading score of 0.65 points and in listening of 0.64 points.[22] These increases are equivalent to improvements over the comparison group, of 8 per cent for listening, 9 per cent for reading, 25 per cent for speaking and 34 per cent for writing skills.

Table 2: Estimates of the improvements in learning assessment scores (on a scale of 10) associated with the use of the language digital course, by language domain

	Listening	Speaking	Reading	Writing
Estimated improvement associated with the use of the course	0.64** (0.280)	1.65*** (0.288)	0.65* (0.342)	1.66*** (0.359)

Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. After the matching procedure n=594 students, including 372 having used the course (treatment) matched with 222 not having used the course (comparison).

Qualitative analysis confirms the positive association of the course with language learning outcomes. It brings additional information on the reasons explaining the positive results and how they vary across different age-groups and initial learning levels.

In relation to speaking outcomes, teachers and students systematically reported that course use positively influenced students' vocabulary knowledge, word recognition and Greek pronunciation. Teachers attributed the positive effects to the new learning practices children used with the digital course. When working on their tablets with headphones, the students can listen to each word and sentence multiple times and adjust learning to their own pace, while engaging in interactive games and activities. Students also frequently repeat what they hear and sing the songs they learned using the course, which further helps improve language skills. However, some teachers who participated in the FGDs suggested that integrating a speech recognition tool (checking pronunciation) in the course would further improve oral fluency.

In relation to listening skills, teachers reported that the use of headphones improves students' concentration. And, through the interactive nature of the varied games and activities, teachers reported that children increased their vocabulary and comprehension of Greek.

In relation to writing skills, teachers and students suggested that the reasons explaining the course's effect varies according to the recipients' level of language proficiency and age. Teachers explained that writing in a new language is a daunting and slow process, especially for students who did not have access to education prior

"[The course] helps a lot with vocabulary and word retention. A child feels very inadequate when they do not understand what is going on in the classroom. Because the course gives them the opportunity to go back and listen to a word over and over again, it sticks with them. And because they can navigate the course easily they understand how to press etc., they feel more confident. It makes them feel like 'I figured it out, I played the game, I had to do it a few times, but I finished it and I got a thumbs up'. So, I think this is encouraging. Especially for the children with low confidence."

–Teacher, December 2019

22 The analysis uses the last assessment results of all students in the sample. To control for potential bias coming from students taking different numbers of assessments, the number of tests is included in the PSM. It should be noted that the software used in classes has evolved during the period of the learning assessments, which may have affected the results. Subsequent analysis with a larger sample, and more stable version(s) of the software could lead to more precise estimates of course effectiveness.

to leaving their countries of origin, and for whom even holding a pen is a new skill that requires practice and effort. While the use of a tablet mitigated that difficulty for early learners (who are more comfortable using a keyboard than paper and pen), GSL educators stressed the need to enhance conventional writing skills. They recommended the use of digital pens and the addition of exercises that would require students to make use of their writing in a notebook. Older students (usually in more advanced classes), take notes of new words, more often than their younger peers, which may have contributed to enhance their understanding of letters and the alphabet as well as improving their handwriting.

> "The teacher doesn't need to be checking all students at all times and this is independence, for both teachers and students. Older students tend to take their notebooks out and take notes while using the platform such as writing down the translation in their native language or taking a note of what was written on the board. I think this is very much blended learning – mixing traditional teaching with technology."
>
> – Implementing partner manager, January 2020

Qualitative evidence also indicates that the digital course positively influenced reading skills. Teachers suggested that the embedded audio files and short sentences assist students, in particular early learners, in forming and dividing words into syllables and thus prepare them for reading. Exercises that require students to associate a picture cue of an object with the target sound seem also to be especially useful for early learners, as they help them understand the relationship between letters and sounds.

### 3.2.2. Student attendance, school readiness and participation in formal education

> "Students love it! They are always very excited when we are working on the tablet! They easily concentrate, far easier than in the typical class. They work on their own with their headphones on and they are also trying to achieve a high score, which promotes learning. I have also noticed that students who don't take part in the typical class for all sorts of reasons, when the tablet is offered, they always want to make use of it."
>
> – Teacher, January 2020

Qualitative analysis indicates that the digital course increases the appeal of learning for students, and their engagement in their own learning process. This is especially important for refugee and migrant children who may have limited experience with formal education, may be unable to read and write in their first language, and for whom learning can be a particularly challenging process. Teachers reported that using the digital course, several students who were unfamiliar with the workings and routines of schools were more confident, tended to believe more in their capabilities and had a stronger motivation and interest in learning.

Lack of confidence and intrinsic motivation to learn often result in withdrawal from class and school dropout. Qualitative evidence suggests that the digital language course has helped prevent students dropping out. Teachers reported that the course played a role in encouraging students to attend classes at the learning centres. For students at early stages of language learning, the course turned the learning process into a fun experience. Students who had trouble engaging in the learning process overall and were at a lower level than the rest of the class, appeared to do particularly well when using the course (*see Figure 8*).

Figure 8: Teacher perceptions on the usefulness of the course for students falling behind the class

■ Strongly agree ■ Agree ■ Neither agree nor disagree ■ Disagree or strongly disagree
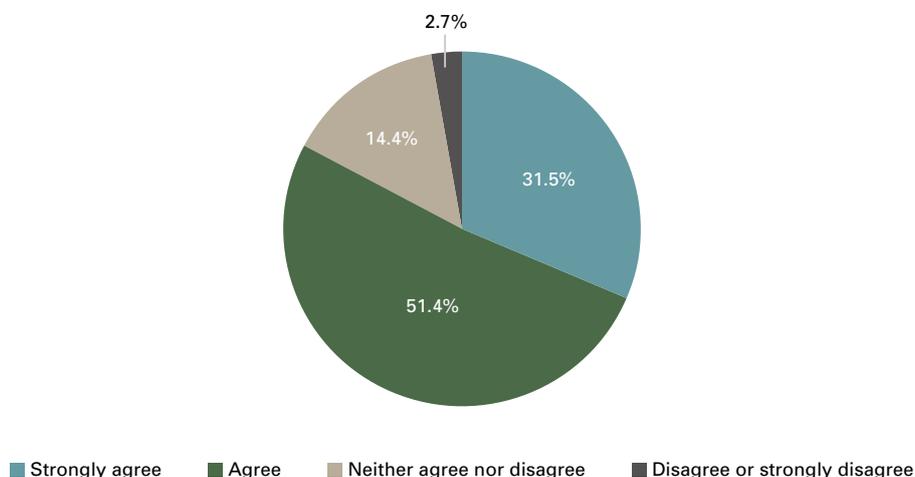
Source: Teacher feedback data, March 2018–February 2020

Learning centre officers and teachers explained that interactive learning using games, visuals and multimedia made language and related concepts more meaningful to those students. Teachers explained that the introduction of increased difficulty levels for games, and the instant feedback and scoring that the course provides at the end of a lesson, were particularly useful in keeping students motivated and engaged.

Attending a Greek formal school is often a 'scary' process for students who lack any prior knowledge of Greek. During FGDs, migrant and refugee students confirmed that language limitations were a barrier for attending formal school, and that their attendance in learning centre classes played a significant role in overcoming this. Students reported that the use of the course within classes allowed them to better understand the benefits of education. Teachers reported that the digital course promoted mutual support amongst students and increased their self-esteem, making it more likely they would attend both the learning centre classes and a Greek formal school.

"Students are more likely to come to class in the first place and to continue to come to class when they are allowed to use the digital course. I think that they love to work with a tablet, having their headphones on and being exposed to something … let's call it fancy."

– Learning centre director, December 2020

"One of the biggest advantages of the digital course is that it increases attendance, perhaps because it makes children's experience within class more interesting. What we have seen is that the mere fact that they are using the tablet that Akelius provides, incentivizes students to attend classes. This certainly pertains to the short term -- hopefully also to the long term."

– Akelius designer, January 2020

4. Lessons learned and recommendations

This section summarizes the main lessons learned and related recommendations stemming from the development and journey to scale of the Greek Akelius Digital Language Learning course in Greece. Recommendations are relevant for the UNICEF-Akelius partnership and for the wider Ed Tech community, educators, international organizations and governments seeking to incorporate Ed Tech into learning processes.

4.1. Education technology developers

- **Education technology is not a silver bullet and is effective only when guided by a clear pedagogical approach**. The provision of hardware alone is not enough to improve learning outcomes. Ed Tech initiatives work better when they are underpinned by pedagogic principles, such as active engagement of students (active learning) with clear learning goals. Collaboration with users and teachers prior to, and throughout, implementation are crucial for enhancing content relevance, cultural appropriateness and impact. Evidence from Greece indicates that a process of co-creation by software developers and implementing educators helps ensure that Ed Tech programmes are fit for their educational purposes.

- **Communication is key**. Translating from software development to implementation can take time and a large amount of effort. Clear collaboration and communication help in ensuring solutions fit for the context and in increasing end-user acceptance and buy-in. Evaluative approaches where developers set aside time to communicate with implementers and adjust software accordingly are more effective than approaches focused on short-term fixes.

- **Designing Ed Tech for the most marginalized means developing (and testing) tools for low connectivity settings.** Even in high-income countries, in order to reach marginalized groups, organizations developing Ed Tech solutions should design and test their tools in low connectivity settings. In Greece, making the course downloadable and usable offline allowed its rapid expansion to refugee camps and accommodation sites with poor connectivity. Continual refinement of content to reduce and optimize file sizes will further improve the use coverage. Globally, for digital tools to be useful in humanitarian contexts, the right balance should be found between high quality interactive content and optimizing applications to be lightweight enough for low connectivity deployment.

4.2. Educators

■ **Using technology in a blended approach can have benefits especially in classrooms with learners from various levels.** Evidence from GLS classes in Greece, which are characterized by having children with various linguistic backgrounds and learning levels, indicates that students benefit from the self-paced functionality of the course. Teachers report that the interactive nature of the course, with games, and instant feedback after lessons, increase students motivation, self-esteem and engagement in the learning process. Such features ensure that on-level and advanced students do not become bored and that struggling students do not experience frustration and can revisit what is taught in the classroom at their own speed.

■ **Continuous teacher training approaches are essential, in particular in humanitarian settings**. The use of technology in the classroom is more than learning how to use a software. It should be closely linked to the academic goals, and methods of teaching in the context. Evidence from Greece shows that adapting to blended learning can be challenging for some teachers. And the frequent teacher turnover, inherent to the humanitarian situation and volunteer status of many teachers, also add challenges for the effectiveness of teacher trainings. An online training and a teacher guidance manual on how to integrate the technology within lessons were provided to respond to these needs. Globally, with the expansion of remote learning due to the COVID-19 pandemic, developing innovative ways to improve teachers' skills using digital learning is more important than ever.

4.3. International organizations and governments

■ **Connectivity is an urgent need that should be invested in.** High quality connectivity can unlock education tools and content for children. However, the quality of connectivity varies greatly within countries and can be extremely expensive and inaccessible for marginalized children and families. This research from Greece shows that even in a high-income country, quality connectivity is not a given and remains a major barrier for successful use of the technology. While improving connectivity infrastructure is a long term goal, practices like "zero-rating"[23] quality education content and subsidizing internet costs can make digital learning accessible to more children in the shorter term.

■ **Investments in the language skills of refugees and migrants are critical for improving their access to education in the host country.** The UNICEF-Akelius partnership is supporting refugees and migrants to enter and learn in Greek formal schools. The Greek digital course content is aligned with the Ministry of Education (MoE) GSL curriculum. It facilitated its approval as an MoE recommended tool for remote learning during COVID-19. Globally, additional resources are necessary for large-scale efforts to prepare refugee and migrant children to enter formal education systems and succeed in host societies.

■ **Developing Ed Tech for vulnerable groups is a challenging process that requires both collaboration with communities and monitoring and evaluation tools**. Governments' and development partners' programmes that are designed with space to iterate and improve are the most promising. Crafting effective partnerships with local stakeholders, including civil society organizations, telecommunication companies and parents takes time, but is essential for the effective delivery of Ed Tech.

■ **Building monitoring and research into implementation of Ed Tech programmes is crucial to improve their design, delivery and use.** As integrating technology into a learning process comes with challenges along the way, investing in monitoring and evaluation, learning assessments and research to understand what works and the how to, is key.

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23   Sometimes referred to as 'toll free' or 'sponsored' data.

- **Further research on the Akelius Digital Learning course is needed to keep on informing its continued development.** As the UNICEF-Akelius partnership expands, additional mixed-methods (quantitative and qualitative) implementation research would cover topics beyond the scope of this report, in particular:

- **Sustainability of effects of digital learning over time and in new contexts –** exploring the longer-term effects of the course (including on the integration of students into formal public schools), and its effectiveness for different languages, new subjects and across multiple implementation settings.

- **Different use cases for digital learning** – examining the process and effectiveness of using digital courses for various modalities of blended learning and self-learning, including adaptations made to implement the course remotely during COVID-19.

- **Co-creation as the programme scales** – exploring how the co-creation and implementation of the course changes as the course expands to new languages and new contexts involving new challenges.
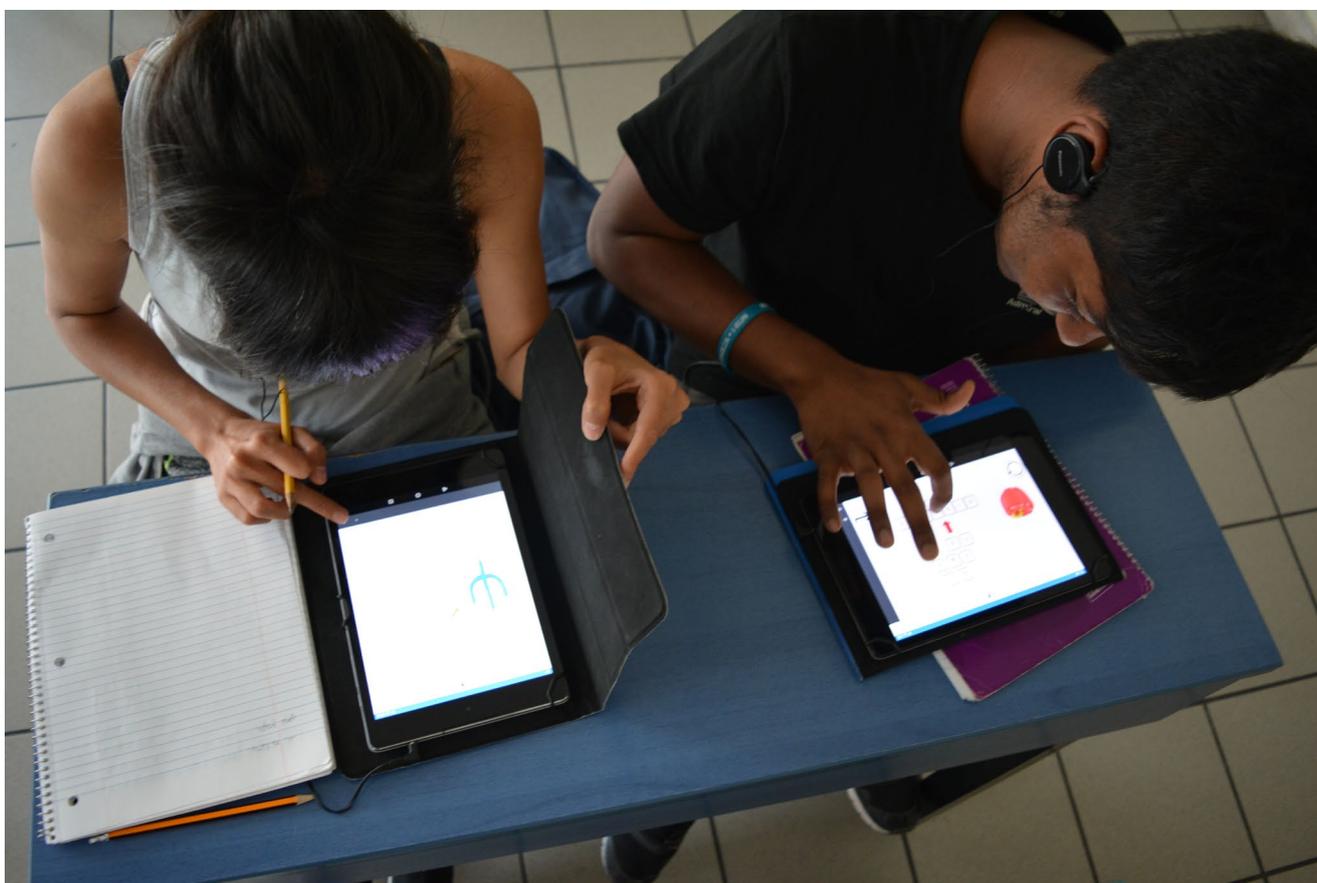
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Annexes

Annex 1: Quantitative sampling and analysis

Propensity Score Matching (PSM) was used to estimate the association between the use of the digital course and learning outcomes. This Annex describes the empirical strategy used to conduct the analysis.

1. Dataset

Datasets were provided by the first GSL implementing partner (ELIX). The dataset included information about students from seven learning centres on:

i) **Socio-demographics**: age, gender, mother tongue, nationality and formal school enrolment status;

ii) **Attendance**: date of enrolment in the learning centre and number of days of enrolment in GSL classes;

iii) **Learning outcomes**: learning assessment scores in four language skill domains (speaking, reading, listening and writing) and number of tests taken since they entered the learning centre.

The total sample included 969 students, with information across the three areas for the period from January 2018 to November 2019. By comparing the date of enrolment in the learning centre with the date of introduction of the course in the GSL classes each student was either included in the treatment group or in the comparison group.

2. PSM estimation strategy

The application of PSM involved several steps. First, a probit model estimated the probability of having access to the digital course (propensity score) using observable characteristics of the students: gender, age, nationality, mother tongue, enrollment in formal education, calendar days enrolled in the learning centre and number of tests taken. Students with similar propensity score across the two groups (treatment and comparison) were matched based on a Kernel distribution. The Kernel distribution was chosen in order to reduce the bias and provide a stronger match between observations.

When students were unable to be matched (with too high differences of propensity scores), they were dropped from the PSM estimation, and thus not used in estimates of outcomes. The PSM estimation was then done using a sample of 594 students, including 372 'treated' students matched with 222 students in the comparison group. Finally, differences in assessment scores (for each of the four domains) between the two groups were estimated and tested using that sample (*see* Table 2 in the main body text).

Table 3: Summary statistics for the treatment and comparison groups

Variable	Comparison group (not using the course)	Treatment group (using the course)
Age	11.6	12.3
Girls	47.7%	45.2%
Enrolled in formal school	69.8%	61.0%
Afghani	50.9%	56.5%
Iraqi	10.8%	12.1%
Syrian	28.8%	22.3%
Other Nationalities	9.5%	9.1%
Arab	36.0%	26.9%
Farsi	46.0%	51.6%
Kurdish	3.6%	7.5%
Other languages	14.4%	14.0%
Calendar days enrolled in the learning centre	210.3	258.7
Number of tests taken	2.1	2.4
Listening score (out of 10)	8.31	8.90
Speaking score (out of 10)	6.64	8.24
Reading score (out of 10)	6.84	7.83
Writing (out of 10)	4.94	6.42
Number of students	222	372

3. Assessment of the Matching Quality

Following best practice suggested by (as suggested, inter alia, by Caliendo and Kopeinig (2005) and Sianesi (2004)), three tests were conducted to test the quality of the matching procedure (*see Table 4*):

(1) **Pseudo-R2** indicates how well the variables used in the matching explain the probability of participation (receiving the digital course). After the PSM procedure there should be no systematic differences in distribution of these matching variables between groups and therefore, the pseudo-R2 should be low (Sianesi (2004)). The results find a low pseudo-R2 of 0.012, indicating that the matching was successful.

(2) **The Chi-squared statistic** tests the joint significance (across variables used in the matching) between the two groups. The results of the Chi-squared test shows that there is no significant difference between the two groups.

(3) **Mean and median standardized bias** assesses the difference in the distributions of the variables used for matching (Rosenbaum & Rubin, 1985). The findings reported in Table 4 show a mean bias of 3.7 per cent and a median bias of three per cent. Most empirical studies recommend that a bias below five per cent is sufficient to indicate good matching quality (Lechner 1999, Sianesi 2004 and Caliendo et al., 2005).

Table 4. Tests of matching quality

Pseudo-R2	Likelihood ratio chi2	p>chi2	Mean bias	Median bias
0.012	12.49	0.982	3.7	3

4. Limitations

The PSM cannot control for unobservable differences between the groups, that may drive both outcomes and entry into a programme (in this case, entry into GSL classes using the digital course) that an experimental design would address. Therefore, this research, while attempting to make the strongest comparison possible given the implementation and data available, cannot fully be interpreted in terms of causal effects.

Annex 2: Qualitative sampling, data collection and analysis

This Annex describes the procedures involved in qualitative sampling, data collection and analysis.

1. Sampling

The study draws from qualitative data collections and school observations in five purposively selected Non-Formal Education (NFE) learning centres implementing Greek as a Second Language (GSL) Classes across Greece. In selecting learning centres, three criteria were used: geography (aiming for the broadest geographic coverage possible); location (rural/urban/refugee camp); and implementing partner (*see Table 5*).

Table 5: Selected learning centres

Implementing partner/ Learning centre	Location	Recipients
ELIX - Patission Learning Center	Athens city centre	Refugee and migrant children residing in downtown Athens
SOLIDARITY Now	Refugee camp – Volvi	Children residing in the Volvi refugee camp
ASB Community Center	Anagnostopoulou refugee camp – Diavata	Children residing in the Diavata reception centre
METAdrasi - Non-formal Education Center	Mytilene city centre, Lesbos	Unaccompanied minors residing in the Moria refugee camp
ILIAKTIDA – Integrated Child and Family Support Hub (TAPUAT)	Loutra (near Moria refugee camp), Lesbos	Students and families residing in the Moria refugee camp

2. Data collection

To collect qualitative evidence the UNICEF Office of Research team, in consultation with the UNICEF Greece Country Office, designed a range of instruments, including five in-depth semi-structured interview guidelines, two guidelines for FGDs and a structured classroom observation tool. The tools were translated from English to Greek and back translated into English to ensure accuracy and consistency.

To assess the duration and flow of instrument administration and the respondents' cognitive understanding of questions and key concepts, data collection tools were pre-tested in the Eleonas refugee camp (Athens - August 4, 2019). Prior to fieldwork, enumerators participated in a two-day training on qualitative research methods and ethics (Athens - December 2-3, 2019). All research instruments and fieldwork protocols were approved by the Health Media Lab (HML) and the Institutional Review Board of the Office for Human Research Protections in the U.S. Department of Health and Human Services Research. Fieldwork began on December 16, 2019 and was completed on February 7, 2020.

At each learning centre, interviews were carried out with implementing partner managers and learning centre directors. GSL teachers were invited to participate in FGDs or group interviews. In total, five teacher FGDs/groups interviews were conducted. All teachers serving in each learning centre participated in the FGDs/group interviews, with the exception of two teachers at one location who were on annual leave when data collection took place. Most interviewed teachers had a postgraduate degree in intercultural studies and a temporary or short-term contract with the learning centres. All respondents were fully qualified primary school teachers (N=10) or secondary school teachers (N=4).

Two FGDs with students were conducted at each of the five selected learning centres. Students were sampled based on their age (9-16 years) and gender and selected via lottery. Each of the ten student focus groups consisted of four to seven students. In total, 56 students participated in the discussions (25 girls and 31 boys). Participants were given stickers on which to write their names and asked to sit in a circle. The moderators made sure that students were fully informed about the purpose and content of the discussion and received assent from the participants and consent from their caregivers. A translator facilitated the discussion in most cases as many students could not speak Greek at a conversational level.

Enumerators also conducted ten classroom observations (two per learning centre) and used a structured observation tool (modelled after the World Bank's TEACH instrument) to collect observational data on three domains: i) classroom environment, ii) time spent on traditional and digital assisted learning, and iii) quality of teaching practices. Information on class length, delayed starts,and educational context was also captured. To avoid observer bias, the two enumerators used the tool independently and then compared notes to determine and assign an overall combined score for each of the assessed elements.

Finally, two Akelius designers interviewed via Skype and five Ministry of Education officials were interviewed face-to-face: the Educational Co-ordinator of the National Institute of Educational Policy in Athens and four Refugee Educational Co-coordinators (RECs) who were deployed in the various research sites. (*See Table 6 for details of sampled participants for each learning center.*)

Table 6: Sampled participants per learning centre

Region	Partner/Learning centre	Interviewees	Classroom observations	Teachers in FGDs/group interviews	Age groups in students' FGDs	Students in FGDs
Attica	ELIX	1 learning center officer, 1 Akelius focal point teacher; and 1 project manager	2	6	1 (9-12yrs)	3 girls 3 boys
					1 (14-16yrs)	2 girls 4 boys
lesvos	ILIAKTIDA (TAPUAT)	1 learning center director and 1 project manager	2	2	1 (10-14yrs)	3 girls 4 boys
					1 (15-17yrs)	3 girls 3 boys
lesvos	METAdrasi	1 learning center director and 1 project manager	2	2	1 (12-16yrs)*	3 girls 3 boys
					1 (14-16yrs)*	2 girls 4 boys
diavata	SOLIDARITY Now	1 learning center director/senior teacher***	2	2	1 (9-11yrs)	3 girls 2 boys
					1 (14-16yrs)	4 boys**
volvi	ASB	1 learning center director and 1 project manager	2	2	1 (9-12yrs)	3 girls 3 boys
					1 (14-16yrs)	3 girls 1 boy
total			10	10	14	10	25 girls 31 boys
additional Interviews		1 National Level Official; 5 Refugee Educational Coordinators; and 2 Akelius designers				

Notes: * All students at the METAdrasi LC were unaccompanied minors, aged 12-17 years old and the vast majority were boys. The learning centre had only six girls in total out of the 120 students at the data collection time. ** No girl was attending the class with the 14-16 years old group. ***The Learning Centre Director was also a senior teacher and took part in the FGD.

3. Data coding and analysis

The multi-faceted data generation strategy employed during fieldwork facilitated the collection of a large amount of qualitative evidence, allowing saturation and triangulation. Interviews and FGDs were transcribed word-for-word, resulting in approximately 200 pages of transcribed material. To systematically analyse and interpret this data, the research team employed Thematic Content Analysis (TCA). The approach used was *deductive logic* and entailed the use of a codebook. Coding was done manually, and data was organized into 17 pre-defined themes that were captured in the interview/FGD guides. In analyzing the coded data, analysts employed frequency measurements and various interpretive methods.

4. Bias risks and mitigation strategies

Response bias: The precarious living conditions and increased vulnerability of several students may have prevented them from fully engaging in the discussions and/or describing their experiences accurately. Similarly, it is difficult to assess how honestly teachers and learning centre directors responded to questions on the effectiveness of blended learning, as in some contexts participants may have perceived the study as potentially affecting their employment status. These limitations were taken into consideration when collecting data. Enumerators were trained to communicate the objectives and clarify any misconceptions regarding implications of voluntary participation, also highlighting the principles of anonymity and confidentiality.

Selection bias: The selection of children who participated in the FGDs was limited to the students who were in school on the day of the data collection. This means that students with higher attendance rates (and other characteristics associated with positive learning outcomes) may have been over-represented. To mitigate this selection bias, none of the learning centre visits was unannounced and students were informed about them well in advance.

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