Launching Swiss Computer Science Education Week

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ABSTRACT
The systemic introduction of computer science education in federalist countries such as the United States, Germany, and Switzerland can be extremely difficult. The lack of top down dissemination mechanisms makes it hard to scale up even successful Computer Science Education strategies to national levels, necessitating bottom up approaches. High profile initiatives such as Computer Science Education Week, including the Hour of Code tutorials, provide an alternate route to reaching potentially large numbers of students, but in international contexts require proper adaptation to local languages and cultures. In 2014, Scalable Game Design Switzerland launched the Swiss computer science education Week featuring a multi-lingual “Frogger 3D” game creation activity. Results show the power of this bottom up approach to help jump-start student exposure to computer science in a relatively short amount of time. The first Swiss Computer Science Education Week reached 10,000 Swiss students, from 21 out of 26 Swiss cantons, with qualitative feedback and quantitative retention data indicating a sustainable and enjoyable experience for students and teachers.

1. INTRODUCTION
Western countries have transferred from production-centered economies to innovation and knowledge driven ones within the last few decades. The emphasis lies on the contribution of knowledge and innovation which are the dynamo of these economies. Only countries that are flexible enough to successfully cope with this shift will stay competitive. In this paper we focus on the situation in Switzerland, which currently has to go through a major reform in its education system. In order to understand the challenges a school reform is facing, we need to look at the special situation in this country. The following sections give an overview of the economical, political and cultural aspects of the Swiss’ school system.

1.1 The lack of ICT skilled workforce
The availability of a technically skilled workforce for a small export-oriented economy like Switzerland is crucial to compete in a global market. A recent study [5] shows that the workforce of information and communication technology (ICT) related fields increased from 2009 to 2012 by 3.5%. The prognosis estimates a yearly increase of available ICT jobs of 2.5% until 2020. That means 72,500 ICT skilled human resources need to be recruited within an eight year period. The study further predicts, that due to a continuing low interest of students in pursuing a career in ICT related disciplines, Switzerland will be short of 25,000 skilled workforce in 2020. A reliable and sustainable strategy to bridge the gap would be to educate people internally. This would require to motivate young people to increasingly pursue a career in STEM (Science, Technology, Engineering, Math) related disciplines. The reality shows, however, that the number of STEM enrollments in tertiary education is constantly low. The Swiss education system is challenged to improve this situation. It is crucial to expose students to STEM disciplines as early as possible. Fostering STEM skills constantly throughout a child’s school career might lower the barriers and increase self-confidence and interest in these disciplines. This demands a joint effort of all parties involved – parents, teachers, schools, universities, politicians, members of the economy, and researchers.

1.2 The situation of Swiss K-12 CS education
Computer science is not a mandatory subject at any school level in Switzerland. To present, ICT education in schools mainly stands for learning to use applications like Microsoft Office. There are, however, many innovative teachers that teach topics beyond that, but all on own initiative. If a student is exposed to computer science throughout his or her school career, it is simply by chance. There are also a number of organizations that have been aiming at improving computer science education (CSE) in K-12 education for many years. The largest one is the Hasler1 foundation. For instance, their initiative “Fit in IT”2 just ended after 10 years duration and 20 million Swiss Francs in funding. Generally, any initiative aiming at introducing computer science

1http://www.haslerstiftung.ch
2http://www.fit-in-it.ch
in K-12 education in Switzerland is funded by associations, foundations, or companies (e.g. Hasler, SVIA⁴, IngCH⁵). They are organizing project weeks in schools, conducting competitions (e.g. Informatik Biber⁶, Swiss Olympiad in Informatics⁷), or offer teacher training. Regarding CSE initiatives on the level of the Swiss state, it is important to mention the “Lehrplan 21”⁸, a new common curriculum for compulsory education composed by a committee of approx. 200 people who worked on it for 8 years. It importantly includes the focus on the learning of competences as opposed to that of pure content and the introduction of CS as a new discipline. It was developed in order to implement article 64 of the Federal Constitution of the Swiss Confederation, stating that the compulsory school system should be harmonized⁹. Also, the Federal Council has defined CSE as an important measure to achieve the goal of establishing an information society in Switzerland [1]. The implementation of “Lehrplan 21” proves to be highly difficult, however. It might not be obvious at first that Switzerland, with a population of eight million and located in the center of Europe is unique in many ways, which brings about both great chances and challenges. It is a federal multiparty republic consisting of 26 cantons and having four official national languages: German, French, Italian and Romansh (native speakers of this language are extremely few, however, and they all learn and speak German). The direct democracy and the state’s highly federalist characteristic is deeply rooted in the society and influences all aspects of life. All cantons’ education systems differ considerably from one another, especially for compulsory education, which is kindergarten, primary, and lower secondary school (total duration of approx. 11 years). A family with school-aged children moving to another canton likely faces a different school system and curriculum. Differences might include the age when compulsory school starts, foreign languages taught, and textbooks used in class. This is striking given the small size of the country. As the name “Lehrplan 21” implies, it only targets the 21 German-speaking cantons. Also, each canton will decide individually, when and how it will implement the new common curriculum. Already half of the 21 cantons are announcing major opposition against Lehrplan 21. ICT topics such as Microsoft Office that are currently taught in schools are seen as useful for a professional career, whereas programming and highly specialized computer science topics are rather perceived as academic skills. Less than 30% of all students will pursue a tertiary education, so why should we teach something that academic to everyone? When speaking of programming in schools we often hear from teachers, “well, that’s definitely something interesting to foster gifted students”.

To summarize, Switzerland needs to educate more skilled workforce in STEM related disciplines. The economy is pushing for that, so does the Federal Council. In a highly federalist country, however, a school reform cannot be achieved with a top-down approach, i.e. by introducing bills. Each canton is autonomous, and the final decision is often made by a popular vote. We need to consider the culture of the parents, students, and teachers. Computer science is perceived as something academic, which is often considered suitable for gifted students only. In this paper we present an attempt to introduce a broad number of students in Switzerland to programming and computational thinking (CT) by launching Swiss Computer Science Education Week (CS Ed Week). CT was famously declared “a fundamental skill for everyone, not just for computer scientists” by Jeannette Marie Wing [7]. Following Wing, many others in the field have acknowledged the relevance of CT for “nearly all disciplines, both in the sciences and the humanities” [4], describing it as “a digital age skill for everyone” [2].

Taking into account the specificities of the Swiss education system, we chose a bottom-up approach to launching Swiss CS Ed Week. By addressing the teachers personally and by partnering up with trusted institutions, we could convince many of them to join the event and consequently, expose a large number of students to programming. We will now describe how we adapted an international event such as CS Ed Week to the local circumstances in Switzerland and how we managed to reach 10,000 students within only a month lead time.

2. OUR APPROACH TO LAUNCH SWISS CSEDWEEK

Scalable Game Design Switzerland (SGDS) is located at the school of education of the University of Applied Sciences and Arts Northwestern Switzerland (FHNW). It is the institution responsible for certified teacher training in northwestern Switzerland. Drawing on comprehensive experiences made in the U.S. SGD project, SGDS aims at exposing students to STEM and computational thinking through motivating game and simulation design activities. To this end, SGD Switzerland holds teacher training workshops, project workshops for students, develops a curriculum for teacher training to be implemented in 2017, and supports the implementation of the Lehrplan 21 among other things. As mentioned above, SGDS launched Swiss CSEdWeek with an activity aimed at motivating Swiss students and teachers serving as an introduction to further computer science classroom activities. Notably, Swiss CSEdWeek was launched within five weeks from the time of its inception to students programming the activity over the week of December 8–14, 2014. In that highly limited amount of time, several crucial factors had to be tackled in order to ensure the success of the launch.

2.1 The Activity

The Scalable Game Design CSEdWeek activity is an HTML5 browser based exercise wherein users program the 80’s arcade game Frogger in AgentCubes Online. Designed by the Scalable Game Design project at the University of Colorado, it had already been successfully introduced in the U.S. during the CSEdWeek 2013 as one of the Hour of Code activities, being used by 250,000 students in only one week [6][5]. AgentCubes Online is a browser based visual programming tool which enables users to build their own games and simulations. The tool implements the pedagogical ap-
2.2 Adapting the activity to the Swiss context

proach of a strong correlation between student motivation resulting from the experience of ownership and the opportunity of being creative on the one hand and learning progress on the other hand [6]. Students can create their own individual 3D-characters called “Agents” from scratch with the built-in graphics editor and select their self-made characters listed in the “Agent Gallery” (Fig. 1, label 1) to design their own virtual 3D-worlds. Users create in-game interactions between the characters by composing character behaviour rules. These rules consist of programming blocks from the “Conditions”-palette (Fig. 1, label 2) and the “Actions”-palette (Fig. 1, label 3), which are assembled in the “Behaviour Editor” (Fig. 1, label 4) by drag-and-drop programming. Equipping AgentCubes Online with an embedded video tutorial in English, Spanish, German, Italian, and French (Fig. 1, label 5), the CSEdWeek activity enables students to build a complete Frogger game guided by the tutorial’s step-by-step verbal and visual instructions. The video itself is supplemented by an interactive table of its contents consisting of indexed links that allow students to (re-)access instructions for each single programming step (Fig. 1, label 6). Students who follow the video tutorial will complete similar Frogger games consisting of identical rules. Figure 1 is a screenshot of this activity when the student has programmed the frog-truck collision and the tutorial shows how to switch to first-person view. The 3D Frogger online CSEdWeek activity instruction guides students through the creation of a game consisting of 215 lines of code. However, this activity is open-ended as students are provided a link enabling them to return, modify, and add to their game whenever they please. As a result, student projects can be of varying program lengths with some students building simple versions of Frogger while other students continue past the end of the video instruction, adding more interactions on their own.

2.2 Adapting the activity to the Swiss context

Switzerland is a highly federalist and multilingual country, and this inherent structure presents some challenges to launching CSEdWeek in Switzerland. This section looks at the modifications to the activity helping to increase its accessibility for teachers and students in Switzerland. All modifications can roughly be placed into three categories: language challenges, recruitment challenges and support challenges.

1. Language Challenges. Apart from being politically highly independent, each of the 26 distinct cantons of Switzerland adopts one of three languages: German, French, and Italian (Romansh speaking people are usually also fluent in German). In order to launch the CSEdWeek activity in Switzerland, the 3D Frogger activity depicted in Figure 1 had to be modified to increase accessibility to Swiss students. The embedded instruction video (Label 5) and the indexed list of the video’s contents (Label 6) had to be translated into German, French, and Italian. The actual conditions and actions (Labels 2 and 3) were not translated to keep consistency between the visual language environments. Instead, the program provided a tooltip in the native language when their cursor hovered over a given condition or action.

2. Recruitment Challenges. In analogy to SGD in the U.S., SGD had to develop partnerships in Switzerland in order to recruit the greatest number of students possible. These partnerships included the Hasler Foundation, SVIA (Schweizerischer Verein für Informatik in der Ausbildung), and SI (Schweizer Informatik Gesellschaft), which are nationally renowned across canton borders for their support of valuable education initiatives. These organizations not only helped us significantly to spread the word, but also provided the then unknown project with a high level of credibility, vouching for its educational value. Other recruitment means included inviting teachers individually to participate in our activity through sending out personal emails from our home institution FHNW, attending computer science education events to hand out flyers and talk to people directly, presenting to teachers at these events, workshops and radio broadcast spots.

3. Support Challenges. Even though the activity is self-contained, novice teachers had to be supported in doing it, for example, in case something went wrong with student projects. In the U.S., this support often takes the form of teacher professional development or online wiki support. With that kind of training lacking in Switzerland, and the time constraints present, we had to provide alternative ways of scaffolding to make teaching accessible to teachers. A Swiss Scalable Game Design wiki in German and French supplied teachers with an activity tutorial and guidelines on how to introduce the activity in the classroom. To alleviate teachers’ possible classroom management concerns, the activity website featured a FAQ section in German and French. Furthermore, comprehensive support was provided during the event. A staff of three people responded to every query, providing an activity blog, daily email support, and a daily ten-hour phone line to every teacher who decided to do the activity with their class.

Figure 1: AgentCubes Online CSEdWeek activity with the “Agent Gallery” listing in-game characters created by the user (1), the “Conditions”-palette (2), the “Actions”-palette (3), and the “Behavior” editor window where students create behavior rules for characters by combining conditions and actions (4), the embedded instruction video (5), and the indexed list of the video’s contents (6).

https://www.agentcubesonline.com/quickstart/
3. RESULTS

Despite a very limited lead time and challenges outlined above, the Swiss CSEdWeek was launched on December 8–14, 2014. Qualitative data gathered included student questionnaires and reports from teachers and optional registration forms (primarily filled out by teachers). Quantitative data included information gathered from Google analytics by geotagging, which showed the locations from where the activity’s website was being accessed to what extent. Furthermore, the analysis of Swiss student games provided information about participant retention, i.e. how far students got in the activity, how many of them completed the project or even continued programming above and beyond what the activity required.

3.1 Reach

The 2014 Swiss CSE Week reached over 10,000 students from 168 cities and villages in 21 cantons. Information from the registration forms indicates that a wide range of schools participated in the event including primary, secondary, district, trade and vocational schools. Figure 2 shows the composite information with different gradation of red color representing the participation of cantons, and different gradations of blue color representing the participation of villages. More saturated colors and larger circles indicate higher participation. The cantons, sorted from high to low participation were Zurich, St. Gallen, Aargau, Lucerne, Fribourg, Bern, Thurgau, Basel-Land, Neuchâtel, Geneva, Solothurn, Schaffhausen, Zug, Vaud, Basel-Stadt, Schwyz, Appenzell Innerrhoden, Graubünden, Ticino, Valais, Appenzell Ausserrhoden. The top five cities were Lucerne, St. Gallen, Baden, Zurich, and Buchs.

3.2 Qualitative data: testimonials

Asking teachers to add something brand new to their curriculum with very short notice might understandably be met with skepticism. In this case, we were asking teachers to adopt a new activity with untested aspects, with only few weeks of notice as part of the banner of CSEdWeek, which is not established yet in Switzerland. Therefore having partners with a well respected track record was crucial to overcome this initial teacher skepticism to the activity. For example, teachers indicated that our partnership with organizations like the SVIA was important for adopting the activity in their classroom. Other reasons why teachers joined included the perceived magnitude of the event and the potential benefits in terms of curricular input as well as potential integration as a practical activity in the context of different subjects. Teacher and student testimonials indicated that teachers not only were able to implement the activity in their classrooms successfully, but also revealed that students enjoyed the activity.

One teacher, who participated with 97 students, spoke about the ease of teaching this unit and the engagement of students indicating future activity use: “Everything worked perfectly and we had great fun. Young people even forgot the break. Creativity knows no boundaries, there were so many different games, as it had learners. Good thing, I will definitely do again next year.” Another teacher, who participated with 80 pupils, also spoke to the motivation students had throughout the activity and beyond saying “It was really fun – even after 6 hours the kids were fully engaged!”. The following quote from a female student describes a typical positive student experience of the activity which helped them overcome their initial fear of programming: “I really liked the programming week. Even if […] my hair was standing on edge […] I was able to form a positive opinion on programming and realized that it isn’t that difficult after all If it was up to me we would have an activity like this again.”. The following last quote illustrates a typical negative student experience wherein students were able to do the activity but were no further motivated to do subsequent activities: “I liked programming my own game a lot. I would love to keep working on it for weeks! Sometimes […] things that I programmed didn’t work, and I had to look for the mistakes and solve them, which I mostly managed to do. However, even though I liked it, I also know now that I don’t want a job later where I have to sit in front of the computer all the time.”

Overall these quotes speak to the sustainability of the activity as teachers felt comfortable giving the activity in class, students were able to not only complete the activity but were motivated and engaged, and both students and teachers expressed interest in being part of CSEdWeek 2015.

3.3 Quantitative data: retention

To assess the efficacy of the activity’s adaptation for use in Switzerland, we used participant retention as an evaluation instrument. Retention in this case meant how long a student remained with the activity before stopping. As explained above, the CSEdWeek Frogger video tutorial provides step-by-step instructions that leads to students building games with the same rules and lines of code. Each programming step taught by the tutorial directly correlates to a known and consistent set of lines of codes in student projects. Because of the direct relationship between the steps of taught by the tutorial and the actual lines of code that students create, the number of lines of code correlates directly to how long a student was retained in the activity. The complete tutorial-guided Frogger activity consists of 215 lines of code in AgentCubes which we calculate by analyzing the XML file that represents each agent’s behavior. In past classroom Scalable Game Design observations, students usually get to a program length of around 46 or 59 within an hour. In the CSEdWeek activity these two lengths correspond to the Frog...
moving in all four directions, at a program length of 46, and the win state of the game wherein the player wins if the frog jumps on a target at the end of the level, at a program length of 59. Quantitative website data show that over 10,000 students accessed the activity and started their own projects by creating 3D characters and worlds. Of these, 2,116 student projects comprised one or more lines of code, which we analysed in terms of retention. Starting at 100% at the program length of 1, data shows that we lose students as their numbers drop off at each program length greater than 1. The general trend of the retention follows a negative exponential curve \( r = 0.933; F(1, 384) = 5375.714, p < 0.01 \). This implies that as students proceeded through the steps of the activity, the rate at which students decided to cease participation decreased. Furthermore, the retention data indicates several points where many students tend to discontinue the activity, specifically at the program lengths of 45 and 59 indicated above. The usual context for CSEdWeek activities is that students will complete an hour of code in their classrooms. If a teacher budgeted exactly one hour for this exercise, the average of 56 lines of code is the approximate point students will reach before discontinuing the activity. Retention data also shows that a large percentage of participants who programmed at least 1 line of code continued significantly beyond one hour writing more than 59 lines of code, with 13.5% of them completing a full Frogger game comprising 215 lines of code.

4. DISCUSSION

The first Swiss CSEdWeek can justly be called a success, considering not only the students’ retention during the week but also the event’s sustainability beyond the activity itself. Our hope is that future events like this have the power of overcoming skepticism towards CSE. In order to make this come true, however, we have to look closely at all the factors we think were crucial to the success of the event on the one hand and aspects that hint at shortcomings in the activity and our implementation strategy, on the other hand. This will enable us to become aware of mandatory adjustments, which, when implemented, might work towards the realization of our hopes. In general, our experiences have confirmed the initial assumption that the greatest challenge to our endeavor is the federalist structure of the Swiss state, that most other challenges result from this structure and that the most effective way to cope with these challenges is the partnering with nationally trusted organizations combined with the bottom up approach. Most of our adjustments will relate directly to the federalist challenge by further refining and broadening the bottom up approach. This section provides an overview of potential reasons for the successful launching of the Swiss CSEdWeek, the assumed shortcomings of our implementation strategy, and, on the basis of that, the strategy adjustments for the Swiss CSEdWeek 2015.

4.1 Language challenges

Catering to the specific language affordances in Switzerland was of the essence for enlisting as much as 10,000 students in a multilingual context. This not only relates to the activity’s translation into German, French and Italian, including the video tutorial and the tooltips, but also to providing additional information, teaching guidelines and the FAQ section in both German and French.

Shortcomings: While by far the great majority of participants were located in the German-speaking part of Switzerland, indicating the usefulness of the activity’s German language adaptation, the German-speaking cantons Obwalden, Nidwalden, Schwyz and Glarus of central Switzerland had very few to no participants. Similarly, although the activity was available in Italian long before the actual event, participation in the Italian speaking canton Ticino was very low. In contrast, although the activity’s French version was provided only three days after the beginning of the CSEdWeek, a considerable number of French speaking students participated in the activity.

Adjustments: While the Italian version of the activity itself had been ready before the event, there were no additional information, teaching guidelines and FAQ sections like in German and French. Also, we had neither Italian nor French versions of the event’s flyer. In order to reach more teachers and students in Switzerland during the next CSEdWeek, especially in the Italian-speaking canton, we need to do even greater justice to the multilingual affordances and specifically cater to the needs of Italian-speaking teachers and students. In addition to providing a multilingual version of the activity itself we will therefore have all promotion and information material as well as teaching guidelines and FAQ sections in all three languages and much earlier.

4.2 Recruitment challenges

On the basis of individual statements made by teachers, it appears that a main reason for their participation was essentially related to the matter of credibility: Apparently it was important, on the one hand, that organizations like the SVIA supported and advertised the activity vouching for its educational value. On the other hand, the fact that the organizers are employed at the school of education of the FHNW generated trust, since that institution is responsible for certified teacher training. Another reason for quite a few teachers’ decision to participate seems to have been the fact that we addressed them personally, sending them invitations in individual emails. This strategy lies at the heart of our bottom up approach which, instead of addressing teachers via their direct superiors or even state institutions, reached out to them on a personal level, thereby signaling our appreciation of their specific contexts and their individual contributions. Another important factor of the bottom up approach to recruitment was that the CSEdWeek activity fulfilled the conditions expressed by Swiss teachers that education activities are sustainable and tie in with the general curriculum in the long run. The activity answered to this requirement in many ways. For one, it is embedded in the broader and sustainable initiative of the CSE professorship including teacher training through workshops and future university courses. Also, the activity itself is open-ended, enabling both teachers and students further developments and adjustments to specific needs and contexts.

Shortcomings: Many teachers who did not participate in the event gave as the major reason that they would have liked to have known about the event much earlier in order to have enough time for preparing themselves properly, establishing the necessary infrastructure in the classroom and being able to integrate the activity into their regular lesson plans.
Adjustments: Having a far greater lead time for 2015 is highly important in this respect as teachers will get to know about the event much earlier. Moreover, the fact that the activity was already implemented successfully in 2014 significantly increases the potential reach and effectiveness of our bottom up approach in many ways. Firstly, many teachers might get to know about the event not only via newsletters, flyers and other anonymous indirect information channels but rather through their own colleagues who already participated in 2014. Secondly, the activity no longer has the status of something unknown, which could help to enlist even skeptical teachers located in more conservative parts of Switzerland. And thirdly, we can reach and potentially motivate a much greater amount of teachers via personal invitations because we have considerably more contacts due to registrations in 2014. Furthermore, both the greater lead time and the successful implementation in 2014 enable us to effect another valuable adjustment, namely the enlistment for patronage or sponsorship of further Swiss wide renowned institutions in the educational sector like the Swiss Conference of Cantonal Ministers of Education (EDK) and education departments of different cantons. The support of these state institutions additionally vouches for the high educational value of the activity and the trustworthiness of the initiative as a whole and might enable us to enroll significantly more participants in 2015.

4.3 Support challenges
While the website provided comprehensive information concerning the introduction of the activity in the classroom as well as a FAQ section, the offer of direct and individual support appears to have been even more important to teachers who participated in the event. Experts providing email and phone support during the actual event seems to have given teachers the feeling that they are “not alone”. Quite a few teachers only decided to do the activity after talking to team members on the phone or receiving extensive counseling as an answer to their support requests via email or on the blog. Also, many of those who called or wrote an email did so repeatedly for different reasons, obviously appreciating the support offer. The central assumption is that this offer of individual support increased many teachers’ willingness to embark on a journey into unknown territory with their students and made them more confident during the event.

Shortcomings: Some teachers’ feedback implies that they found the information material badly presented or insufficient. For example, one teacher complained that the recommendation of the use of the Internet browser Chrome for the activity was not stated clearly enough, leading to complications. Although the information on the recommended browser was part of the guidelines for teachers, it is possible that the format and structure of the MediaWiki website did not present the requested information in a sufficiently accessible way. Based on many teachers’ and students’ feedback, a further major shortcoming was that in case of browser or server problems, students had to start from scratch again because they could not find their original project again. This circumstance certainly demotivated quite a few students and dissuaded them from continuing their programming activity past the minimum time assigned to the activity by the teachers.

Adjustments: For the CSEdWeek 2015, the event website will be thoroughly restructured in order to make essential information more accessible. The problem of lost projects was already solved by inserting a project search function in the Frogger 3D activity. This function enables students to find their “lost” projects on the basis of their project’s name. This adjustment is expected to significantly increase students’ retention and even perseverance.

5. CONCLUSIONS
The Swiss CS Education Week, with a Switzerland specific adaption of the 2013 “Frogger 3D” Hour of Code activity, was launched in 2014. The adaption explored three specific challenges. Firstly, just like the USA, Switzerland is a federalistic country making centralistic dissemination models nearly impossible but, moreover, the presence of four official national languages adds substantial complexity of language as well as cultural barriers. Secondly, recruitment of teachers can be difficult. The participation of President Obama as the first standing US president demonstrating programming was of high PR value for the US but had little impact internationally. Recruiting comparable high profile political figures in countries other than the USA can be extremely difficult. Finally, in a country such as Switzerland with lower average computer use in schools than the USA, there is a higher need for technical and pedagogical support. By addressing these challenges the “Frogger 3D” activity employed at the first Swiss Computer Science Education Week did manage to reach approximately the same percentage of the general population in Switzerland in 2014 as it did during the 2013 Hour of Code in the USA.

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7. REFERENCES