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REVIEWER'S REPORT

Manuscript No.: IJAR-55329

Title: DEVELOPMENT A CODE VISUALIZATION TOOL ON LOOPING MATERIAL SPECIFICALLY Â"FORÂ" AND Â"WHILEÂ" TO IMPROVE STUDENTSÂ' LEARNING OUTCOMES

Recommendation:

Accept as it is .....

Accept after minor revision.....

Accept after major revision .....

Do not accept (*Reasons below*) .....

Rating	Excel.	Good	Fair	Poor
Originality	…			
Techn. Quality	…			
Clarity	…			
Significance	…			

Reviewer Name: Dr. Ishrat Fatima

Detailed Reviewer's Report

The manuscript presents a research and development study focusing on the creation of a web-based Code Visualization Tool designed to enhance students' understanding of looping constructs, particularly for and while statements, in programming education. The topic is timely and relevant, especially given the increasing emphasis on computational thinking and the persistent difficulties novice programmers face when learning abstract control structures.

The research problem is clearly articulated and well grounded in existing literature. The authors successfully establish that looping concepts are cognitively demanding for beginners due to their abstract logic and dynamic variable interactions. The introduction demonstrates adequate engagement with recent and relevant studies, positioning the current work within the broader context of program visualization and educational technology. The rationale for developing a tool specifically focused on looping—rather than general-purpose visualization—is convincing and highlights a clear research gap.

The research design, employing a Research and Development (R&D) approach using the ADDIE model, is appropriate for the stated objectives. The five stages Analysis, Design, Development, Implementation, and Evaluation are described in sufficient detail, allowing readers to understand the systematic process behind the tool's creation. The needs analysis, design considerations (UI/UX components), and technical implementation using an HTML-based standalone tool reflect thoughtful pedagogical and technological planning. However, the manuscript would benefit from a clearer explanation of how instructional principles (such as cognitive load theory or constructivist learning theory) explicitly informed the design decisions.

The methodology is generally sound, but some limitations should be acknowledged more explicitly. The sample size of 20 students, while acceptable for a developmental pilot study, restricts the generalizability of the findings. The use of a one-group pre-test–post-test design provides preliminary evidence of effectiveness, yet it lacks a control group, making it difficult to attribute learning gains solely to the intervention. Including a comparison group or employing a quasi-experimental design in future studies would strengthen the empirical rigor.

The data collection instruments achievement tests, expert validation questionnaires, and student response surveys—are appropriate for evaluating feasibility, usability, and learning outcomes. Expert validation results for both material content and programming aspects indicate that the product meets feasibility standards with minor revisions, which supports the credibility of the developed tool. Nevertheless, the manuscript does not sufficiently report the reliability and validity of the learning achievement test and questionnaires. Providing information such as item examples, reliability coefficients, or validation procedures would enhance methodological transparency.

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The results section is comprehensive and clearly presented, supported by tables and figures that illustrate validation outcomes, student responses, and learning gains. The improvement in average scores from 42.5 to 70 and an N-Gain value of 0.48 (medium category) indicate a meaningful improvement in learning outcomes. The discussion of boxplot distributions and gender-based score comparisons adds depth to the analysis. However, the interpretation of gender differences should be approached cautiously, given the small sample size and uneven learning gains, and should avoid overgeneralization.

The discussion effectively links the findings to existing literature, reinforcing the value of visualization and interactive learning in programming education. The authors convincingly argue that step-by-step visualization helps bridge the gap between abstract syntax and concrete logic flow. The acknowledgment of limitations such as the restricted scope of looping constructs and short-term evaluation is appropriate and demonstrates academic reflexivity. Suggestions for future research, including extending the tool to nested loops and incorporating adaptive feedback, are relevant and constructive.

The conclusion accurately reflects the study's findings and contributions. It reinforces the pedagogical value of the Code Visualization Tool and highlights its moderate effectiveness in improving learning outcomes. The authors' contributions are clearly stated, which aligns with good scholarly practice.

From a language and presentation perspective, the manuscript is generally clear and readable. However, there are noticeable grammatical inconsistencies, awkward phrasing, and occasional redundancy that require careful language editing. Minor formatting issues, repeated headings, and inconsistent citation formatting (including duplicated DOIs and reference entries) should be corrected to meet international journal standards.

Based on the results and limitations of the present study, several recommendations are proposed for future research and further development of the Code Visualization Tool. First, it is recommended that future studies involve a larger and more diverse sample drawn from multiple institutions to enhance the generalizability and robustness of the findings. A broader participant base would provide stronger empirical support for the effectiveness of visualization-based learning media in programming education and further the future research should employ more rigorous experimental designs, such as quasi-experimental or true experimental methods with control and treatment groups. The inclusion of a comparison group would allow a clearer determination of the extent to which improvements in learning outcomes are directly attributable to the use of the Code Visualization Tool rather than external instructional factors.