From refugee to programmer? A framework for a collaborative coding program for higher education institutions

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Abstract

Purpose – The purpose of this paper is to share the lessons learned in teaching programming skills to refugees during a time when circumstances were changing quickly and constantly and the needs of the target group were not well known.

Design/methodology/approach – The integration of refugees poses serious challenges for the hosting society's education system. A large number of refugees can put a strain on all kinds of public resources, and difficulties with differences in languages, previous curricula, falling behind due to having to spend time outside of education, and psychological traumas have to be expected. In response to the refugee crisis and in order to manage mass migration, the adaptive nature and rapid development of civic approaches can contribute to overcoming some of these challenges. To evaluate the impact of civic approaches, the authors have paid attention to refugees{code} an Austrian coding school for refugees which was developed by the civic community and which shows great potential in terms of providing rapid, innovative and adaptive kinds of educational support for refugees, as well as helping to combat the lack of programmers in the Austrian job market.

Findings – As the great potential that initiatives like refugees{code} have for education, there are also substantial challenges. As we learned from the first course, course completion rates were very low. Therefore, it is important to build an infrastructure and a learning environment around the course. This learning environment includes providing mentoring and support, creating spaces where participants can learn. It was also found that having a pedagogically trained staff who is sufficient in the English language, too, is necessary to cater to a heterogeneous group. Also varying teaching strategies according to the needs and skills of the learner is necessary. One of the issues that confronts projects like refugees{code} is also receiving legal status. The collaboration with universities and colleges can be greatly helpful because they are already familiar with the structure of public authorities as well as with heterogeneous groups. Initiatives like refugees {code} are agile and flexible and know how to take advantage of that. The authors conclude that bringing successful education to heterogeneous and culturally different groups is multi-faceted. It is not something any individual organization or project can do; it can only be the result of a system of different actors working together with traditional educational institutions.

Originality/value – This research study reports on two courses of programming for refugees and seeks to offer practical advice for further research and for the implementation of such courses into the educational system. Therefore a framework is proposed which should be taken into account in case of doing similar work.

Keywords Teaching, Programming, Integration, Europe, Austria, Refugees, Coding

Paper type Research paper

Introduction

Beginning in 2015, hundreds of thousands of people sought refuge all over Europe, the Middle East and North Africa, fleeing from war, poverty, violence and persecution. This record-high displacement of people, dubbed the "refugee crisis," did not just put

countries' social security systems to the test, but their educational systems as well. Of the 1.2m first-time asylum applications in Europe 2015, Austria, together with Germany, Hungary and Sweden, received around two-thirds of the EU's asylum applications and is on the top recipients of asylum applications per capita[1]. Due to the scale of the human tragedy, the high level of global awareness and the coverage by the media, a novel and diverse constellation of people, especially from the civic community, responded extraordinarily quickly to this crisis and supported refugees with many different measures and means (Mason *et al.*, 2017). Looking beyond providing basic services to newcomers, questions of integration in the host society needed to be addressed. For this, access to training and education proves to be one of the main factors in response to these new challenges (Korac, 2003; Rooth, 1999; Stevenson and Willott, 2007). To mitigate the risk of a parallel society, the Austrian government promoted language courses, and ordered integration courses and competence checks (Gruber, 2017). While potential stakeholders in the refugee crisis, traditional educational institutions like universities and schools were not able to rise to the challenge nearly as quickly as self-organized volunteers, groups and organizations. The lack of flexibility due to the complexity of internal processes, the strict requirements and the lengthy internal decision-making processes of said educational institutions made it difficult for them to act responsively to the exceptional situation. In this context, civil society stepped in, organizing initiatives for quick and direct integration of the newly arriving people, regardless of age, gender and level of knowledge.

A subset of these initiatives included a substantial number of learning and training programs, in search of meaning and denominator with the newcomers from classes of cooking and knitting to ways to work with charitable organizations or formal vocational training. With the question surfacing about what skills may be most valuable to newcomers, technical skills seem to be the most future-proof as an important factor in work and society. We therefore look into a computer science topic, namely programming. The civic approaches of coding schools founded during the refugee crisis, namely an Austrian initiative named refugees{code}, serves as our case study.

First, we will begin by characterizing coding initiatives in Middle Eastern, North African and European countries, who play a particularly interesting role in the landscape of coding for refugees. Second, we will discuss the background of our case refugees{code} and further explain our research question and design. Third, we present a description of our action-based research, outlining two different courses. Fourth, we give an overview of our results and findings from our action-based research and discuss some challenges as well as solutions and lessons learned common to educational projects for refugees. Finally, we conclude and deliver a framework for educational institutions like universities and colleges that would like to offer courses for refugees.

Overview about coding initiatives
One kind of initiative that emerged during the refugee crisis in 2015 were refugee coding schools, which are training newcomers to code and thereby filling job market demands. In Europe, the Middle East and North Africa, we have identified ten such initiatives (see Figure 1). Since people are still fleeing, not only having to leave behind their homes, but also their current plans for education, still more such projects seem to be forthcoming. As a result, there are a growing number of coding schools not founded by public or educational institutions. Rather, they are founded by a new breed of technology-savvy groups and organizations consisting of people with varying, but often tech-based, backgrounds, an affinity towards start-ups and a tendency to care about social issues (Mason *et al.*, 2017). They are often, either partly or entirely, driven by volunteers, and they aim to become social enterprises which achieve sustainability through a business model rather than external

Figure 1.
The landscape of
coding initiatives for
refugees in the Middle
East, North Africa
and Europe

funding (Mason *et al.*, 2017). Although they share the same objectives as educational institutions, their work is done by rapidly and iteratively testing ideas in a way that traditional education institutions cannot because of limiting factors such as regulations, internal processes or mere traditions.

The educational teams of these coding schools are characterized by their entrepreneurial mindset. They demonstrate a high degree of flexibility and personal initiative and work either unpaid or for nominal wages (Mason *et al.*, 2017). As an example for such a civic project, "Kiron Open Higher Education" was founded in September 2015 by a group of students in Berlin. It aims to support refugees by giving them access to Massive Open Online Courses (MOOCs), and at the same time fast-tracking their entry into the university system. The idea is that after completing two years of study online, students can apply to transfer to a partner university where some of these online courses count toward a fully accredited bachelor's degree.

An example of such a civic project which offers courses for refugees on software development to subsequently find work in the IT sector is refugees{code} in Austria. It was founded in the summer of 2016 by a group of people in Vienna. Refugees are offered the opportunity to study during the time in which application for employment or a university place are unlikely to be successful due to lack of proficiency in the local language. This is not only an efficient use of their time but can give them focus and structure in a period of being in a state of limbo. "At worst, one of our participants has to leave Austria. If that is the case, then at least they will have learned something that they can use anywhere in the world," says refugees{code}-founder Stefan Steinberger. He got the idea for refugees{code} after having a conversation with Dominik Beron from "refugeeswork." Beron explained to him that software developers were in high demand, and that many companies believed they would find staff members through refugeeswork. This lead to refugees{code}, which was founded by three co-founders, one of them who had already been doing volunteer work with refugees.

"We had to choose between letting another semester go by while we were still fleshing out the concept, or just going ahead and starting," says Steinberger. It was decided to offer the course as quickly as possible, to put together an ad-hoc course in a rather unusual situation. "The University of Technology of Vienna had already been holding courses that were open to refugees, and after talking with the initiators of these 'Welcome.TU.code'-courses, we were able to take over and hold one of those," Steinberger noted[2]. Before founding refugees{code},

none of the team members had any experience with implementing such a program. Even though the University of Technology of Vienna already had been holding courses that were open to refugees, they were facing the problem that they were not able to hold course sequentially because the participants were just not attending. Therefore, cooperation with the University of Technology of Vienna was established and a project plan was developed via a few meetings and e-mails.

Research question

Institutions of higher education have an educational mandate when it comes to the future of work and society. "Coding should be a requirement in every public school,"[3] said Timothy D. Cook, the Chief Executive of Apple. On the other hand, Jane Margolis, Senior Researcher at the Graduate School of Education and Information Studies at the University of California points out that "it gets very problematic when industry is deciding the content and direction of public education"[3]. Teaching coding courses has to become an integral part of the educational offer in higher education institutions, but we share the opinion of Angela Hemingway, executive director of the Idaho STEM Action Center, in that industry, education initiatives and higher education institutions shall be "collaborative partners"[3].

We must survey the properties required to effectively and efficiently conduct coding courses aimed at heterogeneous and culturally diverse groups like refugees to be developed and held by institutions of higher education. Initiatives founded by the civic society during the refugee crisis might be able to point the way. Therefore, this research work focuses on the following research question:

> *RQ1.* What are the design parameters of a framework for institutions of higher education in order to develop coding courses appropriate for the needs of heterogeneous and culturally diverse groups?

This research work defines a framework with the most decisive and determining factors of implementing coding lessons for cultural diverse groups at traditional institutions like universities and colleges.

Research design

In the run-up to the first course, we developed a short questionnaire for the applicants. Based on the results, the decision was made to build our research and the course environment through a collaborative approach. Due to the urgency of the situation, the rapid kick-off date of the pilot program, and the large uncertainty about the target group and effective approaches, we needed to research and develop the program at the same time. In such a context, a participatory method is most suitable, by collaborating with the target group and feeding results of the research directly back into practical application. Especially the empirical technique called "action research (AR)." This method is described as participative, cyclic research approach directed towards both research and action (Lewin, 1946). It was found to be the appropriate method for this case because it addresses practical problems in a positive way by feeding results of the research directly back into practical application. This approach allows for the creation of knowledge by means of directly experienced innovation by developing strategies for achieving an improvement in a particular situation. For the development of this program, the formulation of critical hypotheses for each course cycle was essential and allowed us to research the fundamental success factors, while still allowing for practical implementation and responsiveness to our participants.

AR thereby addresses the problem of division between theory and practice by integrating the development of practical application with research knowledge in a cyclical process

(Somekh and Zeichner, 2009; Popplewell and Hayman, 2012; Rose *et al.*, 2014). We worked with constant evaluation cycles and used feedback for maintaining the current course and for designing the next course cycle. The model used in this research is outlined in Figure 2.

During the planning phase, relevant issues with the current situation were identified and ideas for improvement were developed. Interventions were discussed and planned in advance of the action phase. During the activity phase, interventions were carried out. Efforts in the intervention were documented, and data were collected (observation notes, surveys, reflections, interviews, etc.) and analyzed.

A thorough review of a given situation along with past actions can enable a new implementation cycle to improve the process. The end of one AR project may lead to research on other situations, which enables new research and implementation cycles to continue (Brydon-Miller *et al.*, 2003).

In terms of our research work, we applied the principles of AR as follows: through our selection process, we collected data on demographic factors, expectations and past experiences. Then in the middle and at the end of each course, the participants were surveyed twice; and the student teachers were interviewed once, at the end of each course. The participants were closely observed over the entirely course, with the findings being discussed and documented in the refugees{code}-teams weekly "jour fixe." These data were collected and analyzed within 2–3 weeks after the course ended, in order to contrive interventions and improvements for the next cycle.

We strongly benefited from the flexibility in this approach, described by Dick (2002) as a main advantage of AR. He states that the research can start with quite imprecise research questions. The cyclic structure allows refinements of the research design during the research process, as deeper insights into the situation are gained. When moving forward, each cycle is required to become more precise. One of the distinctive features of AR is the participatory nature of the research. This requires that practitioners are participants in the sense of being partners in the research (Denscombe, 2014). One guiding factor in our research was the clarity about our end-goal: integration through coding, and this high
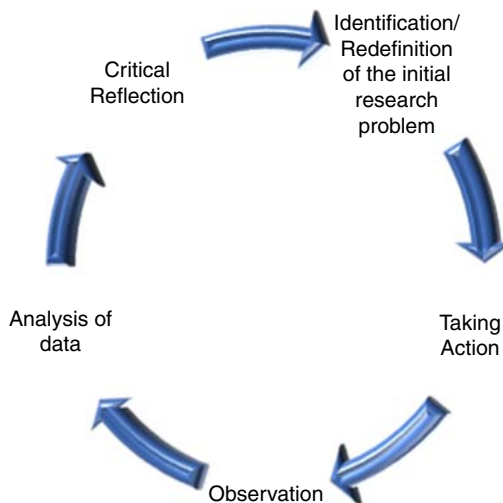
Sources: Adapted from van Akker (1999) and Rose *et al.* (2014)

standard of professional development functioned as orientation for our research approach. Furthermore, the level of pre-knowledge of our participants was not known and past experiences were not available which led to appreciation for the flexibility in the AR approach.

Research study

Course 1

The first course took place between September 2016 and January 2017.

After the kick-off event (see Figure 3) with the refugees{code}-team the participants who passed the application phase got introduced with the refugees{code}-team as well as the time table and the structure of the course.

Course 1 started with 21 male and one female refugees from five different nationalities (Syria, Iran, India, Afghanistan, Bangladesh), all born between 1971 and 2001. Participation was not bound to a legal prerequisite like the person's asylum status. The only requirements for participants were being proficient in the English language, being motivated to learn how to code and having the time to attend.

In order to verify these requirements, the applicants were asked to write a short letter of motivation, a maximum of 150 words, as well as to take a short test consisting of eight logical tasks like completing sequences of numbers and letters.

The course focused on coding in Java[4]. All lessons were held in English as traditional "face-to-face" classes. Each week three 2 h-long lessons took place at the computer labs of University of Technology of Vienna.

Each lesson consisted of a lecture and an exercise. These usually alternated between teaching new content first and then letting participants implement it. At the beginning of each lesson, there were short recaps which included the most important questions from the last sessions.

As the course was only 6 h in total per week, participants were told that it would be crucial for them to learn and code at home. Since not all of the refugees had access to a computer at home.

All teachers were computer science students themselves, who were awarded three ECTS for their efforts. A course of this kind serves as an invaluable lesson for pre-graduate academics, since it allows them to experience standing in front of an auditorium, thereby getting an inside into teaching, and on top of that, being able to put their acquired knowledge
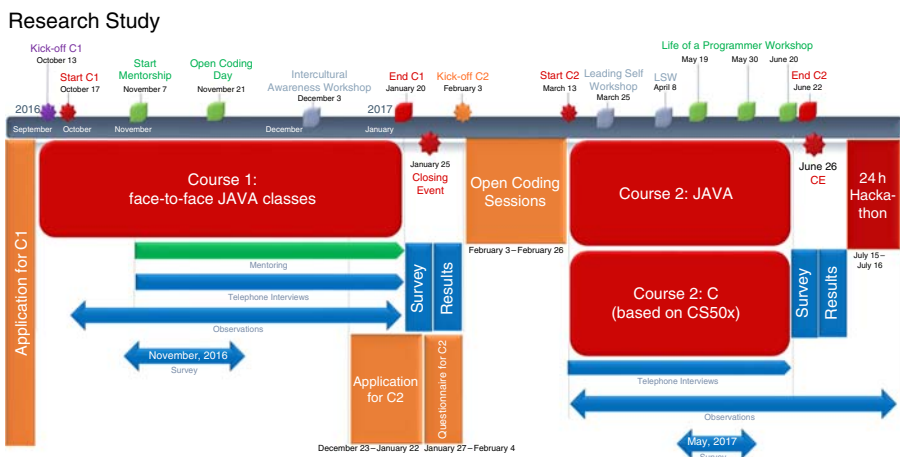

Figure 3.
Time table of the first and second course – the research study

into action, and maybe even to the test. As a result, the concept of "learning through teaching" (e.g. Martin 1985, 1994, 1998, 2001, 2002) is being automatically applied as well.

After the first four weeks, a significant decrease in attendance was noticeable. Therefore, as a countermeasure, a mentoring program was introduced on November 7, 2016 (see Figure 3) in order to enable taking care of individuals' needs and providing care outside the classroom. As a consequence, the participants were separated into five small groups of four to five people and each of them was provided with a mentor from the refugees({code}-team. The task of the team members was to support the participants on a personal level and to serve as a dialog partner for their worries and problems.

Besides the physical course and the mentoring program, virtual spaces in the form of Facebook, Slack[5] and WhatsApp groups were also opened. These allowed the organization and the teachers to share information with the participants and also offered participants channels to ask questions and get them answered.

In addition, a so-called "Open Coding Day" was held (see Figure 3). This was meant to be early conceptual test for a potential second course. Since the thinking behind the concept was rather complex and ultimately based on flawed assumptions, we deem this beyond the scope of this research work and are therefore omit it.

Another special event named "Intercultural Awareness Workshop" was held on December 3 (see Figure 3). The intention behind this event was to facilitate better understanding between the participants from different cultural backgrounds and to allow the participants to reflect on their home and their new environment.

The course ended with a closing event on January 25, 2017 (see Figure 3), at which participants were awarded their certificates.

Course 2

The second course took place between March 2017 and June 2017. It began with 38 male and two female refugees from ten different nationalities between the ages of 19 and 35.

The application period for Course 2 was opened from December 23, 2016 to January 22, 2017 and involved filling out an online application form. Due to the high number of applications, an e-mail was sent to all applicants asking them to fill out an online questionnaire between January 27 and February 4, 2017 (see Figure 3). Further, all applicants were invited to an "info session" by e-mail (see Figure 3), which was ultimately a pre-course Q&A session by the refugees{code}-team for the participants. The applicants' levels of prior knowledge in Course 1 differed widely and the time to evaluate them was very limited as well. Therefore, the applicants were required to attend at least three out for four "Open Coding Sessions" at University of Technology of Vienna (see Figure 3). The "Introduction to Computer Science"-MOOC CS50x from Harvard University was used which allowed applicants to demonstrate their level of prior knowledge and ability to comprehend the elementary concepts of coding. Another reason why this measure was employed was the high rate of drop-outs during the first course. Since taking these "Open Coding Sessions" took the participants some time and effort, it also served as a tool to measure the applicants' motivation as well.

Differing from the first course, the participants were divided into two groups, "Java" and "C." It was intended that the JAVA group gets face-to-face lectures held by the students' teachers (like in Course 1). Since two of the four student-teachers had rather limited English proficiency, that concept was discarded and replaced by a MOOC, namely the JAVA-MOOC by Udacity. However, after the participation in this MOOC turned out to be very low, the decision was made to switch back to face-to-face lectures held by the student-teachers. The "C course" was held as planned, using the Introduction to Computer Science-MOOC CS50x from Harvard University. Its goal and structure was set ambitiously to finish with this intensive 12 week course, which taught C, Python and

JavaScript with nine problem sets. In the second course, refugees{code} reduced the contact to two weekly sessions of three hours, because the feedback from both sides was that communication was difficult between the three different teacher groups. All teachers were again computer science students themselves, who were awarded 3 ECTS for their efforts (see Course 1).

As in Course 1, virtual spaces in the form of Facebook, Slack and WhatsApp groups were opened. In addition, an e-learning platform based on Moodle was introduced as a measure of support for the "CS50x" group of the second course (Figure 4).

As part of the special events, a workshop on the topic "Leading Self" was held (see Figure 3). The workshop covered topics like "How strength-based leadership and positivity can lead to higher performance and happiness at work." The workshop was held on two separate dates in order to keep group sizes small, with half of the class participating on March, 25 and the other half on April 8.

Just like the first course, the second course ended with a closing event on June 22, at which 23 participants (21 men and 2 women) were awarded their certificates.

In addition, a 24-hour Hackathon was held (see Figure 3). This was meant to be a social event where the participants from Courses 1 and 2 could come together to prepare participants for solving real life problems they were interested in. Since the Hackathon was not a fixed component of the course at the beginning and therefore not systematically surveyed, we will not give further explanation on it in this paper.

Research results

The following section presents the results and findings of the surveys. The subjective data (learners' perspectives), experiences from the refugees{code} team taken from their protocols of their "jour fix" meetings, as well as experiences and opinions from the student teachers are presented.

Course 1

Learners' perspectives. A total of six learners were interviewed (telephone interviews, see Figure 3) and asked for the following factors.

Motivation. Asked what they wanted to achieve by attending the course, all expressed slight variations on learning enough coding to be able to get a job or making enough progress to enroll at university:

> I want to make my chances bigger to find a good job here in Austria.

> I want to learn coding because I need to improve my skills and increase my chances on the job market.

> I'm interested in participating in this course because it will help me to improve my programming qualifications and therefore be valuable in finding a job as well.

Figure 4.
Lesson plan of the second course

In Syria, I was studying computer science at Damascus university, but because of the war, I had to interrupt my studies at the beginning of my second year. But when I arrived in Austria, I was hoping to complete my studies here and I think this is the best opportunity to do just that.

General impressions of the course. The interviewees were asked about their opinions on the course that they attended. The responses were positive, with specific mentions of their teachers and colleagues, being able to practice their coding skills and the personal support they have received from the refugees{code} team. One person noted that he liked the positive environment. Another one mentioned the positive value of having the WhatsApp group to receive immediate answers to their questions.

Suggestions. Asked about whether there were any aspects of the course they did not like or would like to change, only a few identified any issues. These criticisms included the inclusion of too many student teachers in class, speaking at the same time during the lesson (the noise was too loud). Two of them also noted that the lectures were inconsistent and not well-organized.

Attendance. After the first four weeks, a significant decrease in attendance was noticeable. Therefore, the six participants who did not attend anymore were called via phone. The following points are the answers given by these participants:

- Conflicting schedule with German courses, temporary just-for-money-job or requirements by the AMS (meaning the "Austrian Job-Market Agency," among other things also the agency in charge of paying out all different kinds of welfare money).

- False expectations about the content of the course, the course's teaching speed or the prior knowledge.

- Realization that learning German is more important.

- Change in housing condition (relocation).

- Found a worthwhile job during the time of the course. This answer was given by two participants – one stated to have found work in IT-network engineering, one in IT-maintenance/-operations.

- Higher interest in networking and web development technologies.

Homework, practicing and feedback. They interviewees were also asked what they found to be their greatest challenge(s) as learners. Most of them were not able to articulate specific challenges or said that they had no problems. The challenges mentioned related to the learning process: being unable to do the homework assignments. Other challenges related to wider issues: lack of time to practice, lack of access to the teachers, and teaching personnel changing repeatedly.

Learning support. Finally, they were asked what best helps them with learning. The response to this question was:

- practicing outside class;

- constant practice;

- the support from other learners and tutors; and

- receiving immediate feedback identifying errors.

Refugees{code}'s perspectives. Volunteering and lack of experience by the student teachers. The refugees{code} team states that there was a lot of fluctuation in the lessons, in the sense that the turnover rate of teachers was high, and some of them did not stay long.

The teachers were students who had never taught before, and it showed in the way they went about holding class. Classes were mostly self-organized and chaotic.

The lack of experience by the student teachers initially created a certain amount of frustration among the refugees{code} team, though, according to them, this quickly turned into a motivational factor to employ the MOOC to get better results.

Mentoring. According to the refugees{code} team, their efforts to accommodate the needs of the specific individuals were not sufficient. A tendency to treat the participants as a homogenous mass rather than individuals seemed to have gotten in the way.

Locals. Another thing which became clear during the first course was that there is little interaction between the Austrian and refugees' communities. This calls for an investigation into ways and means to increase this interaction, which is crucial for integration efforts of all kinds. Therefore, locals should be brought into the groups in order for the refugees to be able to gain experience in working with and alongside people from an entirely different cultural background – an experience they would otherwise very likely lack until actually joining the workforce of a company. Another assumption is, that having native speakers of the language the course is being held in might benefit the refugees, as the native speakers are likely use more expressions and terms commonly used in the industry, which might increase their usage among the refugees as well.

Student teachers' perspectives. The student teachers were asked about their opinion on how to improve the course they were teaching.

Preparation. The student teachers stated that especially, the first few sessions need careful and time-consuming preparation in order to, on the one hand, convey the concepts and ways of thinking of coding to a target group with little to no prior exposure to these, and, on the other hand, to scare off as few participants as possible with the subject matter.

Responsibilities. According to the student teachers, responsibilities should be agreed upon and divided up clearly. Employing teams of two for each of the sessions, who are then responsible for everything concerning that session (preparation, executing and follow-up) has proven feasible.

Content. Initially, a rough timetable for the semester containing the learning content has to be prepared. Even small chunks of the content should be accompanied by examples for practice. In addition, presentation slides and other course materials must to be able to serve as reference materials for homework assignments. Therefore, these materials need to be structured accordingly.

Homework and practicing. The student teachers stated that homework assignments should be given out regularly and subsequently reviewed, preferably with every session. This serves as feedback for both the course teams as well as the students. Useful examples are imperative, whether on the presentation slides, other course materials or with homework assignments. Since coming up with such examples is usually very difficult, using preexisting examples whenever possible is to be preferred. Coding examples should be tested by another teacher first before being tested in the field.

Storage. According to the student teachers, a centralized repository for storing all the course materials and homework assignments is crucial.

Addressing the group. When asked about addressing the group, the student teachers suggested when naming resources, for instance, a github-page, a URL shortener, a Moodle course, etc., the use of the term "refugee" should be avoided. They stated that people taking part in the courses are there as participants first, not refugees, and that is how they should be met and addressed.

Communication and feedback. The student teachers said that being able to communicate with the group as well as an anonymous channel for the group to give feedback is vital and should be available right from the start. For communication between student teachers, "Slack" has proved a viable option. In addition, monthly jour fixes are advisable, which allows the teachers of all groups to exchange views and opinions. After each session,

teachers should give each other feedback about the sessions held (what was taught, what was expected, which expectations were and were not met, what course materials should be repeated, etc.), so that they are in turn able to better prepare themselves.

Course 2
Learners' perspectives. Attendance. The development in terms of the number of participants from the second course shows, that despite the "Open Coding Sessions," the first few weeks still proved to be a significant hurdle for the participants (see Figure 5).

Figure 5 shows the attendance of the participants at the specific dates, whereas "1" marks attendance and "0" stands for absence. If the bar of one particular participant ends at 5, that means that they dropped out of the course at this point. For example, Participant 38 attended the first four sessions, was absent at the next one, came back again the next week and then dropped out entirely. In total, 23 participants completed the entire course, with 14 of them completing the JAVA course (participants 1, 2, 3, 5, 6, 7, 9, 10, 11, 12, 13, 17, 18 and 19) and 9 of them completing the "C" course, based on "CS50" (participants 22, 24, 25, 26, 27, 29, 30, 31 and 32) (Figure 4).

After reviewing all 17 drop-out cases, it was clear that 10 of them had dropped out after the first few weeks. The reasons participants gave for dropping out from course two are as follows:

- personal reasons;
- too much time requirement (20 h);
- attending course in different town or living in another state;
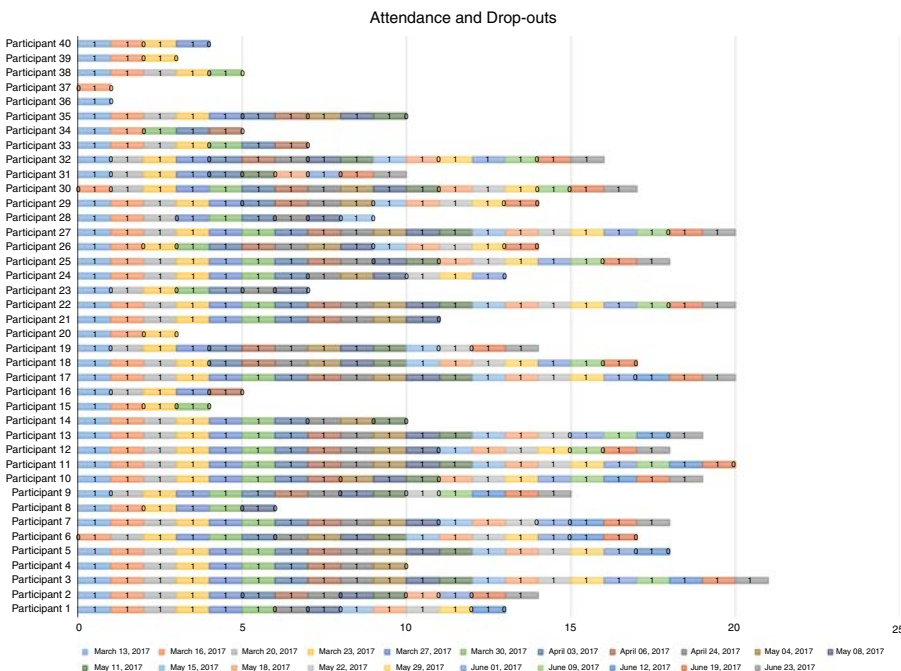- too occupied with other things (job, pet, child, etc.);

Figure 5.
Attendance and
drop-outs

- school;
- relocating;
- German course;
- realized that coding is not his/her thing;
- sickness;
- got an internship;
- course was too difficult; and
- not interested anymore.

E-learning platform. As a measure of support for the "CS50x" group of the second course, the MOOC materials were hosted in an e-learning platform based on Moodle (Figure 6).

Initially, only a small minority of refugees used the e-learning platform. The reasons for this were not systemically surveyed, but it was assumed that many refugees struggled to understand e-learning platforms and had difficulties navigating them. Accordingly, giving better instructions in the beginning of the course could be decisive. As a measure to draw more participants to the platform, a weekly newsletter was set up.

Communication and Information flow. It was also noticed that the WhatsApp group they introduced was primarily being used as a questioning service, much more than the Facebook group or the forum on the e-learning platform:

I really like that in the Whatsapp group, I have the opportunity to ask questions and receive answers immediately.

This could be connected to a broader point about information-seeking behavior shown by refugees. Refugees are generally skeptical of information on the internet and would not use it for information seeking. Evidently, smartphones are not regarded as a device that serves as an information portal which one can independently search for information and resources from an external resource with (Mason *et al.*, 2017). They prefer direct interaction.

Rather, the information flows are predominantly peer-to-peer. If people need to know something, they will most readily seek answers from within their social network rather than, for instance, utilizing a search engine to find an answer (Mason *et al.*, 2017). It is
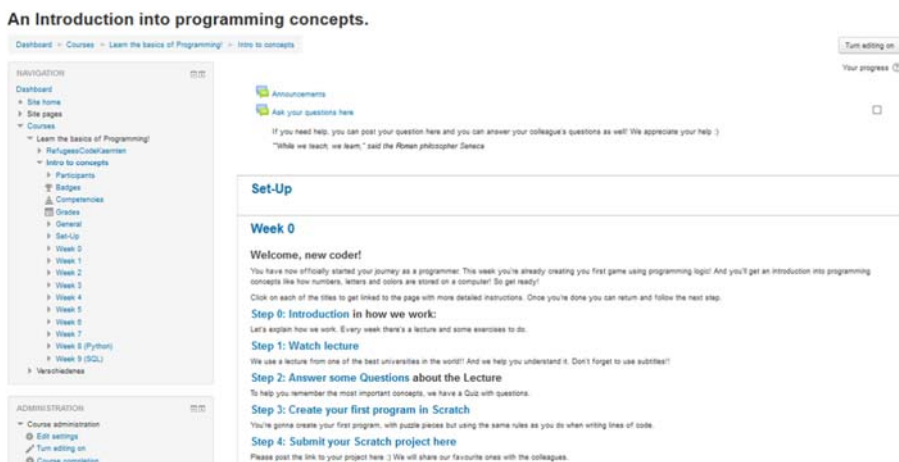

Figure 6.
Structure in Moodle

likely that this is – at least in part – a matter of trust: for people who have lived in situations where media reports are being distorted by partisan propaganda, mistrusting authorities and preferring personal corroboration may well be a sound strategy (Mason *et al.*, 2017).

Language. Language skills and therefore communication overall proved to be problematic on both the teachers' and the refugees' sides. While the student teachers were prone to having difficulties teaching in and communicating complex ideas in English, refugees often spoke more than two or even three languages, but at a somewhat lower level of skill, more superficially (Figure 7).

Women. Since reaching female refugees proved to be very difficult, the women attendance was very low (Figure 8).
This might be because in some of the refugee's cultures, women are more likely to be seen to be more responsible for childcare and housekeeping than for taking part in the workforce and earning a living.

Refugees{code}'s perspectives. Application, language and hardware. While the first course received just a few applicants, the second course counted 135 total applications. With such a large demand for a limited number of spaces, there was a need for a fair and effective selection procedure. Through a focus on competences, the refugees{code}-team structured personal questions, small tasks and some assignments in a form for all applicants. Besides asking for personal information (name, date of birth, nationality, etc.), the applicants were
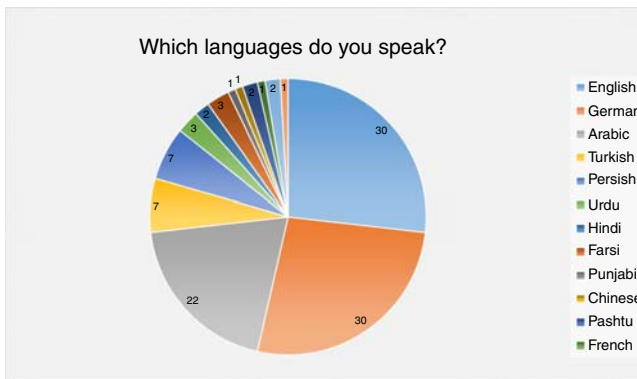

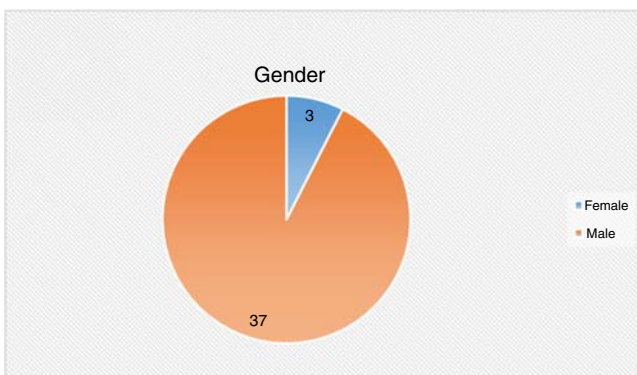**Figure 7.**
Language skills of participants

Figure 8.
Gender distribution in the second course

also questioned as to their expectations for the course, their level of skill in the English language, prior knowledge in programming and their motivation for learning how to code as well.

Additionally, a questionnaire was used to answer whether the participants owned a laptop, whether they were able to attend all or just some of the sessions during the observational phase, their legal status, whether they were currently attending a language course, and what their favorite special subject (web development, mobile development, enterprise software development, etc.) was.

While smartphone ownership is widespread and e-mail was a widely used technology – all participants from course two had an e-mail address and were using it. Ownership of hardware – PCs, laptops, etc. – was widespread in the second course as well, especially among Syrians it was next to universal. Among refugees from less prosperous nations like Afghanistan, not everybody had a laptop.

Since being able to use pre-existing resources was an important part of the program, English sufficiency was crucial, so the questionnaire also contained a link to an online video in English which applicants were asked to watch and answer questions about, in order to find out whether the applicants were able to understand and grasp the video's English-language content. The refugees{code}-team assumed that English levels would be high enough, or at least participants would learn better English for the programmer context. Especially because almost all programming resources online are written in English.

In order to be approved for course participation, applicants had to finish at least three out of four of the "open coding sessions." Besides attendance, progression of the CS50x's "problem sets" – the course's term for practical exercises – was also taken into account. This became a problem in and of itself, as some applicants believed course progression (the number of "problem sets" completed) to be more important than the actual quality of the code. It has to be noted that communicating the intentions and goals of such a measure is vital for its success. Also, differently weighting is advisable, for instance, ranking the applicants attending the sessions in person higher, since the data have shown that they are less likely to drop out of the course.

Building a relationship with teachers. Another hypothesis that building a relationship with teachers was important, something we tested by having two instructor groups instead of three.

(Learning) Support. Dropout reasons were similar to the first course. However, one participant found the progress to low and quit because of that. Therefore, the refugees {code}-team recommended to encourage the more advanced to support the slower ones and thereby practice the skill of explaining: a useful skill for senior developers.

Teaching method and strategy. The refugees{code} team came also to the conclusion that the refugees' needs were different and that the "teacher-in-front" approach was not effective. To integrate the experience and knowledge gained from the first course, the teaching method was redesigned from scratch. The role of the student teachers shifted from being a mere lecturer to being a supportive and encouraging tutor who motivates the participants to explore and experiment. This allowed participants to take charge of their learning process themselves. As a result, the student teachers were able to spend more time on giving one-on-one support to the participants. To better respond to the needs of the participants and to support their development, refugees{code} provided student teachers with relevant background information like their home country, hobbies, expectations and work experience on the participants.

Communication and information flow. The team of refugees{code} seemed to have given more thought to how to reach their target group, having concluded that the prospects of reaching them digitally (or that they will find the site of their own accord)

were poor. One part of this outreach strategy has been through word of mouth, because refugees{code} recognized that the information flow between refugees is predominantly peer-to-peer. The refugees{code}-team also noticed that the WhatsApp group they introduced was primarily being used as a questioning service much more than the Facebook group or the forum on the e-learning platform.

Financing. During both courses refugees{code} was without any budget, spending EURO 50 on a webhost for the website, and many hours observing, interpreting and experimenting. What allowed refugees{code} to act on high quality but a low budget, and was also the use of open source technology, like Open Educational Resources (OER), Server technologies, RaspberryPi's and frameworks and libraries. Laptops for participants were donated from companies.

Levels. When evaluating the levels, the "C" group with only the online course had progressed further than the other group. This could be due to the ambitious but clear time-line, the quality of the online course and the structured learning platform that was available. One participant with previous experience found a job as a developer, and a "Java" participant started an internship at a university supporting the mechatronics department with his newly gained skillset.

Student teachers' perspectives. The student teachers were asked about their opinion on how to improve the course.

Responsibilities. The student teachers noted that they would have wished for better distribution of tasks (which tasks they were responsible for, who to ask in case of uncertainties, etc.), and a more planned out schedule.

Preparation. The student teachers said that the participants often asked for more in-depth explanations for the "problem sets" and stated that they did not fully understand the exercises. They stated that the number of questions raised by the participants increased with the level of difficulty of the "problem sets." Preparing for these questions in advance proved to be effective.

Level of knowledge. Because the number of participants was initially very high, evaluating the level of knowledge for each of the participants was very difficult, especially since the information (grading of the "problem sets," personal impressions of the supervisors, etc.) was distributed and not yet collected or, in some case, not even recorded at all. The student teachers proposed the idea to assign a number of specific participants to each of them, so that they could monitor the participants more effectively. As proposed, this would not only make their job easier, but also would allow them to focus in more on specific people with specific problems, therefore according for the participants' differing levels of knowledge.

Support. The student teachers stated that the one-on-one support for the "problem sets" was of great importance, however, it is also very important to keep in mind not to spend all the available time on a single participant and to make a conscious effort to go from person to person. They also said that the participants have questions but do not pose them actively, especially not If the teacher is busy explaining something to somebody else at that moment. If the same question is posed by more than one person, answering the question "publically" on a flipchart or whiteboard and to employ other participants would know the answer might be didactically valuable as well as a time-saver.

Grading. According to the student teachers the spreadsheets for the grading of the problem sets were very useful. Two of the student teachers noted that the criteria for grading should have been determined from the beginning and communicated to the participants.

Another student teacher noted that the submitted code should be graded by at least two teachers independently in order to see if the grades would lead to (roughly) the same results, and to come to a consistent system of evaluation.

Plagiarism. During the course, multiple cases of plagiarism were noticed by the student teachers. In this case, meant that some participants had copy/pasted solutions they found on github. With MOOCs like CS50x, this is problematic, since there are a great many solutions for its exercises to found on the internet.

Discussion

"Refugees{code}" is a good example for an innovative, agile and adaptable learning approach, as well as an example for developing and deploying a programming course with next to no resources. It opens up prospects of finding work for the students, and it can aid the Austrian job market and thereby the growth of Austria's IT-industry.

As the results show the informal organizational structure is coupled with a strong learning culture, where experimentation is encouraged and failure de-stigmatized. This allows an iterative and adaptive project design according to user-centered principles with a high degree of networking and exchange.

With the field of public education and its old structures being arguably overloaded, the doors for innovators and reformers are wide open. As "Refugee Code" shows, civic approaches can bring benefits like innovation, expertise and energy to educational institutions. It can serve to counteract excessive bureaucracy, lack of transparency and poor coordination of public education institutions.

But cooperating with established actors can also be beneficial for the new players: the organization's stable and proven structures can help them gathering on-the-ground experience, reach the target group and to sustain and scale the project. Therefore, a collaboration between both parties is mutually beneficial, not only in term of education, but economically as well.

Proposed framework

After two courses the research outcome can be seen as a framework of crucial factors, which should be taken into account in case of teaching programming to such a heterogeneous group (Figure 9). Afterwards each single factor will be described in more detail.

Topic 1: organizational. Piloting and preparation. Since such a course concept (as seen in course 1) rarely works on the "first strike," the possibility to test concepts within the limits of a pilot phase and with members of the target audience is vital. Besides the sessions need careful and time-consuming preparation in order to, on the one hand, convey the concepts and ways of thinking of coding to a target group with little to no prior exposure

Organizational
• Piloting and Preparation
• Application
• Pedagogical staff
• Volunteers
• Language
• Support
• Responsibilities

Didactical
• Motivation
• Meeting the Needs
• Teaching Method and Strategy
• Content
• Use of existing educational resources
• Homework, Practicing and Feedback
• E-Learning
• Communication and Information flow

Participation
• Locals
• Women
• Companies
• Multipliers

Technical
• Provide hardware
• Storage
• E-Learning Platform

Financial
• Accreditation and Grading
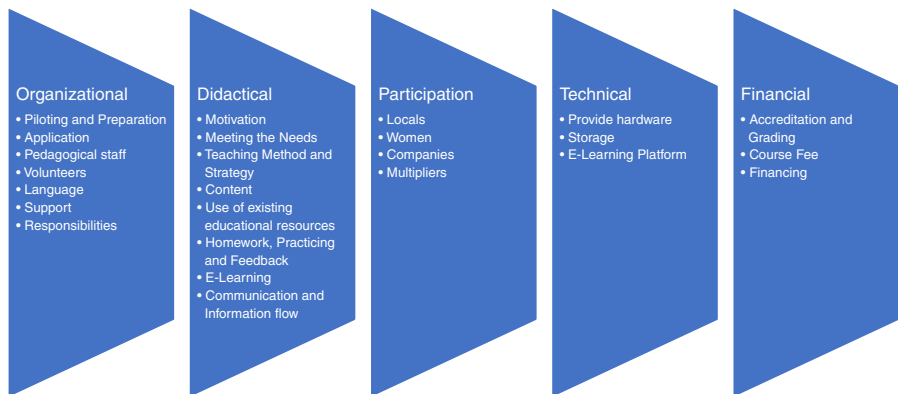• Course Fee
• Financing

Figure 9.
Proposed framework

to these, and, on the other hand, to scare off as little participants with the subject matter as possible.

Application. Going through an extensive application process (as seen in course 2) serves as a strong motivator for participants to stay the course and attend even in the face of adversity, since if they are being challenged in advance of the course, they feel like the earned their seat at the table.

Pedagogical staff. Although the "learning-by-teaching" approach as in the two courses is immensely interesting to people in the field of education, it may be worthwhile to explore the extend of its utility. While the student teachers were able to help by plugging the holes torn open by the crisis situation, ultimately, they could complement the existing structures, but not replace them. Therefore, a pedagogically trained staff who is sufficient in the English language, too, is necessary to cater to a heterogeneous group. While the approach of "learning-by-teaching" is interesting and educational for the student teachers, they also need to be supported by pedagogically trained personnel. A possible solution might be a two-step support concept:

The lion's share of the mentoring work is being done by the student teachers.

The pedagogically trained personnel act additionally, but is responsible for the content and quality of the courses, answers those questions that the student teachers cannot and intervenes.

Volunteers. Although volunteering played an integral role in the two courses, we would recommend to carefully selected volunteers.

Language. Language skills and communication proved to be problematic on both the teachers' and refugees' sides. While the student teachers were prone to having difficulties teaching and communicating complex ideas in English, refugees often spoke more than two or even three languages. The refugees{code} team spoke also from obvious difficulties of working with groups of heterogeneous learners with multiple languages.

Support. As seen in the two courses refugees need more support and mentoring, especially emotional. We recommend creating and sustain a supportive learning environment where motivating, consistent and service-oriented supervision is covered. Further we recommend to encourage the more advanced to support the slower ones, and thereby practice the skill of explaining.

Responsibilities. Responsibilities should be agreed upon and divided up clearly. Employing teams of two for each of the sessions, who are then responsible for everything concerning that session (preparation, executing and follow-up) has proven feasible. We also recommend a distribution of tasks (which tasks they were responsible for, who to ask in case of uncertainties, etc.), and a planned out schedule.

Topic 2: didactical. Motivation. As seen in the first course the refugees wish not just to participate in a bit by bit integration measure, but to be able to see a complete pathway toward successful integration and a better life.

Meeting the needs. Understanding the learners' situations fully is crucial, therefore, we argue for the importance of co-creation and user-centric design meaning talking to learners before and during any attempt to make a course for them. Especially for such a heterogeneous learning group, there is no substitute for talking with them, listening to them, and incorporating them as actively and as centrally as possible into the project design and implementation. We would recommend making courses more responsive and adaptive to meet future challenges effectively. These are points on which traditional institutions can learn from our two courses.

Teaching method and strategy. For this teaching approach especially, the modules must be connected by a common thread, and the questions must be practically oriented. It would be detrimental to the success of a program to start with the assumption that the

coding skills of the participants are high to begin with and then will only continue to rise. While improvements in programming did not always come readily or quickly with the refugees, we recognized that the refugees were keen to apply their new skills in situations outside the classroom, e.g. hackathons. We also conclude that the teaching of refugees would work better if teachers are provided with relevant background information on the participants. There has also been criticism of the teaching skills of some of our student teachers with rather limited English skills (see Pedagogical staff). We recommend greater professionalism.

Content. Programs of this kind force universities and colleges to continually evaluate the relevancy of their teaching content. Exercises and case studies have to have a tangible connection to practical use for refugees to accept them. In order to achieve this, universities and colleges have to work closely together with the course's participants. At this point though, the exact contribution that the different parties have to make is unclear and needs further examination. We also recommend to set the content of the course so that it is possible to follow suggestions from the learners themselves and from current issues and needs arising from the learners.

Use of existing educational resources. As anybody who has worked in the field of education is likely to know, building courses for heterogeneous groups is very difficult – it requires both a lot of time and money. There are different strategies to overcome these tensions. One is to simply accept that creating courses for heterogeneous groups is a resource-intensive undertaking, and make the resources available. A different strategy is not to aim for a sophisticated and polished product, but instead, deliberately put together something "quick and dirty" (Mason *et al.*, 2017). The refugees{code} team did just that, offering the first course within just a few weeks of intense activity. As a consequence, the drop-out rate was very high, but still, this served as a good pilot project out of which improved courses could be developed.

A more powerful content strategy to accelerate the development of programming courses is working with and to adapt material that already exist, rather than starting from scratch. The refugees{code} initiative is therefore a good example, because it was based on the content of pre-existing MOOCs from various sources.

Adapt these pre-existing materials still took a lot of work, but it was still much more time-saving and resource-friendly than starting from scratch. Also it works great in heterogeneous groups because every learner is able to learn and program on their own pace.

Therefore, educational institutions should always consider, before creating something new, whether existing educational resources (like open educational resources) could be used or adapted to fit their purposes. Such an approach is advantageous not only in terms of development, but also outreach and adoption. More cooperation and coordination between traditional education institutions and civic projects like refugees{code} could lead to a better distribution of overall resources.

Homework, practicing and feedback. Homework assignments should be given out regularly and subsequently reviewed, preferably with every session. This serves as feedback for both the course teams as well as the students. Useful examples are imperative, whether on the presentation slides, other course materials or with homework assignments. Since coming up with such examples is usually very difficult, using preexisting examples whenever possible is preferable. Coding examples should be tested by another teacher first before being tested in the field.

e-Learning. The delivery of learning materials via electronic devices can be valuable, but this alone is insufficient and should be accompanied by comprehensive teacher support (Dahya, 2016). One way of achieving this is the so-called "flipped classroom" model which refugees{code} used as well. In this model, content is introduced through a MOOC as well as

videos which can be watch by students online outside of class, which are later clarified and consolidated in class by a teacher.

Communication and information flow. refugees{code} put much thought into how to reach the target audience, and concluded that the prospects of reaching them digitally – or that they will find the site of their own accord – were poor. Part of the outreach strategy was to rely on word of mouth, and the flow of information was mostly peer-to-peer.

Therefore, it is necessary to develop a strategy for reaching them from the very beginning.

We recommend using offline events to explain the course concept to refugees and holding regular events where refugees, teachers, volunteers and locals meet and chat. In addition, we recommend the building of WhatsApp groups. We also recommend being very patient with refugees and explanation to them.

Topic 3: participation. Locals. Although refugees{code} aimed specifically at refugees it is important not to isolate refugees and treat them differently from the rest of the population. Therefore, program participation should also be open to local students sharing similar needs. This will also help to build bridges between refugee population and local communities. On the contrary, not only can the locals be tremendously helpful to the course organizers, but also with the needs of the refugees as well: they can give feedback to the participants, they can help them learning the host country's language, and with personal social contacts, which, like our interviews showed, is the preferred form of interaction of refugees. If refugees were to work as an isolated group, the success and the impact of the program would arguably be limited as well.

Women. As evident by the results, the vast majority of participants were male. We learned only little about women. Most of them seemed to be housewives and active in community work. Specialized programs and courses aimed at women which cater to their specific backgrounds and needs might serve as a remedy for this discrepancy.

Companies. Many participants did not know or had difficulties imagining how work life in European companies is like. Companies could help by, for instance, holding Q&A sessions with programmers, giving tours of the premises, holding workshops or accepting interns.

Multipliers. An effective outreach strategy includes raising not just awareness but also trust, and making the value to the participant immediately tangible. Working through networks that have the personal trust of the refugees could help, for example members of the refugees' community who are advanced tech users could act as multipliers to raise the overall levels of coding literacy.

Topic 4: technical. Provide hardware. An essential prerequisite is having access to hardware. Desktop computers or laptops are still important for most projects of this kind. One way of creating access to these facilities is through providing laptops.

Storage. A centralized repository for storing all the course materials and homework assignments is crucial. This can also be done via the e-learning platform.

e-Learning platform. With refugees as the main user base, lowering the barriers for usage of the e-learning platform as far as possible is a good approach. Refugees have widely varying tech literacy and levels of prior knowledge, and getting the entirety of the user base to actually use the platform is obviously crucial for its success.

Topic 5: financial. Accreditation and grading. In cooperation with the Technical University of Vienna, refugees{code} has found an interesting solution. The students who teach our courses get credited with three ECTS for doing so. For the student teachers, this serves as both a valuable experience as well as academic progress.

So, participating in courses aimed at refugees could be of much greater value to students if it resulted in a form of recognized certification. Refugees{code} cooperates with the Technical University of Technology and does stress this as an important factor.

Course fee. Since the drop-out rate seemed to be quite high in the case of refugees{code}, collecting a minimal course fee or maybe a deposit in advance might be

worth considering. This would serve as an incentive for the participants to attend the course in its entirety.

Financing. Since the expenses for setting up programs of this kind are quite high, access to sufficient resources and funds have to be assured. Without the cooperation with the Technical University of Vienna, refugees{code} would not exist.

In order for projects to progress past the initial stages and eventually even scale up their work, reliable sources of financing are crucial.

Conclusion

The goal of the refugees{code} courses is to impart in-depth skills in the field of programming to refugees, and to put them into the position of being able to further these skills autonomously. The textual orientation is mainly based on universities and colleges, while the practical application and organizational orientation is a contribution by the civic society.

While refugees{code} was guided by certain principles and a clear goal, it would simply not have been possible to plan this project in a traditional way. This combination of goals, principles, and a flexible methodology allowed for iterative cycles. It is no wonder that AR itself can be considered as a pillar of research in information systems. As refugees{code} started as a university cooperation, the refugees{code}-team selected the participants and relied on the Computer Science students from Technical University Vienna to prepare the curriculum, which was delivered purely through direct instruction. As mentioned in the results, refugees{code} started with little resources and structured their curriculum around these.

As the great potential that initiatives like refugees{code} have for education, there are also substantial challenges. As we learned from the first course, the completion rates are very low. Therefore, it is important to build an infrastructure and a learning environment around the course. This learning environment includes providing mentoring and support to create spaces where participants can learn. It was also found that having a pedagogically trained staff with sufficient knowledge of the English language is necessary to cater to a heterogeneous group. Also, varying teaching strategies according to the needs and skills of the learner is necessary.

As the results also show the informal organizational structure is coupled with a strong learning culture, where experimentation is encouraged and failure de-stigmatized. This allows an iterative and adaptive project design according to user-centered principles with a high degree of networking and exchange.

With the field of public education and its old structures being arguably overloaded, the doors for innovators and reformers are wide open. As refugees{code} has demonstrated, civic approaches can bring benefits like innovation, expertise and energy to educational institutions. It can serve to counteract excessive bureaucracy, lack of transparency and poor coordination of public education institutions.

We conclude that bringing successful education to heterogeneous and culturally different groups is multi-faceted. It is not something any individual organization or project can do; it can only be the result of a system of different actors working together with traditional educational institutions.

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