# Tech Review: Game Platform for Upgrading Counting Ability on Preschool Children

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*Abstract*—One of difficulties in learning mathematics (counting) can be overcome by providing a relaxed and fun learning for preschoolers. Games can be used as an alternative solution. This study was conducted as a pilot project for reviewing the Kodu, Unity 3D and Construct 2 game platform for this purpose. The method used is the classification, review/evaluation, prototyping and analysis. Tech Review of these game platforms will be discussed as a result in this paper.

*Keywords— game platform, preschool, mathematics, Kodu, Unity 3D, Construct 2*

## I. INTRODUCTION

Children usually do not like to learn mathematics. Because it's difficult to learn, irrelevant to their lives, and boring [1], it raises mathematics anxiety. Mathematics anxiety and aptitude/achievement measures are inversely correlated. The higher mathematics anxiety is, the lower mathematics performance will be [2]. Many children, including those with and without disabilities, as well as adults, do not feel confident in their ability to do math [3].

Computer games, on the other hand, can be highly effective in increasing children's learning and enjoyment of mathematics. Its effectiveness, however, depends on many things including details of the software design such as interface styles and scaffolding, teacher and student expectations, the level of integration with other learning activities, and the setting and usage pattern [4]. Symbol manipulation (interpreted by something in reality) is the essential characteristic of preschool children [5]. This has been the research basis in improving cognitive abilities, especially for preschool children numeracy skills through the game. This is expected to be able to maximize the symbol manipulation by children.

One of the ways to assist in reducing math anxiety for children is by developing calm/positive ways to deal with their math anxiety, included visualization, positive messages, relaxation techniques, frustration breaks [3] that can be handled by games.

Learning math courseware used is known as playtime learning. It consists of play games and fun activities [6] which covers two modules. First module facilitates to recognize numbers and its sequence and the second one provides training of number addition and subtraction on the lowest difficulty level. In this study, these were used with different game genres like adventure, racing or shooting. These games are a combination of multimedia elements such as graphic and animations facilitating learners to experience mathematics [7].

This study was purposed a comparison between three game platforms that suitable for counting games. It will improve cognitive abilities of preschoolers. Three gaming platforms used were Kodu, Unity 3D and Construct 2. The outcome of this study was choosing the best platform for its application.

## II. LITERATURE REVIEW

### A. Related Works

Children are one of the oriented population sectors who will obtain game treatment and education [8]. It is so undeniable that there are some works dedicated to this goal for example: the story-based math video game has captivated the interest of students and it has been beneficial in improving their performance in an assessment test. Most notably, the improvement was higher for students who used to have poor performance in mathematics [9]. Other work mentioned that a simulation-based "game" environment that included a sequence of challenges would further motivate the student and expand their learning abilities [10]. It's also stated that their observations and findings were on children's psychology of learning mathematics in the context of computer-based mathematical game environments and some elements of computer games that satisfy children's learning needs and motivate them to learn mathematics [11].

Review study in terms of computer game engines stated that several applications of commercially available computer game engines were implemented on virtual education and training environments. While these systems are still in the early stages of their development, they have already provided us with glimpses into their tremendous potential for creating effective learning and training experiences in various fields, including education and student laboratories, medicine as well as disaster response and military training [12].

### B. Game Engine Review

Game Engine is specialized software that used to design and to develop a video game. It is also an important core of a video game with the functional components that can be reused (such as graphics rendering, audio output, physics modeling, game, logic, basic artificial intelligence, interaction users, as well as multi-user network) and usually accompanied by a software development kit (SDK) [12]. Detailed explanation of the features can be seen in Fig. 1. It shows about the features that should be present in a platform game engine namely input support, sound support, graphical support, AI support and physics support [13].

### 1) Kodu

Kodu is software support a creation of child-friendly games (suitable for children at any age) and the programming environment that enables non-technical users to create complete games. It is including behavioral AI (Artificial Intelligence) and many reusable components. Kodu includes graphical programming environment based on a system of rules and it can also be controlled by a 10 year old child. Kodu can be used to implement various game genres, design terrain and complete level. This game platform uses Xbox 360 or Windows PC [14].

Unlike the other game engine, Kodu language uses "when-do" algorithms. Although simple, this model is identified in 346 Kodu programs created by users that show the flow of control and sophistication using complex Boolean logic [15]. It can be seen in Fig. 2.

### 2) Unity 3D

Unity is an integrated tool to create games, simulations and architectural buildings. It can be applied for PC games and online games using the Unity web browser [16].

The programming language used varies, ranging from JavaScript, C #, and Boo. Unity is a Multi platform game that can be deployed on PC, Mac, Wii, iPhone, iPad, Android and browsers. Many things can be done using unity. There are audio feature reverb zone, particle effects, Sky Box, as well as features rendering, lighting, sound effect, and game physics. Unity can also directly edit the texture from editor [17]. Fig. 3 shows about it.

### 3) Construct 2

Construct 2 is an application for creating 2-dimensional games based on HTML-5. It does not require programming skills [18].

The construct 2 display is easy to understand. Its features includes Powerful Event System focusing on logic; Flexible Behaviors (physical properties, movement, plat former, etc.), Instant Preview; Stunning Visual Effects; Multiplatform Export applied in games that can be published to a variety of platforms, namely, Chrome Web Store, Facebook, Kongregate, Newgrounds, Firefox Marketplace, Arcade Sencha while to get the same performance as the previous, PC, Linux, Mac are as good as mobile platforms such as iOS, Android, Blackberry [19].
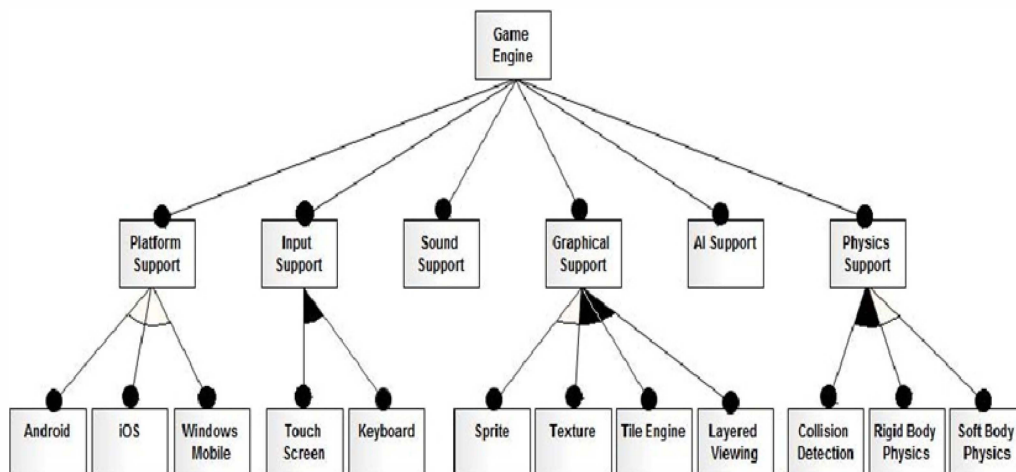


Fig. 1. A Game Engine Features Diagram [13]
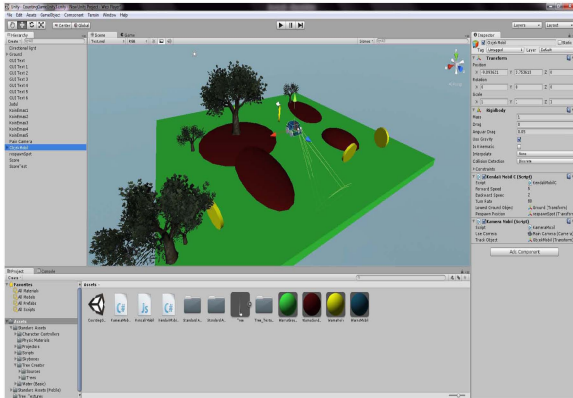
Fig. 2.   Complex Boolean Logic on Kodu



Fig. 3.   Texture Editor on Unity 3D

## III.   METHOD

The method conducted in this study was a modified linear sequential model. This method consists of four software development steps that begin at the system level and progresses through analysis, design, coding, testing, and support [20]. The first step of this research was game engine classification and continued with review and evaluation using part of analysis module. Subsequently, prototyping and analysis (tech review) were the next steps. Research method flowchart can be described as in Fig. 4. It shows that research method contain for steps which are game engine classification, review and evaluation, prototyping, and analysis.

### A.  Game Engine Classification

In this phase, we categorized game engines based on their features and characteristics to be compared and collaborated with software requirements analysis [21]. In this research, it was needed 2D and 3D game engines to support the whole applications. Several game engines were thus classified into these criteria.

### B.  Review and Evaluation

Review and evaluation were carried out by technological observation during the installation process, configuration, programming, interfaces and support tools on each of the game engine. Evaluation methodology will select ideal engines based

on the technical requirements of which an associated link to the driving pedagogic factors [22]. In this step, several game engines were reviewed and evaluated such as jMonkeyEngine, CryEngine 3, Unity3D, Kodu and Blender for 3D game engines;  Adobe Flash Professional, Construct 2, Game Of Engines, GameMaker Studio and AndEngine. The technical requirements for making applications of counting games improves cognitive abilities of preschoolers, support and feature game engines; indeed for the programming easiness, three game engines were selected to be prototyped.
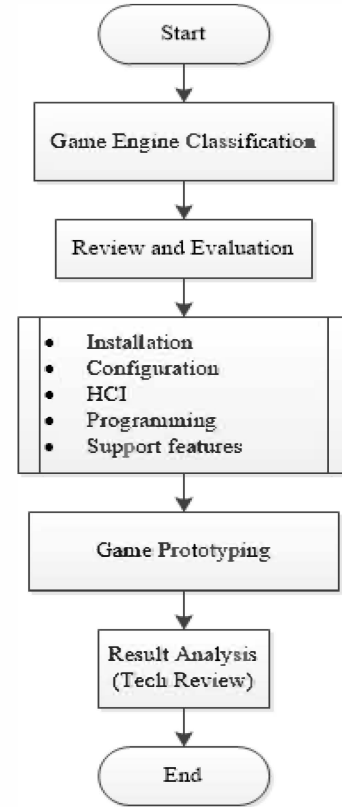


Fig. 4.   Research Method Flowchart

### C.  Prototyping

The prototyping paradigm is begun with requirements gathering. It is continued to identify any requirements and outlining a "quick design". The quick design focused on software aspect representations that would be visible to the customer/user (e.g., input approaches and output formats) [20].

Prototyping was conducted by designing and building a counting game for preschool children using game engines that were selected, namely Kodu, Unity 3D and Construct 2.

### D.  Analysis

Lastly, we observed prototype details, collated and compiled the comparison result as a tech review. In this step, we used personal review to get data on using evaluation, programming experience and support features on the gaming platforms which were analyzed.

## IV. RESULT AND DISCUSSION

### A. HCI (Human and Computer Interaction) evaluation

All games created with this platform still use keyboard control system in which each one uses different genre but having the same goal i.e. to improve the cognitive abilities of children in numeracy.

The colors are attractive and the sound stimuli giving game instructions is also used to increase the children interest in learning to count by using the game. Children will be more interested and fun in playing the game [23]. Interface 3D platform games have a tendency to be more attractive than 2D because children will be able to feel the real environment like in the real world using 3D games visualization facilities [24]. Screenshot HCI on each platform game can be seen in Fig. 5, 6, and 7.

### B. Programming Experience

Programming process undertaken to develop the game in the third platform has its own advantages and disadvantages.
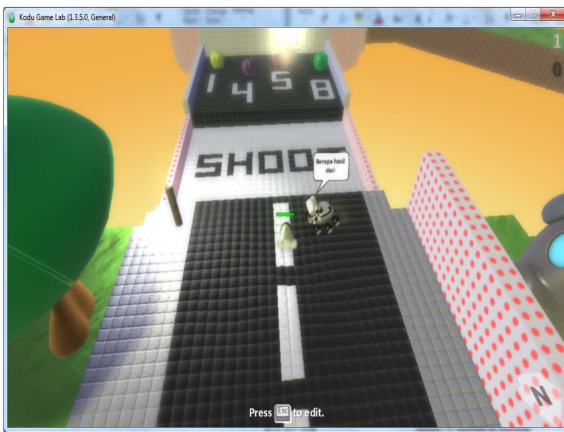


Fig. 5. Screenshot HCI Counting Game with Kodu



Fig. 6. Screenshot HCI Counting Game with Unity 3D



Fig. 7. Screenshot HCI Counting Game with Construct 2

Kodu game development process does not require complex scripting for all events in the game are controlled by algorithms "when-do" using logic Boolean. Therefore, the character of which will be used depending on the character in the game provided the platform without having to create their own character [15] [25].

Unity 3D game scripting is done through Mono which is an open source implementation of the NET Framework, thus the programmer making it will be more flexible to use JavaScript, C# or Boo (which has Python syntax). Unity 3D game character is able to use self-made character or import it from already available one in the Unity Asset. Although using unity, it still needs higher scripting capabilities than Kodu because events that occur in all games must be declared through the scripts used. This would be workflow module development flexibility and a more automated navigation [26].

On Construct 2, a game is created just by dragging and dropping object from scripting through event sheet which is the ability of the core logic requires strong logic games can run well. In the scripting process, Construct 2 also provides the function of default behaviors which has been provided as physical, movement, plat former, etc [18].

### C. Supports

Documentation supports for Kodu, Unity 3D and Construct 2 can be said to be very good with each having its official web page for a basic introduction, detailed information about the function, tutorial and download source [18][25][26].

In addition to support the official website, users and developers community of all platforms are also quite good with a fairly lively forum [27][28][29].

### D. Technology Review

The differences in technical criteria of each game engine are essentially influenced by the intended use of the game engine, as shown in Table 1. Kodu and Unity 3D have some similarities such as the use of graphics API and the environment as both are aimed to construct a 3D game. Kodu and Unity 3D however, also have a very significant difference due to the different target user goal. Kodu is used more to learn programming while the Unity 3D game is more applicable to the professionals or industrial users [30].

TABLE I.　　TECHNOLOGY REVIEW LIST

| Criteria | Kodu | Unity 3D | Construct 2 |
|---|---|---|---|
| Engine Type | 3D Visual game editor | 3D Visual game editor | 2D Visual game editor |
| Target platform | Windows, Xbox | PC, Mac, Android, iOS, Xbox, Wii | PC, Mac, Android, iOS, Blackberry |
| Graphics API | DX 9 Shader Model 2.0 | DX 9 OpenGL | 2D context, WebGL context, based on OpenGL |
| Script runtime environment | .NET Framework 3.5 XNA Framework 3.1 | Mono (open source implementation of .NET) | HTML 5 |
| Physics | N/A | PhysX | Behaviors |
| 3D scene editor | No | Yes | No |
| 3D model editor | No | No | No |
| Terrain editor | Yes | Yes | No |
| Particle system editor | No | Yes | Yes |
| Asset importing | No | Yes | Yes |
| Runtime Engine | .NET Framework 3.5 | Mono 2.0 | HTML 5 |
| Video support | Yes | Yes | No |
| Sound | DirectX | DirectSound3D | Web Audio API |

Construct 2 has a more striking difference with other game engines because it leads to the development of 2D games that do not require rendering realistic environment [24]. It is because the player only controls the game character in a 2D environment [31].

Furthermore, Construct 2 using the HTML 5 web base is different from the others but also supports the Unity 3D web browser to use platform with a virtual world viewer [16].

## V.　CONCLUSION

Game engine can be used based on the system making purpose or market goals. In making application, it should consider the needs analysis and technology criteria owned by a game engine.

Based on the results of tree game engine reviews, they were used to create counting game application aiming to improve the cognitive abilities of preschoolers. Kodu and Unity 3D were more suited for games that emphasized the advantages of three dimensional environments. Although Kodu was faster for prototyping process, Unity 3D had advantages in adding character and properties.

Furthermore, 2D constructs were suitable for creating 2D games with simpler scripting process only by the "drag and drop" and using simple logic in the Event Sheet.

## ACKNOWLEDGMENT

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