

## Chapter 2

# Fostering the Teaching and Learning of Computer Programming With Open Educational Resources: Challenges and Solutions

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### ABSTRACT

*Open educational resources (OER) are materials designed for teaching, learning, or research. They are free and open, facilitating their use and reuse within a community of users. Due to these characteristics, OER can play a crucial role in supporting the teaching and learning of computer programming. They can provide, for instance, resources such as video classes, open books, and free online courses for students, along with various teaching materials for educators. However, these resources are hidden in large digital collections, generating a discovery problem for users. Considering this scenario, the purpose of this chapter is to discuss how to articulate OER and computer programming, emphasizing two main lines of necessary action: first, addressing the challenges that students and teachers still face when seeking such materials; second, outlining solutions that researchers or individuals interested in the topic can adopt to facilitate the reuse of these materials. Together, these two lines of action pave the way for the widespread use of OER in programming education.*

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## INTRODUCTION

Open Educational Resources (OER) are both open and free materials for teaching, learning, and research (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2019). In short, OER encompasses any kind of material that addresses educational content, such as videos, syllabi, open textbooks, among others. Additionally, the content must be open-licensed to enable their use, reuse, and sharing (Muñoz-Rujas, Baptiste, Pavani & Montero, 2020).

Despite the potential of OER to promote the democratization of education, OER are still far from being fully adopted by students and teachers (Cortinovis, Mikroyannidis, Domingue, Mulholland & Farrow, 2019). In fact, there is still a lack of OER in educational contexts as well as difficulties related to the use and identification of relevant resources (Ivanova, 2019; Wiley, Bliss & McEwen, 2013). In this sense, it is essential to establish strategies and solutions for disseminating OER within educational contexts, thereby facilitating their use and adoption by teachers, students, researchers, and other stakeholders (UNESCO, 2019).

According to Wiley et al. (2013), the discovery problem is one of the main factors limiting the potential of OER to be widely adopted. In summary, the discovery problem refers to the difficulty that users face when searching for OER in digital sources. In many cases, searches are ineffective and non-relevant results are produced.

The discovery problem is amplified due to many factors. For example, a teacher of Computing can search for 'Java' within an OER initiative. However, the results presented can be aligned with Geography, showing resources about the island of Indonesia. This occurs because there are many collisions among very distinct subjects within digital collections.

Some users may argue that a more specific search could solve the aforementioned scenario. For instance, searching for 'Java programming exercises' instead of just 'Java'. However, the problem still remains. On the one hand, the amount of educational resources available on the Web is vast and continuously increasing (Popescu & Buse, 2014). In this sense, adding more terms will probably show more resources, making the task of finding relevant and reliable resources a very complex issue. On the other hand, OER are highly heterogeneous (Molins-Ruano, Jurado & Rodriguez, 2019). This implies that each resource has its own logical structure and terminology. Some resources may adopt 'computer programming' instead of 'Java programming'. Other resources may use 'syllabi' or 'coding for students' instead of 'exercises'. In practice, several refinements should be made until to identify a relevant result.

In fact, computer programming is a cross-cutting skill taught in different undergraduate courses, being an evidence that industry expects programming skills and abilities from graduates of all computing related programs (Association for Computing Machinery (ACM) & Institute of Electrical and Electronics Engineers - Computer Society (IEEE-CS), 2020). As a consequence, it has a great impact on the use of OER for programming students. For example, an OER useful for Computer Engineering students may not be useful for Computer Science students because some topics, such as the use of pointers, are more detailed.

Another point related to the discovery problem of OER for programming education is the educational levels adopted. Computer programming can be addressed in different educational levels, as occurs with 'CS1' or 'CS2'. But, there is little agreement on the topics and subjects that should be mastered by beginners (CS1) or advanced (CS2) students in programming (Hertz, 2010). As a result, educational materials for programming education also reflect this trend. In many OER repositories, there is an unclear distinction between these resources. Most of the time, OER for CS1 and CS2 are mixed in the same category, covering similar topics and subjects.

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