



BSc Degree in Software Engineering  
2021-2022

*BSc Thesis*

## “VisualPro: Research and Improvements of Junior Software Engineering”

---

Edward Samuel Ralph Patch

Mike Dacey  
Waterfront Campus - 2021





## **SUMMARY**

**Keywords:** Visual Programming, Visual Scripting, Development



## **DEDICATION**



## CONTENTS

1. INTRODUCTION . . . . .	1
2. LITERATURE REVIEW . . . . .	2
2.1. User Interface and User Experience . . . . .	2
2.1.1. User Interface. . . . .	2
2.1.2. Maintenance . . . . .	3
2.1.3. User Experience . . . . .	4
2.2. User Usability . . . . .	4
2.3. Productivity and Visual Scripting. . . . .	5
2.4. Learning Tools . . . . .	6
2.4.1. Learning Styles. . . . .	6
2.4.2. Tutorial Application . . . . .	6
2.4.3. Tutorial Documentation . . . . .	7
2.5. Tools for the User Interface . . . . .	7
2.6. Libraries for Functionality. . . . .	8
2.7. Testing Functionality. . . . .	10
3. RESEARCH METHODOLOGY . . . . .	12
4. PROTOTYPE . . . . .	13
5. DESIGN AND FEEDBACK . . . . .	14
5.1. Pre-Planning . . . . .	14
5.1.1. HTML Design . . . . .	14
5.1.2. Notebook Page 1-2. . . . .	14
5.1.3. Notebook Page 2-3. . . . .	15
5.1.4. Notebook Page 5-6. . . . .	16
5.1.5. Notebook Page 7-8. . . . .	17
5.1.6. Notebook Page 9-10 . . . . .	18
5.1.7. Notebook Page 11 . . . . .	19
5.1.8. Notebook Page 12-13 . . . . .	20

<b>5.2. Results of Feedback . . . . .</b>	<b>21</b>
5.2.1. Survey Question 1 . . . . .	21
5.2.2. Survey Question 2 . . . . .	21
5.2.3. Survey Question 3 . . . . .	22
5.2.4. Survey Question 4 . . . . .	23
5.2.5. Survey Question 5 . . . . .	24
5.2.6. Survey Question 6 . . . . .	25
5.2.7. Survey Question 7 . . . . .	26
5.2.8. Survey Question 8 . . . . .	27
5.2.9. Survey Question 9 . . . . .	27
5.2.10. Survey Question 10. . . . .	29
5.2.11. Survey Question 11. . . . .	30
5.2.12. Survey Question 12. . . . .	30
5.2.13. Survey Question 13. . . . .	31
5.2.14. Survey Question 14-15. . . . .	31
5.2.15. Survey Question 16. . . . .	33
5.2.16. Survey Question 17. . . . .	33
5.2.17. Survey Question 18. . . . .	34
5.2.18. Survey Question 19. . . . .	35
<b>5.3. Evaluation of Feedback . . . . .</b>	<b>36</b>
<b>6. DEVELOPMENT METHODOLOGY . . . . .</b>	<b>37</b>
<b>7. IMPLEMENTATION . . . . .</b>	<b>38</b>
7.1. Main Layout . . . . .	38
7.2. Error Handling . . . . .	40
7.3. Structure Containers . . . . .	40
<b>8. EVALUATION OF FUNCTIONALITY . . . . .</b>	<b>41</b>
<b>9. EVALUATION OF FEEDBACK . . . . .</b>	<b>42</b>
<b>10. CONCLUSION . . . . .</b>	<b>43</b>
<b>11. REFLECTION . . . . .</b>	<b>44</b>
<b>12. TERMINOLOGY . . . . .</b>	<b>45</b>



## LIST OF FIGURES

2.1	Visual Database Editor Diagram . . . . .	8
4.1	GUI Prototype . . . . .	13
5.1	UI Illustration . . . . .	14
5.2	Notebook P-1.2 . . . . .	15
5.3	Notebook P-3.4 . . . . .	16
5.4	Notebook P-5.6 . . . . .	17
5.5	Notebook P-7.8 . . . . .	18
5.6	Notebook P-9.10 . . . . .	19
5.7	Notebook P-11 . . . . .	19
5.8	Notebook P-12.13 . . . . .	20
5.9	Survey Q-1 . . . . .	21
5.10	Survey Q-2 . . . . .	22
5.11	Survey Q-3 . . . . .	22
5.12	Survey Q-4 . . . . .	23
5.13	Survey Q-5 . . . . .	25
5.14	Survey Q-6 . . . . .	26
5.15	Survey Q-7 . . . . .	27
5.16	Survey Question 8 - Found at: <a href="#">Original Image</a> . . . . .	27
5.17	Survey Q-9 . . . . .	29
5.18	Survey Q-11 . . . . .	29
5.19	Survey Q-11 . . . . .	30
5.20	Survey Q-12 . . . . .	31
5.21	Survey Q-13 . . . . .	31
5.22	Survey Q-14 . . . . .	32
5.23	Survey Q-15 . . . . .	32
5.24	Survey Q-16 . . . . .	33
5.25	Survey Q-17 . . . . .	34

5.26 Survey Q-18 . . . . .	35
5.27 Survey Q-19 . . . . .	36
7.1 GUI Design ML-1 . . . . .	38
7.2 GUI Design ML-2 . . . . .	38
7.3 GUI Design ML-3 . . . . .	39
7.4 GUI Design ML-4 . . . . .	39
7.5 GUI Design EH-1 . . . . .	40
7.6 GUI Design SC-1 . . . . .	40



## **LIST OF TABLES**

2.1 Comparison of Visual Scripters . . . . .	9
2.2 Comparison of Web Builders . . . . .	10



## 1. INTRODUCTION

VisualPro is a lightweight, high-performance Visual Scripting client that enables users to create high-end software, whether the logic is for, not limited to, web, software, Artificial Intelligence. VisualPro would extend the Programming Planner library to show off the potential of the usage and potential of the library, in turn, bringing a different design of Visual Scripting to the table. The software aims to increase workflow without discriminating cognitive ability, whether it is struggling to adapt to a different language or acquiring new skills that impact how the software works.

VisualPro aims to unify languages to achieve, not only for users to adapt to complicated languages but also guide the user to learn what languages have in common and therefore increase the drive to learning new languages without feeling ‘there is only one tool for the job’ condition.

Features that VisualPro brings forward to the table are as follows:-

- **Novice Development:** Studies of how beginners learn and how VisualPro can improve.
- **Dynamic Languages:** The ability to add new languages, the code generation can end up as.
- **Visual Scripting Software:** A tool with zero restrictions on what code the user wishes to generate.

Requirement steps for the VisualPro program include rewriting the Programming Planner console application, written in the C++ language to work in dynamic-link libraries and supporting dynamic languages. After the previous stage, designing the VisualPro interface and learning how a beginner may use the software are essential. Ultimately, implementing the product that achieves a Visual Scripting program that is lightweight, generates quality code and is easy to use for beginners with the potential of persuasion of intermediate and advanced programmers.

## **2. LITERATURE REVIEW**

### **2.1. User Interface and User Experience**

Research for User Interface (UI) and User Experience (UX) analyse how a new developer would use the software with little to no coding experience and what difficulties the UI and UX design may encounter. Methods of outlining and testing the UI and UX are within the chapter, Research Methodology 3, page 12.

#### **2.1.1. User Interface**

To get some ideas for the UI, the Journal ‘Evaluation of a UML-Based Versus an IEC 61131-3-Based Software Engineering Approach for Teaching PLC Programming’ writing by Birgit Vogel-Heuser, Martin Obermeier, Steven Braun, Kerstin Sommer, Fabian Jobst, and Karin Schweizer [1] and the Journal ‘Design Issues and First Experiences with a Visual Database Editor for the extended NF<sup>2</sup>-Data Model’, author(s):- K. Küspert, J. Teuhola and L. Wegner [2]. These Journals cover Unified Modeling Language (UML). The UML concept is predominantly used in relationship diagrams in databases and Visual Scripting.

The addition of UML tools for the frontend to create the Visual Scripting platform proves an excellent opportunity as there is plenty of UML Framework support. Some critical points based on an experiment from Birgit Vogel-Heuser’s Journal Article [1] are listed.

To gather the answer for ‘How effective is UML tools?’, the hypothesis from Birgit’s [1] Journal article answers the question by saying, “Students trained in OO modelling show an improved modelling performance.”

The experiment environment involves the following rules:-

- Software Engineering theme. - Any material created for the experiment to work, the experiment outline is set in a Software Engineering equivalent environment.
- Training Assets and Problem-Solving Exercises. - A series of training materials and problem-solving exercises were created for the experiment to be fair.
- Task Setting and Training. - The author focuses on Task Setting and Training, supported by Hierarchical Task Analysis.

To answer Hypothesis 1 set by Birgit Vogel-Heuser [1] ‘...analysis examined the within factor (before and after the training) and additionally two between factors (notation and expertise)”, the extract as follows is chosen.

*“The data were analyzed using three methods. First, an analysis of variance (ANOVA) was applied to test differences between the variances of several groups in order to show whether their performance changed after the training approaches and whether their performance differed between classes due to expertise level differences. Then, correlations were computed as a measure of the relation between programming/modeling performances on different performance scales. Subsequently, differences in relations between the two software engineering approaches (see hypothesis 3) were shown by computing regression models for the programming performance for both approaches.”* -  
Birgit Vogel-Heuser [1].

The results gathered display that the training set for learning UML in a Software Engineering sense was highly effective. However, the Birgit Vogel-Heuser [1] states that ‘All participants learned from the training.’ and backs it up by ‘...indicating that the -group had learned even more from the training because of their poor results before the training (see also Fig. 2) and their lack of prior knowledge.’ This quotation suggests that UML /tools found in Visual Scripting may not necessarily be complicated for beginners to learn, but they may seem more complex without proper training. This conclusion could suggest that UML methods are not well documented and could indicate that UML may not be well maintained, look at section 2.1.2, page 3.

### 2.1.2. Maintenance

The Journal by Erik Arisholm, Lionel C. Briand, Siw Elisabeth Hove and Yvan Labiche, ‘The Impact of UML Documentation on Software Maintenance: An Experimental Evaluation’, addresses the lack of UML Documentation on both developer-side and client-side. After learning that the individuals who participated in the experiment from section 2.1.1, page 2, the question arose, ‘Was the UML documentation depreciated and how was the documentation notwithstanding on the development side?’ it was vital to determine if UML tools are future-proof or will it prove expensive to maintain. After Erik Arisholm performed tests found in the Journal, the author found that ‘UML documentation does not seem to provide an advantage when considering the additional time needed to modify models.’ Furthermore, disregarding existing UML documentation seemed to correlate compared to the first test, thus suggesting that the UML documentation had the same effect as no UML documentation.

Things to note during this study, if the integration of UML tools within VisualPro, then expenses regarding finance, staff and resources for UML documentation for both developers and clients are necessary. However, the creation and maintenance of the software would require UML Development documentation. Yet, reverse engineering the UML li-

ibraries to create a detailed UML Development and UML Usability Documentation for both users before any development can begin on the software. This event is due to understanding how the UML tools operate and integrating the software properly to work in the future.

### 2.1.3. User Experience

Within the Journal, written by Birgit Vogel-Heuser, Martin Obermeier, Steven Braun, Kerstin Sommer, Fabian Jobst, and Karin Schweizer [1], ‘Evaluation of a UML-Based Versus an IEC 61131-3-Based Software Engineering Approach for Teaching PLC Programming’, an experiment to test whether beginners excelled at object-orientated programming (OOP) or functional programming (FP). The quote follows:-

*“Berges and Hubwieser investigated Computer Science freshmen’s abilities to learn OO programming in two and a half days with as little (human) instruction as possible [27].*

*Examining 300 students’ program code, they found that most were able to write quite satisfying programs. They identified two types of students: those who accept and apply the OO concepts, and those who prefer to program in a more traditional procedural way. They also tried to define the characteristics of object orientation to evaluate measures for program quality, e.g., one instance of a class is created.” [1]*

This test suggests that after three hundred students were tested with little instruction from other peers, which opens an interesting fact that most of the three hundred students wrote acceptable code in both OOP and FP categories. The test’s conclusion finds two types of students, and the students either found OOP or FP easier. After analysing this specific test, beginners may have different mindsets and thinking styles.

## 2.2. User Usability

As the principle of the product covers beginners’ use of Visual Scripting to aid the users with the proficiency and capability to understand and further their logic building skills, it is vital to understand how usability is measured and evaluated. According to Dana Chisnell [3] Usefulness, Efficiency, Effectiveness, Learnability and Satisfaction are five necessary components of how the usability tests should carry out. These selections establish how the target audience will interact with the software and test if the target audience stays interested in the software without feeling any frustration towards the software.

VisualPro’s end product needs to increase the efficiency of standard programming and Visual Scripting and manage to keep effectiveness and usefulness. For example, based on Dana Chisnell [3], the software could achieve the ‘...system is easy to use, easy to learn...’ and is ‘...satisfying to use...’, the product will gain no interest and have limited use if ignoring these objectives. This example backs up that it could be catastrophic with too

much focus on one topic. However, if the software generates the information for the target audience and still keeps the audience interested, it could change the Web and Software industry as we know it today.

Detlef Zuehlke [4] mentions that using a survey and final testing of user usability is not efficient to guarantee a usable UI. As VisualPro intends to create a more effortless Programming experience, other usability testing methods are required.

A method of deciphering the results from any quantitative research from User Usability testing is to group the results using Fuzzy Logic that enables results to fall into different categories to convert to a binary format, for example, *I* being effective and *0* being ineffective. Fuzzy Logic enables two sets of data with multiple thresholds to combine to create a noisy environment into a more straightforward process.

Extensive research to discover how and if Fuzzy Logic is an excellent tool to examine and conclude any usability tests. The Journal Article, Marwa Bentati [5], ‘A Fuzzy-logic System for the User Interface Usability Measurement’ mention efficient ways of how Fuzzy Logic help with the conclusion of Usability Testing and provides examples of measurement references to create the best analyst. Marwa Bentati [5] found that an ideal fuzzy system uses three main contributions to produce effective use of results found from User Usability testing.

Fuzzy Logic could compare data to decide if the temperature is cold, warm or hot. A demonstration fabricated by Edward Patch displays an example:-

### **2.3. Productivity and Visual Scripting**

Productivity, specifically within the software engineering field, Dr. Caitlin Sadowski’s [6], ‘Rethinking Productivity in Software Engineering’ Book states, “Productivity is a challenging concept to define, describe, and measure for any knowledge work that involves nonroutine creative tasks. Software development is a prime example of knowledge work, as it too often involves poorly defined tasks relying on extensive collaborative and creative endeavors. As in other areas of knowledge work, defining productivity in software development has been a challenge facing both researchers and practitioners who may want to understand and improve it by introducing new tools or processes.” When reading further into the chapter, the following points evaluate how we should think about productivity:-

- “Velocity: How fast works gets done.” [6]
- “Quality: How well works gets done.” [6]
- “Satisfaction: How satisfying the work is.” [6]

After thinking about this, VisualPro, in theory, should increase the rapidity of the individual’s work. Suppose VisualPro changes the way Visual Scripting works today, making

it lightweight and understandable compared to existing Visual Scripting (For example, Unreal Engine's Blueprints [7]), with the ability to generate any desired code. In that case, the quality and satisfaction of the developer amplify.

## 2.4. Learning Tools

Research of obstacles and potentials help identify existing and future issues that Visual-Pro software could generate. The aim is for amateurs new to the development field and suggests existing problems that put a ‘brick wall’ in learning programming and potentials of how VisualPro can solve these issues. This topic may reflect on the critical components of UI and UX previously mentioned.

### 2.4.1. Learning Styles

After observing Tileston Donna Walker's [8] book, for VisualPro to increase programming skills to beginners, three styles, *visual, auditory and literature*, benefits any implementation with the software or documentation. It is essential not to overuse any style to pursue a healthy balance with this software, as some individuals like a challenge to overcome problems before being presented with a solution.

### 2.4.2. Tutorial Application

*“In EE 220, Network Analysis I, 12 tutorials were created. One of these takes the student through the solution of a three-phase power problem. First, the student receives a statement of the problem and a diagram of the circuit. The student is then asked to find the power consumed in one phase of the load. If the student answers incorrectly, a hint is given: “One third of the power is used in each of the three phases of the load.” More hints are given until the student gets the right answer. The student then moves on to the next page of the lesson, asking for a calculation of the line voltage. After 8 pages, the student has solved the problem for all the voltage, current, and power values of the circuit” - Dr Thomas G. Cleaver [9].*

Dr Thomas G. Cleaver set up the Network Analysis I tutorial experiment, creating 12 tutorials with different properties. A particular property is a hint system that would work well in VisualPro's tutorial system. As previously described, not all individual's likes step-through guides and may prefer to work in a challenging environment. A solution based on this example tutorial provides a hint to the user.

From the understanding of Dr Thomas G. Cleaver [9] Interactive Web-Based Tutorials for Engineering Education, a feature from the ‘RAISE (Remote Asynchronous Instruction in Science and Engineering) program at the University of Louisville...’ that enables individual's to create interactive tutorial's with ‘rudimentary knowledge of HTML’. Based

on this concept, separate interactive tutorial's could enhance the learning process for beginners using VisualPro, or better yet, the adaptation of interactive tutorial's could work within the VisualPro's environment. A plan to create an interactive tutorial is to design tutorial files that create an end product that will load a series of highlights over draggable items and text areas with a box that flags the user with the entry data. With relevant tips and examples during each interactive tutorial pack should excel the learning process.

#### **2.4.3. Tutorial Documentation**

### **2.5. Tools for the User Interface**

Whilst observing the book, ‘Using UML: software engineering with objects and components, by Pooley R. J. and Perdita Stevens[10], it is important to think about why UML may make a good UI method. UML intends to meet the criteria of allowing Software Engineers to design a software platform and demonstrate it to their clients. At the same time, it gives a comprehensive plan instead of focusing on Pesudeo code, supported by the quotes, Pooley R. J. [10] ’...help to resolve misunderstandings’ and ‘...developer’s effort can be spent on work that requires their skills, not on routine work such as making a diagram using a drawing tool;’.

Another method of creating the UI is a Node Tree that displays the objects in containers and links them together with arrows to display the object’s relationship. A Visual Database Editor diagram in figure 2.1 illustrated by K. Küspert [2]. The node tree, in this case, is to construct a database structure design. Although, this could prove an easy-to-read method for Visual Scripting. Perhaps a mix of UML and Node Tree’s could benefit from displaying relationships, for example:- *Parents* → *Children*. In theory, VisualPro could potentially change Visual Scripting as it is today and demonstrate the power of the C++ Dynamic-Link Library (DLL), Programming Planner library can do.

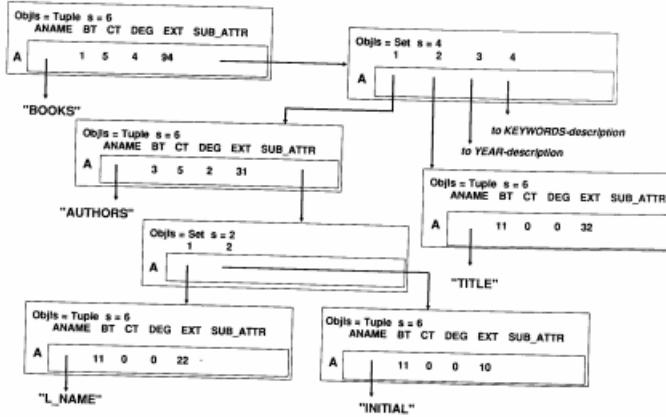


Fig. 3: Node Tree for Scheme BOOKS

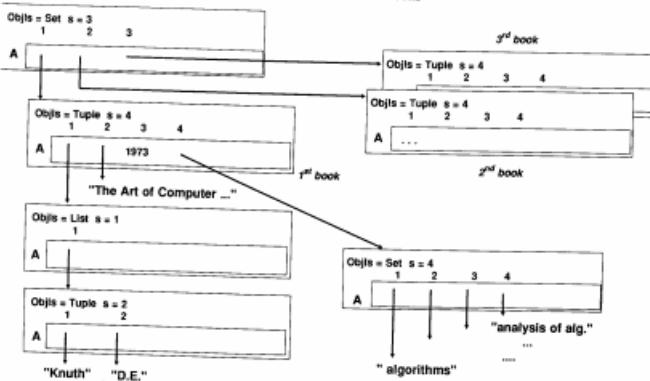


Fig. 4: Node Tree for a BOOKS Table

Fig. 2.1. Visual Database Editor Diagram [2]

## 2.6. Libraries for Functionality

From GitHub Repositories, a list of Visual Scripting libraries are listed:-

- Language: GDScript - Author: [Swarnimaran](#) - Repository: [Visual Scripting Node Library](#).
- Language: Python - Author: [leon-thomm](#) - Repository: [Ryven](#).
- Language: C# - Unity Game Engine - Author: [ConstellationLanguage](#) - Repository: [Constellation](#).
- Language: Web Scripting - Author: [ericabouaf](#) - Repository: [webhookit](#).
- Language: Web Scripting - Author: [WebCabin](#) - Repository: [wcPlay](#).

These Visual Scripting software listed are identical to standard Game Engine Visual Scripting logic. Even though some are easy to use in the demos, a commonality is that they only allow users to control a live environment, whether it is a built-in game engine or an addition to an existing Game Engine, and they are mainly game orientated. VisualPro

aims to support different platforms, such as Web, Mobile, Software, Data Analytics and Games. This aim is possible due to the diversity of users, adding new languages by entering the desired language within the XML document; though, it requires documentation to support users in adding new languages for the program to work correctly.

A table of a few Web Builders and Visual Scripters demonstrates the difficulty of different platforms. Visual Scripting Software 2.1:-

Name	Description	Difficulty: Hard (0-10) Easy	Explanation?
Unreal Engine 5 [7]	Game Engine (C++ Language)	Beginner: 3-0   Experience: 5-10	A beginner who does not understand the principles of code may struggle over time.
Unity Engine [11]	Game Engine (C# Language)	Beginner: 2 - 6   Experience: 8-10	With the documentation available and the simplicity of the Unity Visual Scripting design, it seems beginner-friendly.
Minecraft [12]	Game (Redstone) Represents binary coding.	Beginner: 7-10   Experience: 10	Even though Minecraft does not create programming languages, it shows that many ages who enjoy logging onto Minecraft to make Redstone functionality, passively learn about Binary code.

TABLE 2.1. COMPARISON OF VISUAL SCRIPTERS

After studying different Visual Scripting software, there is no portable Visual Scripting made for versatility. Both seem to only aim at Game Engines. Minecraft does not offer the ability for Visual Scripting. However, to bring attention to the Redstone feature in Minecraft, the feature is interesting for the audience, even to none-programmers. Could the VisualPro library be made into a Visual Scripting game, or specific in-game blueprints/prefabs be placed into the environment, generating code, so that the user can create programs whilst maintaining interest? Redstone accomplishes Binary teaching with Redstone passively by using on and off instead of 1s and 0s.

Visual Scripting, Unreal Engine has a ‘messy’ look, especially when the game logic is more clunky and complex, whereas Unity seems to have a better order. The problem with Visual Scripting in both engines is that the performance of the code is slow compared to writing the code manually. Would this uplift the software market sections if the VisualPro Scripting Pad software could generate code in the desired language with the most effective running time?

In one form, Web Builder’s give an idea of what makes Visual Scripting easier. This concept is down to the research, design, and implementation of existing developers who had to look into individuals with no coding experience. If there is a correlation between designing a more straightforward Visual Scripting interface using methods that Web Builders introduced, it could update Visual Scripting and bring it into future software design. Perhaps, it could be a tool to visualise JavaScript so that users can build a website and add functionality, or create code snippets, for example, MelPy to animate 3D models within Autodesk Maya and other products, making Artists thrive more rather than

Name	Description	Difficulty: Hard (0-10) Easy	Explanation?
WordPress	Web Builder	Beginner: 8-10   Experience: 9-10	WordPress offers many themes and plugins to the user base.
Wix	Web Builder	Beginner: 9-10   Experience: 10	Wix is designed to help businesses to design webpages with no skill required.
Bootstrap Studio	Web Builder	Beginner: 5-7   Experience: 7-10	Bootstrap Studio is a similar interface to Adobe Dreamweaver. It offers templates and allowed websites to be designed. This interface is difficult with no experience with Bootstrap.

TABLE 2.2. COMPARISON OF WEB BUILDERS

relying on a Software Engineer to make their vision.

## 2.7. Testing Functionality

Testing functionality, whether performance, bugs or critical issues, is essential, especially before conducting any User Usability tests for many different reasons. The following scenario should create an understanding of why this stage is critical.

“Unit tests not only catch implementation bugs, but also have a positive effect on the design of the code under test (CUT) as they enforce testability [3]. Code developed without unit tests in place often has a much lower testability, which in turn increases the cost of retrofitting unit tests later on.” - Clause Klammer [13].

Trying to shape User Usability testing around Software with no unit testing creates a complex testability environment down the line. Clause Klammer’s [13] states, ‘Code developed without unit tests in place often has a much lower testability...’ that suggests further testing like Performance testing and User Usability tests could prove costly if poorly written code is in play. Furthermore, the Journal Article [13] argues that code is hard to maintain and proves more challenging to evolve, backed up by ‘As our experience taught us, the consequence is a heritage of legacy code that is hard to maintain and evolve.’ Clause Klammer [13] raises the fact that after the implementation stage of the code, Unit Testing is rarely added and left alone, backed by ‘However, over years of working with legacy code, we found that unit tests are rarely added afterwards. Code that has not been developed in conjunction with unit tests right at the beginning typically remains without unit tests ever after which conforms to Don Well’s statement: “*If you do not start adding UnitTests today then one year from now you will still not have a good unit test suite.*” [2].

Unit Testing is an excellent way of providing functionality testing, as a developer can create code directly from design plans before any implementation is committed or create and implement code around the test. From the Journal Article, Zenon Chaczko [14] suggests that unit testing indicates any flaws in the code and looks for any lousy programming practices. It is usually the case to pass a test before implementing the final product. Two unit tests are vital as the application uses both C# .NET Framework 4.7.2 frontend and C++ backend. This process aids the software to meet a standard and provides the right results for both the developer and tester.

### **3. RESEARCH METHODOLOGY**

This chapter describes the different methodologies available, methods of analysing the results and constructs an experiment that would provide insight on how User Usability should commence. After extensive research, four techniques closely reflect on VisualPro's testing. Quantitative Research, Qualitative Research, Descriptive Research, and Fundamental Research help justify the techniques VisualPro intends to help novice programmers.

**Quantitative Research** enables calculations to provide answers to complex questions. This research method can measure productivity and User Usability to ensure the software is beginner-friendly. It is crucial to reflect on the calculations mentioned in the Literature Review to evaluate the data throughout the design period. **Qualitative Research** focuses on satisfaction experience, behaviours and intellect. A requirement of a complete analysis to check credibility. A survey inviting a mixed background of participants would support the research. **Descriptive Research** uses statistical data to analyse any design flaws within a project using official data. For accurate data that is relevant, the most up-to-date information dependent upon the scenario is suitable. **Fundamental Research** allows multiple research methods to correlate the information in a design plan. To justify the best research methodologies suitable for VisualPro's, Quantitative, Qualitative and Descriptive Research will support the design and development research of VisualPro. These methodologies help limit design flaws using up-to-date statistics, calculations to understand complications of comparing data to the gathered statistics, and any current design flaws within prototypes and VisualPro end implementation.

The data collection requires a survey, screen recording and microphone data of applicants. This extra data will coincide with the Preference side of the test to understand if the software enables beginners to learn quickly with excellent user experience and usability.

## 4. PROTOTYPE

To access the prototype that demonstrates communication from a .NET Framework 4.7.2 to a C++ backend library, go to [Prototypes/GUI Prototype .NET-C++ \[15\]](#). Even though this prototype is not related to the current project, it demonstrates how the frontend can interact with the backend and provides insight into how this is possible. The purpose of the application is not to measure the application's performance merely to provide insight and experience on how the application communicates to the backend.

The source code, found in [Prototypes/GUI Prototype .NET-C++ \[15\]](#), demonstrates the functionality to load the DLLs within the application. Implementation of two techniques follows:-

- *DllImportAttribute* (Enables the ability to import Native DLLs into the application).
- *\_declspec(dllexport)* (C communication files use this to create entry points.)

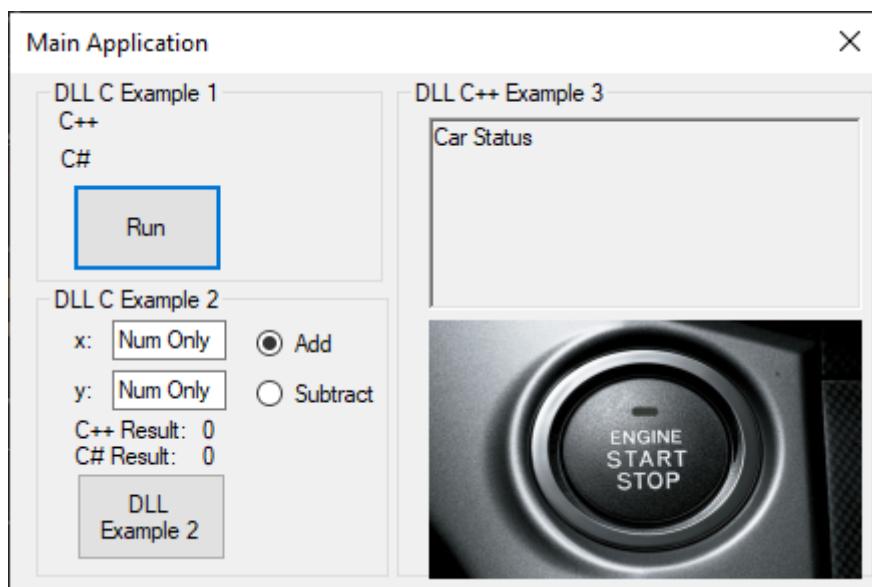


Fig. 4.1. GUI Prototype Communication C# to C++

## 5. DESIGN AND FEEDBACK

The Design and Feedback section covers the Research Methodology and the Pre-Planning, which shows the steps and the level of thought that went into deciding VisualPro's purpose and the existing software and prototypes. Some Notebook Planning may not make sense as some foreseeable problems were thought and planned ahead of time.

### 5.1. Pre-Planning

#### 5.1.1. HTML Design

Figure 5.1 shows a HyperText Markup Language (HTML) Design of how the UI should look. The Empty Column is where the user drops elements like Classes, Functions or Variables. Buttons on the right can be dragged and dropped on the Empty Column to the left. The functionality of the drop should create a new container, giving the user acknowledgement there's a new parent or sub-element with room for configuration and another drag and drop container within the class or function.

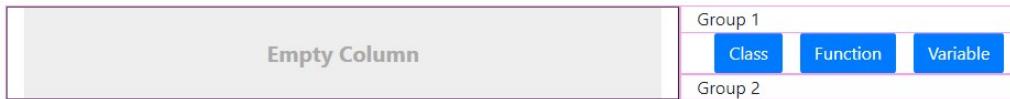


Fig. 5.1. HTML Design - Found at: [Original Image](#)

#### 5.1.2. Notebook Page 1-2

Figure 5.2 contains numerous ideas. Page 1 contains a heading, 'Personal Assistant', which indicates the thought process of a personal assistant before the Visual Programming Scripting program progressed. After planning this, it became apparent to use a type of Artificial Intelligence (AI), which knew the basic syntax of different languages and would write or advise the user when typing. This process is very similar to TabNine [16].

The second page of this figure, shows a few different examples of IF statement syntax from languages to find a 'dynamic' common rather than keep it static like the previous software. The sketch below shows a name for the software and a example of how the language selection would look on UI.

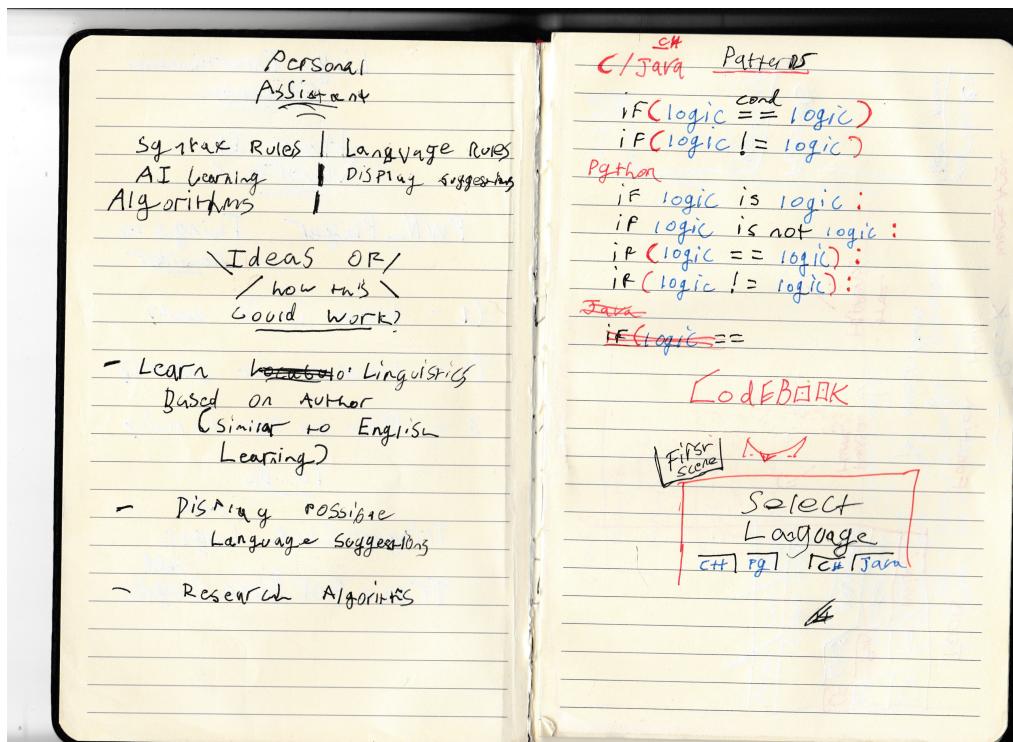


Fig. 5.2. Notebook Plan Page 1-2 - Found at: [Original Image](#)

### 5.1.3. Notebook Page 2-3

Figure 5.3 displays two pages of how the Visual Scripting could look. The top page shows the tools on the left, such as Logical, Structure and Scoping tools. On the right, it should show a list of current variables, functions and classes in a hierarchy style. The middle of the application is the work area.

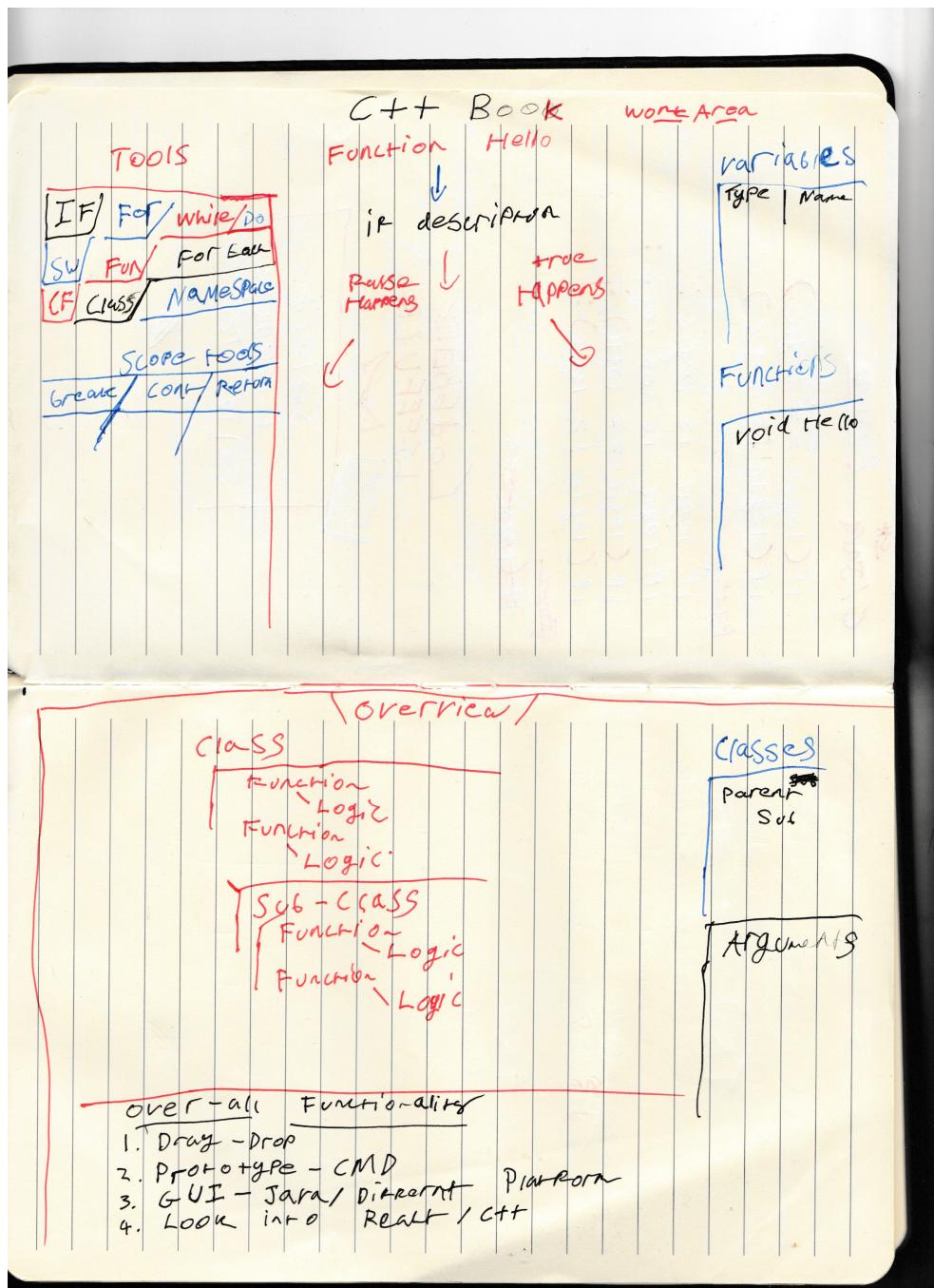


Fig. 5.3. Notebook Plan Page 3-4 - Found at: [Original Image](#)

#### 5.1.4. Notebook Page 5-6

Figure 5.4 gives the planning of how the syntax for most programming and scripting languages. The plan points out patterns and tries to identify their names for the Extensible Markup Language (XML) and backend to comprehend. This piece of planning helped excel the development of the program's dynamic side to allow the addition of new languages to the software.

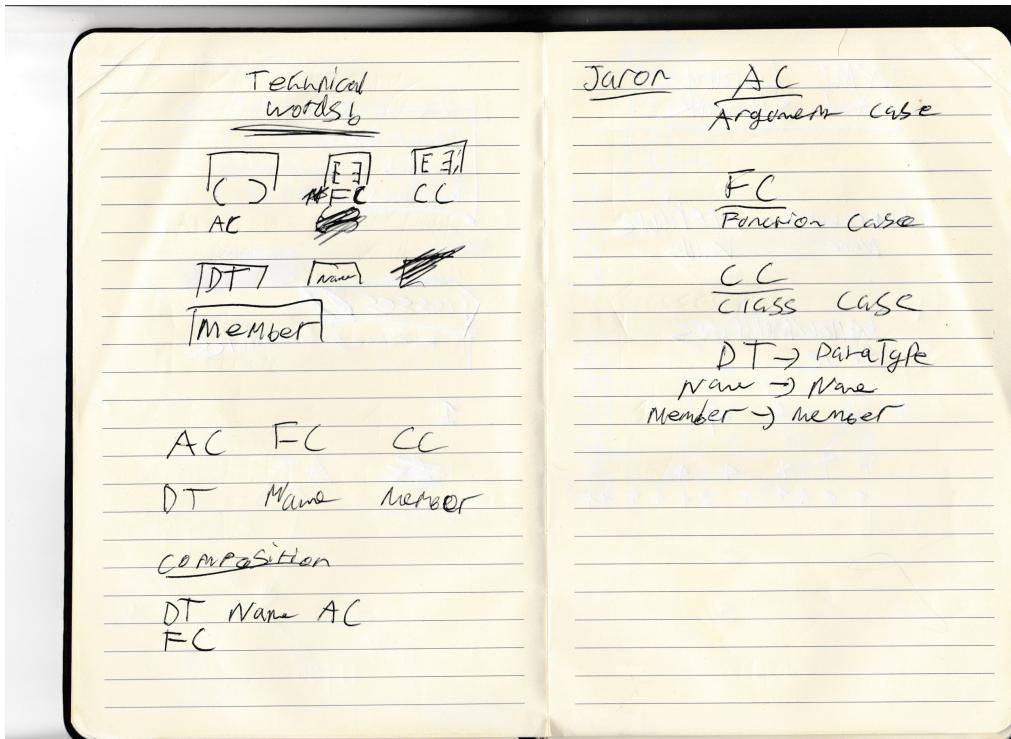


Fig. 5.4. Notebook Plan Page 5-6 - Found at: [Original Image](#)

### 5.1.5. Notebook Page 7-8

Figure 5.5 demonstrates how the XML would possibly look. The table shows N (Node), A (Attribute) and the Meaning. To explain what is going on, Node |0| is the header node (holds library data such as **system** or **iostream**), holds three attributes. Attribute |0| holds ‘Type’, which is the purpose, Attribute |1| holds the ‘Name’, which is the library’s name. Attribute |2| holds the ‘Syntax Value’, which in C# it is *using* ; and in C++, the value is **#include <>**.

According to the second node |1| holds information for structure or classes in languages. This node contains three attributes. Attribute |0| holds ‘Name of Struct (*or*) Class’, which contains the user-defined name they have created inside VisualPro. Attribute |2| holds the ‘Properties’ like the member of the struct/class. Attribute |3| holds the syntax value, the open and close case of a struct/class and layout within the struct/class.

The image shows two pages of handwritten notes. The left page contains a table titled 'C ONLY' with columns 'N' and 'A'. The right page contains a table with columns 'Name' and 'Type'.

**Left Page (C ONLY Table):**

N	A	Meaning
0	0	Holds Header tag
0	1	Type (Purpose)
1	0	Name or Lit
2	2	Syntax value
0	1	Holds struct tag
0	0	Type (Purpose)
1	1	Name of Elt
2	2	optional properties
3	3	Syntax value

**Right Page (Table with Name and Type columns):**

Name	Type
Headers	list
Type	list
Name	list
Value	list
Structs	list
Type	list
Name	list
optional	list
value	list

Fig. 5.5. Notebook Plan Page 7-8 - Found at: [Original Image](#)

### 5.1.6. Notebook Page 9-10

Figure 5.6 answers how the loops and logical statements work in the LanguageCompiler library. This planning shows how the XML nodes and the Planner List should work together. In theory, the Planner List, of what the user populates with the program's use, combines with the XML document with the chosen language.

Patterns	
Syntax I	J
Header 0	0 1
Class 1	0 1
Function 2	0 1 3 4
CONS	
Syntax I ≠ Planner A	
IF <sup>0</sup> construction	
IR <sup>1</sup> C2	
IF <sup>2</sup> A2	
IF <sup>3</sup> Args	
STRUCTURE	
IF <sup>0</sup> Then Replace	
dt → B0	
None → B1	
IF <sup>1</sup> Then Add END	
IF <sup>2</sup> Then Add ( )	
IF <sup>3</sup> Then Add dt <small>optional</small>	

Fig. 5.6. Notebook Plan Page 9-10 - Found at: [Original Image](#)

### 5.1.7. Notebook Page 11

Figure 5.7 displays how the function node should work. This miniature theory is to help the developer understand how the XML document should work in a programmatical sense. This again helped when it comes to the prototypes further in this document.

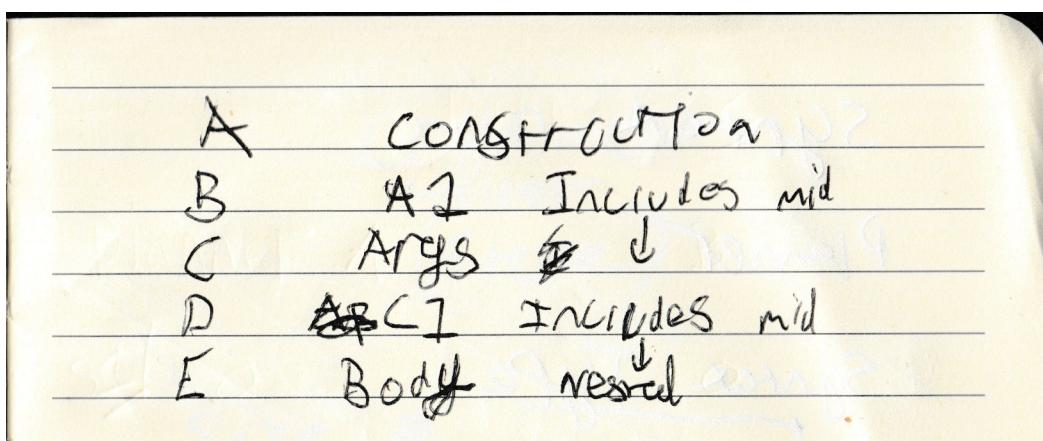


Fig. 5.7. Notebook Plan Page 11 - Found at: [Original Image](#)

### 5.1.8. Notebook Page 12-13

Figure 5.8 shows a predicted problem is as follows:

#### Description:

How will the program know where to put a sub-child and how will it?

#### Answer:

The planner would hold its parent and sub identity, and the Triangle (30 Code) symbol tells the software where to put the child. The Triangle symbol will only appear of classes or functions that have children. This means that the program will focus on parents, close the tags, then rescan to put the children in the code. The problem before is that it would be hard to tell the program to remember when and where to close tags if it got too deep in theory.

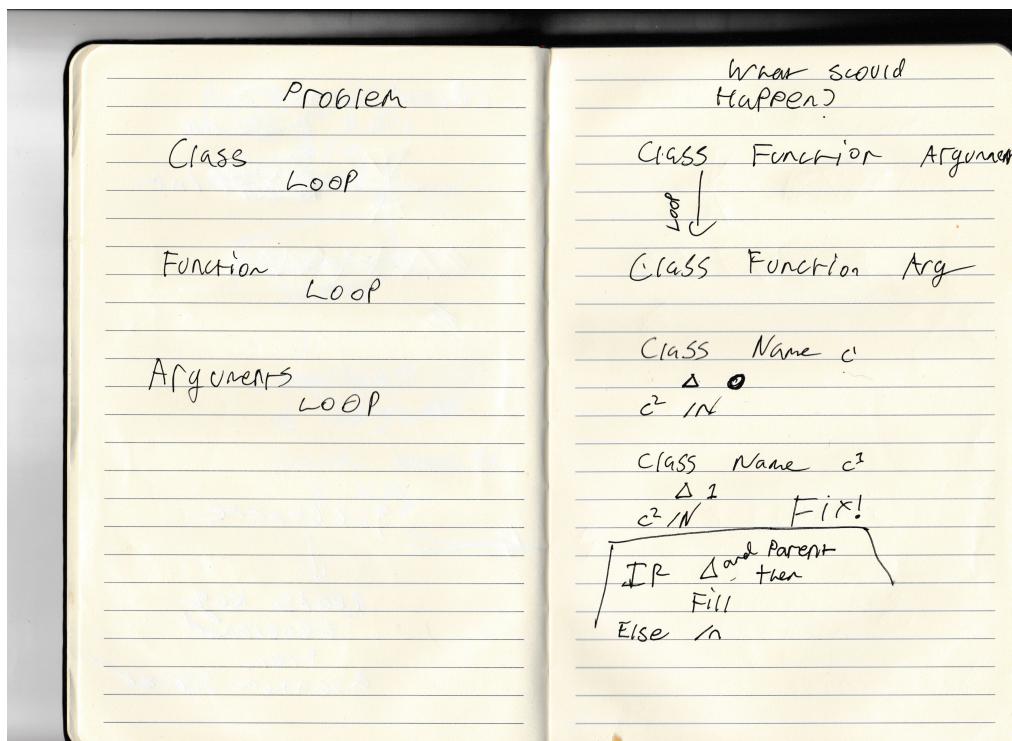


Fig. 5.8. Notebook Plan Page 12-13 - Found at: [Original Image](#)

## 5.2. Results of Feedback

### 5.2.1. Survey Question 1

According to the chart 5.9, 87.5% chose ‘Programming Planner Improved’, and 12.5% chose ‘None of the Above’ to the question, ‘As a developer, which program worked for you?’. This data suggests that most of the responses preferred ‘Programming Planner Improved’ out of eight.

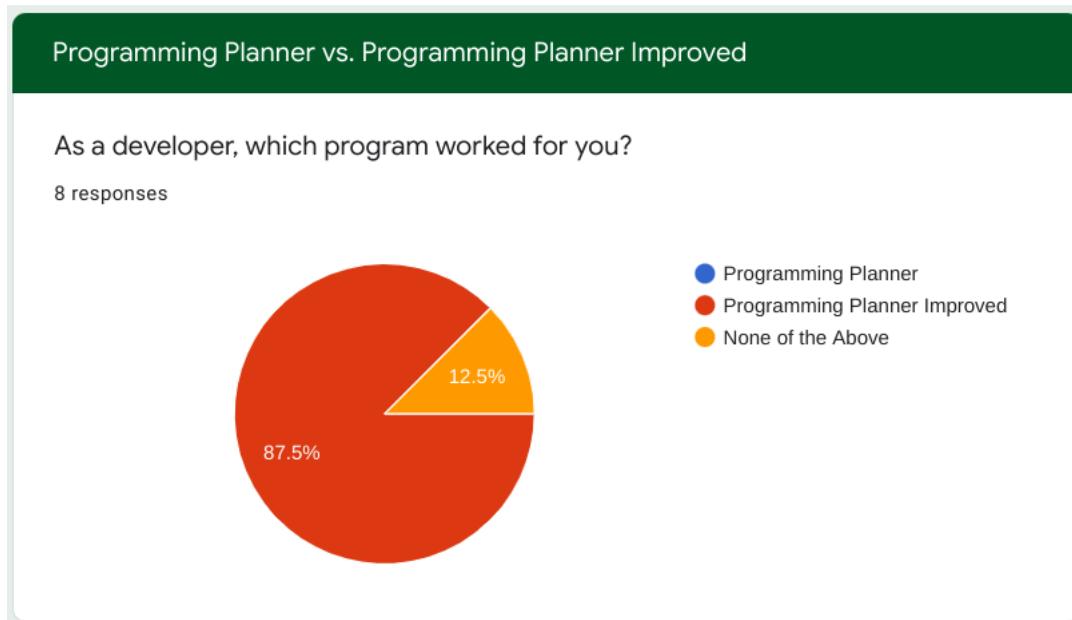


Fig. 5.9. Survey Question 1 - Found at: [Original Image](#)

### 5.2.2. Survey Question 2

Figure 5.10 asks the question, ‘If the last option on the previous question is ticked, then explain why?’ . Four responses replied with:-

- ‘More flexibility’ -

This response could mean two things: the Programming Planner Improved is more flexible than the first program or that both programs would benefit from more flexibility.

- ‘Both work’ -

This response indicates that both software works.

- ‘The option to choose the desired programming language at the end of the programming’ - A surveyee liked the option in Programming Planner Improved to select different programming languages.

- ‘Because it had more options and had example code at the end of planning’ - This answer describes that the Programming Planner Improved offered more options, such as argument selection and code language.

If the last option on the previous question is ticked, then explain why:

4 responses

More flexibility

Both work

The option to choose the desired programming language at the end is a useful addition.

Because it had more options and had example code at the end of planning

Fig. 5.10. Survey Question 2 - Found at: [Original Image](#)

### 5.2.3. Survey Question 3

Figure 5.11 asks the question to Surveyee’s, ‘Did the tutorial at the beginning of Programming Planner Improved help navigate around the application?’. This question tries to find out if the application is hard to use overall. The responses were 87.5% for yes, and 12.5% for no. Even though the most of the responses chose yes, the application may still be hard to use if, theoretically, one out of eight users found the User Experience frustrating or confusing.

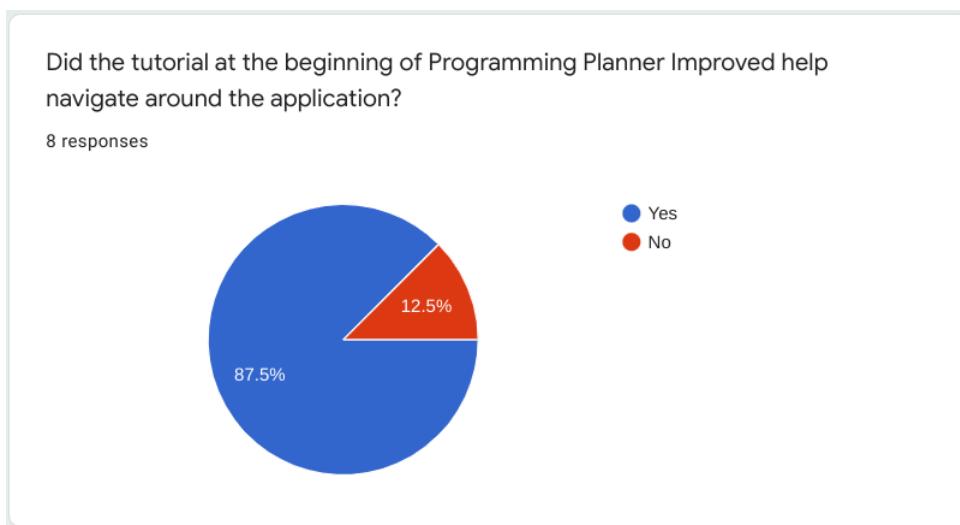


Fig. 5.11. Survey Question 3 - Found at: [Original Image](#)

#### 5.2.4. Survey Question 4

Figure 5.12, ‘What makes the Programming Planner Improved better than the previous product?’ checkbox question, offered five qualities. These are:-

- **Ease of Use** - Aimed to find out how easy the application is easy to use. 50% of the responses think it was easier to use than the previous product. This feedback could mean to things, the first product was similar and consequently did not improve the application in this quality or that the product needs to improve in this area.
- **Performance** - To see if the audience could notice any performance difference. This quality is vital as a Graphical User Interface (GUI) can somewhat be ‘chunky’. The responses were 0% out of the responses; though this may seem negative, it is sometimes hard to notice the difference between console and desktop applications.
- **Extra Features** - The quality, ‘Extra Features’, displays if the extra features in the new application stood out and improved the previous application. The responses were 62.5%, which indicates that the extra features did stand out and made the application better.
- **File Structure** - The quality, ‘File Structure’ of the second application is revised and stores the saved file in a directory other than the ROOT directory. 25% of the responses chose this option, which means that the File Structure did not impact the application as effectively as the ‘Extra Features’ quality.

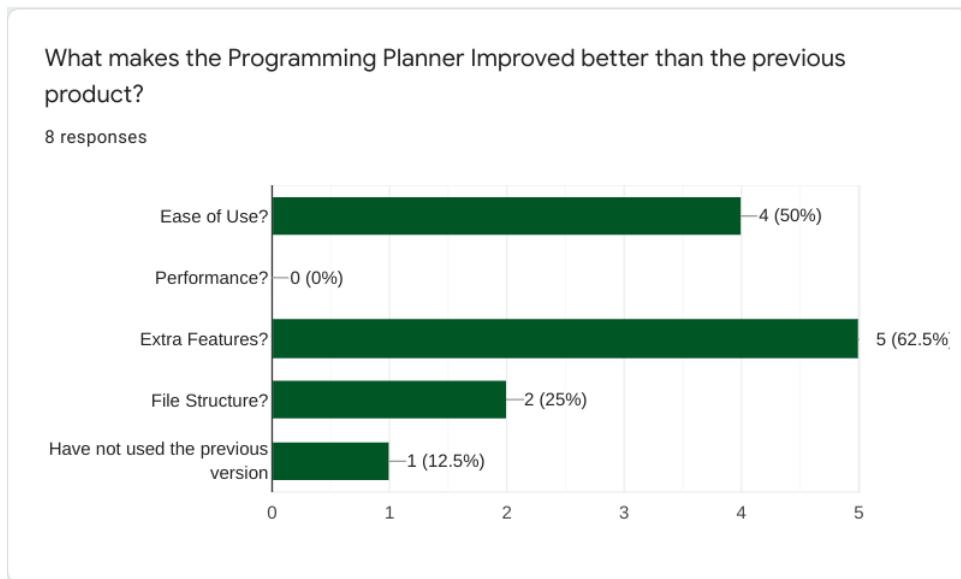


Fig. 5.12. Survey Question 4 - Found at: [Original Image](#)

### **5.2.5. Survey Question 5**

Figure 5.13 asks the Surveyee's, 'Explain your answer' to the last question. This question will tell what the Surveyee's felt when answering the last question. The responses are as follows:

- 'More features allowed for a wider range of approaches' - This specific feedback suggests that it is better to add more functionality in the GUI application to allow for more usability.
- 'More languages and was easier to use. Very impressed' - This response implies that the idea of a dynamic language interface to allow users to add more languages will increase User Experience.
- 'Easier to use, the better' - Visual Scripting already is complicated when looking at the Unreal Engine's Visual Scripting interface. If it is possible to create a lightweight Visual Scripting pad to allow a programmer to create code snippets, it could bring more developers into the field and increase production time already in the field.
- 'Have not used the previous version' - This suggests that the Surveyee only tested Programming Planner Improved.
- 'Allowed me to create a function structure and save it. Seemed difficult to follow (variables weren't numbered)' - According to this response, the user found it difficult to follow through and should be something to think about when making the GUI application.
- 'Easy, helpful and understandable' - This response shows that the user found the software easy to use, helpful and understanding during their experience.
- 'The extra features added to the improved version of the program improve user experience by adding expanded usability' - The response suggests that again the extra functionality helped improve the User Experience, in Programmer Planner Improved.
- 'It just had extra features and seemed more useful' - Which implies that the user found the extra features more comfortable and useful to use.

Explain your answer:

8 responses

More features allowed for a wider range of approaches

More languages and was easier to use. Very impressed.

Easier to use, the better

Have not used the previous version

Allowed me to create a function structure and save it. Seemed difficult to follow (variables weren't numbered)

Easy, helpful and understandable

The extra features added to the improved version of the program improve user experience by adding expanded usability.

It just had extra features and seemed more useful

Fig. 5.13. Survey Question 5 - Found at: [Original Image](#)

### 5.2.6. Survey Question 6

Figure 5.14 asks the Surveyee, ‘How would you rate the User Experience (overall)?’. The question tries to aim for an idea of how the UX of the two products. On a scale of one (Stressful) to ten (Relaxing), 62.5% of the responses went with option eight, 37.5% of the responses went with option seven. These figures show that the UX has room for improvement. When designing and implementing the GUI product, it is important to think about the UI and UX.

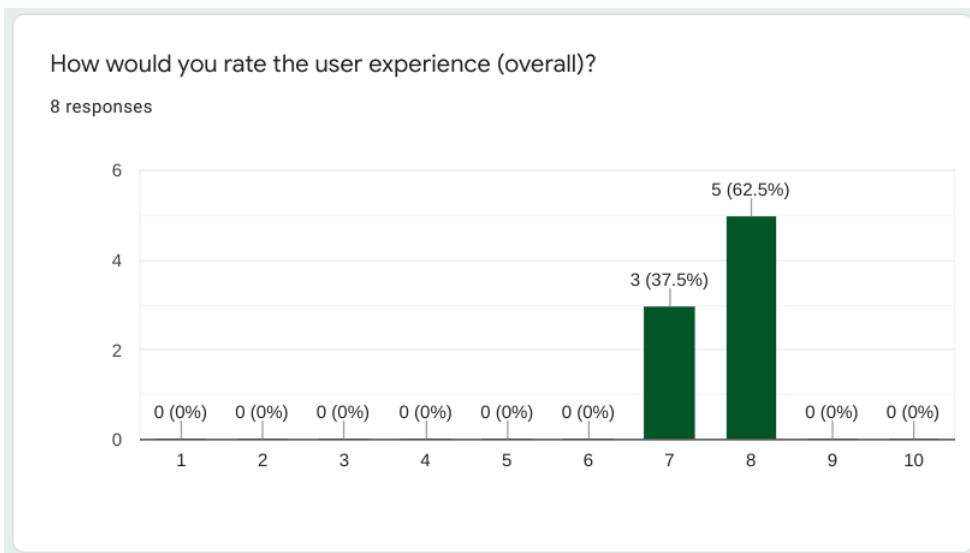


Fig. 5.14. Survey Question 6 - Found at: [Original Image](#)

### 5.2.7. Survey Question 7

Figure 5.15 asks the question, ‘How useful is Programming Planner for beginners?’. This question is done on a scale of one (Complicated) to five (Useful). The feedback is ranged from one to five and suggests that beginners may find this platform hard work. The responses are as follows:

- **One** - 25% responses. These respondents reckon that Programming Planner is complicated for beginners.
- **Three** - 12.5% responses. These respondents thought that Programming Planner is a little complicated for beginners.
- **Five** - 50% responses. These respondents figure that Programming Planner is close to Useful for beginners.
- **Six** - 12.5% responses. These respondents consider that Programming Planner is Useful for beginners.

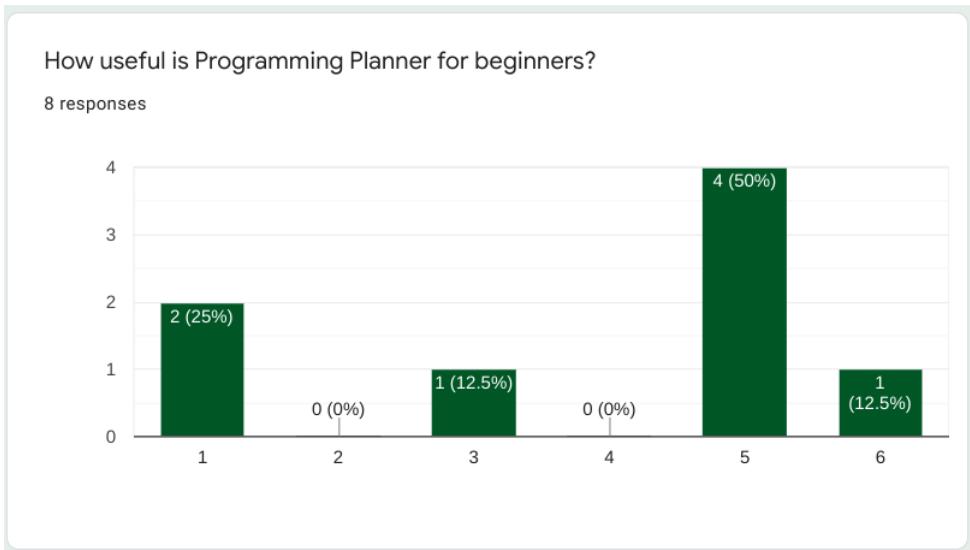


Fig. 5.15. Survey Question 7 - Found at: [Original Image](#)

### 5.2.8. Survey Question 8

Question 5.16 ‘Did this help create a structure of your favourite language faster than standard methods?’. 75% of responses said Yes, 12.5% of responses said ‘Would not recommend to new programmer as they will not learn the basics’ and 12.5% said ‘I have not used other methods’. This chart suggests that the majority found this software to be faster than their standard methods.

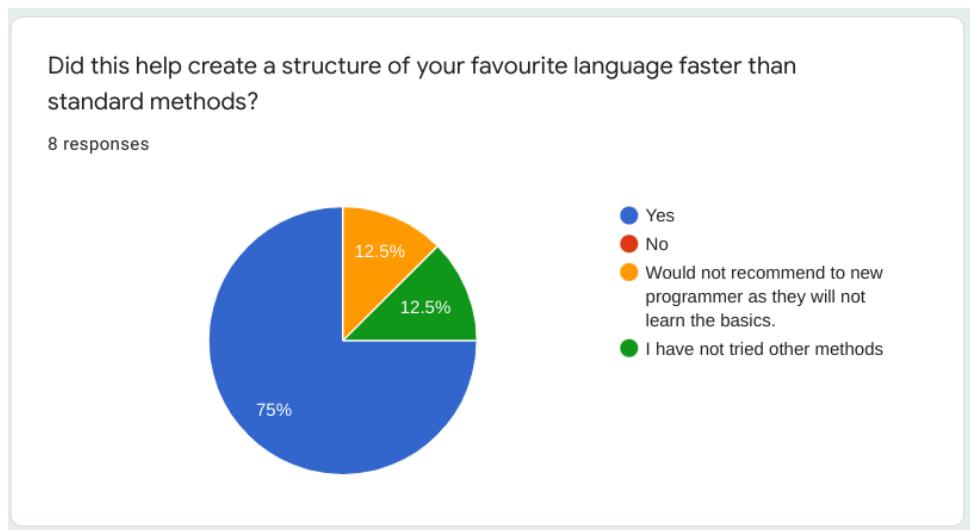


Fig. 5.16. Survey Question 8 - Found at: [Original Image](#)

### 5.2.9. Survey Question 9

Question 5.17 ‘What features would you wish Programming Planner to offer?’ . This question attempts to determine if the user has any requests about the software they have

used. These were the responses:-

- ‘When I wanted only one function on the variable creation it asked if it works with other functions but I didn’t have any other functions’ - This suggestion shows that the user was confused with the way the program asked the user if the variable was a argument or a standard variable.
- ‘The target audience for this program will have little coding experience, and may forget what is required of a function, variable, etc. Adding examples to each page may be a good idea to reduce confusing.’ - This suggestion shows that a help page or tips pop up on creating an element within the GUI program will help beginners use this software.
- ‘A set of pre made open source programs that could be quickly accessed’ - Perhaps, the program could offer a GitHub repository import, which will examine the code and visualise it for the user.
- ‘Would be better with visualisation if writing a longer program’ - The response could mean two things. It could mean that the user wanted to have an ability to overview the code within the console application, or it could mean that the user would have preferred a GUI work area.
- ‘A GUI’ - This response means that the user would have preferred a GUI product rather than a console application.
- ‘Allow sudo code comments to be added to the function’ - In the GUI application, it could have the ability for the user to enter comments.
- ‘Calculator?’ - This response did not seem useful to add in to the future software, as popup calculators are available in most operating systems.

What features would you wish Programming Planner to offer?

7 responses

A set of pre made open source programs that could be quickly accessed

Would be better with visualisation if writing a longer program.

Calculator?

A GUI

Allow sudo code comments to be added to the function

The target audience for this program will have little coding experience, and they may forget what is required of a function, a variable, etc. Adding examples to each page may be a good idea to reduce confusion.

When I wanted only one function on the variable creation it asked if it works with other functions but I didn't have any other functions

Fig. 5.17. Survey Question 9 - Found at: [Original Image](#)

### 5.2.10. Survey Question 10

Figure 5.18 ask ‘Would a Graphical User Interface uplift the User Experience?’ as a multiple-choice question. The 100% chose the yes choice. This feedback implies that they would like a GUI to work with over a console application out of the eight responses.

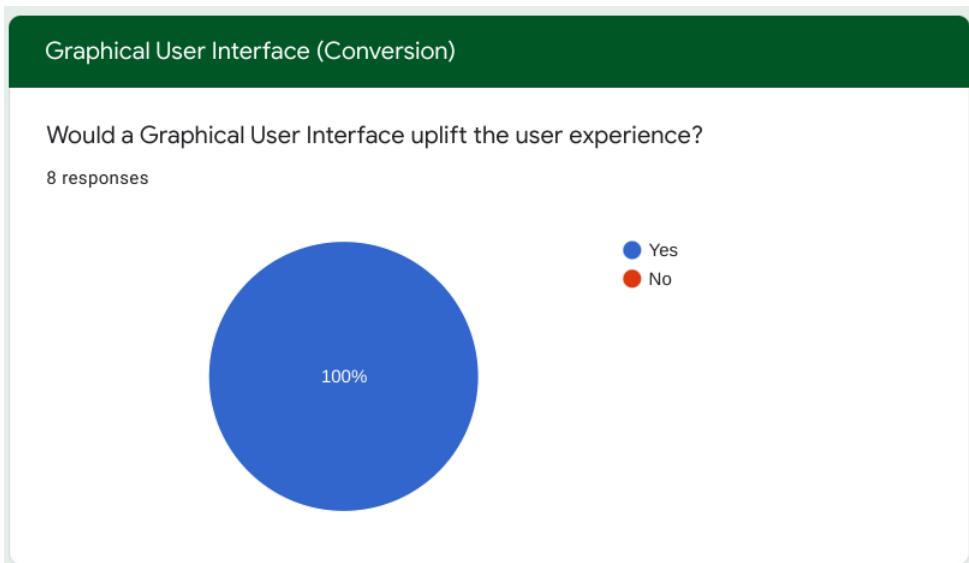


Fig. 5.18. Survey Question 10 - Found at: [Original Image](#)

### 5.2.11. Survey Question 11

A grid question asked ‘According to you, how should the features of the Graphical User Interface have to work?’. The following options are: ‘Clickable’, ‘Drag and Drop’, ‘Drop Down Menu’ and ‘Text Filled’. The details are ‘Structure Elements’, ‘Logic Elements’, ‘Select Languages and Save’ and ‘Sub Elements’. After overlooking the table 5.19 ‘Structure Elements’ looks like it favoured Drag and Drop the most by four responses. The Drag and Drop were also voted for the ‘Logic Elements’ by five responses. The ‘Select Languages and Save’ preferred the Drop Down Menu by six responses, and lastly, the ‘Sub Elements’ liked the idea if it was Text Filled.

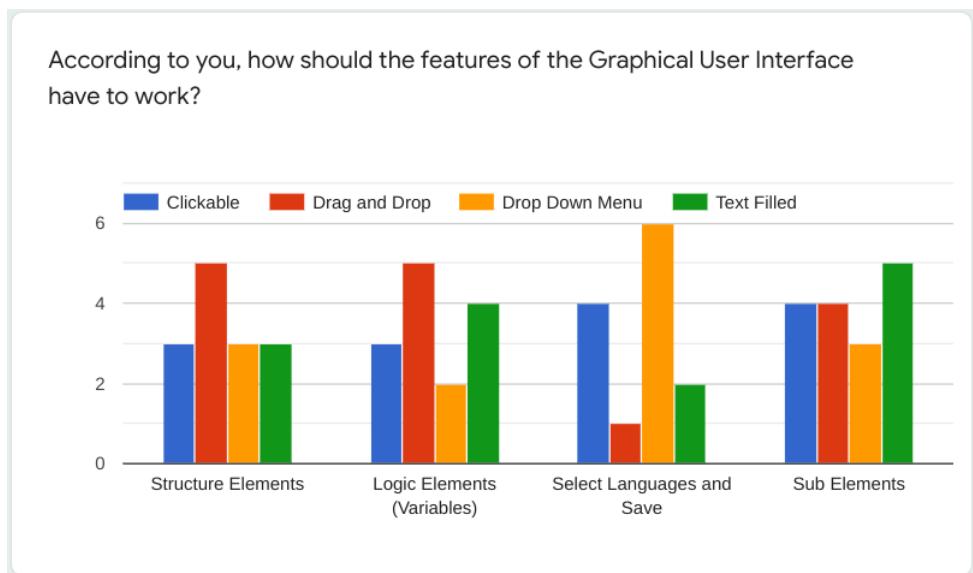


Fig. 5.19. Survey Question 11 - Found at: [Original Image](#)

### 5.2.12. Survey Question 12

This grid asks the participants, ‘How would you prefer to access the software?’. The options are ‘Windows Operating System’, ‘Linux Operating System’, ‘ChromeOS/Android’ and ‘iOS’. The details are ‘Computer, Laptop or Tablet Devices’, ‘Web Application’, ‘Mobile Devices’. For the first column, the responses favour the Windows Operating System by eight. The second column, Windows Operating System, is also preferred by eight. The last column, ChromeOS, is the six responses favourites, and iOS is preferred by four. After reviewing this, the application aims for the Windows Operating System to get the most attention. Programming Planner and Programming Planner Improved works for both Windows and Linux Operating Systems.

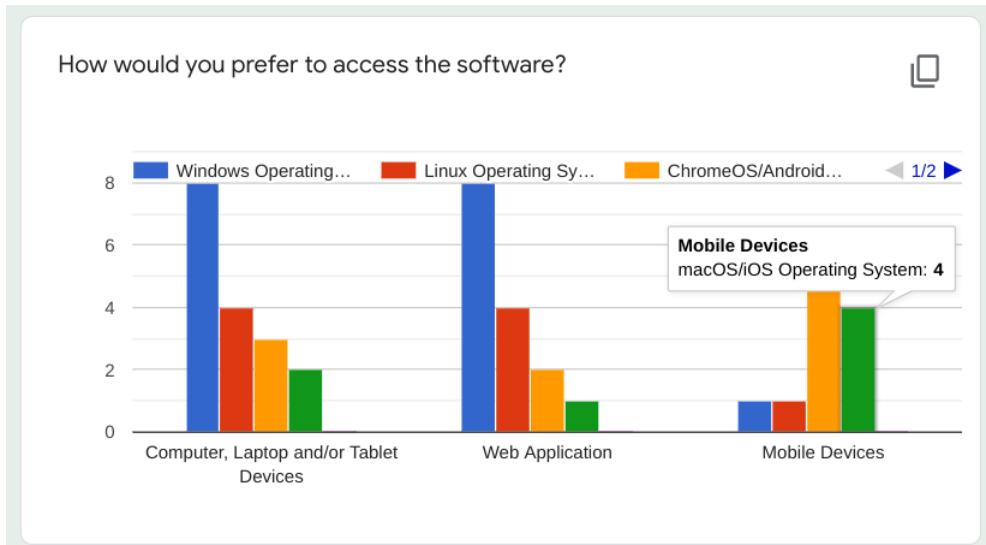


Fig. 5.20. Survey Question 12 - Found at: [Original Image](#)

### 5.2.13. Survey Question 13

Figure 5.21 a question, ‘Any comment?’ follows the last questions. The only response was ‘No’.

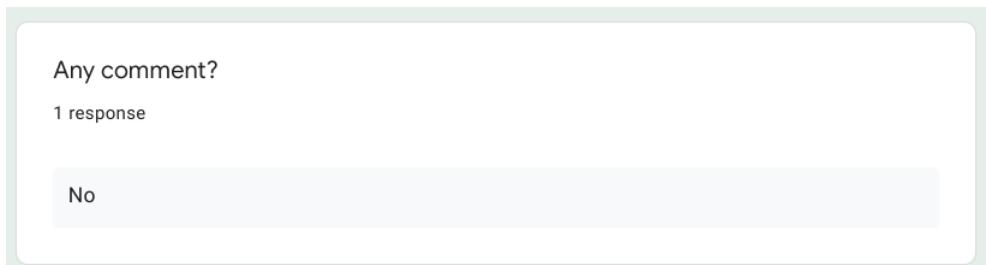


Fig. 5.21. Survey Question 13 - Found at: [Original Image](#)

### 5.2.14. Survey Question 14-15

Figures 5.22 and 5.23 shows two questions, ‘How complicated is Visual Scripting? (Reference to Unreal Engine for an example).’ Furthermore, ‘How complicated is Website Builders?’ these questions portray how existing Visual Scripting Web Builders are successful, and if it is possible to do a service that is easier to use, similar to a web builder. The question is on a scale of one (Piece of Cake) to five (Complicated). The feedback from the first question:-

- Three - 37.5% of the responses. This indicates that this percentage of the participants find Visual Scripting moderately easy.
- Four - 50% of the responses. This displays that 50% of the participants find Visual Scripting a bit more complicated than the 37.5%.

- Five - 12.5% of the responses find Visual Scripting tough.

The feedback from the second question:-

- One - 25% of the responses find Web Builders a ‘Piece of Cake’.
- Two - 50% of the responses find Web Builders more or less easy.
- Three - 25% of the responses find Web Builders moderately easy.

These findings will change the research perspective to look more into the Web Builder layouts, functionality and UX to work out the GUI of the product.

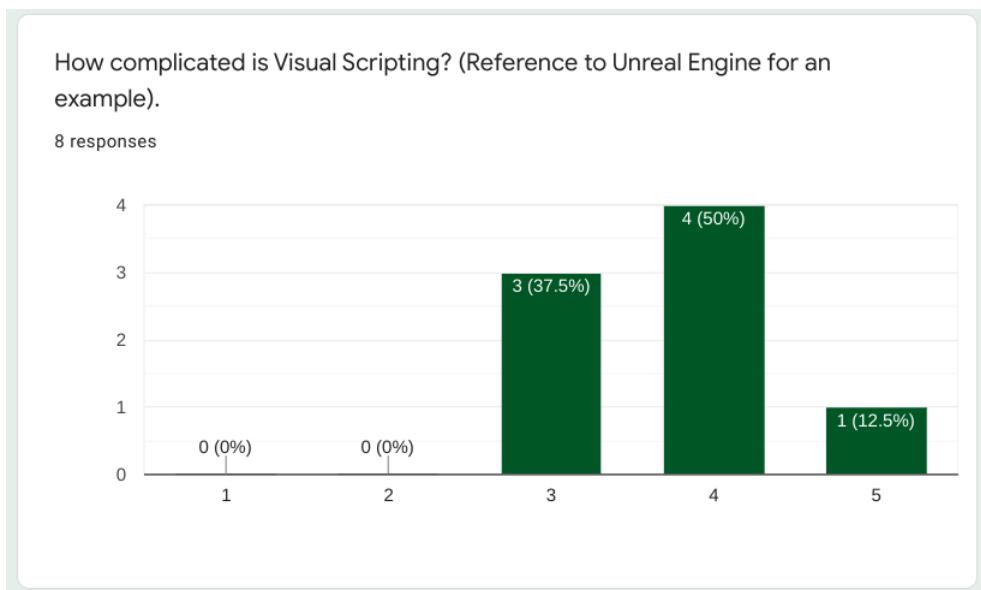


Fig. 5.22. Survey Question 14 - Found at: [Original Image](#)

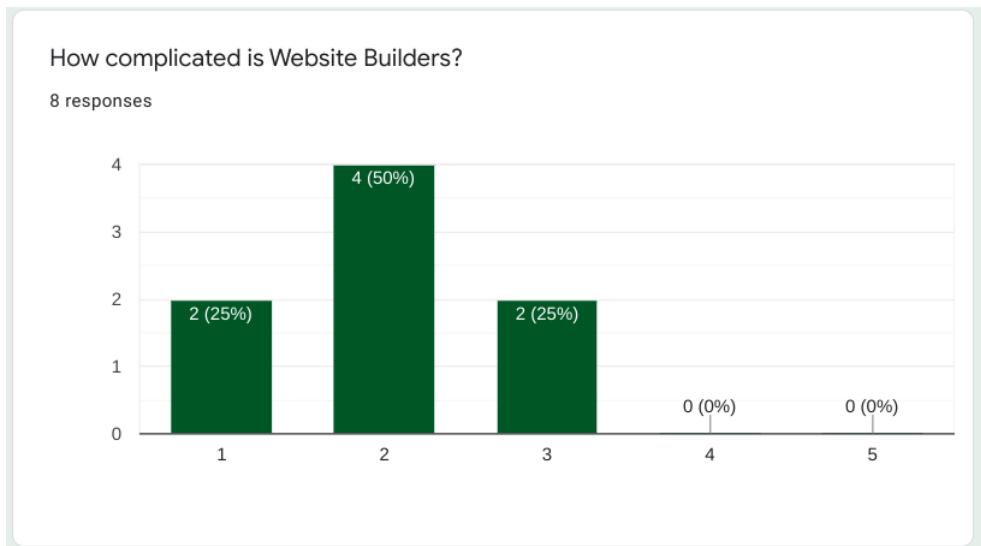


Fig. 5.23. Survey Question 15 - Found at: [Original Image](#)

### 5.2.15. Survey Question 16

Question 5.24, ‘If Programming Planner had an easy-to-use drag and drop feature without input and output relationships, then will this improve Visual Scripting overall?’, the question paints a picture from the participants to see if the relationships in Visual Scripting that is similar to Entity-Relationship Diagrams if they cause a problem. All eight responses replied back with yes.

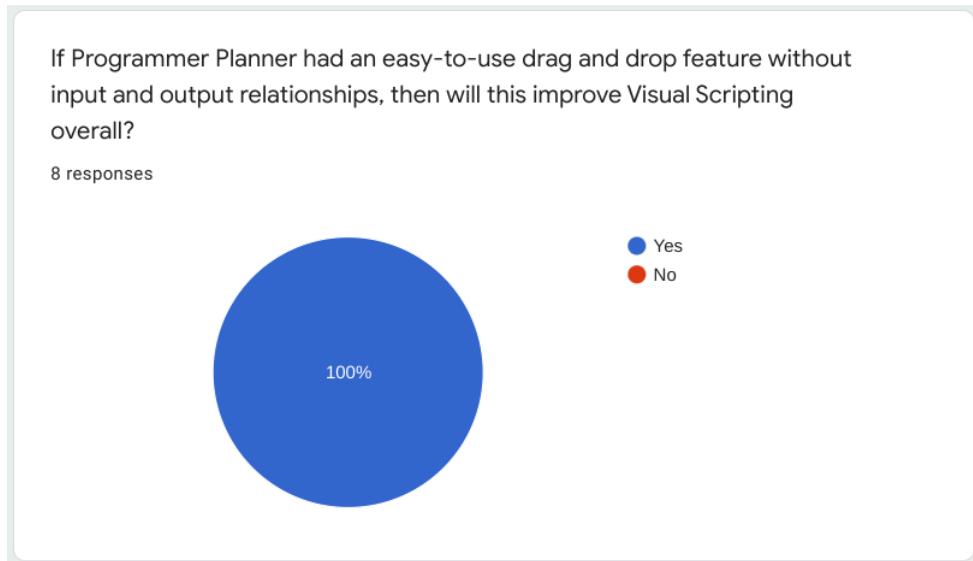


Fig. 5.24. Survey Question 16 - Found at: [Original Image](#)

### 5.2.16. Survey Question 17

Similar to the previous question to paint an image from what the participants want to see, ‘Would Visual Scripting be better if it allowed users to add any language they wish and generate any language with one click of a button?’. According to the figure 5.25, all of the eight responses responded with yes.

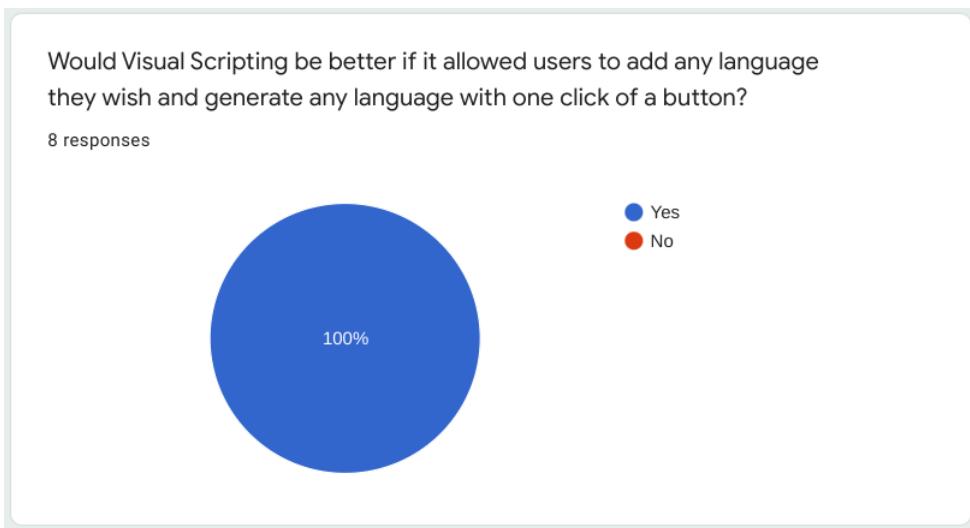


Fig. 5.25. Survey Question 17 - Found at: [Original Image](#)

### 5.2.17. Survey Question 18

To squeeze more information from the participants, a question, ‘What was the reason for your selection?’ was asked and made compulsory. The responses are as follows:-

- ‘Would be easier to write programs (for some people)’
- ‘A feature such as this would greatly reduce the production times involved in program development.’
- ‘save time and allow users to focus on the details’
- ‘I would like to code in any language I choose if that option was applicable.’
- ‘Useful feature’
- ‘Makes it more visual’
- ‘Again, the easier to use, and the more features, the better’
- ‘More accessibility’

After reading the feedback, a few points are to address. The current software already makes it easier to write code for some people, so it is imperative that the new software does not distract but improve the capability of writing software. The command-line may benefit users as it keeps developers in a similar environment they are probably already using. Another point to address is this question, ‘Will the GUI software get too heavy with too many features making it no longer lightweight?’. The best thing about having Dynamic-Link Libraries is that developers can incorporate into Java Android, iOS, Web Applications and, but not limited to, Visual Studio Code Extensions. The backend can

open a ‘can of worms’ to allow different interfaces to the top of the backend, like digital notebooks or other ideas. Anyone who develops on top of the backend can make any interfaces or even new scripting languages. This idea, in turn, will enable others to make it easier to use Visual Scripting and Languages to Write. For example, Python or JavaScript has the potential of being converted into C++ and vice-versa.

What was the reason for your selection?

8 responses

- save time and allow users to focus on the details
- I would like to code in any language I choose if that option was applicable.
- Again, the easier to use, and the more features, the better
- Useful feature
- Makes it more visual
- More accessibility
- A feature such as this would greatly reduce the production times involved in program development.
- Would be easier to write programs (for some people)

Fig. 5.26. Survey Question 18 - Found at: [Original Image](#)

### 5.2.18. Survey Question 19

Final question which asked the participant, ‘Would you like to leave any extra feedback?’, which hopefully gets any extra feedback that the survey missed out. Six responses, excluding two including the response ‘No’, are displayed below:-

- ‘Introducing both drag and drop, as well as text filled features will appeal to both beginners and experienced programmers.’ - The reply suggests that both Drag and Drop menus and Text Filled features will appeal to both programmers than just one of the methods used. Another idea this program opens up is creating snippets that can work in Visual Studio Extension, giving the user more flexible tools for development.
- ‘A training manaul along with some begginer tutorials would really help new users get to grips with the software’ - A training manual or documentation would benefit both the console and GUI applications.

- ‘Command-line is hard on eyes when using. Not very good for Visual Scripting in general.’ - The best thing about the console application is that it already has a language compiler, which plays a massive part to give the GUI application a backend. However, this response backs up the reasoning why the frontend matters in this project.
- ‘Nothing besides a nice GUI’ - Many Visual Scripting is done in GUI applications, so it was unusual for a console application to have achieved a similar result.

Would you like to leave any extra feedback?

8 responses

No

A training manual along with some beginner tutorials would really help new users get to grips with the software

Command-line is hard on eyes when using. Not very good for Visual Scripting in general.

Nothing besides a nice GUI

Nope

Introducing both drag and drop, as well as text filled features will appeal to both beginners and experienced programmers.

Fig. 5.27. Survey Question 19 - Found at: [Original Image](#)

### 5.3. Evaluation of Feedback

## **6. DEVELOPMENT METHODOLOGY**

## 7. IMPLEMENTATION

### 7.1. Main Layout

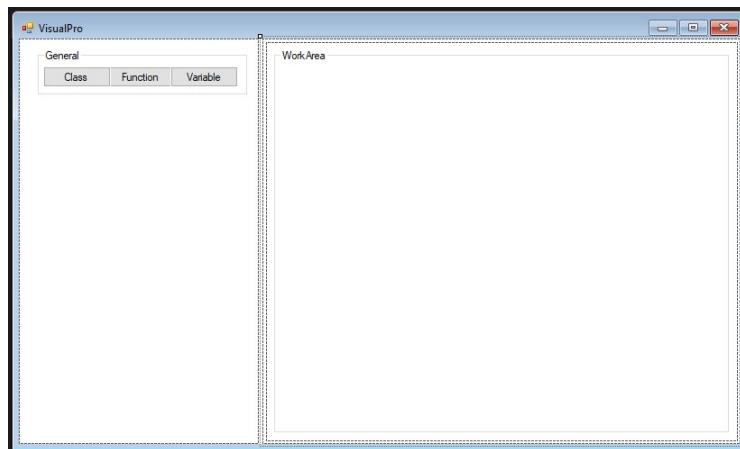


Fig. 7.1. Design Planning - Stage 1

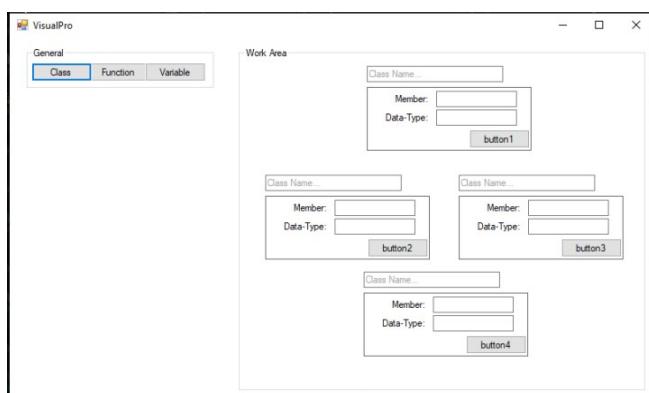


Fig. 7.2. Design Planning - Stage 2

A flaw of Classes', Functions and Variables' can be declared during development under the parent class. This problem meant that the class would be declared inside another class programmatically if the problem occurred under the current logic when the compilation happened. An example could be an '*int variable = int variable;*'. The code syntax makes no sense, resulting in a compilation error.

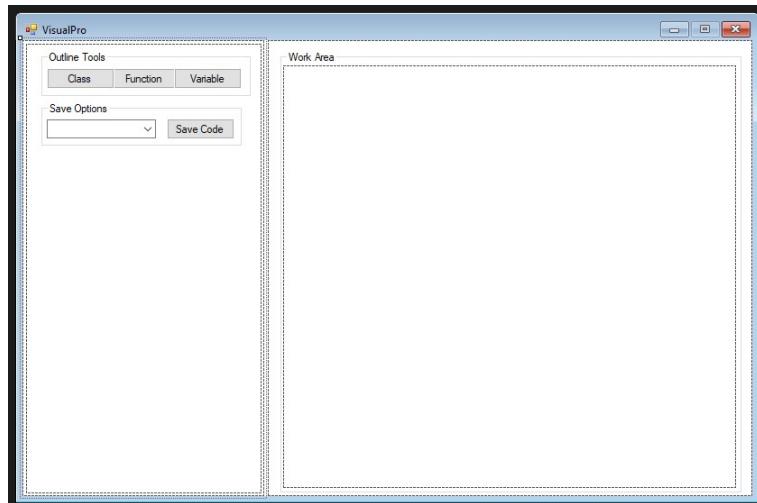


Fig. 7.3. Design Planning - Stage 3

Figure 7.4 shows the implementation of the design using the designs shown beforehand. Rather than shortcircuiting relationships between each class, function and variables by nesting them, the final implementation prevents the user from dragging and dropping the same type of container onto another container. A property button appears on each container to control function arguments and relationships between classes, functions, and variables, opening up a dialogue containing a property sheet.

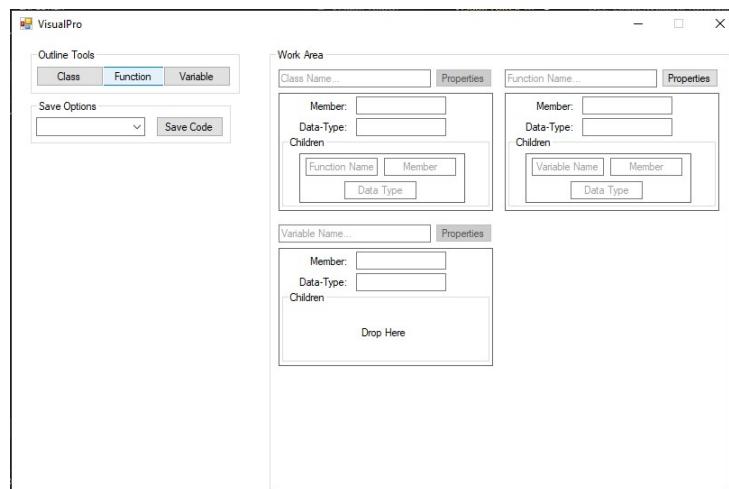


Fig. 7.4. Design Planning - Stage 4

## 7.2. Error Handling

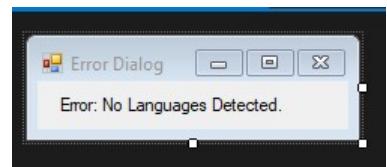


Fig. 7.5. Error Handling

## 7.3. Structure Containers

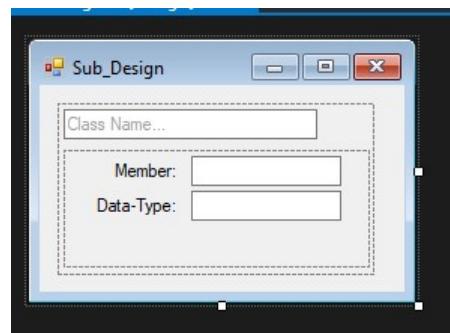


Fig. 7.6. Design Planning - Stage 1

## **8. EVALUATION OF FUNCTIONALITY**

## **9. EVALUATION OF FEEDBACK**

## **10. CONCLUSION**

## **11. REFLECTION**

## **12. TERMINOLOGY**

List of terminologies used in this document:-

- UI - User Interface.
- UX - User Experience.
- UML - Unified Modeling Languages.
- OOP - Object-Orientated Programming.
- FP - Functional Programming.
- RAISE - Remote Asynchronous Instruction in Science and Engineering.
- DLL - Dynamic-link Library.
- HTML - HyperText Markup Language.
- AI - Artificial Intelligence.
- XML - Extensible Markup Language.
- GUI - Graphical User Interface.

## **ACKNOWLEDGEMENT**

Appreciation goes out to the survey participants, which helped better understand how VisualPro may impact consumers in the future. Having the support from these participants helped advance the UI and UX progress of VisualPro.

## BIBLIOGRAPHY

- [1] B. Vogel-Heuser, M. Obermeier, S. Braun, K. Sommer, F. Jobst, and K. Schweizer, “Evaluation of a UML-Based Versus an IEC 61131-3-Based Software Engineering Approach for Teaching PLC Programming,” *IEEE Transactions on Education*, vol. 56, no. 3, pp. 329–335, 2013.
- [2] K. Kuspert, J. Teuhola, and L. Wegner, “Design issues and first experiences with a visual database editor for the extended NF<sup>sup</sup> 2-/data model,” in *Twenty-Third Annual Hawaii International Conference on System Sciences*, vol. 2, 1990, pp. 308–317 vol.2.
- [3] Chisnell Dana and Rubin Jeffrey, *Handbook of usability testing how to plan, design, and conduct effective tests*, 2nd ed. Indianapolis, IN: Wiley Pub, 2008.
- [4] D. Zuehlke and N. Thiels, “Useware engineering: a methodology for the development of user-friendly interfaces,” *Library Hi Tech*, vol. 26, no. 1, pp. 126–140, 2008, ISBN: 07378831. [Online]. Available: <https://www-proquest-com.ezproxy.uwtsd.ac.uk/scholarly-journals/useware-engineering-methodology-development-user/docview/200606343/se-2?accountid=130472>
- [5] M. Hentati, L. Ben Ammar, A. Trabelsi, and A. Mahfoudhi, “A fuzzy-logic system for the user interface usability measurement,” in *2016 17th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD)*, May 2016, pp. 133–138.
- [6] Dr. Caitlin Sadowski and Dr. Thomas Zimmerman, Eds., *Rethinking Productivity in Software Engineering*, 1st ed. Apress, 2019. [Online]. Available: <https://doi.org/10.1007/978-1-4842-4221-6>
- [7] Unreal Engine, “Introduction to Blueprints.” [Online]. Available: <https://docs.unrealengine.com/4.27/en-US/ProgrammingAndScripting/Blueprints/GettingStarted/>
- [8] Tileston Donna Walker, *10 best teaching practices how brain research and learning styles define teaching competencies*, 3rd ed. Thousand Oaks, Calif. ;: Corwin, 2011.
- [9] T. Cleaver, “Interactive Web-based tutorials for engineering education,” in *Proceedings IEEE Southeastcon’99. Technology on the Brink of 2000 (Cat. No.99CH36300)*, Mar. 1999, pp. 126–127.
- [10] Pooley R J and Stevens Perdita, *Using UML: software engineering with objects and components*, second edition. ed., ser. Addison-Wesley Object Technology Series. Harlow, England: Pearson Education Limited, 2006.
- [11] Unity Technologies, “Unity engine visual scripting | Game development software without coding | Unity Bolt | Unity.” [Online]. Available: <https://unity.com/products/unity-visual-scripting>

- [12] Mojang, “Minecraft - Getting Started with Redstone.” [Online]. Available: <https://help.minecraft.net/hc/en-us/articles/360045950932-Minecraft-Getting-Started-with-Redstone>
- [13] C. Klammer and A. Kern, “Writing unit tests: It’s now or never!” in *2015 IEEE Eighth International Conference on Software Testing, Verification and Validation Workshops (ICSTW)*, Apr. 2015, pp. 1–4.
- [14] Z. Chaczko, R. Braun, L. Carrion, and J. Dagher, “Design of unit testing using xUnit.net,” in *2014 Information Technology Based Higher Education and Training (ITHET)*, 2014, pp. 1–9.
- [15] E. Patch, “VisualPro (Visual Scripting Pad),” Jan. 2022, original-date: 2021-09-24T08:51:54Z. [Online]. Available: <https://github.com/ShinkuKira21/VisualPro-FinalProject>
- [16] “Code Faster with AI Code Completions | Tabnine.” [Online]. Available: <https://www.tabnine.com/>
- [17] A. M. Winn and T. J. Smedley, “Multimedia Workshop: Exploring the Benefits of a Visual Scripting Language.” IEEE Computer Society, Sep. 1998, pp. 280–280. [Online]. Available: <https://www.computer.org/csdl/proceedings-article/vl/1998/87120280/12OmNBl6EH3>
- [18] E. T. Ray, *Learning XML*, 2nd ed. Sebastopol, California: O’REILLY.
- [19] G. K. Behara, *Why Python is Popular for Machine Learning Implementations?* New Dehli: Athena Information Solutions Pvt. Ltd.
- [20] “Markup Languages: Theory & Practice,” *Markup Languages: Theory & Practice*, vol. 1, no. 4, pp. 46–46, 1999, publisher: MIT Press. [Online]. Available: <https://ezproxy.uwtsd.ac.uk/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=7317014&site=ehost-live>
- [21] Microsoft, “Compare Project Management Solutions and Costs | Microsoft Project.” [Online]. Available: <https://www.microsoft.com/en-gb/microsoft-365/project/compare-microsoft-project-management-software>
- [22] G. Costa and R. Ortale, “Machine learning techniques for XML (co-)clustering by structure-constrained phrases,” *Information Retrieval*, vol. 21, no. 1, pp. 24–55, Feb. 2018, num Pages: 24-55 Place: Dordrecht, Netherlands Publisher: Springer Nature B.V. [Online]. Available: <http://www.proquest.com/docview/2002401888/abstract/100992F450AA4EEFPQ/1>
- [23] Microsoft, “Exporting from a DLL Using \_\_declspec(dllexport),” May 2019. [Online]. Available: <https://docs.microsoft.com/en-us/cpp/build/exporting-from-a-dll-using-declspec-dllexport>
- [24] ——, “DllImportAttribute Class (System.Runtime.InteropServices).” [Online]. Available: <https://docs.microsoft.com/en-us/dotnet/api/system.runtime.interopservices.dllimportattribute>
- [25] ——, “What is .NET Framework? A software development framework.” [Online]. Available: <https://dotnet.microsoft.com/learn/dotnet/what-is-dotnet-framework>

- [26] GitHub, “GitHub: Where the world builds software.” [Online]. Available: <https://github.com/>
- [27] Git, “Git.” [Online]. Available: <https://git-scm.com/>
- [28] Microsoft, “Visual Studio: IDE and Code Editor for Software Developers and Teams.” [Online]. Available: <https://visualstudio.microsoft.com/>
- [29] “Full details and actions for Creating the productive workplace.” [Online]. Available: <https://www-vlebooks-com.ezproxy.uwtsd.ac.uk/Vleweb/Product/Index/62495?page=0>
- [30] D. Clements-Croome, Ed., *Creating the Productive Workplace*, 2nd ed. 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN: TAYLOR & FRANCIS, Aug. 2006.
- [31] M. Kalicinski, “RapidXml,” 2009. [Online]. Available: <http://rapidxml.sourceforge.net/>
- [32] Epic Games, “Unreal Engine 5.” [Online]. Available: <https://www.unrealengine.com/en-US/unreal-engine-5>
- [33] E. Arisholm, L. C. Briand, S. E. Hove, and Y. Labiche, “The Impact of UML Documentation on Software Maintenance: An Experimental Evaluation,” *IEEE Transactions on Software Engineering*, vol. 32, no. 6, pp. 365–381, Jun. 2006. [Online]. Available: <https://www.proquest.com/docview/195572945/abstract/75B2DD5585C6437DPQ/1>
- [34] Wiklund Michael E, *Usability in practice: how companies develop user-friendly products*. Boston ;: AP Professional, 1994, book Title: Usability in practice : how companies develop user-friendly products.
- [35] Albert Bill and Tullis Tom, *Measuring the user experience: collecting, analyzing, and presenting usability metrics*, ser. The Morgan Kaufmann series in interactive technologies. Amsterdam ;: Morgan Kaufmann, 2008, book Title: Measuring the user experience : collecting, analyzing, and presenting usability metrics.
- [36] “Understanding new and emerging user values,” *Telesis*, no. 97, p. 14, Dec. 1993, ISBN: 00402710. [Online]. Available: <https://www-proquest-com.ezproxy.uwtsd.ac.uk/trade-journals/understanding-new-emerging-user-values/docview/222355229/se-2?accountid=130472>
- [37] J. Nielsen and J. Levy, “Measuring usability: preference vs. performance,” *Communications of the ACM*, vol. 37, no. 4, pp. 66–75, 1994, place: New York, NY Publisher: ACM.
- [38] P. Capek, E. Kral, and R. Senkerik, “Advanced Testing Tool for .NET Applications,” in *2017 International Conference on Computational Science and Computational Intelligence (CSCI)*, 2017, pp. 1799–1800.
- [39] L. Mukkavilli, “Smart Unit Testing Framework,” in *2012 IEEE 23rd International Symposium on Software Reliability Engineering Workshops*, 2012, pp. 70–79.
- [40] J. Cho, “Getting Into the Field,” in *Evaluating Qualitative Research*. New York: Oxford University Press, 2017. [Online]. Available: <https://oxford.universitypressscholarship.com/10.1093/oso/9780199330010.001.0001/oso-9780199330010-chapter-1>

- [41] I. Grout and A. K. B. A'Ain, "Adapting an on-line tutorial tool with web analytics to incorporate analysis of tutorial use," in *2012 15th International Conference on Interactive Collaborative Learning (ICL)*, Sep. 2012, pp. 1–7.
- [42] P. Gopal, N. Varkey, and K. M. Moudgalya, "Visual Maps for Collaborative Spoken Tutorial Development," in *2012 IEEE Fourth International Conference on Technology for Education*, Jul. 2012, pp. 253–254.
- [43] C. Troussas, K. Chrysafiadi, and M. Virvou, "Personalized tutoring through a stereotype student model incorporating a hybrid learning style instrument," *Education & Information Technologies*, vol. 26, no. 2, pp. 2295–2307, Mar. 2021. [Online]. Available: <https://ezproxy.uwtsd.ac.uk/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=bri&AN=149397930&site=ehost-live>
- [44] Z. Luo, "Using eye-tracking technology to identify learning styles: Behaviour patterns and identification accuracy," *Education & Information Technologies*, vol. 26, no. 4, pp. 4457–4485, Jul. 2021. [Online]. Available: <https://ezproxy.uwtsd.ac.uk/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=bri&AN=151490161&site=ehost-live>
- [45] Lo Mun Ling, Pong Wing Yan, and Chik Pui Man Pakay, *For each and everyone catering for individual differences through learning studies*. Hong Kong: University Press, 2005.
- [46] Pritchard Alan, *Ways of learning: learning theories for the classroom*, fourth edition. ed. Abingdon, Oxon ;: Routledge, 2018.
- [47] L. Shao, F. Zhu, and X. Li, "Transfer Learning for Visual Categorization: A Survey," *IEEE Transactions on Neural Networks and Learning Systems*, vol. 26, no. 5, pp. 1019–1034, May 2015.
- [48] R. Crepon, "Application of design research methodology to a context-sensitive study in engineering education," in *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, Oct. 2014, pp. 1–4, iSSN: 2377-634X.