Lab 1 - PolyMorpher Product Description

Kevin Santos

Old Dominion University

CS411W

Professor Thomas Kennedy

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Lab 1 - PolyMorpher Product Description

1. Introduction

Programming is a technical skill that requires one both retain and apply the skill in practice. Programming can be very intimidating for those not committed to learning it. Programming requires a different perspective. It requires a logical angle that laymans in this fields are not used to thinking. Traditional forms of teaching Object Oriented Programming and problem-solving skills at Old Dominion University and other colleges/universities are not producing the desired results. PolyMorpher is a game that is designed to teach the player complex OOP concepts and problems solving skills. For PolyMorpher to succeed, it must address the deficiencies and mistakes traditional academic learning has.

1.1 Team Members

A group of Computer Science majors from ODU students proposed and are currently developing a solution to this particular to this problem under the guidance of Thomas J. Kennedy, who is their mentor. Team Silver consists of nine member who are:

- Casey Batten, Team Member

- Peter Riley, Team Member

- Matthew Tuckson, Team Member and Project Manager

- Kevin Santos, Team Member

- Colten Everitt, Team Member and Web Designer

- Daniel Dang, Team Member

- Nathaniel DeGrace, Team Member

- Tyler Johnson, Team Member

1.2 Problem Statement

As discussed in section 1, programming can be an intimidating skill to learn. ODU programming students often dropout or switch majors because of the rigor required to learn Object Oriented Programming(OOP) and problem solving skills. The traditional academic techniques and tools used to teach OOP do not work effectively. Section 1.3 will show the statistical data provided by Mr. Kennedy regarding the dropout and switch out of major rates in the CS department.

1.3 Problem Characteristics

Team Silver's mentor, Mr. Kennedy provided very astonishing ODU records that shows a decreasing trend of CS students moving successfully forward to advance level courses. Furthermore, the volume of students enrolled in 300 level CS courses at ODU has decreased significantly. Figure 1 shows the current data flow diagram of the possible paths CS students take towards their CS degree. It illustrates both conditions if the student successfully understands the OOP concepts and proceeds to the next CS course or vice versa. Figure 2 shows the ODU record data Team Silver gathered from Mr. Kennedy.

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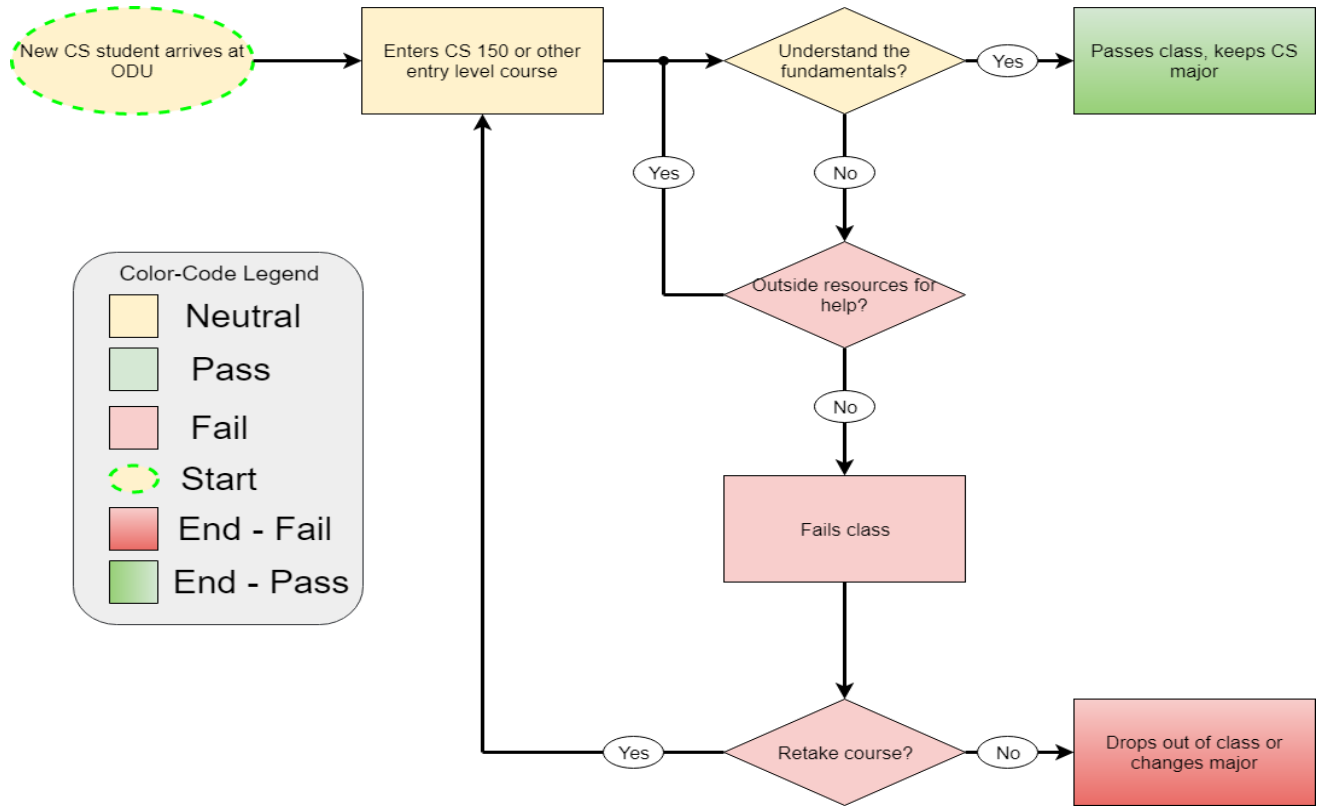
Figure 1: Current Process Flow Diagram 1

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	CS 150	CS 250	CS 361	CS 330	CS 350
2013-2014	804	327	161	111	93
2014-2015	672	367	208	203	148
2015-2016	937	327	217	195	183
2016-2017	920	337	199	180	182

Approximated Student Headcount

White Noise From Course Overlap
Core Student Body

2014 - 2017

CS 410 I Team Silver I 2017-12-07 I 10

Number of Students in 2014-2017 CS Classes

CS 350
11.7%
CS 330
11.5%
CS 361
12.8%
CS 250
21.0%
CS 150
43.1%
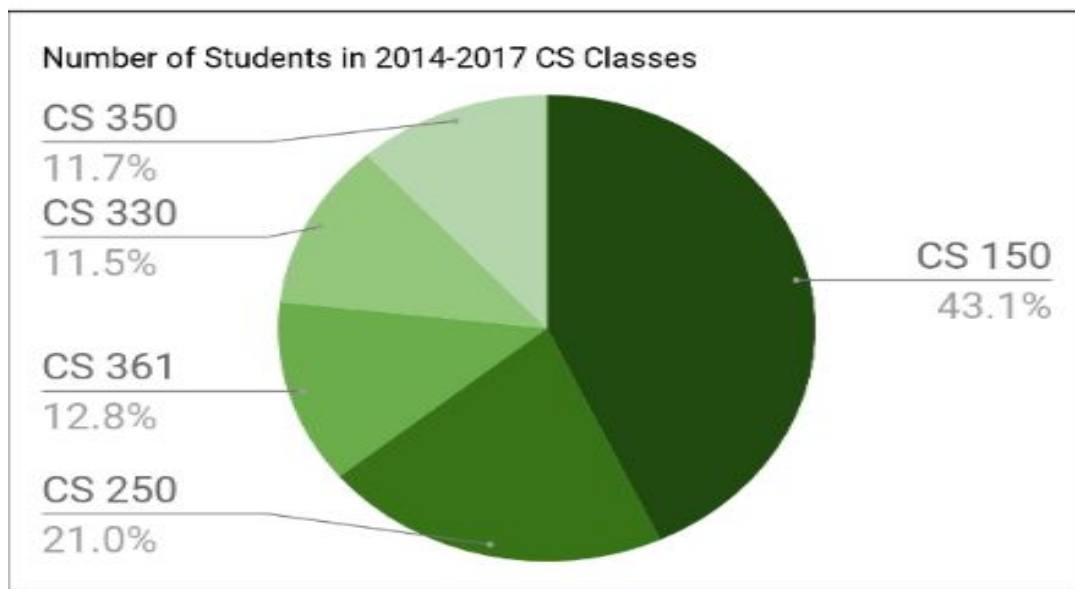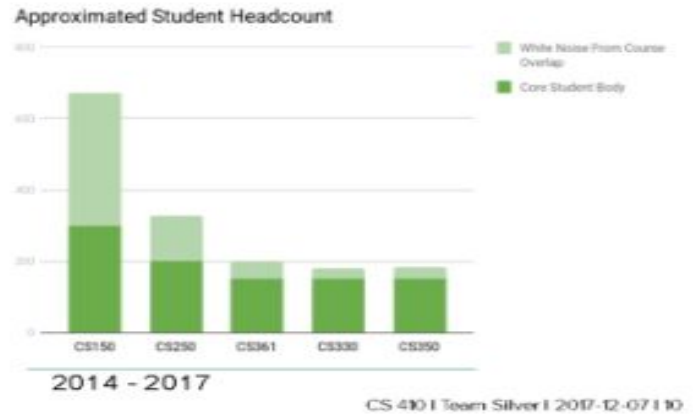
Figure 2: Combined Matrix, Bar Graph and Pie Chart

1.4 Solution Characteristics

PolyMorpher is a game that is intended to teach the player OOP concepts in an engaging and interactive way. The game will make use of an Tangible User Interface (TUI) and a management simulator. Polymorpher will improve on using and teaching OOP concepts that are not strictly addressed by its competitors as illustrated in Table 1. Figure 2 shows the ideal scenario if a student at ODU understands the fundamentals of OOP and continues as a CS major progressing through the next required courses.

Game	Experience	Uses OOP	Teaches OOP	# Languages	Multiplayer
PolyMorpher	Low-Mid	Yes	Yes	1	No
Code Combat	Low	Yes	No	5	No
Screeps	Mid-High	Yes	No	1	Yes
CheckIO	Low-High	Yes	No	1	Yes
Code Monkey	Low	No	No	1	No
Elevator Saga	Mid-High	Yes	No	1	No
Codewars	Mid-High	Yes	Yes	6	Yes
Codingame	Low-High	Yes	No	25+	Yes
Game	Experience	Uses OOP	Teaches OOP	# Languages	Multiplayer
PolyMorpher	Low-Mid	Yes	Yes	1	No
Git Games	Low	No	No	1	No
CSS Diner	Low	No	No	1	No
Flexbox Defense	Low-Mid	No	No	1	No
Ruby Warrior	Low	No	No	1	No
Untrusted	Mid-High	No	No	1	No
Empire of Code	Low-Mid	Yes	No	2	Yes
Ruby Quiz	Mid-High	Yes	No	1	No

Table 1: Competition Matrix

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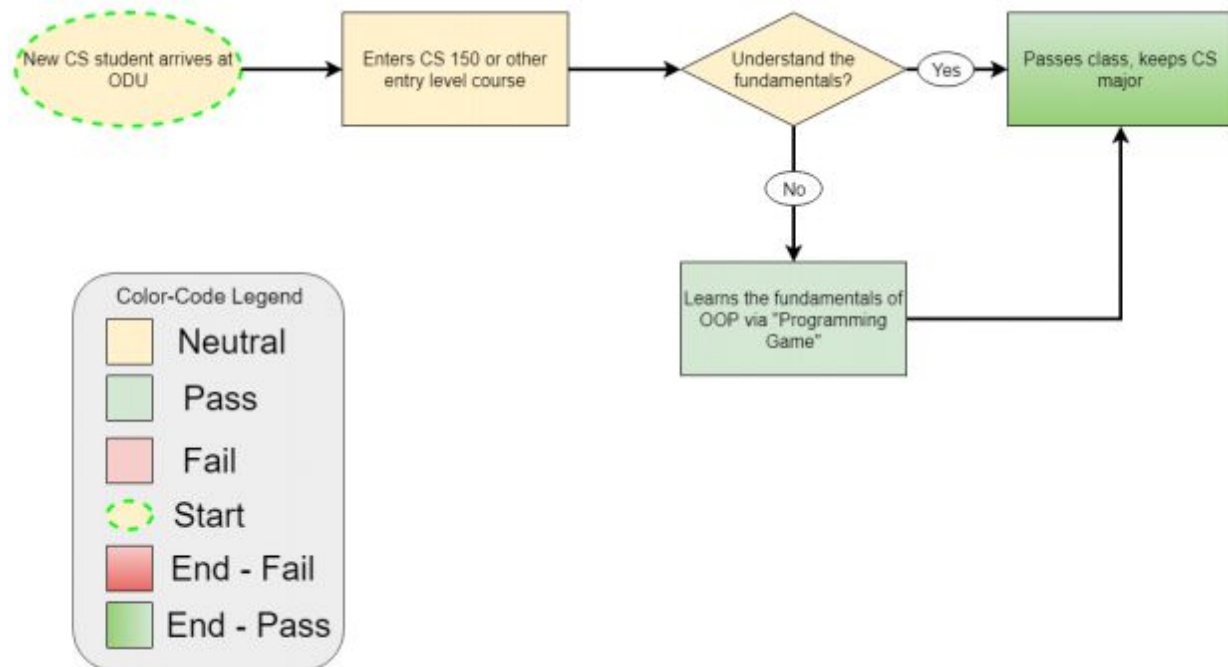
Figure 3: Solution Flow diagram

2 Product Description

The uniqueness of PolyMorpher and as stated in section 1.4, it is a game that teaches

OOP concepts in a way that is interactive and engaging. Research conducted by Team Silver

through an article published by ABC News stated that games, in general, are interactive and

engaging. Thus, PolyMorpher will take advantage of that to teach OOP concepts that traditional

academic learning does not address. PolyMorpher will consist of three important concepts that

are:

- Realist Approach

- Improvement on Teaching

- Balance Gameplay

The Realist Approach allows the game to use applicable and retractable examples to teach the

player OOP. Improvement on Teaching will consist on facilitating the teaching of complex OOP

concepts to the player. The Balanced Gameplay concept will apply both the gaming and learning

experience.

The competition matrix in Table 1 will show that most of the competitors do not

primarily focus on OOP. As the problem statement for Team Silver embossed previously, their

research pointed out that traditional educational tactics towards teaching OOP concepts are not

effective to new learners. Thus, they claim that PolyMorpher will effectively teach the player

mainly the important aspects of OOP. According to Table 1, only 1 of 14 competitors teaches

OOP concepts which is the focus of PolyMorpher.

2.1 Major Functional Components (Hardware/Software)

PolyMorpher will be compatible with modern versions of Windows, Linux, and

MacOSX. PolyMorpher will be implemented as a 2-Dimensional game that will draw minimal

computing resources. Polymorpher will be optimized to perform with Intel's 4th generation i3

processor and beyond. The player will need an internet connection to navigate in Team Silver's

website to download the game. Figure 3 shows the major functional components as to how the

player can access the game.

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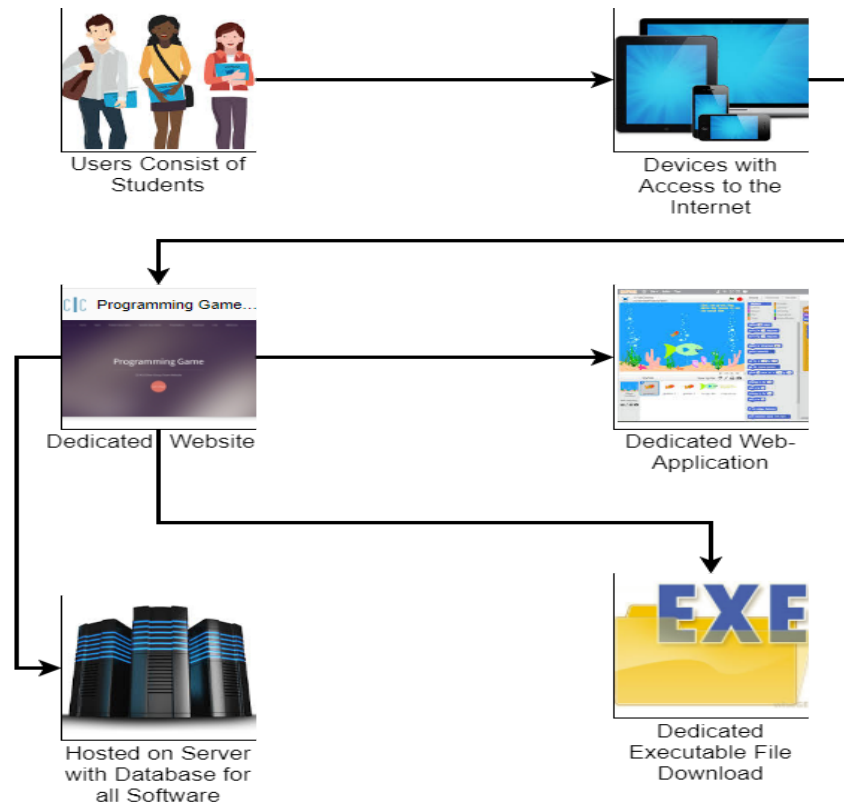
Figure 4: Major Functional Component Diagram

3 Identification of Case Study

The potential end users for PolyMorpher are students that are either from ODU or other colleges/universities. Potential customers for PolyMorpher are in same category as end users but extend to people from different academic and work areas.

3.1 End-User: Students

The end users for PolyMorpher will be primarily students who want to learn programming based on OOP concepts. PolyMorpher is also geared towards helping students that enjoy playing games as a hobby. Thus, PolyMorpher provides the benefit of letting students play and simultaneously teaching complex OOP concepts.

3.1.1 ODU

One of the primary end users are particularly ODU students in the CS department. According to the enrollment data shown in Figure 2, ODU students are negatively affected by the constraints regarding the traditional teachings of OOP. Thus, they are potential end users that can benefit from PolyMorpher.

3.1.2 Other colleges

Other colleges and universities will be potential end users. Particularly, their CS students will benefit greatly from PolyMopher because it will address the difficulties they are possibly having with comprehending and understanding OOP concepts and problem-solving skills. PolyMorpher will not have to accommodate to particular colleges/universities regarding their CS curriculums because they are similar to the one at ODU. Thus, PolyMorpher will help CS students from other colleges/universities because the same solution characteristics that Team Silver has stated will help ODU CS students, will help them as well.

3.1.3 Those generally interested in programming

The data in Figure 2 also shows that students from various major backgrounds that are struggling with learning OOP concepts. Team Silver has considered them as potential end users. PolyMorpher can help them because it focuses on dealing with the teaching and interactive aspect of the game instead of the individual itself.

3.2 Customers

Potential customers that are to be considered are programming instructors. Besides students, instructors can greatly benefit from using PolyMorpher. The reason is that if they can benefit from learning OOP concepts and problem-solving skills, then they can teach it effectively

to their students. Instructors can also use PolyMorpher as part of their programming course curriculum labeling it as a new effective teaching tool.

4 Product Prototype Description

The prototype deliverable will be an exact simulation of the possible final product as illustrated in the tech demos by Team Silver. One of the main purposes to create a prototype is to show the end users and customers a version of PolyMorpher they can find useful. No external hardware is required for using PolyMorpher besides the player's PC.

4.1 Prototype Architecture (Hardware/Software)

PolyMorpher prototype architecture will be identical as the one in final product.

4.2 Prototype Features and Capabilities

Both the PolyMorpher prototype and final product will be able to be downloaded from its website as stated in section 4. The prototype and final product will also be compatible with most common operating systems such as Windows, Linux, and MacOS. Table 2 will illustrate the summary of the 16 possible differences between the PolyMorpher Prototype and its final product.

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Elements	Description	Real World Product	Prototype
Teaches Polymorphism	Provision of a single interface to entities of different types	🟩	🟩
Teaches Abstraction	Technique for arranging complexity of systems	🟩	🟩
Teaches Encapsulation	Building of data with the methods that operate on that data	🟩	🟩
Teaches Inheritance	When an object or class is based on another object or class, using the same implementation	🟩	🟩
Single Language Taught	A single programming language will be focused on C#.	🟩	🟩
Single Player	Focused on an experience targeted to interact with only one player	🟩	🟩
Downloadable .EXE File	Desktop application version of the game	🟩	🟩
Game Assets	Primary components that are used as building block to construct the more complex features and levels of the game	🟩	🟩
Developed Story	Narrative used to drive progression or direct player throughout a more guided/linear experience	🟩	🟩
Portable Compiler	Code compiler used to run player-made code on the fly in game	🟩	🟩
Tutorial Section	Precursor series of levels meant to help the player adjust to the in-game toolset given to them and also prep them with knowledge of the language(s) they will be working with	🟩	🟩
Multiple Platforms	Version support for multiple operating systems (Windows, Mac OS, Linux)	🟩	🟩
Sandbox Level	Open level where the player has access to all tools at once and can build their own level sequences and puzzles	🟩	🟨
Player-Made Content	Variant of Sandbox Level, potentially allows the player to share custom levels with one another	🟩	🟨
Multiple Player	An experience geared toward multiple players interacting with a game environment together	🟩	🟥
Web Application	Web based version of the game running in-browser	🟩	🟥
Multiple Languages Taught	Alternative programming languages for the player to use and learn in-game	🟩	🟥

KEY

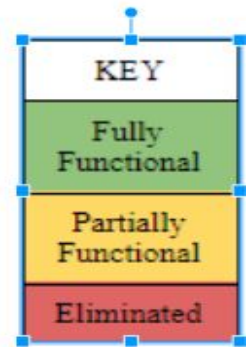| KEY |
|---|
| Fully Functional |
| Partially Functional |
| Eliminated |

Table 2: Features of the Completed Product against the Prototype

It will be guaranteed that PolyMorpher will be able to teach some of the most important OOP

concepts that includes Abstraction and Encapsulation. In addition, the player will be able to

benefit from a story progression and a tutorial section so that they can see their amelioration as

they move from one level to another while they play through the game. One of the partially

functional features that might be implemented on PolyMorpher is a sandbox level. This is where

the player is allowed to have access to all the tools available in the game so that they can design

their game levels and puzzles. Lastly, the eliminated features of PolyMorpher for both the

prototype and the final product are multiplayer, multiple languages taught, and the web

application. All three of these applications requires a constant internet connection.

4.2.5 Algorithms

      PolyMorpher prototype will consist of three important algorithms that will contribute to

its capabilities and features. The three algorithms that will used for this game are the following:

- Core Algorithm

- API Book Algorithm

- Compiler Algorithm

The following subsections will go into further details explaining how each of three algorithms

will work.

4.2.5.1 Core Algorithm

      The Core Algorithm will consist of one component option named "Morph" that will

deliver three sub options. The procedure of this algorithm starts with allowing the player to select

the main option of "Morph" which allows objects in the game be edited. Then, the algorithm

through the game will create a text box with a game loop that will give the player three options.

The player can choose to type their own code directly into the text box to modify the script,

choose a function from the API Book, or reset the script to its original content. This algorithm

with the aid of the compiler, will determine if there were any compilation errors from the input

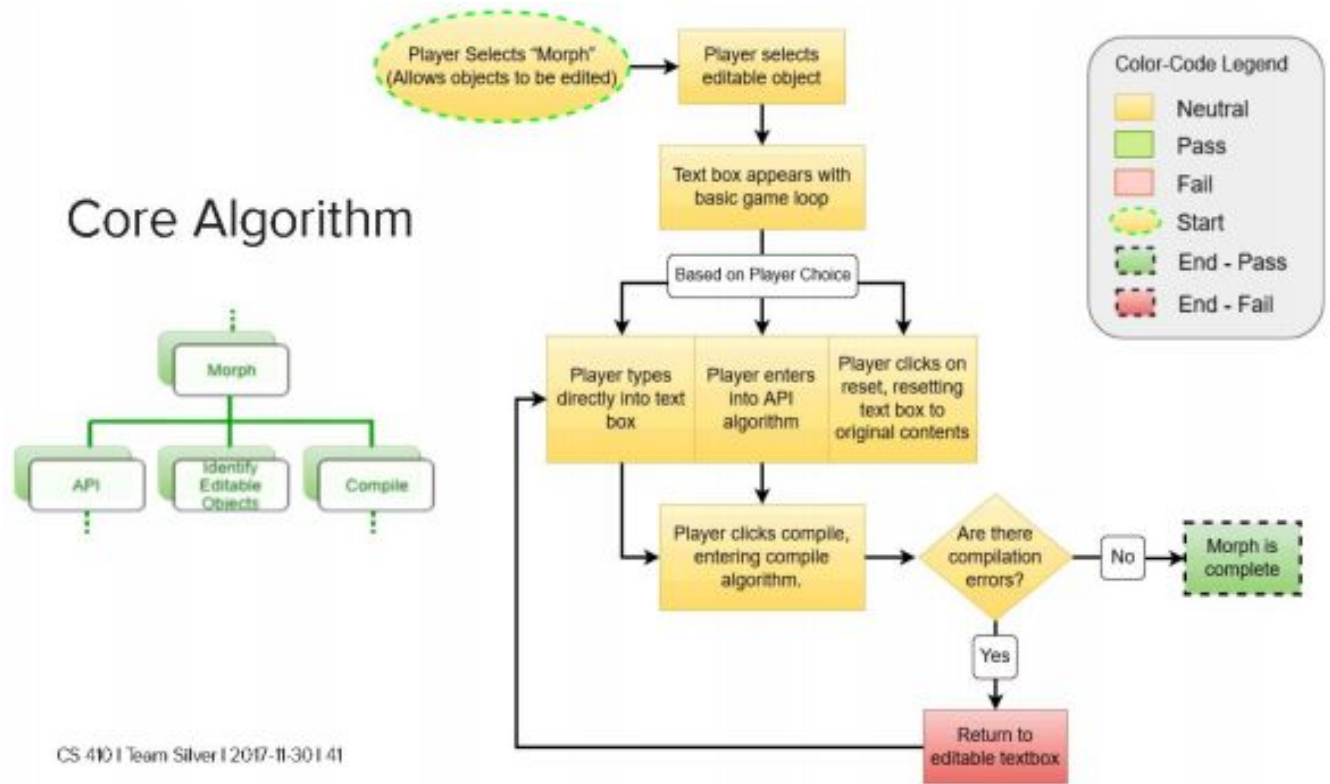entered. Figure 5 illustrates the Core Algorithm in detail.

Figure 5: Dataflow Diagram for the Core Algorithm

4.2.5.2 API Book Algorithm

The API Book Algorithm will consist of allowing the player to access the API Book that

PolyMorpher provides. This algorithm administers the educational information that Team Silver

had decided to implement in their design and grants that to the player. The API Book provides a

variety of tools to help them complete the puzzles and challenges in each level. This algorithm

consists of three simple procedures. First, the player selects the API icon which will be an image

of a book that appears in a textbox. Then, they select a function inside the provided API Book.

Lastly, the function the player selects appears in the textbox which it can be editable and

manipulated. Figure 6 shows API Book Algorithm diagram for further details.
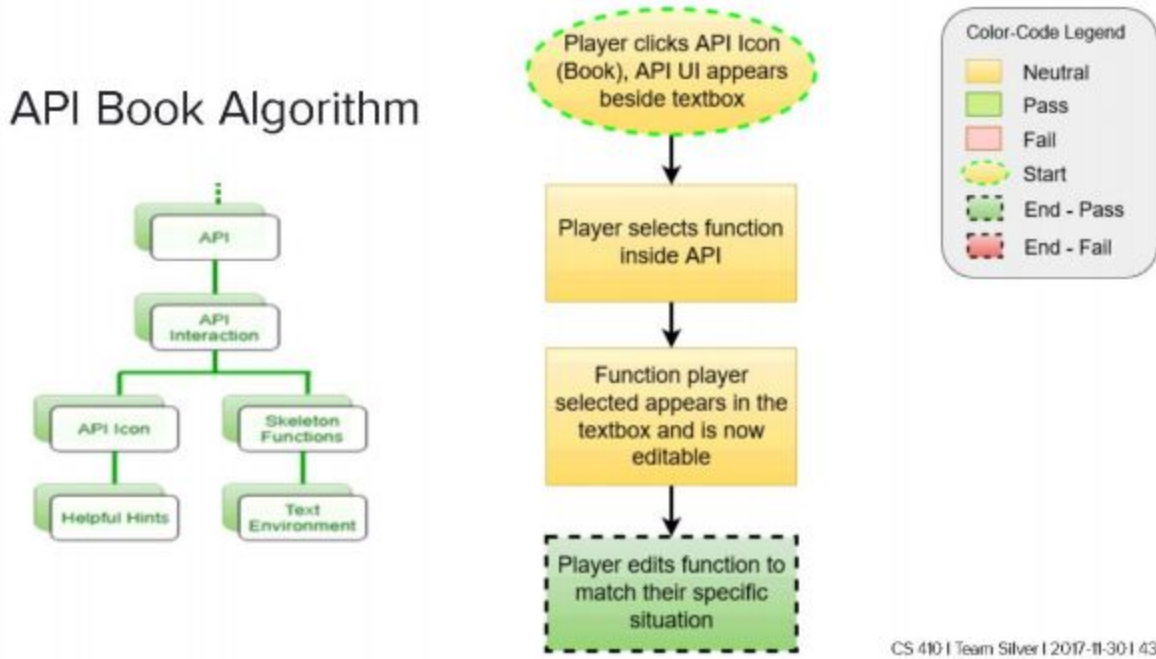
Figure 6: Dataflow Diagram for the API Book Algorithm

4.2.5.3 Compiler Algorithms

The Compiler Algorithm will act as a portable assembler to process the scripts the player

enters as they are solving a puzzle or challenge. The procedure starts with saving the player's

script in the StreamingAssets Directory. Next, a Runtime Object is created, and it functions

along with a premade LoadScripts.cs file. This file pulls the player's script and marks it as

"Source Code".

The LoadScript.cs file calls another premade file called ScriptBundleLoader.cs to

perform the portable compilation on the source code. ScriptBundleLoader.cs has a

CodeCompiler class that performs the compilation of the player's stored script.

ScriptBundleLoader.cs will determine if there were compilation errors in the player's script.

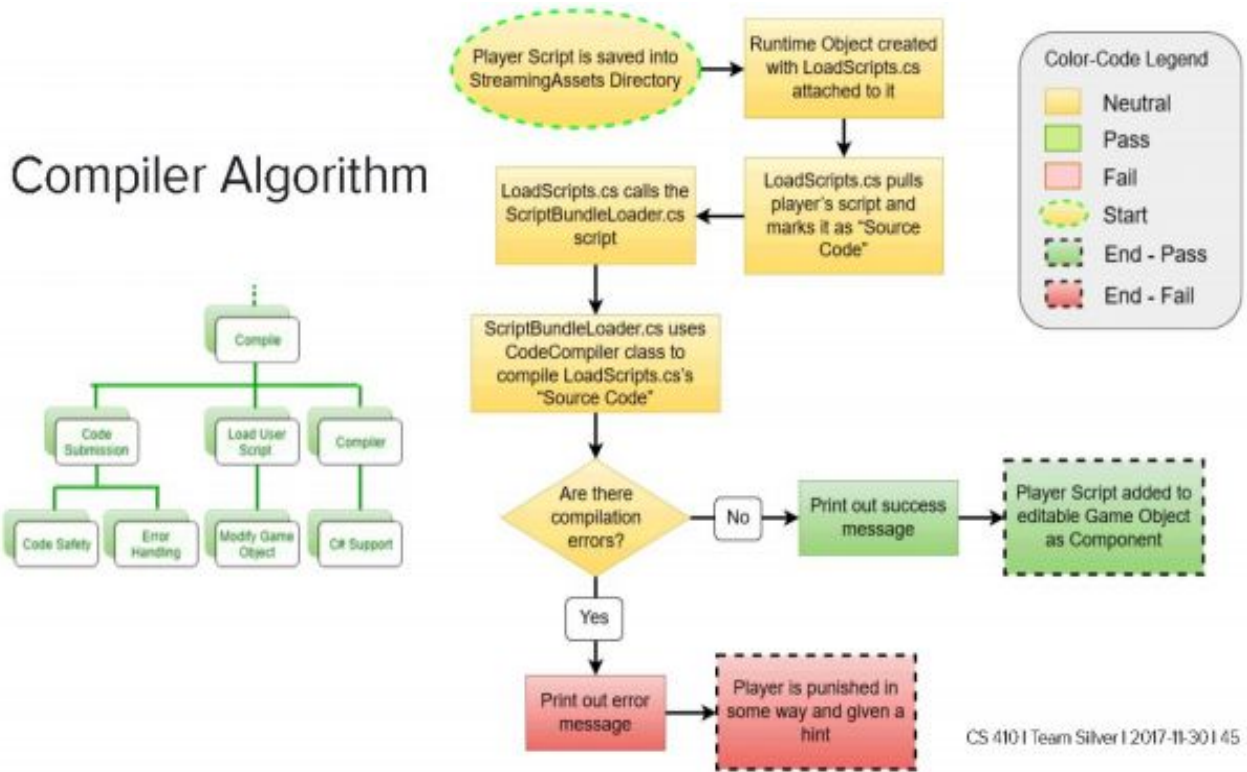Figure 7 illustrates the diagram for the Compiler Algorithm.

Figure 7: Dataflow Diagram for the Compiler Algorithm

4.3 Prototype Development Challenges

The development of the PolyMorpher prototype by Team Silver will encounter five

challenges that were analyzed closely. The subsections will elaborate further on each of those.

4.3.1 Design continuity

The consistency of the design for PolyMopher is imperative because it promotes the

stability for the prototype and final product. Team Silver plans to maintain the design of

PolyMorpher consistent through weekly meeting.

4.3.2 Difficulty debugging

A rigorous development challenge that Team Silver will encounter is debugging

PolyMorpher. One aspect that Team Silver must consider is debugging the numerous and vague

scripts the player can enter. Thus, Team Silver will strategically find ways to cause errors and

glitches within PolyMorpher to debug it effectively.

4.3.3 Playtesting

Playtesting is an important challenge that Team Silver must take into consideration. It

requires to test if the main components of PolyMopher are working efficiently. The main

components are:

- TUI and GUI functionalities

- Compilation of player's code

- The effectiveness API Book references

The challenge constraints will be noted on the lengthy time it might take to test these

components individually.

4.3.4 Maintaining player engagement

Keeping the player engaged and entertained is another major challenge for PolyMorpher.

Playtesting results will be a major aid to Team Silver in determining how entertaining this game

will be.

4.3.5 Teaching enough

As referred in section 1, the goal of PolyMorpher will be to teach the main concepts of

OOP. However, in programming there are a lot of other important concepts that can be beneficial

to the player. Team Silver is faced with a bigger challenge that is if teaching enough is only

sufficient with OOP.

4.4 Risk Matrix/Risk Mitigation

  The risk mitigation and matrix for PolyMorpher is designed to demonstrate the three

main scenarios of impact and probability risks. There are two important categories as well which

are Customer and Technical. The matrix is divided into three colored sections. Table 3 illustrates

the Risk/Mitigation matrix for PolyMorpher in detail.

Table 3: Risk/Mitigation Matrix of Customer & Technical Risks for PolyMorpher

4.4.1 Technical risks and mitigations

  There are four potential technical risks that Team Silver identified. The first technical risk

is that user implements bad code. The mitigation for this risk is that if the user implements

malicious code that comes from an uncredible online forum, it could potentially crash

PolyMorpher. The second technical risk for PolyMorpher deals with there being insufficient

hardware for the game itself. The mitigation for this risk is that PolyMorpher will be

implemented as 2-dimensional game allowing it not to draw much resources from the player's

machine.

The third technical risk for PolyMorpher deals with critical software bugs in the game.

The mitigation for this risk is to test and assure that the game is fully optimal and functioning at

the desired expectations. The last and fourth technical risk for PolyMorpher deals with

insufficient API support. The mitigation for this risk is that if the API does not provide all the

sufficient function references the player needs to solve puzzles and challenges, they will not be

able to effectively learn OOP concepts.

4.4.1 Customer risks and mitigations

As stated in section 4.4, there are three main customer risks and mitigations. The first

customer risk deals with the user getting stuck in solving a puzzle or challenge. The mitigation

for this risk deals with the user struggling to play PolyMorpher and giving up. The users who can

be affected by this risk either have low or no programming experience.

The second customer risk that Team Silver has identified is if the player is dissatisfied

particularly with GUI and UI/UX design. The mitigation for this risk is that Team Silver can not

accommodate nor implement all the possible types of GUI and UI/UX designs. Team Silver is

committed though to find and implement a GUI and UI/UX design that can satisfy most of its

users.

The third and final customer risk for PolyMorpher deals with the insufficient content and

time that PolyMorpher will be able to teach to its players. The mitigation of this risk is that if

PolyMorpher does not have sufficient OOP content to teach, the user will not learn the important

concepts of OOP. Team Silver also took into consideration time constraints. This is to determine

if the player will have the sufficient time to play the game and learn OOP concepts at the same

time.

5 Development Pipeline

The tools that will be needed to successfully develop PolyMorpher include the following:

Unity SDK, Gitlab, SourceTree, MonoDevelop, and C# programming language. The subsections

below will discuss these tools in detail.

5.1 Unity SDK

Unity is a popular gaming engine that has the sufficient development built-in tools to

construct PolyMorpher as a game. Unity has many premade objects and environments that can

be useful for developing the GUI and UI/UX design. MonoDevelop is the IDE that is integrated

into Unity to develop games and the programming language that will be used to do it is C#.

Team Silver will use C# to build PolyMorpher. C# was developed by Microsoft and so Unity

uses their compilers. Visual studios from Microsoft is the main IDE for C# and can be used to do

development in Unity. However, Team Silver decided to use MonoDevelop instead because it's

an integrated feature of Unity.

5.2 SourceTree

SourceTree is a free git client for Mac and Windows. Team Silver will use SourceTree to

interact with GitLab and manage their repositories both online and local. SourceTree uses

PuTTY which is a popular pageant client to connect and communicate with GitLab remotely.

5.3 Version Control

Team Silver's version control will require SourceTree, Gitlab, and PuTTY to connect and

communicate simultaneously with their repositories. The version control process begins when

the developers updated their local repositories with the master branch in gitLab and vice versa

through source tree. The connection made between source tree and gitlab is through the PuTTy

pageant. The developers will do the editing of the source code in MonoDevelop before they

begin making commits in source tree. Figure 8 illustrates Team Silver's version control diagram
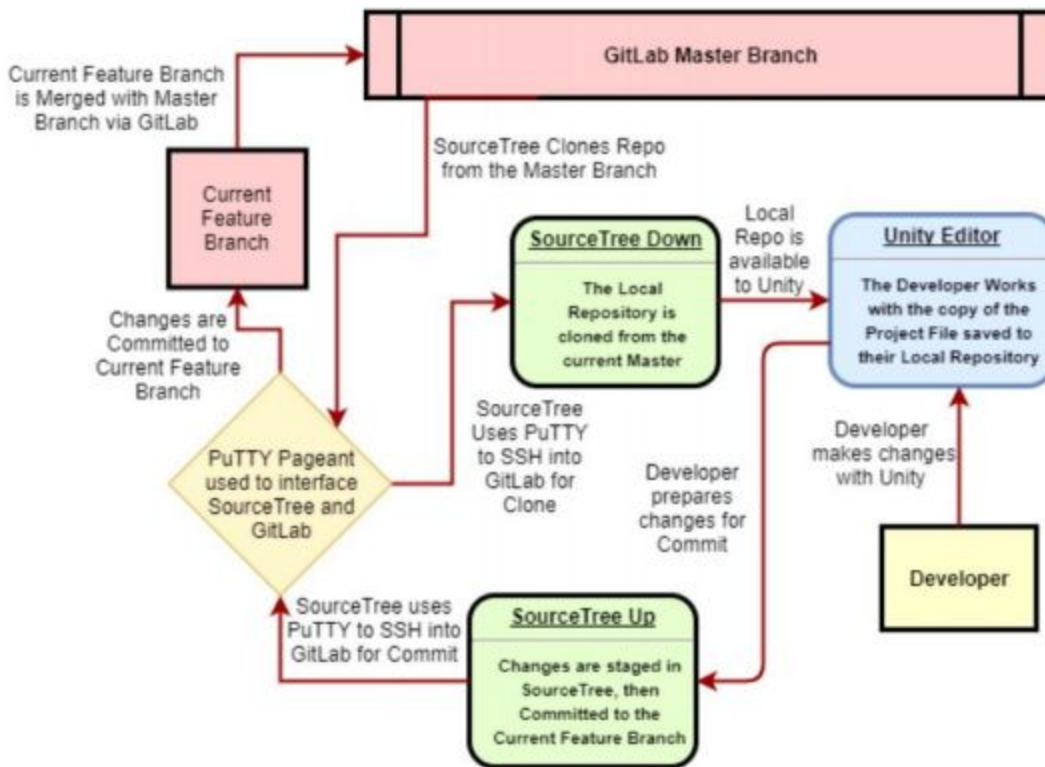
in detail.

Figure 8: Dataflow Diagram for Version Control

5.4 Development Model

Agile was the development model that Team Silver will use to develop PolyMorpher. As

illustrated in Figure 9, this development model shows quick versions of prototype models done

each of the developers. It encourages a rapid workflow among the developers since if one

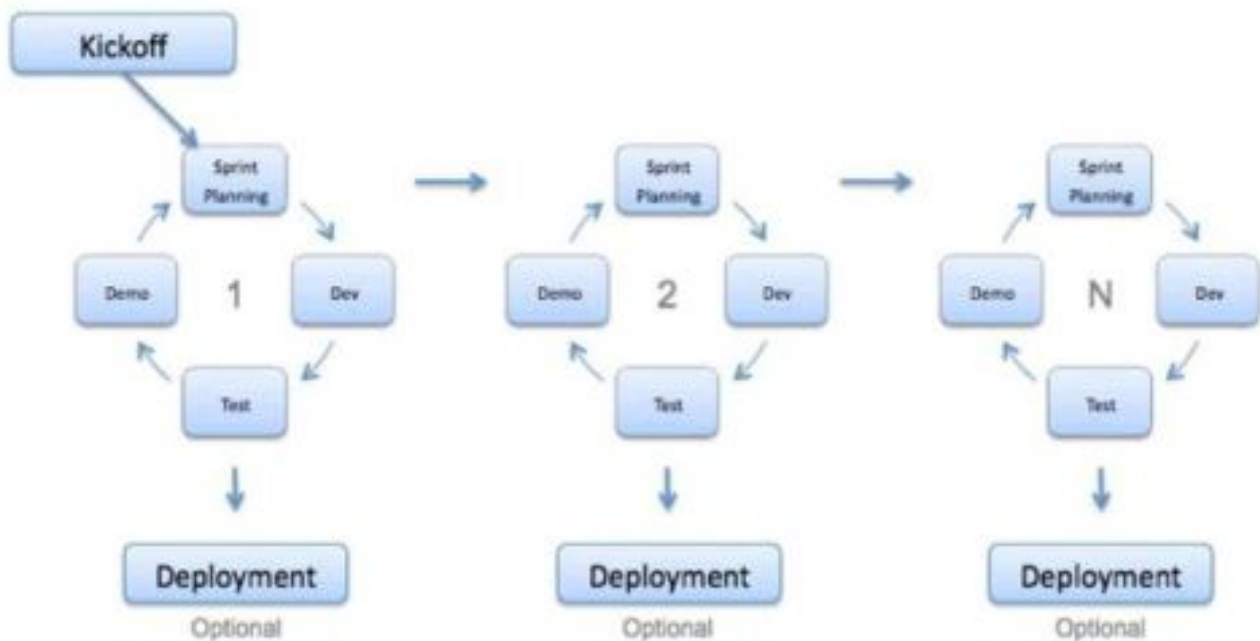prototype model is not liked by the team, they move on to next.

Figure 9: Dataflow Diagram for Agile Development Model

5.5 Work Management

Team Silver will be split into three development groups. Each group will be assigned with two OOP concepts and they will be given the task to design a puzzle or challenge for a level. They have to design such puzzle and challenge to effectively teach their assigned OOP concepts to the player. Once all three groups successfully complete their tasks, the levels will be integrated into PolyMorpher.

Glossary

API: Application Program Interface

Computer: a programmable electronic device designed to accept data, perform prescribed

mathematical and logical operations at high speed, and display the results of these

operations

Computer Programming: a process that leads from an original formulation of a computing

problem to executable computer programs

Computer Science (CS): the science that deals with the theory and methods of processing

information in digital computers, the design of computer hardware and software, and the

applications of computers

Design: an outline, sketch, or plan, as of the form and structure of a work of art, an edifice, or a

machine to be executed or constructed

Git: version control system for tracking changes in computer files and coordinating work on

those files among multiple people

GitLab: web-based git repository manager the includes wiki and issue tracking

Gradle: an open-source build automation system that was designed for multi-project builds

GUI: Graphical User Interface

JavaScript: a programming language commonly used in web development where the the code is

processed by the client's browser

IDK: Integrated Development Kit

Management Simulator: a way to simulate the management of a game in an organized fashion

MySQL: an open source multi-user database management system

Non-Technical Game: user-friendly gameplay able to be utilized by non-technical users

Non-Technical User: user who lacks formal education or knowledge in computer science,

computer programming, object-oriented programming, or problem solving skills

Object-Oriented Programming (OOP): A schematic paradigm for computer programming in

which the linear concepts of procedures and tasks are replaced by the concepts of objects

and messages

ODU: Abbreviation for Old Dominion University

PC: Personal Computer that will be used to describe the player computer/machine

Platform: an integrated set of packaged and custom applications tied together with middleware

PolyMorpher: a programming game that focuses strictly on teaching OOP and problem solving

skills

Problem Solving: the process of finding solutions to difficult or complex issues

Programming Game: a video game which incorporates elements of computer programming

into the game, which enables the player to direct otherwise autonomous units within the

game to follow commands in a domain-specific programming language

Regression Testing: a type of application testing that determines if modifications to the

application have altered the application negatively

Software Development Kit (SDK): a set of software development tools that allows the creation

of applications for a certain software package

Student Involvement: the amount of physical energy students exert and the amount of

psychological energy they put into their college experience

Student Progression Dilemma: the problem of CS majors at ODU not advancing through the

CS course schedule in order to graduate with a CS degree

TUI: Tangible User Interface

Ubuntu: open-source Linux operating system

Unity: a popular game development platform

User-Friendly: easy to comprehend by non-technical users

Virtual Machines: emulations of computer systems that provide functionalities of physical

computers

Web Application: a client-server computer program in which the client (including the user

interface and client-side logic) runs in a web browser

Wiki: a website on which users collaboratively modify content and structure directly from the

web browser

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