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# Imikode: A VR Game to Introduce OOP Concepts

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## ABSTRACT

This research paper presents Imikode, a virtual reality (VR)-based learning game to support the teaching and learning of object-oriented programming (OOP) concepts in computing education. The system was implemented using Google Cardboard SDK and works with any Cardboard compatible headset. The teacher can use Imikode to introduce OOP class in an immersive and engaging way. This early prototype provides basic features to help introduce OOP concepts. We aim at extending it using Artificial Intelligence (AI), by adding a conversational agent able to parse erroneous statements and provide adequate instructions on how to fix them.

## CCS CONCEPTS

• **Social and professional topics** → **Computer science education.**

## KEYWORDS

Virtual reality, Computing education, Object-oriented programming, Google cardboard SDK

### ACM Reference Format:

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## 1 INTRODUCTION

In this paper, we present a virtual reality (VR) system that supports the teaching and learning of Object-Oriented Programming (OOP) concepts in computing education. The purpose of the learning tool is for the students to gain understanding and be able to grasp the basic concepts of OOP even before the topic is fully taught. In many computer science departments, OOP is taught early in the programming curriculum. Even though OOP is considered fit for

construction of large and complex software, teachers perceive the teaching of OOP as being difficult and therefore students find it hard to comprehend [1]. To tackle these undesired anomalies in the teaching and learning process of OOP, we propose the use of a complementary tutorial session to support the teacher in introducing the topic in an engaging and immersive way. VR-based learning is nowadays the trend in formal and informal education. A variety of mobile-based VR technologies and application are built in computing education to enhance learners' experiences and cognitive skills [2], [3]. In class, the students will practice the use of objects, methods and arguments. The teacher is expected to also provide a small documentation that the students will need to check and know how to use the system for them to be able to create the scenes in Imikode.

## 2 VR-BASED LEARNING IN COMPUTING EDUCATION

Oracle's Java documentation defines an object as follows: "Objects are key to understanding object-oriented technology. Look around right now you'll find many examples of real-world objects: your dog and, your desk, your television set, your bicycle." [4]. Learners are subsequently invited to think of the world as a set of objects having properties and performing behaviors, an idea that has been put into practice by Alice in 3-D [5]. Various research works connected VR to programming education. cMotion is a 3D game which uses virtual characters to teach children programming concepts and logic [6], while Chandramouli et al. use gamified real-world examples, such as the solar system, to help students grasp the basics of programming [7]. Stigall et al. suggest a VR-enabled game which uses pseudocode and UML notations to help students learn OOP concepts like polymorphism and inheritance [8]. In Imikode, We use a VR storytelling environment which facilitates entry for first-time programmers. Imikode is motivated by the idea that storytelling is a natural way to introduce the basic concepts behind OO programming [9].

## 3 IMIKODE SYSTEM

Imikode allows users the creation of a virtual world using simple OOP instructions. The instructions have been simplified to allow the learner to draw a connection between OOP statements and their natural language counterparts. For instance, a statement like "fox.run()" can be easily traceable to the natural language sentence "the fox runs". By means of this tool, we aim to help students

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Figure 1: A. First game level. B. Environment updates throughout the game. C. Code updates throughout the game



Figure 2: A. Fox Instantiation. B. Fox walk behavior. C. Fox die behavior

develop an intuition into OOP programming very early in their programming journey. We hypothesize that this will help them better grasp more advanced OOP concepts given their familiarity with the basics. Throughout this short project, we wanted to develop a VR tool that is affordable to the general public, and that can be used within or outside school. This motivated our choice of Google Cardboard SDK, given the affordability of its headsets, and its ease of use. Imikode was implemented using Unity 3D, Android SDK and Google Cardboard. It uses 11 levels to introduce and engage students in the OOP paradigm.

### 3.1 OOP Concepts

Imikode covers the basics of OOP which includes: objects, methods/behaviors, setters and getters, method arguments and garbage collection. Setting up the scene wherein the exercise takes place requires the user to select some variable values for the number of houses and trees in the environment. Table 1 above shows the OOP concept alongside its corresponding exercise in the system.

Table 1: OOP Concepts Introduced in Imikode

Concept	Statement in Game	Level
Object Instantiation	fox= new Fox()	3
Method Call	fox.run()	4
Method Argument	fox.run(position1, position2)	11
Getter	tree1.getPosition()	7
Setter	tree2.setPosition(2)	8
Garbage Collector	Destroy(Fox)	6

### 3.2 Game Interface and Gameplay

The learner is first introduced to the game objective by a virtual character, 'Bob', which accompanies the user throughout the levels of the game using instructions displayed in speech bubbles and generated as sound. The user is first placed into an empty space facing a whiteboard and the bubbles containing the OOP keywords

required to make a statement as shown in figure 1A. Figures 1B and 1C show the environment and the code updates as the learner progresses throughout the levels. In figures 2A, 2B and 2C we show how the game characters are controlled with basic OOP statements.

## 4 CONCLUSION AND FUTURE WORK

Imikode is a prototype game that helps introducing basic OOP concepts to learners in their early programming sessions. We developed the game with a focus on cost-effectiveness, only requiring learners to acquire a low-cost headset and Bluetooth controller. Although we do not cover the OOP concepts in depth, but the tool is at this stage only meant to help give learners a flavor of OOP concepts and help them gain some intuition on objects, behaviors, getters/setters and arguments. We aim to extend the game using AI whereby we make the virtual agent smart, able to guide students throughout the game by analyzing the erroneous statements and providing adequate feedback in natural language.

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