SECURE DIGITAL ASSESSMENT OF DATA ANALYSIS COURSES USING R

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Abstract

Ensuring the integrity of assessments in data analysis courses has become increasingly challenging due to the rise of AI-assisted tools. This study explores the implementation of a secure digital evaluation framework for courses such as "Statistics" and "Data Analysis" at ETSII-UPM (School of Industrial Engineering – Technical University of Madrid, Spain), leveraging the Moodle interface and the Safe Exam Browser (SEB). Our approach involves analysing different online platforms that support R programming, evaluating their feasibility for controlled assessment environments. The study reviews technical implementation, student feedback, and instructor experiences in maintaining a fair evaluation process while harnessing the benefits of digital platforms. The findings provide insights into best practices for integrating R-based assessments in higher education while mitigating unauthorized AI usage during exams.

This framework is currently being implemented in the courses *Statistics*, *Design of Experiments and Regression Models*, and *Data Analysis*, which are part of the second- and fourth-year curriculum of the Industrial Technologies Engineering, Chemical Engineering, and Organization Engineering degrees at the Technical School of Industrial Engineering, Technical University of Madrid (ETSII-UPM). Each year, approximately 1,200 students are assessed using this system, providing a robust dataset for evaluating the effectiveness of the proposed methodology. One of the main challenges lies in the fact that around 400 to 500 students take their exams simultaneously, which requires secure platforms capable of handling high demand with minimal risk of crashes or slowdowns to ensure a smooth and reliable assessment process.

Keywords: Digital Assessment, R Programming, Safe Exam Browser, Moodle, AI-Resistant Evaluation.

1 INTRODUCTION

Traditionally, computer-based assessments in data analysis courses required students to work on university-provided computers or personal laptops, executing code and submitting their answers under supervision. This approach allowed students to analyze large datasets using the R statistical software installed on their devices, and to respond to exam questions accordingly. Limited access to online resources was permitted during exams, as, at that time, no web platforms or tools were capable of solving the specific, contextualized problems presented in the assessments. Search engines and online materials did not offer direct solutions to the questions posed.

Over the past few years, this assessment system, based on Moodle, has been adopted at the Technical School of Industrial Engineering, Technical University of Madrid (ETSII-UPM), and it has been used to evaluate approximately 1,200 students annually.

However, in recent years, the emergence of accessible web platforms and generative AI tools has dramatically changed the landscape. These technologies can now provide answers to exam questions simply by analyzing a screenshot or pasted text. As a result, the teaching team has been compelled to redesign the assessment methodology in order to restrict access to such platforms, while still maintaining the use of Moodle and allowing students to work with R-based environments installed on their devices—whether on Windows, macOS, or iPadOS. (Support for Android tablets and Chromebooks is not yet available or implemented.)

The aim of this article is to describe the experience implemented in these courses to prevent academic misconduct and ensure the integrity of student assessments.

2 EXAM ENVIRONMENT

2.1 Moodle

Given the large number of students involved—over 400 taking the exam simultaneously—a robust and scalable assessment system is required, along with automated digital grading. Since students must use a computer to analyze data with R, and to ensure a fast and efficient grading process, it was deemed

appropriate to implement a fully digital assessment platform, with no paper-based submissions. Moodle was selected as the evaluation platform, as it is fully integrated with the digital infrastructure and services offered by the Technical University of Madrid (UPM).

2.2 Safe Exam Browser

To ensure a secure and controlled examination environment, Safe Exam Browser (SEB) has been implemented as a key component of the digital assessment process. SEB is an open-source web browser environment designed specifically for online exams. SEB has been developed by ETH Zurich, IT Services, based on the original idea of Safe Exam Browser by Stefan Schneider, University of Giessen.

SEB restricts access to unauthorized resources by locking down the testing device, disabling system functions, and preventing the use of other applications, screen capturing, or access to external websites. When integrated with Moodle, SEB provides a reliable method to enforce strict exam conditions, ensuring that students can only access the assessment content and approved tools or websites, during the examination. Its use has proven essential in maintaining academic integrity during high-stakes assessments involving large student cohorts.

2.3 R platforms

Regarding the software used to solve the exercises, students have traditionally worked with either RStudio or the web-based platform posit.cloud. However, both options allow the use of R packages that can connect to external servers capable of processing text or images using artificial intelligence. In addition, they enable code sharing among users. For these reasons, neither platform was considered appropriate for secure examination conditions, and their use has been discontinued in the current assessment setup.

The following sections will analyze the different web-based R platforms that allow the execution of R code, highlighting their main advantages and limitations.

2.3.1 Technical features

To guide the evaluation of each platform, a set of specific features has been defined to assess their suitability for use in secure academic assessments. These features cover both technical capabilities and potential security risks. Each platform will be analyzed according to the following criteria:

- **Basic Code Execution (BCE):** Whether the platform allows running basic R code successfully.
- **Offline Execution (OE):** Whether the environment can load entirely in the browser and support simple calculations without an active internet connection.
- **Browser File Upload (BFU):** Ability to upload files directly from the local device via the browser for use within the R environment.
- **External File Upload (EFU):** Ability to access and use external files, such as datasets or R scripts hosted on platforms like GitHub.
- **Access to Default Datasets (ADD):** Availability of built-in R datasets for immediate use.
- **Graph Generation (GG):** Capability to generate and display graphical outputs from R code.
- **Custom Function Support (CFS):** Support for defining and executing user-defined functions.
- **Code Sharing (CS):** Whether users can share their code or access code executed by others.
- **Artificial Intelligence (AI):** Integration with AI-based tools or services, including image or text processing.
- **Search Tool (ST):** Inclusion of built-in search functions to find code examples or documentation.
- **Account Requirement (AR):** Whether access to the platform requires user registration or subscription.
- **Execution Speed (ES):** A subjective evaluation of the platform's responsiveness and performance during code execution.

2.3.2 R platforms analyzed

Adaface is a recruitment platform offering pre-employment coding tests [3]. Its R environment supports basic code execution and is optimized for short analytical tasks. Web access: *www.adaface.com/online-compiler/online-r-compiler*

AlphaCodingSkills is designed as an online learning portal that provides free tutorials on various programming languages, database languages, data structures and algorithms [4]. Its R environment

supports code execution and built-in datasets. Web access: *www.cg.alphacodingskills.com/compile-r-online.php*

CodeChef IDE is an online coding platform where you can learn to code, practice coding and participate in coding competitions, supports basic R functionality, including dataset access [5]. Web access: *www.codechef.com/r-online-compiler*

CodeExampler is a minimalist compiler-hosting site offering basic R support [6]. It allows custom function execution but not plotting capabilities. Web access: *www.codeexampler.com/compiler/r*

Coderpad is developed by CoderPad, Inc., a U.S.-based company that provides real-time collaborative coding environments, primarily used in technical interviews [7]. It supports basic R code execution but lacks graphical output and advanced R features. Its interface is simple and the platform responds quickly without requiring complex setup. Web access: *coderpad.io/languages/r/*

DomSignal is a comprehensive suite of website testing tools designed to enhance overall website performance, search engine optimization (SEO), and security. It supports multiple programming languages and appears to be developed primarily for educational or personal use [8]. It enables basic R code execution but lacks support graphical features. Web access: *domsignal.com/r-online-compiler*

FreeCodeCompiler is a generic online compilation tool with no clear institutional backing [9]. It provides basic R code execution. Web access: *www.freecodecompiler.com/r-compiler*

Fynd Academy IDE, part of a tech training initiative by Fynd, offers a browser-based R environment for beginners [10]. It supports basic code execution. Web access: *www.fynd.academy/online-compiler/r*

GeeksForGeeks IDE is part of a widely used educational platform that provides tutorials and coding environments for various programming languages [11]. Although it supports basic R code execution, it does not offer functionality for plotting or advanced statistical analysis. Web access: *ide.geeksforgeeks.org/ide/online-r-compiler*

Ideone is an online compiler and debugging tool which allows you to compile source code and execute it online in more than 60 programming languages [12]. It allows quick testing of R code but does not support some R-specific features. Web access: *ideone.com/l/r*

Infovistar is a leading software company offering customized solutions for healthcare, logistics, e-commerce, and education [13]. It supports basic R code execution but offers no graphical capabilities. Web access: *infovistar.in/tools/compiler/r*

Intellipaat IDE is part of an Indian ed-tech platform offering certification programs [14]. Its online R environment is intended for hands-on practice and supports only basic code execution. Web access: *intellipaat.com/blog/online-r-compiler/*

JDoodle is a lightweight online IDE (Integrated Development Environment) that supports many languages, including R [15]. It offers basic execution but does not support plotting. Web access: *www.jdoodle.com/execute-r-online*

Lejarza IDE, developed by the University of Valencia, is used in engineering and statistics courses [16]. It supports R code execution with good performance. Web access: *www.uv.es/lejarza/eaa/ronline.htm*

MyCompiler is a browser-based IDE with support for multiple programming languages [17]. It allows R code execution. Web access: *www.mycompiler.io/es/new/r*

Naukri IDE, part of the Code360 initiative by Naukri, is used for coding practice and interview prep [18]. Its R support is limited to basic code testing. Web access: *www.naukri.com/code360/online-compiler/online-r-compiler*

Newtum IDE is an online training academy providing technical education from children to highly experienced professionals, includes a basic R interpreter with limited features [19]. While it supports simple code execution and includes a built-in search tool, it does not allow for advanced plotting. Web access: *newtum.com/compiler/compiler-r*

NextLeap IDE is an ed-tech startup voted as one of the Top 100 Edtech Startups in South Asia with a mission to help early career professionals to transition into roles in product management, UX design and software engineering in product companies [20]. Its R environment supports only basic code execution. Web access: *nextleap.app/online-compiler/r-programming*

OneCompiler is a general-purpose online IDE supporting many languages, including R [21]. It allows for fast testing but lacks support for plotting. Web access: *onecompiler.com/r*

Online IDE, hosted at online-ide.com, is a general-purpose code execution tool with very limited R capabilities [22]. It does not support advanced R features. Web access: *www.online-ide.com/online_r_compiler*

OnlineGDB is a web-based IDE with debugging capabilities, originally for C/C++ but now supporting various languages including R [23]. Web access: *www.onlinegdb.com/online_r_interpreter*

Paiza.IO is a cloud-based compiler from Japan that supports over 20 languages [24]. It allows basic R code execution and some graphical output, though without a dedicated interface. Web access: *paiza.io/en/projects/new?language=r*

Programiz IDE is a Nepal-based educational platform offering tutorials and embedded IDEs [25]. Its R environment is integrated into its learning path and supports only basic code execution. Web access: *www.programiz.com/r/online-compiler/*

Rdrr.io is a platform focused on R documentation and code snippet execution, developed by the R community in Germany [26]. It offers full R support, including access to datasets, and is suitable for data analysis tasks. Web access: *rdrr.io/snippets/*

Rextester is an online code execution platform supporting multiple languages, originally created for demonstrations [27]. It allows basic R code execution. Web access: *rextester.com/l/r_online_compiler*

Studyopedia provides tutorials and basic IDEs for programming practice [28]. Its R environment allows basic code execution. Web access: *studyopedia.com/online-r-compiler/*

W3Schools R IDE is part of the W3Schools tutorial platform [29]. Its "Tryit" editor for R supports basic commands. Web access: *www.w3schools.com/r/tryr.asp?filename=demo_compiler*

WebR is an innovative project built on WebAssembly that runs R entirely in the browser without server interaction [30]. It supports plotting and advanced code execution. Web access: *webr.r-wasm.org/latest/*

3 RESULTS

3.1 Secure assessment setup

After thoroughly analyzing all the previously mentioned web platforms, we concluded that WebR [30] offers the most comprehensive set of features.

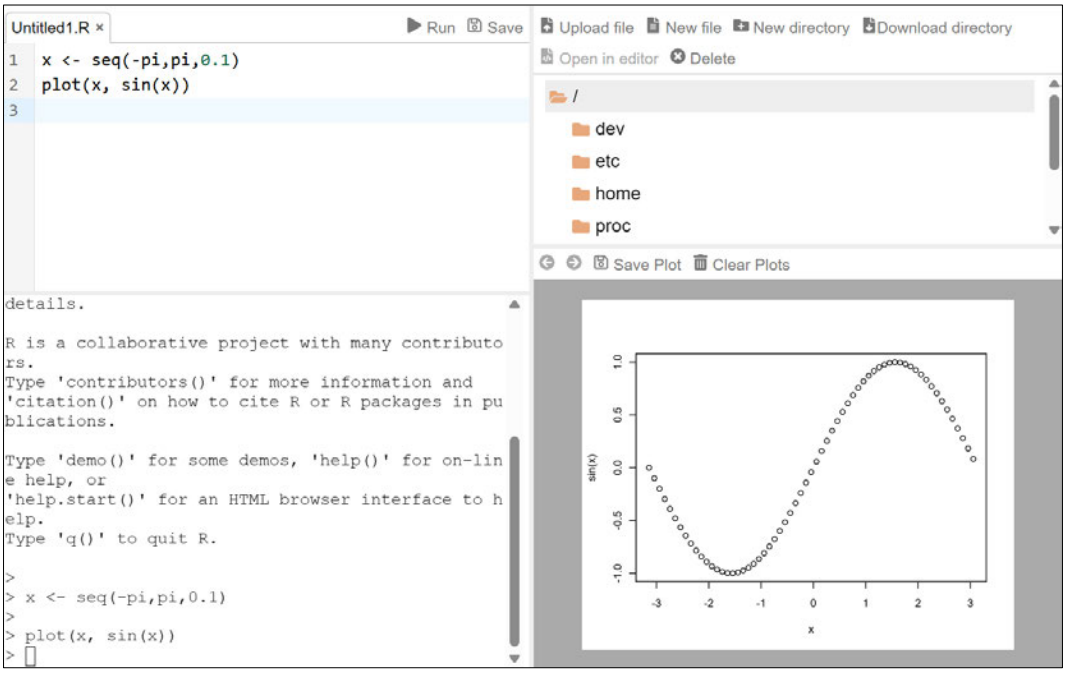

Figure 1. Example of R code execution in the WebR environment [30]. The interface displays an editor, console, file browser, and graphical output area.

It stands out for several reasons:

- It provides a visual interface similar to RStudio. It includes separate windows for the editor, numerical outputs, graphical displays, and directory navigation (see Figure 1).
- Multiple editable files can be open simultaneously.

- Users can navigate between different plots.
- It allows access to datasets stored on GitHub.
- Since interaction with the server is minimal, most computations are performed locally without requiring an internet connection. This is especially important when assessing hundreds of students simultaneously, since, in previous experiences, some servers became overloaded due to a high number of simultaneous requests.
- It supports loading and using standard R libraries.

In this way, the Moodle platform can be used for assessment purposes, with Safe Exam Browser (SEB) [33] integrated into it. From the Moodle interface, SEB can be easily configured to restrict web access, allowing students to navigate only to the institutional Moodle site and to WebR. This configuration ensures a secure testing environment, as illustrated in Figure 2. This approach is available for Windows-based and Apple-based computers or tablets, without the need for preinstalled RStudio software.

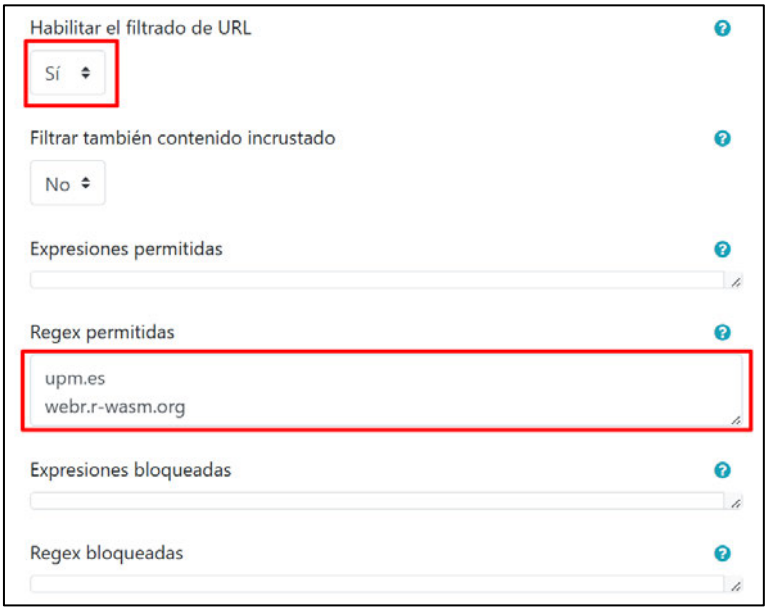

Figure 2. Configuration panel in Moodle for Safe Exam Browser integration [32]. URL filtering is enabled, and only domains matching upm.es and webr.r-wasm.org are allowed, effectively limiting student access to institutional resources and the WebR platform during assessments.

Figure 3 illustrates the proposed secure assessment setup, in which the student takes the exam entirely within the Safe Exam Browser (SEB) environment, with internet access strictly limited. SEB is configured to allow access to only two web platforms: first, the UPM Moodle platform, where students can read the questions and submit their answers; and second, the WebR platform, which enables them to load files from GitHub repositories and use R packages available in the cloud.

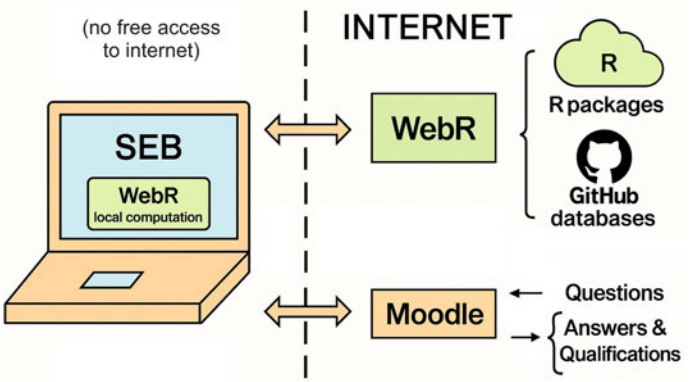

Figure 3. Conceptual diagram of the proposed secure assessment setup.

3.2 Feedback

The assessment framework described in this study is currently being implemented in second-semester courses, including Statistics, Design of Experiments and Regression Models, and Data Analysis. Initial feedback has been highly positive from both students and instructors, who have highlighted the clarity of the digital environment, the fairness of the evaluation process, and the improved control over academic integrity during exams.

4 CONCLUSIONS

This study presents a practical and scalable framework for secure digital assessment in data analysis courses using R, combining Moodle [1] and Safe Exam Browser (SEB) [3] with the WebR platform [30]. By analyzing a wide range of online R environments, WebR emerged as the most appropriate solution due to its ability to perform local computation within the browser, minimize server dependency, and support interactive plotting and dataset access—all without compromising exam integrity. The successful implementation of this setup across multiple engineering degree programs at ETSII-UPM demonstrates its robustness, particularly in high-demand scenarios involving over 400 students simultaneously. The dual integration of SEB and Moodle ensures a controlled and standardized testing environment, resistant to unauthorized AI-assisted tools. This experience highlights that secure, large-scale digital assessments in programming-heavy subjects are not only feasible but can maintain academic rigor and fairness while leveraging modern educational technologies. Future work may focus on extending compatibility to other platforms (e.g., Android, Chromebooks) and further refining the user experience for both students and instructors.

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DISCLAIMER

The information provided about each R platform is based on manual testing conducted at the time of writing. While we aimed for maximum accuracy, platform features may change over time, and some unintentional inaccuracies may exist. Readers are encouraged to verify current functionalities and terms of use before adopting any platform for academic purposes.

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