

Jonathan Tow

Dr. Stuver

CSE 300

The Effectiveness of Teaching Object Oriented Programming with Interactive Games

In the early 1990's, the computing world witnessed a computational paradigm shift between the once popular and traditional imperative languages of the past to the more progressive object-oriented based languages that have been at the forefront of introductory programming courses in recent years. With the tech industry leading way in the transition from old to new, computer science departments across the globe followed suit, thus prompting new problems concerning curriculum design. Students were now expected to learn OOP, which is imperative at its core, along with its abstract concepts of class, objects, and information hiding (encapsulation). For many computer sciences departments this led to high attrition rates. Many researchers have conducted studies on the design of introductory courses attempting to address the problem of exposing beginner students to object-oriented programming. Understanding the most effective forms of teaching this specific paradigm can greatly forward the progress of computer science education in todays OOP dominant tech industry. This review examines the effectiveness of teaching object oriented programming with interactive games.

One of the first studies on the effectiveness of game based programming was *Evaluating the Effectiveness of a New Instructional Approach* by Barb Moska, Deborah Lurie and Stephen Coop of Saint Joseph's University and Colorado School of Mines. Moska, Lurie, and Coop designed a 2 credit course offered at both Saint Joseph's University (SJU) and Ithaca College (IC), that ran concurrently with the introductory programming course of the aforementioned universities. This course was constructed around the Alice 3D programming environment which educates users on OOP concepts through animated gameplay. Users are able to write simple programs that can control object state and behavior which is the central focus of OOP. For analysis purposes, Moska Lurie and Coop identified students participating in the course who were deemed either of the following; at risk and enrolled in Alice (Treatment Group), at risk and who did not enroll in the Alice (Control Group1), or not at risk or low risk and who did not enroll in the Alice course (Control Group3). The major finding of this study was that students in the treatment group on average a near entire grade point better than the students at risk and who did not enroll in Alice (Control Group1). Specifically the treatment group had an overall performance of 3.0 ± 0.8 GPA in the introductory programming course while the control group1 had an overall performance of 1.9 ± 1.3 GPA in the same course.

More recently (2010) Arwa A. Al-Linjawi and Hana A. Al-Nuaim of King Abdulaziz University, revisited Alice as a tool for teaching object-oriented programming in their paper *Using Alice To Teach Novice Programmers OOP Concepts*. Al-Linjawi and Al-Nuaim constructed a 2 hour course held once a week for seven weeks where Alice was used as the sole programming environment for two groups of student volunteers. Twenty-four of the students belonged to the treatment group that took part in the Alice course while twenty-one students with similar grades to the treatment group belonged to the controlled group which were restricted to the university's traditional teaching of OOP. Al-Linjawi and Al-Nuaim conducted two tests on the subjects, a pre-test to assess knowledge of OOP prior to the courses and a following post-test that tested each groups object-oriented understanding after their respective courses. When comparing pre-test scores, Al-Linjawi and Al-Nuaim found that both groups obtained similar marks. On the other hand the post-test results showed a mean mark of 81 for the controlled Alice user group while the treatment group had a mean of 64.88. Note that these results are similar to those found by Moska, Lurie, and Coop.

Teaching object-oriented programming through the Alice environment is only one of several attempts at game based approaches. Some researchers have gone on to design their own games that help to provide students with interactive and relatable learning environments. For example, in

GameTheme Based Instructional Module for Teaching Object Oriented Programming, Sharad Sharma of Bowie State University examined the outcome of supplementing the university's introductory OOP course with his own OOP focused video game as a study tool and class activity. Sharma designed the game to contain three individual modules all of which discuss a single topic on object oriented programming. Each of these modules (Inheritance, Polymorphism, Encapsulation) contain an exam at completion and returns feedback on the user's solutions. The video game was used throughout a single semester, which formed the basis of the study. At the end of this semester, a survey was given out to the class of 20 students. A majority of the students (75%) rated their understanding of the three topics discussed in the game as excellent or good. Note that this test lacks a control group and thus there is no benchmark to truly measure how well the tested subjects understood the OOP concepts. Furthermore the number of participants was limited to 20.

Another case study using an "in-house" designed game is in *Computer Game As Learning and Teaching Tool For Object Oriented Programming in Higher Education Institution* where Seng and Yatim of KDU University's School of Computing conducted a study on the affect of educational role playing games (RPG) on object oriented learning. In particular, Seng and Yatim designed an RPG framework tailored specifically to the incorporation of OOP concepts. Progression through an appropriately

designed level only occurs when the player, a student, demonstrates a clear understanding of a certain OOP topic. For their study, Seng and Yatim selected 40 students from 2 programs (Bachelor of Computer Science and Bachelor of Software Engineering) and had the participants play the game. Afterwards, the students were given a questionnaire to fill out. From this survey of questions they observed that 86% of students participating found the game based learning approach better than the university's traditional teaching methods. Note this study carries the inherent disadvantages of questionnaires. Specifically the study does not test the actual learning of the material but only the subjective responses of students to aspects of the game design in relation to OOP. Furthermore the participants were exposed to the game for only a day.

Video games are not the only game based approach as is evident in *A Game-Based Approach to the Teaching of Object-Oriented Programming Languages* where researcher Jose Corral and his team examine the use of a more physically interactive game-based course design. Unlike the other studies, Corral made use of tangible user interfaces (Sifteo Cubes) as a means of interactive gaming. These LCD screened cubes were programmed through objected oriented C# programs. The course was specifically designed in tandem with the Sifteo Cube API which contains a Cube class that represents the physical device. Corral and others conducted a two part test to examine the affects of tangible gaming devices on two groups; an

experimental group containing students who had taken the university's OOP with Sifteo Cubes and a controlled group of students who had taken the introductory course yet only learnt OOP through C#. Considering mean values, the former group showed higher marks in both parts of the test. Note that the total number of participants was 30 with 15 in each group and all of the chosen individuals were students whom recieved high grades in their respective introductory courses.

From the studies mentioned above we are able to see a common pattern of success in the comprehension of object-oriented programming when taught to beginners through game-based approaches. More testing under larger groups may benefit our understanding of the effectiveness of the technique. Although the studies focused on undergraduate students this approach may be effective in teaching younger students and in particular high school students attending computer science courses that use OOP as a foundation.

References

- [1] Moskal, Barbara, Deborah Lurie, and Stephen Cooper.
"Evaluating the Effectiveness of a New Instructional Approach."
ACM SIGCSE Bulletin 36.1 (2004)
- [2] Arwa Al-Linjawi, and Hana Al-Nuaim.
"Using Alice to Teach Novice Programmers OOP Concepts."
Journal of King Abdulaziz University-Science 22.1 (2010)
- [3] Sharad Sharma.
"GameTheme Based Instructional Module for Teaching Object Oriented
Programming."
2015 International Conference on Computational Science and
Computational Intelligence (CSCI) (2015)
- [4] Wong Yoke Seng, and Maizatul Hayati Mohamad Yatim.
"Computer Game As Learning and Teaching Tool For Object Oriented
Programming in Higher Education Institution"
Procedia - Social and Behavioral Sciences 123 (2014)

[5] Jose Maria Rodriguez Corral, Anton Civit Balcells, Arturo Morgado Estevez, Gabriel Jimenez Moreno, and Maria Jose Ferreiro Ramos.
"A Game-based Approach to the Teaching of Object-Oriented
Programming Languages."
Computers & Education 73 (2014)