

# Northern Regional Hub-funded project

Project Report



## Demystifying the code: Learning fundamental programming concepts without coding

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## Background

Object-oriented programming is difficult for novice students to learn. Textual languages, such as C++, require students to learn the syntax and mechanics of the programming language in addition to the concepts. This leads students to spend more time and effort on learning the language and less on understanding the important programming concepts.

Block-based programming languages have been proposed to help students learn programming concepts without the added complexity of textual languages. They can also be used to help students transition to textual language by showing the corresponding code.

## Introduction

Learning to write computer code is the most fundamental skill in software development. But before writing code, a student needs to understand the underlying programming concepts, and then *apply* those concepts using a particular programming language.

With so many different programming languages available, each with their own technical peculiarities, the challenge of coding quickly obstructs the learning of key concepts. To overcome this problem the authors created an interactive website that is relevant and accessible to a wide range of students and teachers in introductory programming courses.

The activities were designed based on learning outcomes defined in the ACM and IEEE Computer Society's curriculum guidelines, primarily focusing on key programming concepts. By using a visual block-like environment, students concentrate on the underlying concepts. Once the concepts have been mastered, students will be able to export their work to real code and therefore align it with the respective concepts.

This project investigated the impact of using a block-based programming tool on students' learning of object-oriented programming concepts. The students were allocated into two groups: the Blockly group (treatment) and C++ group (control group).

Both groups first undertook a test to measure incoming misconceptions, before completing a series of activities (in either Blockly or C++).

Following this, a repeat test was undertaken to measure final understanding and therefore measure the differences in impact between Blockly versus C++. While both groups saw improvements, the Blockly group saw slightly stronger improvements.

Following the final test, the C++ students were offered Blockly and the Blockly students were offered C++ to ensure equal learning opportunities. Students responded very positively to Blockly:

<b>Reflective Questions</b>	<b>SD</b>	<b>D</b>	<b>N</b>	<b>A</b>	<b>SA</b>
Q1. Blockly-OOP helped in understanding how to design and implement a class.	6	7	22	47	37
Q2. Blockly-OOP helped in understanding how to correctly reason about control flow of an OOP program.	8	7	25	54	25
Q3. Blockly-OOP helped in understanding OOP encapsulation mechanisms, such as private members.	6	16	41	41	15
Q4. Blockly-OOP helped in overall understanding of OOP concepts.	6	5	23	51	34
Q5. Using Blockly-OOP helped me absorb OOP concepts better than would have been possible with C++ alone.	8	13	28	40	30
Q6. The ability to convert from Blockly-OOP to C++ was helpful for my learning.	5	1	21	43	49

## Conclusions

- The feedback around Blockly from Blockly users was extremely positive.
- The exercises helped students to gain an understanding of common object-oriented misconceptions based on the improvement in quiz results.
- Almost all students who visited the application completed the activities and Blockly had a very strong completion rate.
- More than half of the students allocated to Blockly viewed the corresponding C++ code at least once. 77% of Blockly students agreed or strongly agreed that viewing the corresponding C++ code was helpful for learning.
- Blockly students on average required fewer hints in completing the exercises.

The Blockly website: <https://blockly.auckland.ac.nz>

Instructors interested in using [Blockly](#) with their students should contact [Nasser Giacaman](#).

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