Learning Iteration for Grades 2-3: Puzzles vs. UMC in Code.org

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ABSTRACT

In a project partially supported by research grant PANN20_00690 to Italy's CINI National Lab "Informatica e Scuola", we compared the effectiveness of two alternative instructional methods applied to scaffold the learning of iterations in grades 2-3. Eight university groups collaboratively ran the project in two successive rounds throughout 2022. Teachers' feedback collected across the two rounds helped fine-tune the deployment of the interventions. The two alternative methods showed measurable outcome differences in the short term.

RESEARCH GOALS

To run the project, we recruited 125 primary-school teachers in two successive rounds, aligning them to the design of two variants of a learning module centred on the concept of iteration using block-based programming targeted to grade 2-3 children. The project aimed to compare the performance of those two learning variants in terms of children's measured effectiveness and perceived satisfaction by all participants. Variant V1 used the Use-Modify-Create (UMC) approach [2], requiring children to first use and modify projects previously built for them with the Code.org Artist (Pre-Reader) lab [1], and then create their own projects in the same environment. Variant V2, with a more rigid structure, employed a standard set of Puzzle-type coding exercises from the Code.org platform. The two learning variants were isomorphic for duration, expected outcomes, and evaluation criteria.

APPROACH

We ran the project in two successive rounds of three weeks each. The first round took place in Spring 2022, the other in Fall 2022.

The two rounds followed exactly the same principled approach, except that lessons learned in the first round helped fine-tune the second one. We invited to the project several hundreds of primary-school teachers across the Country. We eventually recruited 22 of them to the first round and another 93 to the second round, the Fall period fitting them better. We divided the teachers into two per-variant groups of near-equal size, balancing provenance and professional profile. One group was assigned to the V1 learning variant (UMC), the other group to the V2 variant (standard Code.org). All teachers across both groups: (**a**) aligned their students using two 1-hour Code.org lessons on sequences, identical across groups; (**b**) administered an identical pre-test to assess the children's understanding of sequences; (**c**) taught the concept of iteration after the group-specific learning variant in two-to-four 1-hour lessons; (**d**) administered an identical questionnaire to assess children's satisfaction with the activities, and an equally identical post-test to evaluate the children's understanding of iteration for concept and use; (**e**) completed an evaluation survey on their own experience.

PRELIMINARY FINDINGS

13 of the 22 teachers recruited for the first round carried out all of the proposed activities, for a total of 184 participating children (87, V1; 97, V2). All 93 teachers recruited for the second round completed the full program, for a total of 1434 participating children (711, V1; 723, V2). Post-project analyses of the children-side responses for the first round show measurable V1-to-V2 differences in some hotspots. The V1 group felt slightly more fatigued by the learning effort, had more trouble understanding the code shown in two pre-test questions, performed worse in two post-test questions (a counted iteration of a single instruction and a counted iteration of two instructions), and better in one (a sequence of two counted iterations). Analysis of second-round responses is currently underway. All children, aged 7-8, and all teachers found the program very engaging.

REFERENCES

[1] Code.org. 2022. *Artist pre-reader.* https://studio.code.org/projects/artist_k1/new
[2] Irene Lee, Fred Martin, Jill Denner, Bob Coulter, Walter Allan, Jeri Erickson, Joyce Malyn-Smith, and Linda Werner. 2011. Computational Thinking for Youth in Practice. *ACM Inroads* 2, 1 (2011), 32–37. https://doi.org/10.1145/1929887.1929902