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| Proposing a model for teaching Boolean logic through Minecraft  A research proposal for COS 700, University of Pretoria. | Abstract  Abstract to come  11004322  11004322@tuks.co.za |

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# Introduction

Mathematicians George Boole and Augustus De Morgan founded the modern subject of symbolic logic (a representation of Boolean logic) which, today, forms the basis of many areas of computer science such as digital logic circuits design, relational database theory, automata theory and computability, and artificial intelligence (Epp, 2011).

The subject of Boolean logic is an integral concept in the field of computer science. Without a thorough understanding thereof a student will never succeed in becoming a computer scientist. Students would make first contact with the basic concepts of Boolean logic during their first year of a computer science degree where a lecturer would try to explain these concepts on a very abstract and theoretical level.

This is often difficult to comprehend for many students without having a practical or tangible reference coupled to the theory. Using the Minecraft game, we can infuse the process of learning with amusement and help the student to visualize Boolean logic in an environment that simulates the real world.

The goal of the research is therefore to provide a model that uses propositional logic and logic gates to provide a visual representation, in Minecraft, of the concepts of Boolean algebra and thereby provide the student with a learning tool that is less intimidating than pure theory.

# The problem

Boolean logic concepts are highly theoretical, and therefore difficult to convey to students in a manner that most would find appealing and fun.

# Methodology

The problem is to be addressed by providing a model to teach Boolean logic using the game world of Minecraft. The model will outline how the setup of an educational session will look and how the syllabus will be presented. The model will be supported by a prototype to be implemented in Minecraft, with Redstone Minecraft blocks.

# Literature survey

The research proposed is multi-faceted. We would need to know how the syllabus for a Boolean logic course looks, how students learn, What gamified learning efforts have already been made, as well as how a solution could be built using a computer game.

## Boolean algebra and the syllabus

Susanne Epp (Epp, 2011) sets out a complete introduction to Boolean algebra in her book on discrete mathematics. Her book includes course work and exercises which form the basis of the discrete mathematics course of the University of Pretoria, and will therefore also form the basis of our research. Where clarification is needed George Boole (Boole, 1847) set out details on logic, including propositional logic. Visualization of the concepts was set out by the IEEE standard 91A-1991 (IEEE, 1991) by standardizing a number of symbols that represents the different logic gates. These gates can then be used to build up different truth tables (Epp, 2011).

## Learning methods

*How people learn* (Bransford, et al., 2000) is a book that sets out how people obtain knowledge, and how to create effective learning communities, therein helping us understand how we could possibly implement a collaborative learning environment in Minecraft.

The research will also consider how deductive (Orlich, et al., 2012) and inductive (Prince & Felder, 2006) learning and teaching will fit together to provide an engaging learning experience.

Furthermore, each student learns in a different way, and the proposed research should take that into account. J. Keefe and J. Jenkins set out these differences in learning, with suggestions on how to approach these differences (Keefe & Jenkins, 2008). Peter Honey and Alan Mumford proposed that a learner is able to adapt his/her- self between different stages of learning (Honey & Mumford, 1992). If the research takes these stages, as well as students’ differences in learning into account, we can provide an inclusive learning environment that optimizes the students’ ability to digest as much information as possible at that specific point in time.

## Learning with computer games

M. Hendrix performed a study that showed that educational games, like that of the proposed research, can be effective learning aids (Hendrix , 2013). B. Wu builds on this with his doctoral thesis and outlines how “lecture games” can be integrated into coursework to great success (Wu, 2013).

## Logic in Minecraft

Minecraft is a simplistic virtual world where everything is composed out of blocks (Minecraft, 2015). Each of these blocks have their own characteristics, our research will focus on using Redstone blocks and connectors. These virtual objects where created to simulate electronic circuits (minecraft101, 2015) and will therefore be a good fit to our research.

# Planning

The following chronological outline of work shows when and for how long each unit of work will be performed. Note that each point provides a focus area for a duration of time, this is done in order to not exclude any other piece of work that might spark up while working in the main focus for that allotted time. All time ranges exclude working on Sundays.

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| Nr. | Task | Number of days | Start date | End date |
| 1. | Focus on reading up on the Boolean algebra syllabus. | 5 | 29 April 2015 | 4 May 2015 |
| 2. | Focus on outlining the Boolean algebra syllabus. | 3 | 1 May 2015 | 5 May 2015 |
| 3. | Focus on researching deductive and inductive teaching methods. | 3 | 6 May | 8 May |
| 4. | Focus on researching learning methods and how to use these methods in games. | 12 | 12 May | 23 May |
| 5. | Focus on writing about deductive and inductive learning as well as learning methods. | 15 | 6 May | 24 May |
| 6. | Focus on researching and planning how tasks 4. and 5. will be implemented in Minecraft. | 2 | 12 May | 13 May |
| 7. | Focus on writing up the educational model. | 46 | 15 June | 31 July |
| 8. | Focus on implementing a prototype for the model. | 31 | 1 August | 31 August |
| 9. | Review the model based on new knowledge gained from implementing the prototype. | 9 | 1 September | 9 September |
| 10. | Perform the final writing and analysis of the model and prototype. | 25 | 10 September | 5 October |

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