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Current Trends in Online Programming Languages Learning Tools: A Systematic Literature Review

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Abstract

Students face difficulties in programming languages learning (PLL) which encourages many scholars to investigate the factors behind that. Although there a number of positive and negative factors found to be effective in PLL procedure, utilising online tools in PLL were recognized as a positive recommended means. This motivates many researchers to provide solutions and proposals which result in a number of choices and options. However, categorising those efforts and showing what has been done, would provide a better and clear image for future studies. Therefore, this paper aims to conduct a systematic literature review to show what studies have been done and then categorise them based on the type of online tools and the aims of the research. The study follows Kitchenham and Charters guidelines for writing SLR (Systematic Literature Review). The search result reached 1390 publications between 2013-09/2018. After the filtration which has been done through selected criteria, 160 publications were found to be adequate to answer the review questions. The main results of this systematic review are categorizing the aims of the studies in online PLL tools, classifying the tools and finding the current trends of the online PLL tools.

Keywords

Online Programming Languages, Online Learning, Use of Information Technology, Online Platforms, Online Courses, MOOC

1. Introduction

Learning programming languages is one of the crucial knowledge in todays' education [1] [2]. Although there are difficulties in programming learning [3],

online programming learning tools were found to be essential positive factors that enhanced programming teaching and learning [4] [5] [6]. Consequently, many studies attempt to improve the materials and tools utilized in online programming teaching and learning, for instance, [3] [7] [8]. However, there is a need to classify them. While, there are a large number of online materials that are available for programming learning, yet the classification of their types and the aims of the investigations are not categorized. Also, the current trends of the online PLL tools are still mysterious. Therefore, this systematic literature review aims to analyze the studies that were conducted on the online PLL tools between 2013-September 2018, which would guide to better future investigations.

2. Related Work

There are few SLR publications conducted for online learning and online programming learning. For example, the paper [9] provided an SLR to show the advantages and challenges of using open source in computer science education generally. The study [10] conducted a systematic literature review to clarify how to include computational thinking into schools. The study [11] also conducted a SLR to illustrate integrating computational thinking in education procedure. The study [12] employed an SLR to find out the functionalities required to design massive open online practical programming courses. The study [13] showed how the self-regulated learning is addressed in Computer Science online learning tools. The study [14] conducted their systematic review to analyze the outcome of educating programming among children. However, there is a lack of a comprehensive view about the current trends on online programming learning.

3. Review Process

This systematic review follows the guidelines specified in [15]. Thus, the researchers plan the review first, then they conduct it in the second phase, and thirdly they report it. For planning the review phase, the researchers identify the need, select the research questions, decide the procedure and evaluate it. For applying the review, the researchers clarify the research, select studies and show the method of extracting data. Finally, the researchers format the report.

3.1. Research Questions

Two research questions were developed for this review.

Q1. What is the aim of the studies that were conducted for online programming languages learning tools?

Q2. What are the tools that were applied in online programming languages learning?

3.2. Data Sources

Five databases had been searched to be the data source for this paper as following: IEEE Explore, ISI Web of Science, ACM Digital Library, Scopus and ERIC.

3.3. Search Strategies

The research terms that were used are: (programming, online, learning, and "programming language"). The AND and OR Boolean characters were used to manage the search.

3.4. Selection Criteria

- **Inclusion criteria:**
  Papers published between 2013-2018.
  Papers talked about online programming languages learning tools.
  Papers were written in English.
  Availability of the papers.
- **Exclusion criteria:**
  Papers published outside of 2013-2018.
  Papers did not talk about online programming languages learning tools.
  Papers were not written in English.
  Unavailability of the papers.

4. Finding

4.1. Search Result

The first result of the database search had found 1390 publications. After evaluating all papers through their title and abstract the number was reduced to 560. The number becomes 552 after moving the resources to Mendeley software to delete the duplication. Finally, after applying the inclusion and exclusion criteria the number of papers becomes 160 which have been adequate to answer the questions of the paper (Figure 1).

As it can be seen, the percentage of the studies attempted in developed countries is about double those conducted in developing countries. It could be an indicator to the significance of having more investigations in developing countries (Figure 2).

As it is appeared in the above figure, there is a constant increase in the publications of the online PLL tools from 2013 to 2017 which gives an impression about the current curiosity among scholars interested in enhancing programming learning.

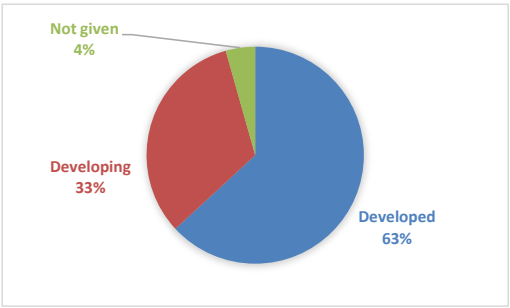

Figure 1. No. of online PLL publications in developed and developing countries.

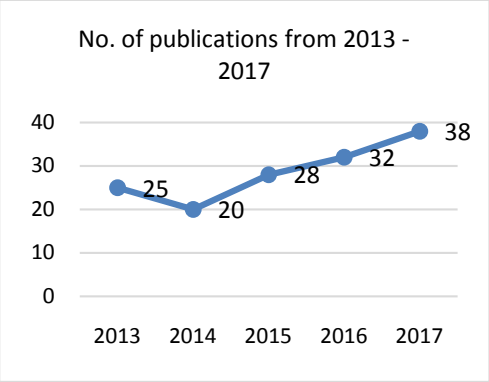

Figure 2. No. of online PLL publications between 2013-2017.

4.2. Research Question Answers

Q1. What is the aim of the studies that were conducted for online programming languages learning tools?

As it can be realized from **Figure 3**, there are three aims that were encouraging authors to conduct researches for online PLL tools which are: designing a new tool, integrating a tool in the learning environment and evaluating the use of an existed tool that already implemented. It is clear that the number of studies aimed to integrate a tool in programming learning procedure is the biggest with 58 publications. In the second place, studies that aimed to propose or design a tool for programming learning with about third of the works. While studies aimed to evaluate a tool in the programming education are 50 publications. For example, following studies aimed to design tools for online PLL [4] [16]-[37]. Those studies design online platform. [38] [39] [40] [41] aimed to evaluate the tool such as Online materials. [42]-[51] aimed to integrate the tools such as online software. However, the difference between the numbers of researches is not significant, which could be an indicator for the need of future researches in all three areas.

Q2. What are the tools that were applied in online programming languages learning (**Figure 4**)?

The pie chart illustrates the four applied types of online programming languages tools which are: general online learning materials, online platforms, designed software and online courses such as MOOC and online website. As it can be seen, the most investigated and applied tools were online programming learning courses with 36%. Also, the online websites and platforms were appeared to be an interesting area of research. Almost more than third of the publications considered them. Moreover, 28% of the studies were conducted to provide new software tools in online programming learning. This clarifies that computer science scholars are interested in applying online software tools to enhance the situation. Nevertheless, the lowest kind of publications in online programming learning tools are those considered as general online learning materials.

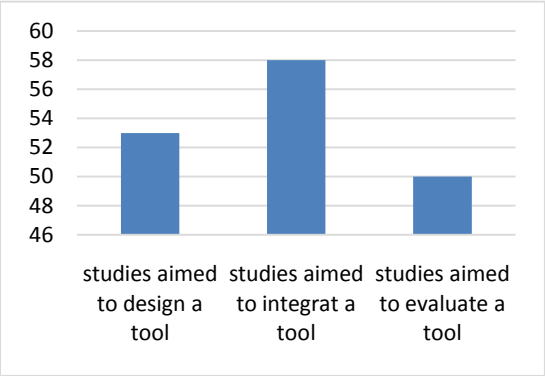

Figure 3. Categorization of the aims of publications in online PLL.

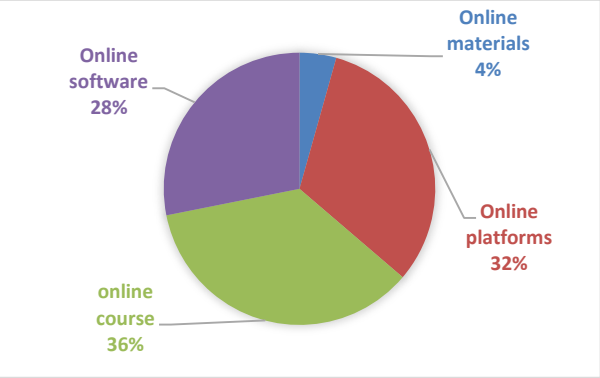

Figure 4. Categorization of the tools applied in PLL.

5. Discussion

After studying 160 publications in online programming languages learning tools between 2013-09/2018, it is recognized that the main aims were: designing a new tool, integrating an online tool in PLL environment and evaluating an existed tool that was already implemented. Furthermore, the applied tools investigated by previous studies could be classified into four kinds as following: 1) online websites that were designed to provide specific materials for PLL 2) online courses that were presented as online PLL classes 3) online software that was designed and added into online environments as an additional feature and 4) online materials which could be videos, exercises or documents that were downloaded from different online resources. This section discusses each aim and the tools that were applied to achieve it. It determines a graph for each aim to show the type and percentage of each utilized tool.

As it is illustrated in **Figure 3** the most popular aim amongst publications was to integrate a tool in programming learning procedure. However, **Figure 5** shows that half of those studies were interesting in integrating online courses. It is an indicator that online courses are more attractive than others. Also, online platforms and websites have a good number of publications that explain their integration in PLL. About third of the studies adapted online platforms to en-

hance PLL. Nevertheless, the graph shows that the number of studies that integrated online materials and existing software are few. Table 1 shows the studies integrated tools into PLL.

Figure 6 illustrates that new online platforms are the most preferable designed means. 43% of the studies aimed to design a new tool for PLL implemented online environments. Also, the studies that were interesting in designing software had a big number that reached 42%. However, there are few studies that paid attention to designing new online courses. As it is shown, just 15% of the studies were interesting in that. Table 2 shows the studies designed tools for PLL.

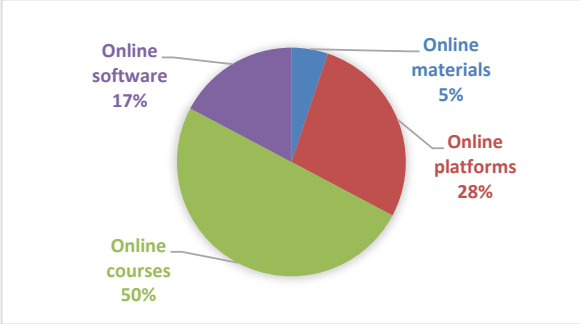

Figure 5. Tools integrated into PLL.

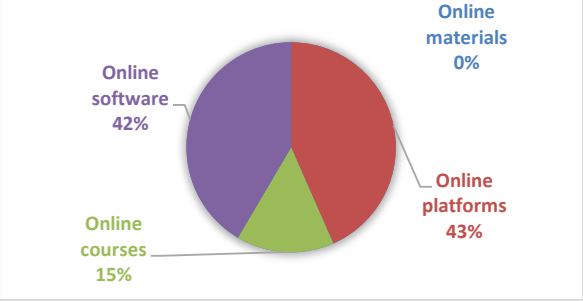

Figure 6. Tools designed for PLL.

Table 1. Categorization of the studies integrated tools into PLL.

Studies	Tools
[52] [53] [54]	Online materials
[2] [55]-[69]	Online platforms
[70] [71] [72]-[97]	Online courses
[42]-[51]	Online software

Table 2. Categorization of the studies designed tools for PLL.

Studies	Tools
[4] [16]-[37]	**Online platforms**
[98]-[105]	**Online courses**
[24] [106]-[127]	**Online software**

Although Figure 6 shows that there are few studies were interesting in designing new online courses, Figure 7 shows that most of the publications aimed to evaluate the effectiveness of the use of online PLL tools were interesting in online courses 45%. More than quarter of the publication investigated the beneficial of the use of online platforms. Also it is appeared that the online software means got almost similar curiosity with 23%. However, there is poor interest in looking at the effectiveness of the use of general online materials with 6%. Table 3 shows the studies evaluated the effectiveness of tools in PLL.

As it is illustrated previously, online courses in PLL are the most preferable means integrated and evaluated by the publications. However, it would be noteworthy to find out the kind of online courses had been mostly applied. Therefore, the researchers went through the previous online courses studies and found that they are two types. The first type is private online courses and the second one is massive open online courses (MOOC). As it can be seen in Figure 8, the most applied type of online programming learning tools is MOOC with 63%, and the privet courses are appeared to have 37%.

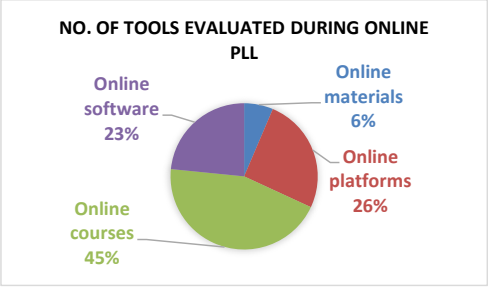

Figure 7. Tools evaluated during PLL.

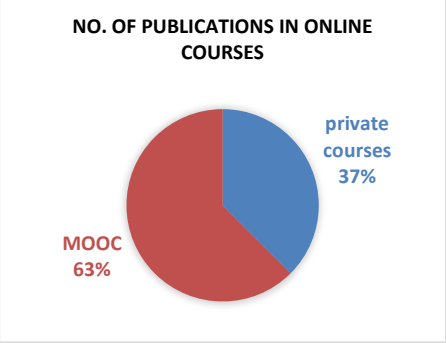

Figure 8. categorisation of publications in online courses.

Table 3. Categorization of the studies evaluated tools during PLL.

Studies	Tools
[38] [39] [40] [41]	**Online materials**
[128] [129]-[139]	**Online platforms**
[1] [6] [140]-[157]	**Online courses**
[5] [158]-[169]	**Online software**

6. Conclusion

Knowing the current trends in online PLL tools is an essential step that helps researchers to understand what are already done and what are needed to be investigated in future works. This study is a systematic literature review intended to clarify the previous researches in online PLL tools. The review shows that there are three aims that motivated scholars to conduct their researches in online PLL which are: designing a new online tool to enhance PLL, integrating an online tool in PLL environment or evaluating an existed tool that has already been implemented in PLL procedure. Also, it is found that there are four kinds of online tools that were applied in PLL which are: online websites, online courses, online software and general online learning materials. Moreover, it is clarified that online courses are the current trends of the online PLL tools. Also, it has appeared that more than half of the studies aimed to integrate online PLL tools were interesting in online courses. Also, about half of the investigations that aim to evaluate the effectiveness of online PLL tools were interesting in online courses. Furthermore, the researchers found that MOOCs' studies are the most applied online PLL courses. This could be an indicator for scholar that there is a need to have more investigations on the currently available online courses generally and MOOCs specifically. It would be essential to know types, applications, user's acceptance, adaption and advantages and weaknesses of massive open online programming courses.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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