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Digital Logic Gate Simulation in Computer and IT for Agricultural Communications Course

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Abstract

The Computer and Information Technology (IT) for Agricultural Communications Course requires students to learn about computers and electronic devices. The course includes instruction on logic gates. This study proposes a hands-on operational design using the WeMos D1 R2 microcontroller as a research facility for experiments in the basic logic gate laboratory. The results of the experiment show that the system can be used because the results obtained are based on theoretical results. The electronic circuit's components were replaced by the WeMos D1 R2 microcontroller. It is simple to use and adaptable, demonstrating the operation of logic gates and Boolean algebras. This practice is also an innovative teaching of logic gates and Boolean algebra that has been demonstrated for a clearer and better understanding.

Keywords: Digital Logic Gate, Simulation, WeMos D1 R2

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1. Introduction

Logic gates are the building blocks in logic design. The fundamental gates are used in a sequential and appropriate manner to develop sequential and combinational circuits to solve complex problems. The understanding of basic gates functionality through simulation using LEDs and switches controlled by Arduino represents a strong learning aid. Teaching and learning mechanisms are presently transforming into new dimensions by making use of the latest state-of-the-art technologies to present information in an easy and lucid manner to the learner [1].

Amazingly, computers, digital calculators, and devices that can work for humans are all made up of digital devices and circuits that work logically, and digital circuits have the basic component of logic gates. Because logic gates operate in the same way as binary number systems (with 0 and 1), people who work with electronic digital systems must understand and use them correctly. This research will investigate the functions of basic logic gates such as AND, OR, NOT, NOR, and NAND as the foundation for building more complex logic circuits [2]. Digitalization technology plays a role in the operation of electronically controlled devices allowing more efficient development and ability to work quickly with complex systems. The design can be created cheaply, easily, and quickly, which is the problem with having to create digital circuit learning materials, because learning digital circuits in general does not yield immediate results. It's difficult to comprehend. As a result, the researchers concluded that creating a Digital Logic Gate using the WeMos D1 R2 microcontroller for teaching can be used as a learning medium for digital design that students can use effectively and improve their understanding. It simulates digital circuit operation on the WeMos D1 R2 microcontroller, which simulates a logic gate AND, OR, and NOT gates.

The WeMos D1 R2 can connect to a 2.4 GHz Wi-Fi network, connect both boards via a USB cable, and the WeMos D1 R2 adapter can be connected via an additional voltage regulator, and the power from the 9-12 volt adapter can be powered by a 9-12 volt adapter [3]. The Computer and Information Technology for Agricultural Communications course is taught to first-year Agricultural Leadership and Communications students at the Faculty of Animal Science and Agricultural Technology, Silpakorn University. All students must take this course, which includes the implementation of a low-cost WeMos D1 R2, which costs only 3 USD. In addition to learning about microcontrollers, electronics is also essential for understanding the WeMos D1 R2 device. It is used in the field of things and others related to smart agriculture, which is why this research is being conducted.

We understand that students in the agricultural communications course need to learn about digital circuits, so we created a learning resource to help them under-

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stand better. We use WeMos D1 R2 microcontroller in this study to build a foundational learning unit that allows students to experiment with basic digital logic circuits. We recognize the importance of using technology in teaching and learning by connecting WeMos D1 R2 microcontroller with the study of digital circuits and Boolean algebra. It improves students' understanding and effectiveness in teaching digital logic circuits and Boolean algebra, allowing them to tackle more complex problem-solving tasks. Experimenting with WeMos D1 R2 microcontroller-based digital logic circuits, for example, can help students understand the practical application of logical principles and Boolean algebra in real-life scenarios. We establish a link between experiments and the learning outcomes that students can derive from using this technology in their coursework by constructing digital logic circuits that operate in real-world situations using the cost-effective WeMos D1 R2 microcontroller. As a result, expanding on the problems and rationale for this research demonstrates its importance in improving teaching and learning in the Computer and Information Technology for Agricultural Communications Course.

2. Implementation of WEMOS D1 R2 Logic Gates

WeMos D1 R2 is a board that uses ESP8266 WIFI to create a format similar to the Arduino UNO R3, making it easier for users to connect. Or it's the ESP8266 WIFI in the Arduino UNO draft. Connect via USB with TTL USB Chip CH340 for uploading programs to the board. We can use the Arduino IDE, but it is necessary to install its USB driver first [4].

WeMos D1 R2, a microcontroller based on the ATmega328p, is low-cost, intelligent, and flexible, and is used to develop small circuits by connecting sensor devices to WeMos D1 R2 via digital and analog input/output pins [5]. The sketch can be uploaded to the microcontroller by the programmer using the Arduino IDE software [6]. An image of WeMos D1 R2 board is shown in Figure 1.

3. Logic constants and logic variables

Operation in digital format It is explained using algebraic logic equations with logic variables. It is a variable that only accepts two values, also known as a two-state variable, because only two states can exist and will be in either state. Being located in both states at the same time does not represent various meanings such as on-off, high-low, one-zero, and so on [7].

Algebraic logic It is used to discover facts about logical actions that are distinct from algebraic. In general, logical algebra is made up of constants, and only two variables, 0 and 1, are called logic variables and can be represented by letters like A, B, C, a, b, c,... etc.

The logic level is the value of a logic variable that has a value of 0 or 1 at different times. We can replace it with a logic level, such as a voltage level ranging from 2 to 5 volts, with a logic 1 value, so that the voltage value in a digital circuit has a logical level of 0 or 1, depending on the actual value of the circuit operation.

4. The circuit diagram

4.1 Circuit Diagram Description:

In this example, we'll build a circuit with a WeMos D1 R2 microcontroller to simulate an AND gate using LEDs and switches. This basic circuit will assist students in comprehending the operation of logic gates.

4.2 Components Needed:

4.2.1 WeMos D1 R2 microcontroller
4.2.2 Two touch-press switches (SA and SB)
4.2.3 Two LEDs (green for switches A and B)
4.2.4 Two 220-ohm resistors
4.2.5 Jumper wires

4.3 Circuit Connections:

4.3.1 Connect SA (switch A) to digital pin D1 on the WeMos D1 R2.

4.3.2 Connect SB (switch B) to digital pin D2 on the WeMos D1 R2.

4.3.3 Connect the green LED for switch A with a 220-ohm resistor in series to digital pin D3 on the WeMos D1 R2.

4.3.4 Connect the green LED for switch B with a 220-ohm resistor in series to digital pin D4 on the WeMos D1 R2.

4.3.5 Connect a red LED to digital pin D0 (D3) on the WeMos D1 R2. This LED will represent the output Z of the AND gate.

4.4 Circuit Operation:

4.4.1 When both switches SA and SB are in the OFF position (0), the green LEDs for switches A and B will remain OFF.

4.4.2 When either switch SA or SB is turned ON (1), the respective green LED will turn ON.

4.4.3 When both switches SA and SB are turned ON (1), both green LEDs will be ON.

4.4.4 The red LED connected to digital pin D0 (D3) will act as the output Z of the AND gate. It will only turn ON when both switch A and switch B are ON (1).

This simple circuit allows students to experiment with an AND gate's behavior using the WeMos D1 R2 microcontroller. It visually demonstrates how logic gates operate by controlling LEDs based on the input switches' positions.

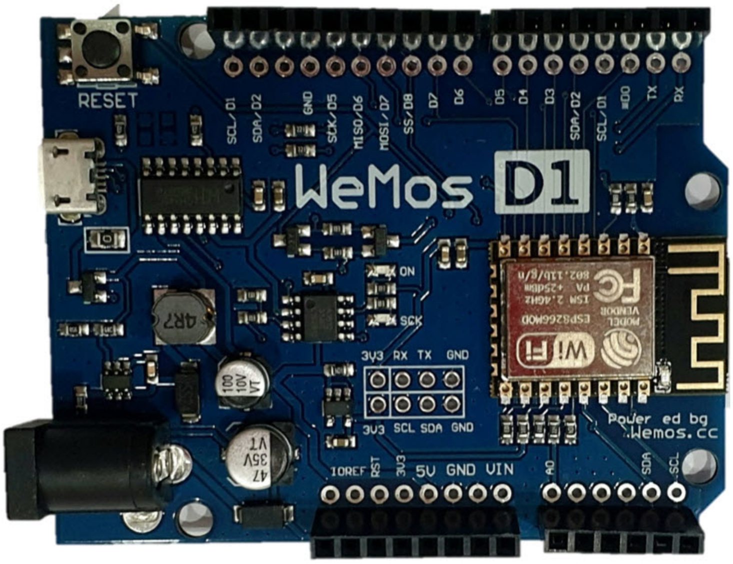


Figure 1: WeMos D1 R2 board.

5. Teaching instruction sheet design

In this section, we will look at the design of the teaching instruction sheet, which is an essential component of our educational approach. The teaching instruction sheet is an essential tool for learning and experimenting with digital logic circuits using WeMos D1 R2 microcontroller.

Our goal is to provide students with a well-organized and user-friendly resource that will help them better understand digital logic gates and their applications. The following key elements have been incorporated into the design of the teaching instruction sheet:

5.1 Title and Objective: The teaching instruction sheet starts with a clear and concise title that summarizes the subject of study. It also includes a brief statement of the learning objectives, emphasizing what students should gain from the activity.

5.2 Components List: We provide a detailed list of the components needed for the experiment. WeMos D1 R2 microcontroller, USB cable, touch switches, resistors, LEDs, and jumpers are all included. For easy identification, each component is accompanied by a brief description.

5.3 Circuit Diagram:A detailed circuit diagram is included to show how the components are connected. We emphasize the importance of understanding the circuit layout and how each element contributes to the logic gates' functionality.

5.4 Step-by-Step Instructions: The teaching instruction sheet's heart is made up of step-by-step instructions for setting up the experiment. We break the process down into manageable stages so that students can follow along without getting lost. To aid comprehension, each step is accompanied by clear explanations.

5.5 Logic Gates Exploration: We encourage students to use WeMos D1 R2 microcontroller to investigate the behavior of basic logic gates such as AND, OR, and NOT gates. The instructions walk them through different input scenarios and show the corresponding output results.

5.6 Discussion Points: We incorporate discussion points and questions throughout the teaching instruction sheet to actively engage students in the learning process. These questions encourage students to think critically and reflect on the results they have observed.

5.7 Troubleshooting Tips: Recognizing that experimentation can be difficult at times, we have included a section with troubleshooting tips. This gives students advice on how to deal with common problems that may arise during the experiment.

5.8 Learning Outcomes: We conclude the teaching instruction sheet by summarizing the experiment's key learning outcomes. This reinforces the educational objectives and allows students to assess their understanding.

Overall, the goal of our teaching instruction sheet design is to encourage students to actively participate in hands-on learning experiences, resulting in a better understanding of digital logic gates and their practical applications. It is consistent with contemporary educational approaches that use technology to enhance the learning process and make complex concepts more accessible to students. We emphasize the importance of this instructional resource in improving teaching and learning in the Computer and Information Technology for Agricultural Communications Course by linking it to our research.

6. The Application and Results

This section delves into the practical application of WeMos D1 R2 microcontroller-based digital logic gate experiments, as well as the outcomes of these educational endeavors. Our goal was to help students understand the practical implications of digital logic gates and Boolean algebra by bridging the gap between theoretical knowledge and real-world application.

6.1 Practical Application of WeMos D1 R2

WeMos D1 R2 microcontroller was an invaluable tool in demonstrating the usefulness of digital logic gates. This versatile microcontroller, outfitted with ESP8266 WIFI capabilities, enabled us to create an environment that was very similar to the Arduino UNO R3, facilitating ease of use and connectivity. Although it required the installation of a USB driver, its compatibility with the Arduino IDE streamlined the programming process [4].

WeMos D1 R2 microcontroller was instrumental in introducing students to the world of microcontrollers and electronics in the context of the Computer and Information Technology for Agricultural Communications Course. While the primary focus was on digital circuits, students also learned about the functionality of WeMos D1 R2 device. Given the device's importance in smart agriculture and the Internet of Things (IoT), this comprehensive approach was critical.

6.2 Educational Outcomes and Results

In terms of educational outcomes, our digital logic gate experiments produced significant results. Students were able to understand theoretical concepts as well as witness their practical implementation by using the WeMos D1 R2 microcontroller. The following are the key findings and outcomes of the experiments:

6.2.1 Enhanced Understanding: Hands-on experiments with WeMos D1 R2 microcontroller improved students' understanding of basic logic gates such as AND, OR, and NOT gates significantly. They could see how these gates worked in real time and how input changes affected the output.

6.2.2 Application of Boolean Algebra: Students were able to design and understand digital logic circuits using Boolean algebra principles. This practical application bridged the knowledge gap between theory and practice.

6.2.3 Problem-Solving Skills: Experimenting with digital logic circuits based on WeMos D1 R2 microcontroller provided students with problem-solving skills. They could troubleshoot and debug circuit problems, developing critical thinking skills.

6.2.4 Relevance to Smart Agriculture: Students recognized the real-world relevance of their learning because WeMos D1 R2 microcontroller has applications in smart agriculture. They could see how their new skills could be applied in agricultural settings, which aligned with the course objectives.

6.2.5 Linking Experiments to Learning Outcomes: We established a clear link between the experiments and the course learning outcomes. Students were able to see how the practical application of logical principles and Boolean algebra helped them achieve specific educational objectives.

Finally, the digital logic gate experiments using WeMos D1 R2 microcontroller proved to be a valuable educational tool. They not only improved students' understanding of digital circuits, but they also provided them with practical skills that can be applied in a variety of fields, including agriculture. We ensured that the educational outcomes were met effectively by aligning the experiments with the course's learning objectives. These findings highlight the significance of incorporating innovative teaching methods and technology to promote a deeper and more comprehensive understanding of complex subjects.

The study was carried out experimentally in electrical and electronic laboratories, simulating logic gates. For logic simulation, the gate simulation to demonstrate the mechanisms of three basic logic gates is AND, OR, and NOT gates. Simulation with WeMos D1 R2 requires the following: A USB cable, 2 touch switches, 220 ohm resistors, 3 LEDs, and jumpers. Figure 2: Actual circuit construction for a logic gate experiment

To make the circuit work, the code was developed using the C language and the Arduino IDE. The circuit consists of two touch-press switches as switch inputs, SA and SB; two LEDs as inputs, green for switches A and B, respectively; and red LEDs as Z outputs. When the LED is turned on, the binary number '1' is recorded, and when the LED is turned off, the binary number '0' is recorded, and the output LED lights turn on according to the operation of the LED. The output Z is put on pin 0 (D3) GPIO: General Purpose Input/Output of Wemos D1 R2. The Arduino IDE code for AND, OR, and NOT gates is as shown below in Figure 3, Figure 4, and Figure 5, respectively. Tables 1–2 show the results of each logic gate.

Input logic circuit simulation defined as LED A and B defines LED output Z, with output Z open or closed according to the truth table of basic logic gates, namely, AND, OR, and NOT gate. As a key component of this research, these are basic circuits that will amplify the complex work results that benefit students in laboratory activities.

7. Conclusion

Finally, this study provided invaluable insight into the effective integration of WeMos D1 R2 microcontroller as an educational tool for teaching digital logic gates. Our findings show that students' understanding of fundamental logic gates, their practical appli-

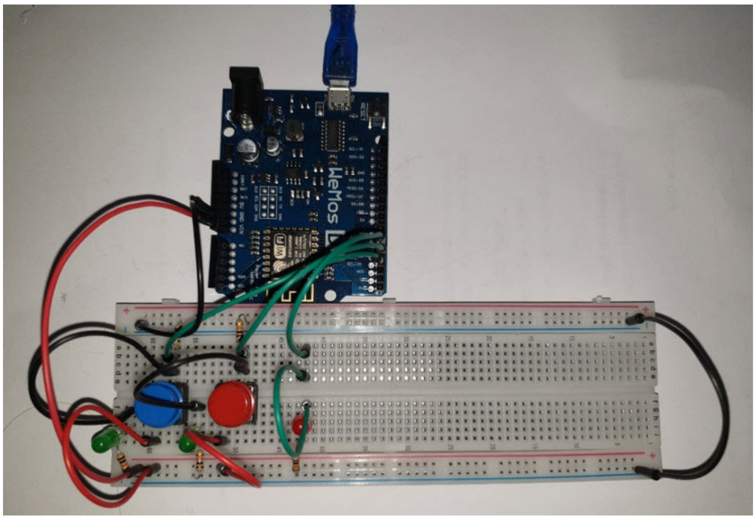


Figure 2: Actual circuit construction for a logic gate experiment.

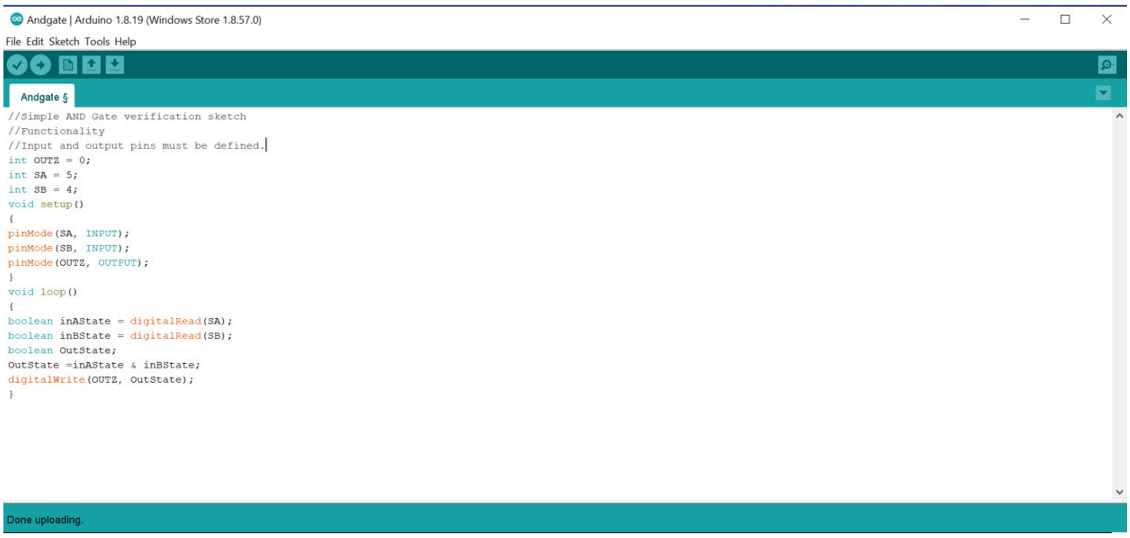


Figure 3: Shows an AND gate's Arduino code.

Table 1. AND gate results

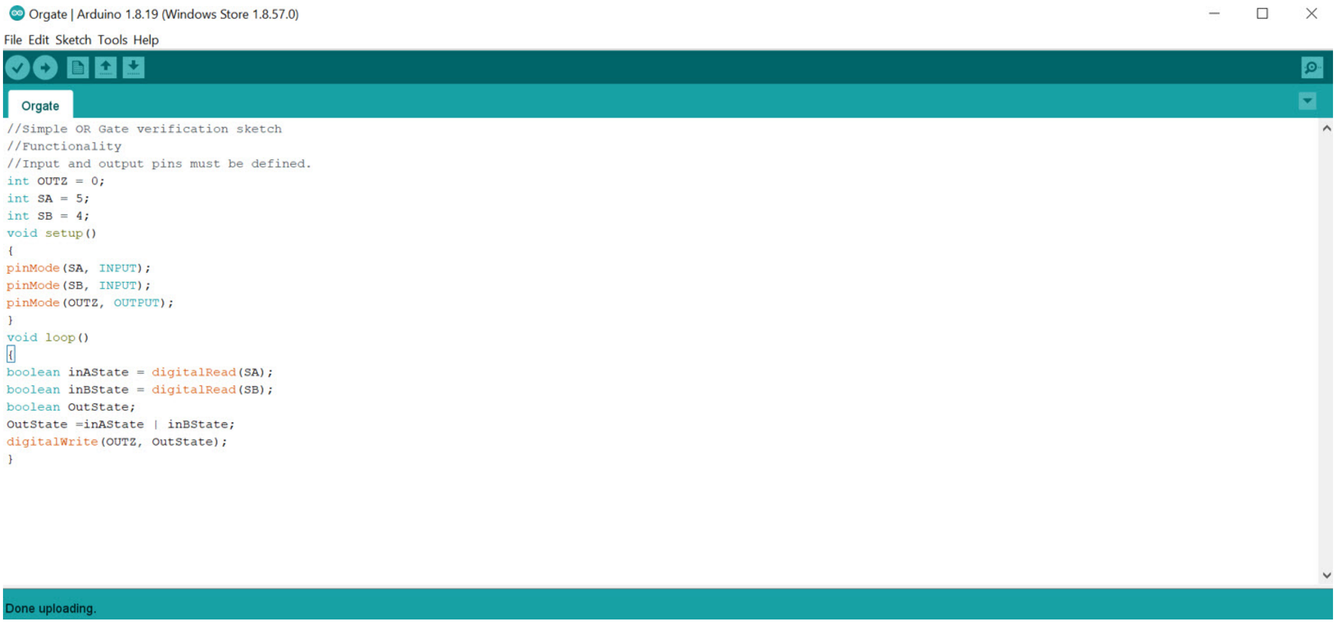
Input logic		Logic Output Z	
SA	SB	Theoretical	Experimental
0	0	0	0
0	1	0	0
1	0	0	0
1	1	1	1

Table 2. OR gate results

Input logic		Logic Output Z	
SA	SB	Theoretical	Experimental
0	0	0	0
0	1	1	1
1	0	1	1
1	1	1	1

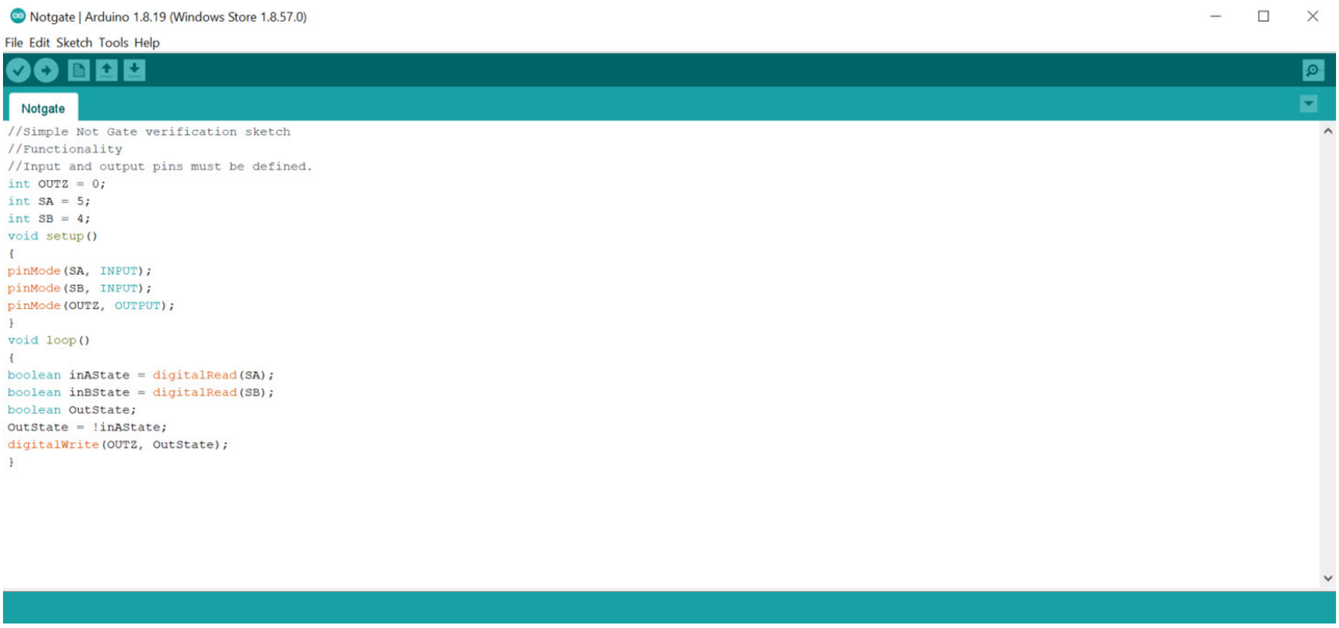
Table 3. Not gate results

Input logic	Logic Output Z	
SA	Theoretical	Experimental
0	1	1
1	0	0




```
//Simple OR Gate verification sketch
//Functionality
//Input and output pins must be defined.
int OUTZ = 0;
int SA = 5;
int SB = 4;
void setup()
{
pinMode(SA, INPUT);
pinMode(SB, INPUT);
pinMode(OUTZ, OUTPUT);
}
void loop()
{
boolean inAState = digitalRead(SA);
boolean inBState = digitalRead(SB);
boolean OutState;
OutState =inAState | inBState;
digitalWrite(OUTZ, OutState);
}
```

Figure 4: Shows the Arduino code for the OR gate.




```
//Simple Not Gate verification sketch
//Functionality
//Input and output pins must be defined.
int OUTZ = 0;
int SA = 5;
int SB = 4;
void setup()
{
pinMode(SA, INPUT);
pinMode(SB, INPUT);
pinMode(OUTZ, OUTPUT);
}
void loop()
{
boolean inAState = digitalRead(SA);
boolean inBState = digitalRead(SB);
boolean OutState;
OutState = !inAState;
digitalWrite(OUTZ, OutState);
}
```

Figure 5: Shows the Arduino code for the Not gate.

cations, and the bridging of the gap between theory and real-world relevance in smart agriculture have improved significantly.

Students not only gained a better understanding of digital circuits through hands-on experiments and simulations, but they also developed critical problem-solving skills. These newfound abilities enable them to effectively address complex challenges in the field of agricultural communications.

The versatility and low cost of WeMos D1 R2 microcontroller make it a valuable asset in the educational landscape, providing students with a tangible platform to explore digital logic principles. Furthermore, our instructional approach is consistent with current educational trends that use technology to make complex concepts more accessible and engaging.

Overall, the successful implementation of WeMos D1 R2 microcontroller in teaching not only improved students' learning experiences, but also demonstrated its potential as a transformative tool in fostering a deeper understanding of digital logic gates and their real-world applications. We believe that this research will make a significant contribution to the advancement of innovative teaching methods and the integration of technology in education.

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