Online Integrated Development Environment (IDE) in Supporting Computer Programming Learning Process during COVID-19 Pandemic: A Comparative Analysis

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Abstract— **COVID-19 has spread to various countries and affected many sectors, including education. New challenges arise in universities with study programs related to computer programming, which require a lot of practice. Difficulties encountered when students should setting up the environment needed to carry out programming practices. Furthermore, they should install a text editor called Integrated Development Environment (IDE) to support it. There is various online IDE that supports computer programming. However, students must have an internet connection to use it. After all, many students cannot afford to buy internet quotas to access online learning material during the COVID-19 pandemic. According to these problems, this study compares several online IDEs based on internet data usage and the necessary supporting libraries' availability. In this study, we only compared eleven online IDEs that support the Python programming language, free to access, and do not require logging in. Based on the comparative analysis, three online IDEs have most libraries supported. They are REPL.IT, CODECHEF, and IDEONE. Based on internet data usage, REPL.IT is an online IDE that requires the least transferred data. Moreover, this online IDE also has a user-friendly interface to place the left and right sides' code and output positions. It prevents the user from scrolling to see the results of the code that has been executed. The absence of advertisements also makes this online IDE a more focused appearance. Therefore, REPL.IT is highly recommended for users who have a limited internet quota, primarily to support the learning phase of computer programming during the COVID-19 pandemic.**

Keywords— integrated development environment; online IDE; computer programming learning; COVID-19 pandemi;, comparative analysis

1 INTRODUCTION

The COVID-19 outbreak has changed the daily life of people in many countries. Many sectors, including education, have been affected by the outbreak. Many states have decided to close educational institutions, which impacted over 60% of students and caused a massive disruption of the education scheme [1]. In Indonesia, the epidemic has made many community activities centered at home, including teaching and learning activities. The Indonesian Minister of Education and Culture has issued a policy to educational institutions, including universities, to encourage learning from home [2]. It forces the educational process to be carried out through a distance learning approach, such as online learning.

Online learning is described as a learning experience using various devices with internet access in a synchronous or asynchronous environment [3]. Students can learn and communicate with lecturers and other students anywhere in this environment [4]. Online learning is an effective way to apply in education, especially in universities that already understand technology use [5]. Besides, online learning also supports asynchronous learning methods, a learner-centered process of utilizing online learning resources to facilitate information distribution despite time and place limitations between people's networks [6]. Many media such as articles, PowerPoint, audio, and video are flexibly used in online learning activities that students can access freely and often [7]. In his study in 2020 [8], Daniel argued that universities should take advantage of asynchronous learning, which works best in digital format. However, lecturers should actively explore effective online teaching methods to provide good learning experiences for students at home [9].

In universities with study programs related to computer programming, new problems emerge that involve a lot of practice. Difficulties encountered when students should setting up the environment needed to carry out programming practices. Furthermore, they should install a text editor called Integrated Development Environment (IDE) to support it. Using IDE, users can differentiate text with the color highlight distinction in the program code. By using the highlight function, programmers can easily recognize the language structure and change the code. Minimal technical constraints are a real challenge for students in the first semester. The fact that the same operating system is not used by all students further aggravates this problem. To reduce these problems, using an online IDE is the best solution [10]. It allows programmers to write or change their source code at any location and whenever they want [11].

Many online IDEs support computer programming. Lecturers have to choose the best online IDE to keep the learning process of computer programming optimally. In this case, the best online IDE is an online IDE that students can easily use and support necessary libraries, even though it is accessed for free. Moreover, IDEs with the least internet quota data usage are preferred because online learning also impacts economic conditions. After all, many students cannot afford to buy internet quotas to access online learning media during the COVID-19 pandemic [12]. According to these problems, this study compares several online IDEs based on internet data usage and the necessary supporting libraries' availability. In this study, we only compared online IDEs that support the Python programming language, which is the top 1 programming language to learn in 2020 based on statistic data from Towards Data Science [13]. The popularity of Python is growing, especially in data science, which, as a consequence, has an increasing number of free libraries available for use [14].

Studies related to the online IDE comparative analysis, mainly based on internet data usage, ease of use, and available features, has never been conducted in previous studies. Most of the earlier studies discuss the comparison of learning platforms. In 2016 [15], Mutu et al. analyzed comparatively Massive Open Online Course (MOOC) platforms in terms of features, based on the user's implication and demands, namely related to course design, business model, and popularity among online users. Virvou et al., in 2017 [16], compared LMS and CMS platforms supporting social e-learning in higher education. They argued that the media have a user-friendly dashboard and a variation of education-oriented service. In 2018 [17], Elisabeta and Alexandru presented a comparative analysis of e-learning platforms on the market and how the educational systems assimilate them. In 2015 [18], Ahmed highlighted the contribution of cloud-based e-learning and the impact on learning solutions. The difference between this researches conducted with previous similar studies is that this study carries out a comparative analysis between several online IDEs based on internet data usage, ease of use, and available features, which has never been done before. This research contributes to the online IDE, which has the least amount of internet data usage with the best feature support to be used by students who have internet quota limitations.

2 METHOD

The comparative analysis process between the online IDE consists of some sub-process, which are shown in Figure 1. Several online IDE supports the Python programming language, free to access, and does not require logging in, searched on the Google search engine based on relevant keywords in the first step. We used the Google search engine since, by page rank, it prioritizes outcomes based on relevance while also using different techniques to enhance search efficiency [19].

In the second step, we review the literature related to each online IDE, which is done thoroughly by reading the relevant scientific articles. We used Google Scholar to search for it. Then, we analyze it and present it in the result and discussion section. In knowing each online IDE's internet data usage, we experimented by writing python code from a data structure material and using a Google Chrome extension called Data Usage to compare them. This extension serves to find out how much data is consumed by a website. Knowing each online IDE's available features, we found the information directly on the main website.

In the last step, we performed a comparative analysis between online IDEs based on these two parameters. The comparative analysis methodology has been used in several different studies. Dawarka and Bekaroo in 2018 [20] conducted

a comparative analysis of existing cloud robotic platforms to provide recommendations on future use and gaps that need to be addressed. Elisabeta and Alexandru in 2018 [17] also showed a comparative analysis of existing E-learning platforms on the market to support educational systems.
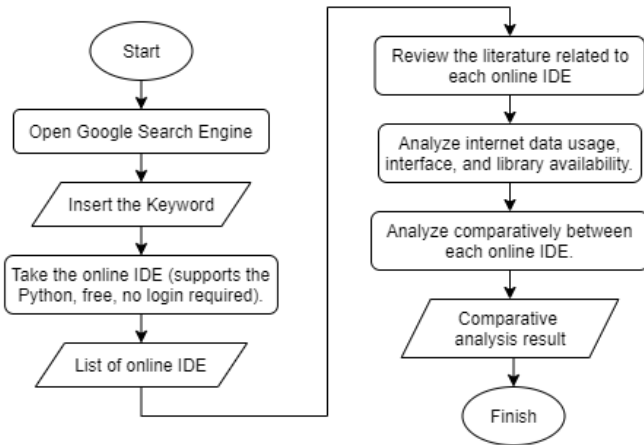

Figure 1.   Comparative analysis process

3 RESULT AND DISCUSSION

In September 2020, we searched several Online IDE Python free to access and do not require logging in. Eventually, we were able to identify 11 online IDE. Table 1 shows the list of these online IDE.

Table 1 Online Ide That Supports Python

No	Online IDE name	Web Address
1	Repl.it	https://repl.it/languages/python3
2	Browxy	https://www.browxy.com/
3	myCompiler	https://www.mycompiler.io/new/python
4	CodeChef	https://www.codechef.com/ide
5	Programiz	https://www.programiz.com/python-programming/online-compiler/
6	JDoodle	https://www.jdoodle.com/python3-programming-online/
7	TutorialsPoint	https://www.tutorialspoint.com/execute_python_online.php
8	PYnative	https://pynative.com/online-python-code-editor-to-execute-python-code/
9	Ideone	https://ideone.com/
10	Paiza	https://paiza.io/en/projects/new
11	Trinket	https://trinket.io/python

This section discusses the literature study based on the twelve online IDEs identified. However, not all online IDE has been used in previous studies. REPL.IT is an online IDE for programming in various languages, including Python, for writing and teaching. The web interface on REPL.IT allowed us to write programs during class for demonstration purposes. Zubrycki and Granosik in 2017 [21] used REPL.IT supports robotics teaching, an online IDE that offers numerical or symbolic computing to many popular libraries, such as Numpy or Scipy. Skoric et al., in 2020 [22], explored the acceptance of the online IDE in an introductory programming course, which one uses REPL.IT. They said this online IDE is a representative sample of the web-based coding tool because it allows learners to work on the same code concurrently, watch others' work, fix mistakes, comment, and run programs. Rahman et al., in 2019 [23], said that REPL.IT is an incredibly robust technology applied to a classroom setting in supporting interactive and collaborative learning to teach an introductory programming course. Using this online IDE, a teacher can invite students to join the virtual classroom, allowing them to collaborate with the teacher and fellow students. Cooper et al., in 2020 [24], revealed that students that use REPL.IT exhibited a higher comfort, confidence, and fondness for using this online IDE.

Trinket is an online IDE that supports Python. It can run directly, with no need to log in, download plugins, or install any software. Kurniawati et al., in 2018 [25], used Trinket as tools for teaching and learning introductory programming for beginners. They said that by using Trinket, teachers could present their code for students in real-time, which makes it interesting, inciting curiosity and motivation learning. Moreover, with the Trinket, the learner can share the code for collaborative learning with other students because the screen looks like their screen. Miskin and Gopalan, in 2017 [26], used Trinket as one of an online IDE for use in Python programming learning systems. Trinket executed all code on the browser, rendering it responsive and providing graphical output from code running. IDEONE is a free online IDE and debugging platform that allows users to share and run code in 40 + programming languages with their input data remotely [27].

Based on the eleven online IDEs in Table 1, we conducted experiments by writing python code from data structure materials. We analyzed internet data usage using a Google Chrome extension called Data Usage. We also conducted experiments by writing some popular Python libraries code such as NumPy, SciPy, Pandas, Matplotlib, and TensorFlow [28] to determine if the online IDE supports it is shown in Table 2.

In knowing each online IDE's internet data usage, we used the total transferred size parameter. Total transferred size is the total amount of bytes traveled across the wire, while total resource size refers to those files' weight once they're downloaded and un-compressed. According to Table 2, we can see that REPL.IT, CODECHEF, and IDEONE are the online IDE that has most libraries supported. By what was conveyed in previous studies that have discussed, REPL.IT is an online IDE that provides several popular libraries. Based on internet data usage, REPL.IT is an online IDE that requires the least transferred data. It is highly recommended for users who have limited internet quotas. Moreover, this online IDE also has a user-friendly interface to place the left and right sides' code and output positions. It prevents the user from scrolling to see the results of the code that has been executed. The absence of

Table 2 Experiment Result

No	Online IDE Name	Interface (Code and Result Location)	Ads	Total Transferred Size (KB)	Total Resources Size (KB)	Support for Several Popular Python Libraries				
						NumPy	SciPy	Pandas	Matplotlib	TensorFlow Basics
1.	Repl.it	Left & Right	No	36	8000	√	√	√	√	√
2.	Browxy	Above and Below	No	529	2000	X	X	X	X	X
3.	myCompiler	Different Tab	No	240	1000	X	X	X	X	X
4.	CodeChef	Above and Below	No	100	2000	√	√	√	√	√
5.	Programiz	Left & Right	Yes	254	1000	√	X	√	X	X
6.	JDoodle	Above and Below	Yes	810	4000	X	X	X	X	X
7.	TutorialsPoint	Left & Right	No	343	2000	√	√	√	√	X
8.	PYnative	Left & Right	Yes	344	2000	√	√	√	√	X
9.	Ideone	Above and Below	Yes	101	301	√	√	√	√	√
10.	Paiza	Above and Below	No	29	7000	√	√	√	√	X
11.	Trinket	Left & Right	No	567	2000	√	X	X	√	X

advertisements also makes this online IDE a more focused appearance. Figure 2 shows the interface of REPL.IT.
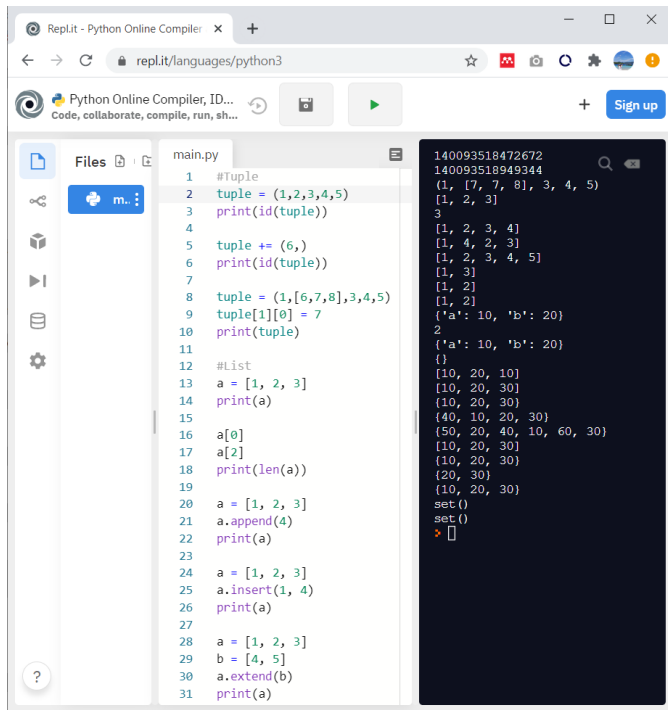

Figure 2.   The REPL.IT interface

Besides, CODECHEF and IDEONE are the second and third-ranked online IDEs that require the least amount of data to be transferred. However, specifically for the TensorFlow library in both online IDEs is still using a version lower than 2.0.0, while REPL.IT is already using version 2.3.1. TensorFlow is an open-source software library for numerical computation developed by Google, which is now widely used by several large organizations [29]. Tensorflow provides strong support for deep learning and machine learning, along with the flexible foundation of numerical computation [30].

Moreover, the user interface from both online IDEs also still has a less user-friendly interface that places code on the top side and output at the bottom position. This interface makes the user have to scroll to see the results of the code that has been executed. Figure 3 shows the interface of IDEONE that places code on the top side and output at the bottom position. However, when compared to IDEONE, CODECHEF is better because there are no advertisements on display. It may be distracting but not very significant.

As a highly recommended online IDE, we can use REPL.IT for specific needs, such as programming competitions, e-learning, mobile applications, and recruitment services. We can also use this online IDE for software testing, such as unit testing of code fragments and web application testing. REPL.IT is a good IDE for students to use within small resources with many limitations, especially about internet quotas, primarily to support the learning phase of computer programming during the COVID-19 pandemic.
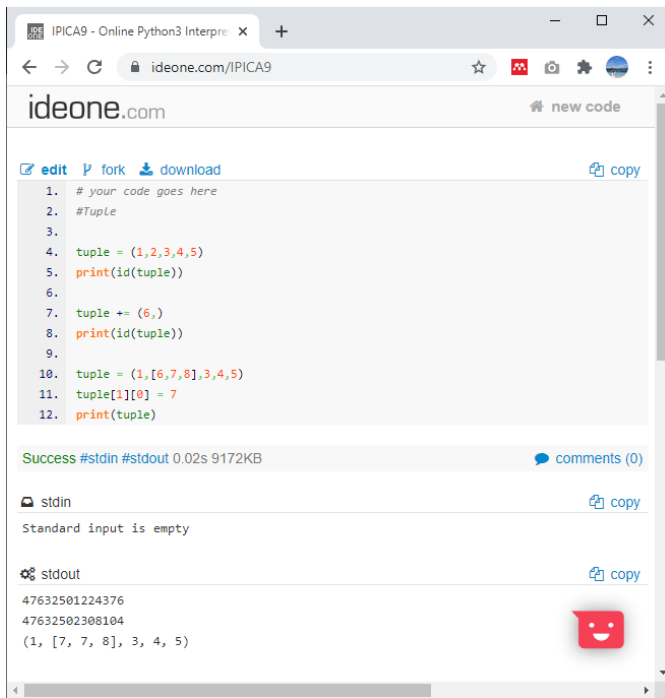
Figure 3.   The IDEONE interface

4 CONCLUSION

This study compares several online IDEs based on internet data usage and the necessary supporting libraries' availability. We only compared online IDEs that support the Python programming language. Based on the comparative analysis, there is two online IDE that has most libraries supported. They are REPL.IT, CODECHEF, and IDEONE. However, based on internet data usage, REPL.IT is an online IDE that requires the least transferred data. Moreover, this online IDE also has a user-friendly interface to place the left and right sides' code and output positions. It prevents the user from scrolling to see the results of the code that has been executed. Therefore, REPL.IT is highly recommended for users who have a limited internet quota, primarily to support the learning phase of computer programming during the COVID-19 pandemic.

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