

# It's in your pocket: A MOOC about programming for kids and the role of OER in teaching and learning contexts

Maria Grandl<sup>1</sup>, Martin Ebner<sup>1</sup>, Wolfgang Slany<sup>1</sup>, Stefan Janisch<sup>1</sup>

<sup>1</sup> Graz University of Technology, Graz, Austria

## Abstract

Programming is considered as an essential skill in the 21st century. Visual programming languages and age-appropriate development environments allow an easy entry into this field. Nevertheless, it is very challenging to bring those skills in a very short time frame to schools, to their teachers, and to school children themselves. Therefore, Graz University of Technology started a Massive Open Online Course named “Learning to code: Programming with Pocket Code” which is intended to teach coding skills to school children as well as teachers in a very fast, flexible and effective way. The learning content within the course is published under an open license to allow the reuse, modification and dissemination of the materials in different teaching and learning contexts. In this research work, we will present structure and concept of the MOOC. A special emphasis will be given on how the MOOC can be used in school and on the fact, that the content can be disseminated in a variety of ways.

**Keywords:** MOOC, OER, Coding

## 1. Introduction

Computational thinking (CT) is considered as an essential skill in the 21st century. According to J. Wing, it “represents a universally applicable attitude and skill set everyone, not just computer scientists, would be eager to learn and use.” (Wing, 2006) Coding is one way to train and practise CT. A report of ACM Europe and Informatics Europe emphasises, that all of “Europe’s citizens need to be educated in both digital literacy and informatics.” In view of a rapid technological progress, it is not sufficient to be only a user of new technologies. (Informatics Europe/ACM Europe, 2013) We need to have a general understanding of the technical aspects behind them. Visual programming languages and age-appropriate development environments allow an easy entry into this field. Nevertheless, it is very challenging to bring those skills in a very short time frame to schools, their teachers and to school children itself. Therefore, Graz University of Technology started a Massive Open Online Course named “Learning to code: Programming with Pocket Code” aiming to allow children and teenagers to learn essential programming skills just online within 5 weeks. Teachers can also use the course to acquire knowledge or improve their coding skills. Each single learning content has been defined as Open Educational Resource (OER), allowing the reuse in different learning and teaching contexts. Working with MOOCs has a long tradition at our university. In 2014, the first and so far only Austrian MOOC platform iMooX.at<sup>1</sup> was founded, which has meanwhile achieved a high degree of recognition in Central Europe, especially in the German-speaking area. (Khalil & Ebner, 2016)

In this research work, the MOOC “Learning to Code – Programming with Pocket Code”, which is available on iMooX.at, is presented with reference to the course structure and the creation of age-appropriate content. First conclusions can be drawn from the behaviour of the learners and their

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<sup>1</sup> <https://imoox.at/>

results, which are discussed in this work. Additionally, follow-up projects showed the reuse of the open content in an open learning scenario and how other educators use the course. It can be concluded, that open educational resources helps to train multipliers in a fast and effective way.

## **2. Related work**

Graz University of Technology has a long tradition in working on Massive Open Online Courses (MOOCs) in middle Europe, especially in the German-speaking area (Ebner et al., 2015). Together with the University of Graz, a MOOC platform was founded in 2014. Since then, more than 40 different MOOCs have been made accessible. They cover different topics and address different groups of learners (Neuböck et al., 2015). With the help of learning analytics different studies found out, where MOOCs add a value to education (Khalil & Ebner, 2016).

MOOCs, firstly named by McAuley et al. in 2010, are a driving force for open education due to their free and open accessibility. Any learner worldwide can access the provided content for free. Since famous universities like Harvard, MIT and others started offering public online courses, the MOOC-movement has become a mass phenomenon (Carson & Schmidt, 2012). Those online courses have been booked by thousand over thousands of people from all over the world to learn about various topics. Most of the time, those MOOCs are following a very strict structure: They are more or less based on video lectures and enhanced by additional learning materials and self-assessment-activities. Discussion forums serve as a place for communication and foster exchange between students and teachers and students and students. (Khalil & Ebner, 2013) Typically those courses last about 6 to 8 weeks.

At first glance, those MOOCs helped to open up education to the public and offered educational content worldwide, but at second glance, different problems occurred:

1. Most of the courses were closed after the end of the course.
2. The learning content offered by most of the courses did not represent an open educational resource. With other words, videos and additional material were not licensed with an open license (for example, a Creative Commons license).

Nevertheless, there is one big problem, especially in the German-speaking countries. Due to a very strict copyright law, open content without a license cannot be used for teaching purposes (Ebner et al., 2016). Moreover, the usage can be penalized with an arbitrarily amount of money.

Therefore, the MOOC platform iMooX.at of Graz University of Technology and University of Graz holds an explicit policy to offer only online courses where every single content is published under an open Creative Commons license to allow the reuse and distribution in different teaching and learning contexts.

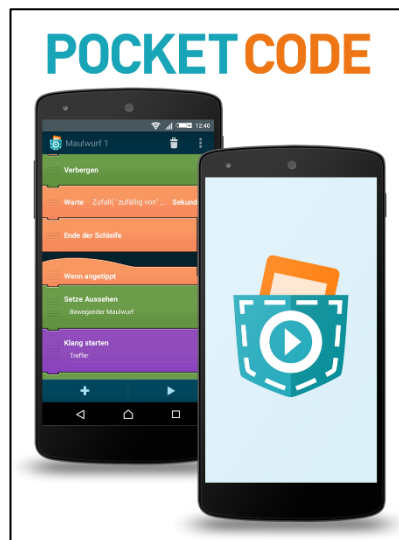
As well as that, the open license allows the use of the MOOC content in different didactical approaches, such as Blended Learning scenarios or flipped classroom settings. Even more, a new scenario was developed called Inverse Blended Learning. With the help of local learning groups that are hosted by a local trainer in a face-to-face situation, the online course gets integrated into offline situations. (Ebner et al., 2017)

## **3. MOOC “Learning to code: Programming with Pocket Code”**

To support a learning environment that allows children and adolescents between the ages of 10 and 14 to work on their own Pocket Code projects in a playable way, a MOOC was created, which is now available on iMooX.at. The aim of the course is to help young people to gain first experiences with programming and to boost interest in further topics regarding computer science.

## A. APP Pocket Code

Pocket Code is a free mobile app, which was developed within the non-profit Catrobat project at Graz University of Technology to assist beginners to acquire coding skills in an entertaining and engaging way. It acts as a development environment for programs that can be created directly on the smartphone or tablet with access to all built-in sensors. The used block-based programming language was developed according to the model of *Scratch* (Slany, 2014). Users can quickly write programs with the help of command bricks, which are categorized in command classes (e.g. *control*, *events* or *movement*) and which differ in colour. Compared to Scratch, children and teenagers can use their own mobile devices regardless of time and place to create a program. In particular, schools often lack an appropriate IT infrastructure. (cf. mpfs 2016) With Pocket Code, students can use their own devices - according to the principle of "Bring your own device" (BYOD). (cf. Nagler et al., 2016)



**Figure 1:** Logo and user interface of Pocket Code, a development environment for creative apps

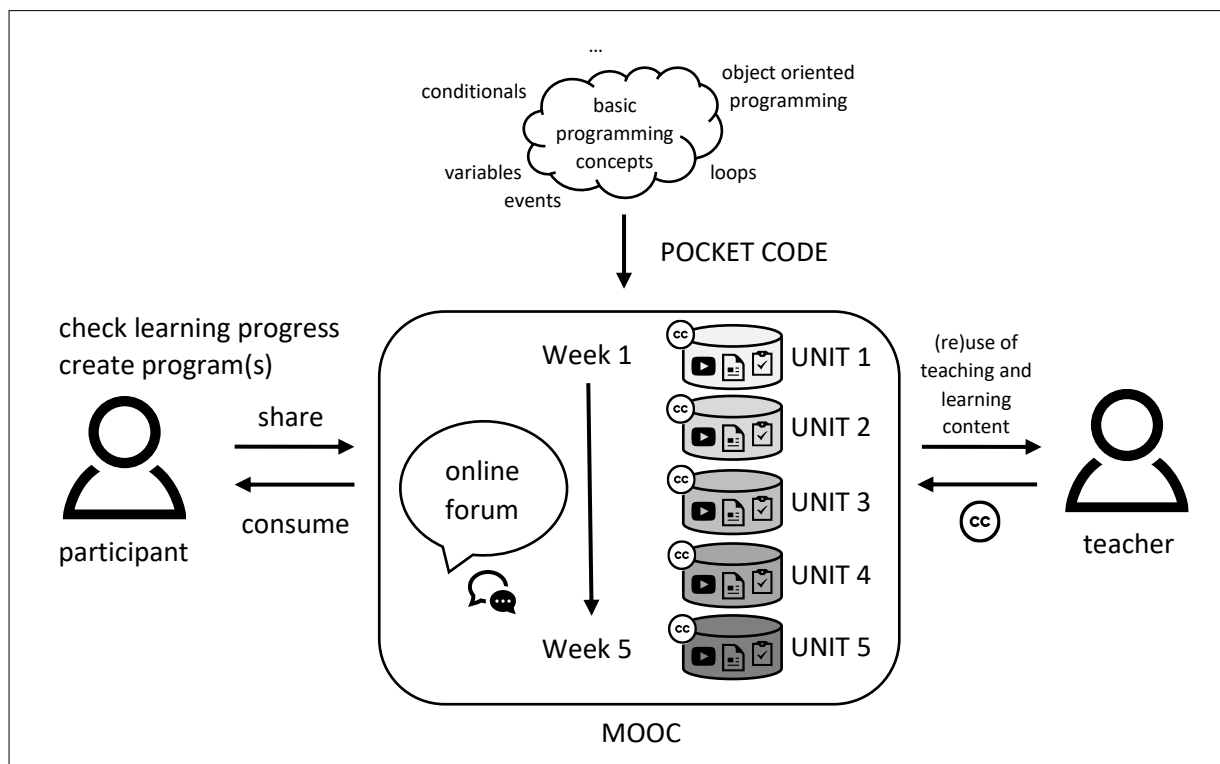
According to Seymour Papert, founder of constructionism (Schön et al, 2014) and developer of LOGO, one of the first programming languages for children, a programming language needs to be characterized by the following two characteristics: On the one hand, it should enable an easy and intuitive introduction to programming ("*low floor*"). On the other hand, it should allow users to implement complex and extensive projects ("*high ceiling*"). Mitchel Resnick, a student of Papert and professor at the Massachusetts Institute of Technology, who is involved in the development of Scratch, added the property "*wide walls*". Accordingly, a programming language should enable the implementation of many different projects to meet the user's different interests and learning methods. (cf. Resnick et al, 2009) Pocket Code allow to follow the "*low floor*" - "*high ceiling*" - "*wide walls*" principle. Programs created by the users show that Pocket Code appeals to different target groups. The topic of a program is not limited to areas related to computer science. Thus, Pocket Code can be used in all school subjects. As computer science is not a compulsory subject in many schools, this is an important aspect. A lot of European countries follow a cross-curricular approach concerning the use of information and communication technologies.

## B. COURSE FORMAT

Each course on iMooX.at follows a specific structure. The content is split into 5 to 8 lessons. Each lesson consists of at least one video. In most cases, a lesson includes 2 to 3 videos. The videos have an average length of 10 minutes. In addition to the videos, other materials such as files and links can be added. A self-assessment test must be created for each lesson. To complete the course

successfully, 75% of the self-assessment-questions need to be answered correctly. In this case, participants will receive a confirmation of participation for the online course. A MOOC starts on a certain date. Every week a new lesson will be released. The MOOC is supervised until the last lesson has been activated. Participants can use the online forum to ask questions or to submit solutions to a certain task. Each MOOC on iMooX holds an open-license (Creative Commons) and is available for free.

As shown in figure 2, the main content of the MOOC “Learning to code: Programming with Pocket Code” refers to different programming concepts. The goal of the MOOC is the creation of an individual game. The MOOC comprises 5 units. The first unit explains the user interface of Pocket Code and shows how to create a simple program. The second unit deals with loops and discusses if-else-statements more detailed. Sensors, variables and the role of random numbers in programming are topics of the third and fourth unit. The fifth unit introduces more features of the app that play a significant role when creating a game. Each lesson contains several videos, which introduce different problems and explain the corresponding command bricks. In addition to the videos, a written description is provided.



**Figure 2:** Structure and concept of the MOOC “Learning to Code – Programming with Pocket Code”.

As well as watching video tutorials and reading the written instructions, participants need to create programs on their own to improve their computational thinking capacity. Therefore, there are one or more tasks per unit. Participants are supposed to work on these tasks, which always refer to the creation of a program. During the course, participants have the possibility to receive feedback on the programs they have created. To do this, the participants need to upload the program via the app and announce the name of the program in the discussion forum. For every single task a description, a hint and a possible solution are provided. At the end of each unit, there is a quiz consisting of multiple-choice questions to check one’s learning progress. For each self-assessment test, 5 attempts are possible. The self-assessment questions are optional, but a prerequisite for obtaining a certificate.

The learning content within the course is published under an open Creative Commons license to allow the reuse, modification and dissemination of the materials in different learning contexts. All videos are available on YouTube as well.

### C. ORGANISATION

The course was offered for the first time in October 2016. The course was now held for the second time. In 2016, the MOOC was additionally offered as a private course in school. 14 children in the age of 10 to 11 took part in the course. (cf. Janisch et al., 2017) Instead of the concept of blended learning, where lessons are supplemented by e-learning elements, the concept of inverse blended learning came into play. (cf. Käfmüller, 2016; Ebner et al., 2017) Thereby, the children worked with the online content of the MOOC in class by using a tablet and earphones. At the same time, they had the possibility to ask questions or to share their programs with their classmates in an offline kind of way.

## 4. Results

In 2016, 571 people were registered for the course. However, only 64 participants completed the whole course. (cf. Janisch et al., 2017) An analysis of the participant activities confirmed the problem of high drop-out rates, which is a characteristic behaviour in the context of MOOCs. (cf. Lackner et al., 2015) The MOOC was launched again in October 2017. By March 2018, 626 participants, 55 more than in 2016, had taken part in the course. Unfortunately, until March only 44 participants received a certificate of participation. In 2017, the course run as a pure online course. We did not explicitly offer offline courses or meetings to foster participant communication and collaboration. In contrast it should be pointed out that in the school setting of 2016, all children finished the MOOC.

year	number of the users registered for the course	number of participants who requested a certificate	drop-out rate in %
2016	571 (12/2016)	64	88.79
2017	626 (03/2018)	38	93.93

**Table 1:** Number of participants of the MOOC “Learning to Code – Programming with Pocket Code” on, which was launched for the first time in October 2016 and for the second time in October 2017.

An analysis of the number of accesses in 2017 to the self-assessment questions also confirmed the decline in user activity. The number of users who successfully completed the self-assessment questions per unit are as following:

Quiz 1	123
Quiz 2	74
Quiz 3	55
Quiz 4	46
Quiz 5	42

**Table 2:** Number of participants, who completed the quiz

41 users successfully completed all quizzes. 142 out of 626 participants, 23% of all registered users, worked on at least one quiz. On average, 2 attempts were required for a quiz. As well as in 2017, there was also a decrease in the number of video views during the course.

Nevertheless, the participants, who completed the course in 2016 and 2017, were very satisfied with the content, design and structure of the course. These results are based on the analysis of the feedback questionnaires, which need to be completed by the participants to get a certificate of

participation. The feedback questionnaire is intended to record the participant's experience, impression, motivation and satisfaction related to the course. 43 of 45 participants who filled out the questionnaire graded the course as "very good" or "good". On average, they spent 1-3 hours per week on the course.

#### **A. ONLINE FORUM**

The lack of interaction among participants as well as between course instructor and participants is a frequent reason for not finishing a MOOC. (cf. Neuböck et al., 2015; Khalil & Ebner, 2013) Therefore, the online forum is intended to act as a place for communication, to ask questions, to talk about problems, that have occurred during the course, to give helpful hints and tricks and to share experiences. In 2017, the communication was mainly between the course instructor and participants, ranging from suggestions for improvement for the Pocket Code app and specific questions concerning the functionality of the app to information about ambiguous self-assessment-questions and small mistakes in the written descriptions. In total, there were 122 forum contributions.

The participants were asked to share their solutions to the tasks for each unit in the online forum. Only a very small number of adult participants took the possibility to do so.

For the tasks described in unit 1 to 4, only 10, 5, 9 and 4 programs were submitted. Most of the solutions even exceeded the requirements. The task of unit 5 asked for the creation of an individual program or game with respect to the programming concepts, that were discussed and practised during the MOOC. Unfortunately, only 2 participants announced the name of the created programs in the forum.

#### **B. PARTICIPANTS**

Although the course was designed for children and adolescents between the ages of 10 and 14, mostly adults, especially teachers, participated in the course. Some school classes did also register for the course. Based on the feedback questionnaire, the participants stated that they were interested in additional training and that they wanted to gain experience with MOOCs and online courses in general. As well as that, the participants appreciate that the course can be done for free and regardless of location and time. The graphical and textual presentation of the learning content was also judged appropriate.

#### **C. DIDACTICAL RE-DESIGN**

After the end of the course, another research project was built out of the open educational resources, that were used in the MOOC. This resulted in a Moodle course to support an open learning scenario in class. Moodle is an open source learning management system (LMS), that allows users to export courses, which then can be important in any other Moodle system. In Austria, Moodle is a common LMS that is used by schools and educational institutions. Due to the use of open Creative Commons licenses, nearly all videos have been adopted and were rearranged. Additionally, worksheets and tasks for school children were prepared, based on the given materials. A so-called "work-plan" was created to help children choose their own learning paths in the open learning scenario (Höllerbauer et al., 2017). The provided materials should enable students to learn on their own or in a group, according to their abilities and previous knowledge.

#### **D. PROFESSIONAL DEVELOPMENT COURSE FOR TEACHERS**

In Austria, teachers need to attend further training courses to stay up-to-date to subject-specific and pedagogical developments. The Virtuelle Pädagogische Hochschule (VPH) provides "*support in gaining digital competencies, i.e. being able to professionally implement technology assisted teaching*

*into classrooms, and knowledge of current teaching and learning methods.”*<sup>2</sup> In summer 2017, the MOOC “Learning to code – Programming with Pocket Code” has been added to the list of (online) training courses. Teacher and pre-service teachers had the possibility to take part in the MOOC and to receive credits for a successful participation. In addition to the MOOC, 3 different online lectures were held by the course instructor, in which the content of the course units was summarized and supplemented with didactical and pedagogical comments. Unfortunately, only a very small number of teachers and pre-service teachers took the opportunity to take part in this kind of further training course or to watch one of the three online lectures. This is also strongly related to the fact that computer science as a school subject is still not as important as other scientific subjects. (cf. Grandl & Ebner, 2017) As well as that, 38 out of the 44 participants, who finished the course, stated, that they are familiar with the use of new media and computer-aided learning environments. Therefore, it can be concluded that further training courses that are held purely online rather appeal to technophile teachers.

## 5. Discussion and Future Work

In our research work, we studied the impact of a MOOC to teach coding skills to school children as well as teachers. It can be summarized that in 2017, 626 learners in the German-speaking area were reached just through the online course, that is still available on the Austrian MOOC platform iMooX.at. The creation of open educational resources that are used in the MOOC allowed and fostered the reuse, modification and dissemination teaching and learning materials in different learning contexts. The whole course was reworked to an open Moodle course, which supports the implementation of an open learning scenario in class. As well as that, the MOOC was offered as an online further training course for teachers over the Austrian “Virtuelle Pädagogische Hochschule”. Currently, the research team is working on a translation of the MOOC in English to offer it on other open MOOC platforms.

The next goal is that the MOOC reaches more students. Teachers need to be informed about different teaching and learning scenarios in connection with MOOCs. In particular, teachers can apply the concepts of “blended learning”, “inverse blended learning” or “flipped classroom” by using MOOC materials. (cf. Li et al., 2015) Especially young people do not likely register for the MOOC on their own. Schools, teachers and parents play a major in this context, as they make children and teenagers aware of these kind of offers or use MOOCs and videos in class.

To do something about the high drop-out rate and to increase user activity, we need to think of a *“granular certification process makes specific learning achievements visible.”* This might answer *“participants’ need to be able to select different topics and units that are important for their personal non-formal learning process.”* (Lackner et al., 2015) As well as that, gamification elements can be included to boost motivation.

It can be concluded that MOOCs allow learners to access content in a very fast, flexible and effective way. Due to the nature of open educational resources within MOOCs, it is possible to build new learning scenarios upon it. More than that, content can be spread in different and manifold ways, that were not intended in the beginning.

The extent to which MOOCs are gaining acceptance in the educational sector, especially in the field of basic computer science education, is currently difficult to predict. The format has successfully shown that it is not only suitable to teach different aspects of computer science, but also to boost interest in a specific topic.

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<sup>2</sup> Virtuelle Pädagogische Hochschule (VPH) <http://www.virtuelle-ph.at/ueber-uns/onlinecampus-virtuelle-ph/information-in-englisch/> (last visited on 10 March 2017)

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