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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DESIGN THINKING LAB

REPORT

Theme: COMBINATIONAL CIRCUITSCAPE: AR & VR ADVENTURES

Title: COMBINATIONAL CIRCUITS

Submitted by

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ABSTRACT

In digital electronics, learning about combinational circuits can be tough because they're abstract. Regular teaching methods might not make it fun or easy to understand. But we've come up with a cool way to teach it using Augmented Reality (AR), Virtual Reality (VR), and special computer programs. We use software like Unity, MIT Scratch, and Blender to create virtual worlds where you can see and play with digital circuits. You can watch how the parts work together in real-time and even design your circuits. It's like playing a game, but you're learning at the same time. We also use programs like MIT Scratch and Blender to simulate circuits without needing actual equipment. This means you can experiment and learn without being in a lab. This approach is great because it suits different learning styles. If you like seeing things visually, the 3D graphics are helpful. If you prefer hands-on learning, you can experiment with circuits in the virtual world. Best of all, these programs are easy to access and don't cost much. So, anyone can learn about digital electronics, no matter where they are. Incorporating AR, VR, and simulation software revolutionizes how we teach combinational circuits, making learning both engaging and accessible to all. This innovative approach paves the way for further creativity in electronics education methods moving forward.

ACKNOWLEDGEMENT

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CHAPTER 1

EMPATHY

1.1 Introduction to Empathy

Empathy means understanding how someone else feels and thinks, even without them saying it directly. It's like walking in their shoes to see the world from their perspective. When we empathize, we're more likely to help others when they're having a tough time.

For designers, having empathy means understanding how users feel when they use a product or website. Does it make them frustrated or happy? By putting ourselves in their shoes, we can make products that they really like and find easy to use. Without empathy, our designs might not be as successful because they won't focus on what users need and want.

STAKEHOLDERS

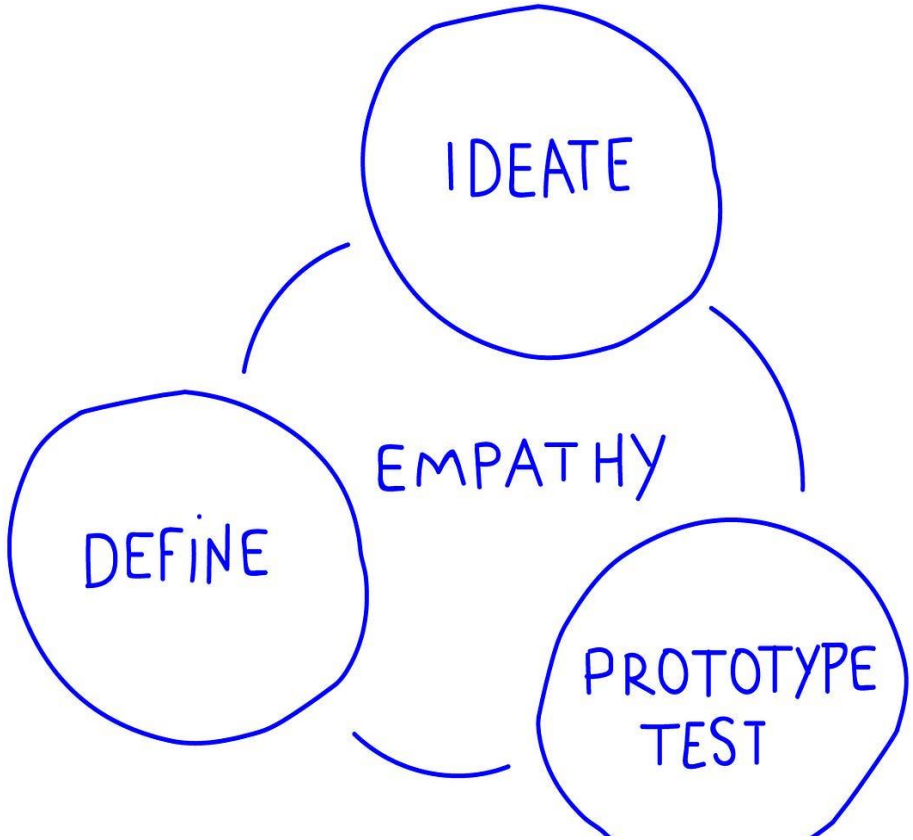


Figure 1.1.1 Empathy Diagram

Students: People who've studied combinational circuits are like important members of our digital electronics community. Those who've learned about it act as links of knowledge. Older students, who know how to practically use combinational circuits, become helpful guides. Younger students, who are still learning, represent the future users and learners. Their involvement in understanding and applying combinational circuits helps everyone learn and grow in the field, setting the stage for those who come after them.

Teachers: Teachers are super important in the world of combinational circuits. They know a lot and teach students everything they need to know about it. Teachers who are also experts in the subject give valuable insights into what the industry needs. They make sure that what students learn matches with what's actually used in the real world. These teachers connect the things students learn in class with how they're used in the industry, so students are ready for jobs in combinational circuits.

Industry Professionals and Employers: People who work in companies related to electronics and technology are big players in the combinational circuits world. They share practical knowledge about how combinational circuits are used in different areas. Also, companies that hire people care a lot about what students know about combinational circuits. Talking to these professionals can help students understand how things work in the real world. This helps make sure that what students learn matches with what companies are looking for, making it easier for them to get jobs.

QUESTIONNAIRE FOR THE STUDENTS

1. How confident are you in your understanding of combinational circuits?
2. Which specific aspects of combinational circuits do you find challenging?
3. How beneficial would be a hands-on practical session be in enhancing your understanding of combinational circuits?
4. Can you identify real-life applications where combinational circuits play a crucial role?
5. To what extent do you feel prepared for assessments (e.g., exams, quizzes) on the topic of combinational circuit?
6. Share your feedback on what resources or support would have helped you perform better in your assessments related to combinational circuits?
7. Are there any suggestions or changes you would recommend to improve the teaching approach or materials for understanding combinational circuits in your curriculum?
8. Have you explored any external resources (books, online tutorials, etc.) to supplement your understanding of combinational circuits? If yes, which ones have been most helpful?
9. How would you rate the effectiveness of current teaching methods in conveying the concepts of combinational circuits?
10. How often do you engage in collaborative learning or discussions with peers to enhance your understanding of combinational circuits?

1.2 Customer Persona and Environment

In design thinking, a customer persona is a detailed and empathetic representation of the ideal user or learner for a specific product, service, or educational content. It involves creating a fictional character that embodies the characteristics, behaviours, and needs of the target audience. This persona is crafted through research and understanding of real users to ensure a human-centered design approach.

In the context of combinational circuits, a customer persona in design thinking would provide insights into the user's background, motivations, challenges, and preferences. It serves as a valuable tool to guide the design process, helping designers empathize with users and create solutions that truly meet their requirements and enhance their learning experiences.

Example:
Name: Alex (Electronics Enthusiast)

Demographics:
Age: 21
Education: Undergraduate student in Electrical Engineering
Location: Urban area, close to academic institutions

Goals:
1. Understand the principles of combinational circuits thoroughly.
2. Apply knowledge to design and troubleshoot digital systems.
3. Score well in academic assessments related to combinational circuits.

Challenges:
1. Balancing academic workload with extracurricular activities.
2. Finding practical resources for hands-on learning.
3. Grasping complex concepts in a way that aligns with coursework.

Interests:

- Active participant in online forums discussing electronics and circuit design.
- Enjoys experimenting with DIY electronics projects.
- Values interactive and visual learning experiences.

Preferred Learning Environment:

- Enjoys hands-on workshops and practical demonstrations.
- Comfortable with online platforms and interactive learning modules.
- Appreciates real-world applications of theoretical concepts.

Understanding this customer persona helps tailor educational materials, resources, and engagement strategies to match the preferences and needs of someone with Alex's characteristics. It can inform the design of courses,

workshops, or online content related to combinational circuits, ensuring it aligns with the target audience's expectations and learning preferences.

A customer persona provides a detailed profile of the ideal customer, while the customer environment encompasses the various touchpoints and channels through which the customer interacts with a business or product. Both elements are essential for creating targeted and personalized marketing approaches that resonate with the specific needs and preferences of the target audience.

1.3 CUSTOMER JOURNEY MAP

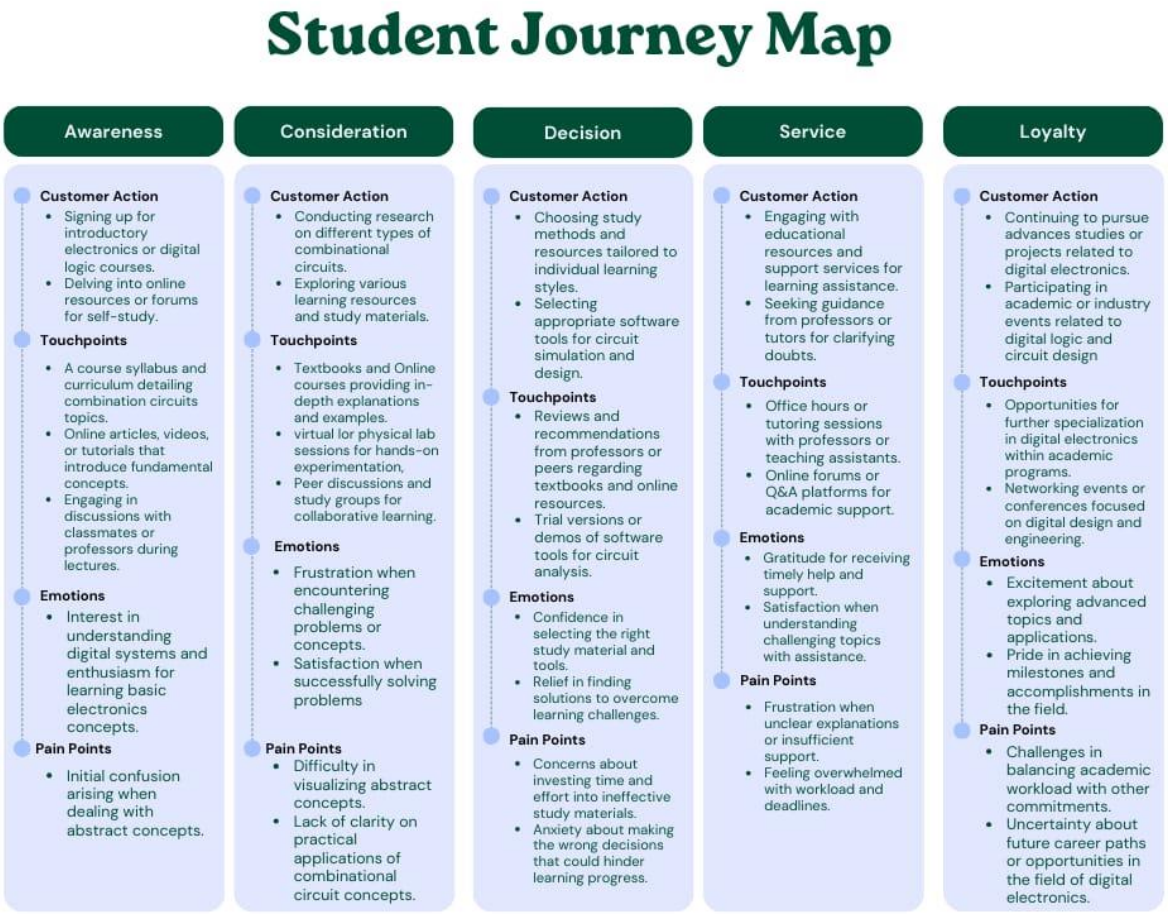


Figure 1.3.1 Customer Journey Map

The student journey in comprehending combinational circuits begins with an awareness phase marked by initial confusion, leading them to enrol in introductory courses and explore online resources. During consideration, students conduct research, experience moments of frustration and satisfaction, and make decisions on study methods and tools. The decision phase involves choosing tailored approaches and seeking recommendations to overcome challenges. As students engage with educational resources and services, they express gratitude for support but may face moments of frustration. Finally, in the loyalty phase, students continue their academic journey, participating in advanced studies, industry events, and experiencing excitement and pride, despite challenges in balancing workload and uncertainties about future career paths. This holistic journey underscores the dynamic emotional and educational landscape students traverse while navigating combinational circuits.

1.4 Customer Empathy Maps

STUDENT EMPATHY MAP

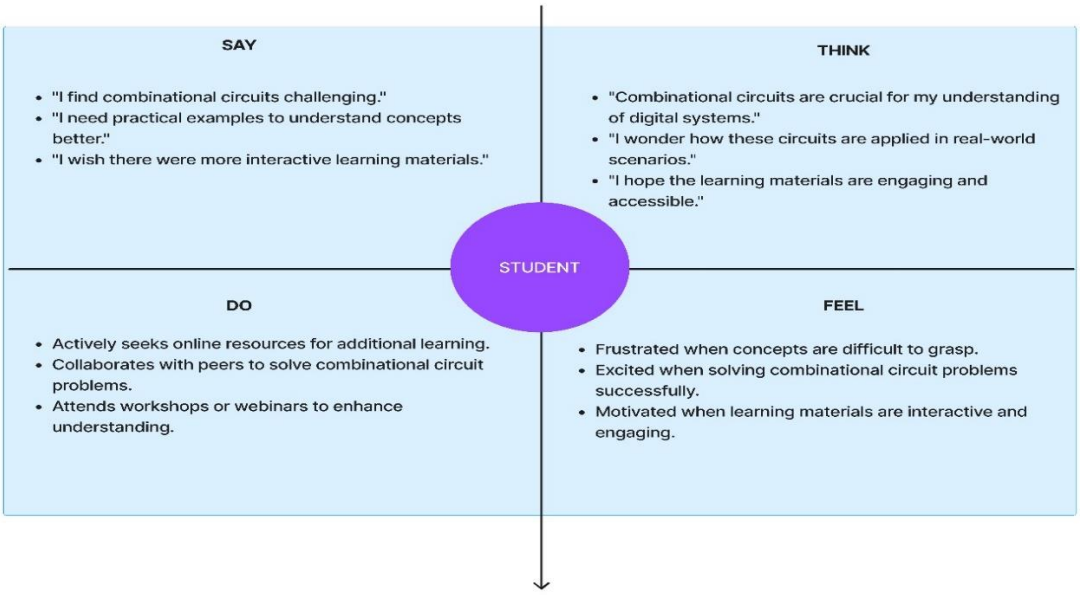


Figure 1.4 Student Empathy Map

The student empathy map helps us understand students better by looking at four important things: what they say, what they think, what they do, and how they feel. In the "SAY" part, we listen to their words and opinions. The "THINK" part helps us understand what goes on in their minds. "DO" is about observing their actions and habits when learning. Lastly, in the "FEEL" part, we explore their emotions and reactions. By looking at all these aspects, we can design solutions that really fit what students need and how they experience learning about combinational circuits.

EDUCATORS EMPATHY MAP

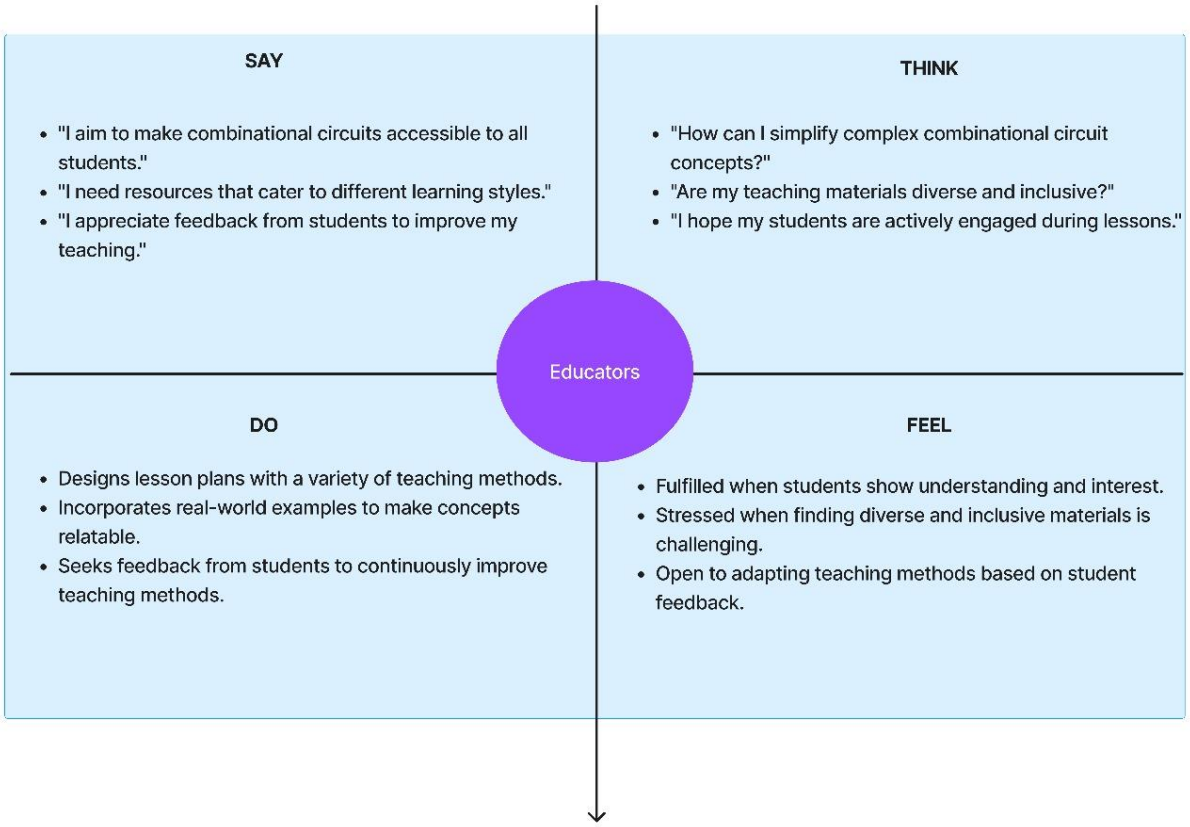


Figure 1.4.2 Educators Empathy Map

The educator empathy map offers a holistic view of educators' experiences by examining what they say, think, do, and feel in the context of teaching combinational circuits. In the "SAY" dimension, we pay attention to their expressed thoughts and needs. Exploring the "THINK" aspect helps uncover their beliefs and considerations. Observing their teaching methods and interactions with educational resources is covered in the "DO" category. Lastly, the "FEEL" section dives into their emotional responses. By understanding these four dimensions, we can design tailored solutions that align with educators' expressed needs, thoughts, actions, and emotions, ultimately fostering an enriched teaching experience for combinational circuits.

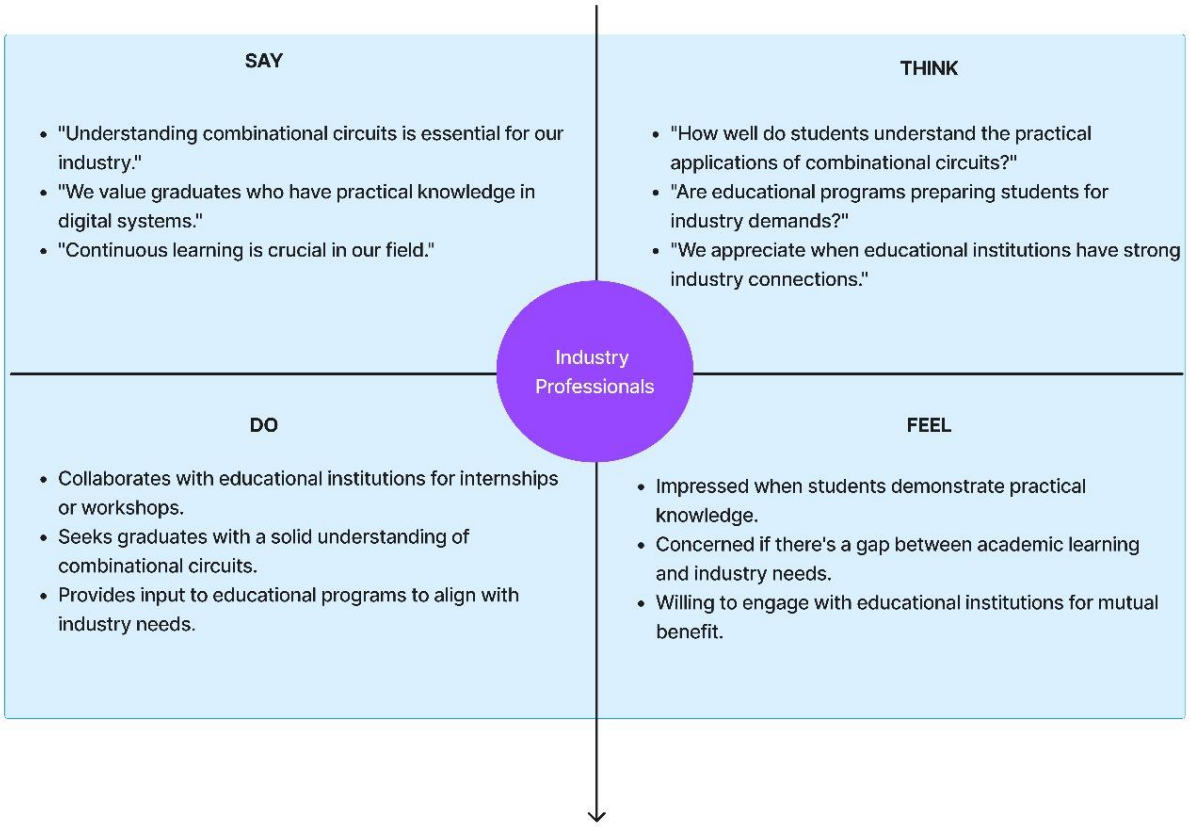
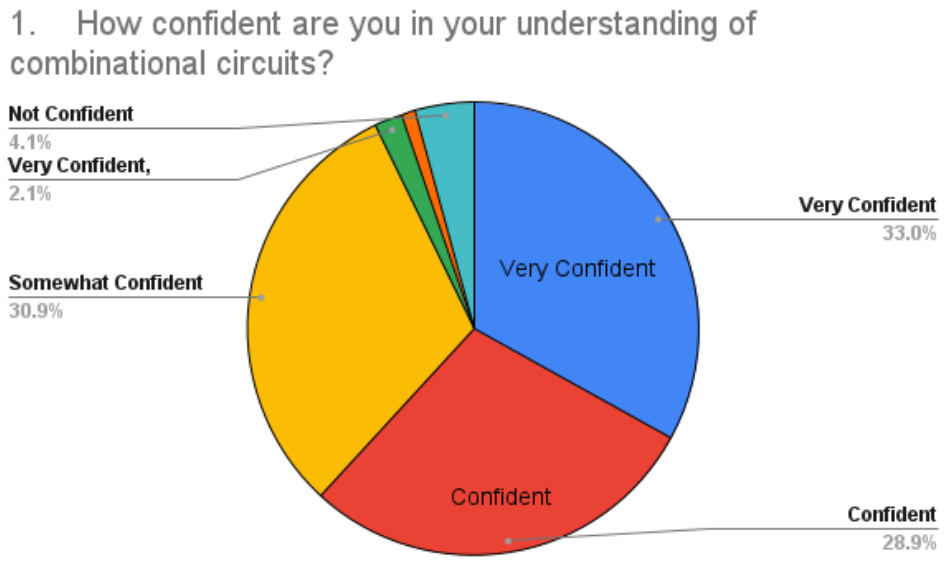


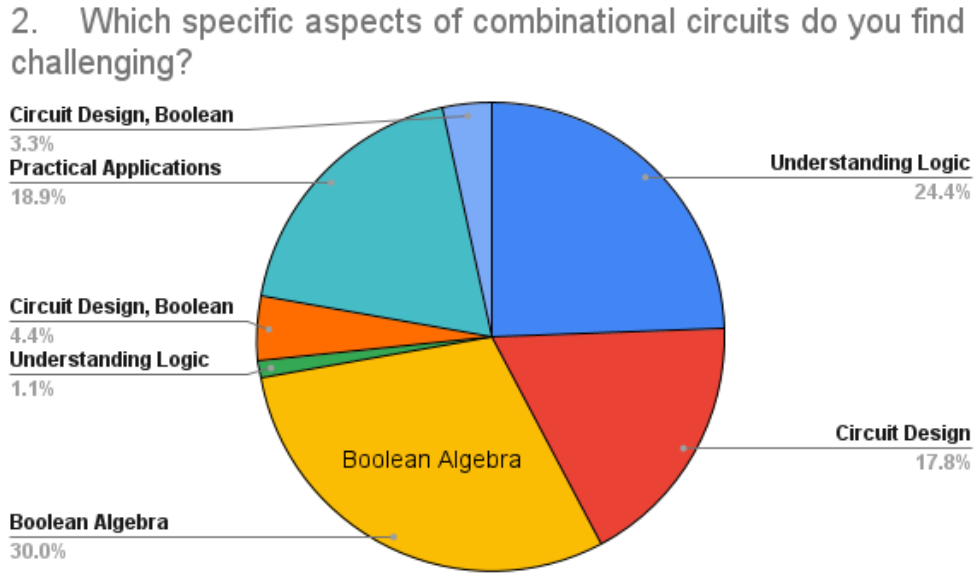
Figure 21.4.3 Industry Professionals' Empathy Map

The industry professionals' empathy map provides a comprehensive understanding of their perspective across four dimensions: "SAY," "THINK," "DO," and "FEEL." In the "SAY" dimension, we gather insights into their expressed thoughts and needs regarding the applications and relevance of combinational circuits in their fields. Exploring the "THINK" aspect reveals their internal considerations and expectations regarding the practical implications and future advancements in combinational circuits. Observing their actions and behaviours in the "DO" category helps us understand how they utilize combinational circuits in their work and interact with related technologies. Lastly, the "FEEL" section delves into their emotional experiences, uncovering sentiments, concerns, and aspirations related to combinational circuits. By considering these dimensions, we can design tailored solutions that address industry professionals' expressed needs, thoughts, actions, and emotions, facilitating collaboration and advancement in the field.

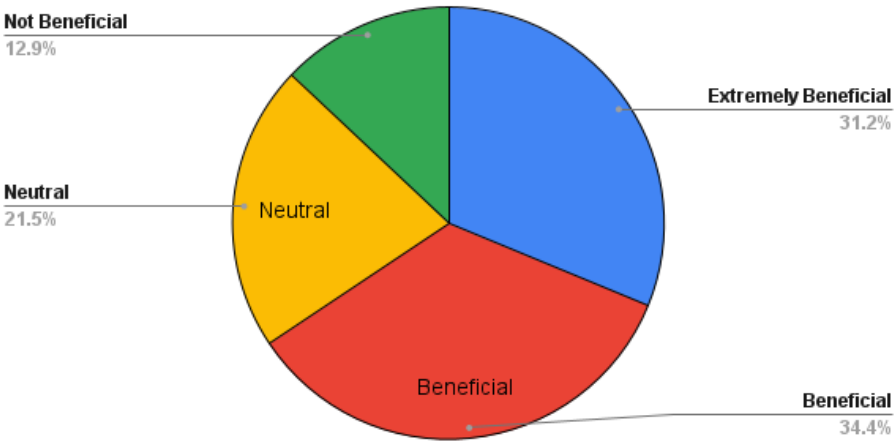
1.5 Tools Used for Empathy

1.5.1 Customer Survey and Analysis

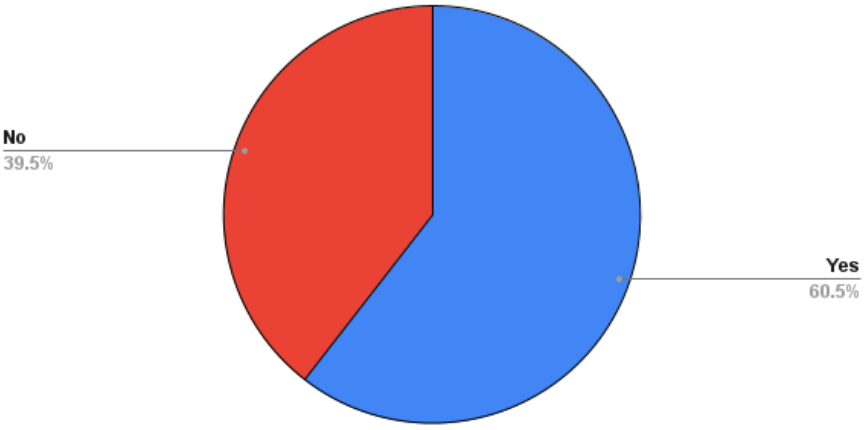




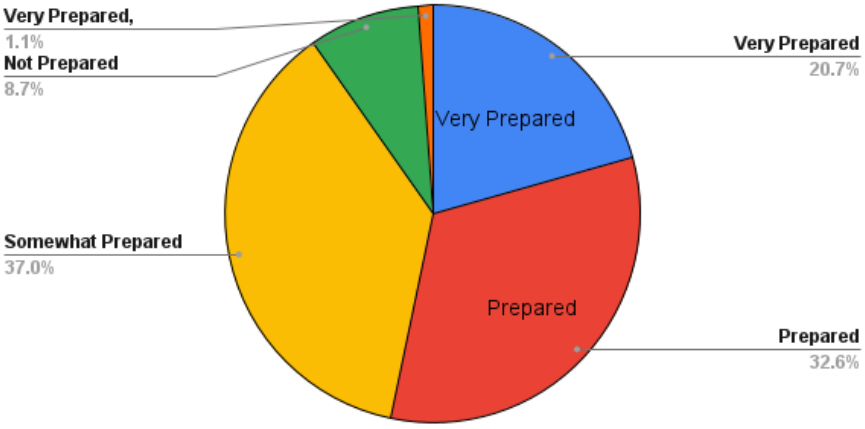
3. How beneficial would a hands-on practical session be in enhancing your understanding of combinational circuits?



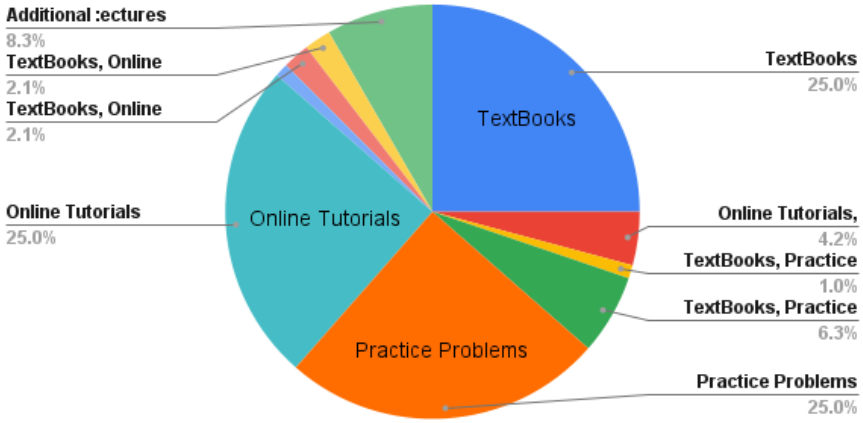
4. Can you identify real-life applications where combinational circuits play a crucial role?



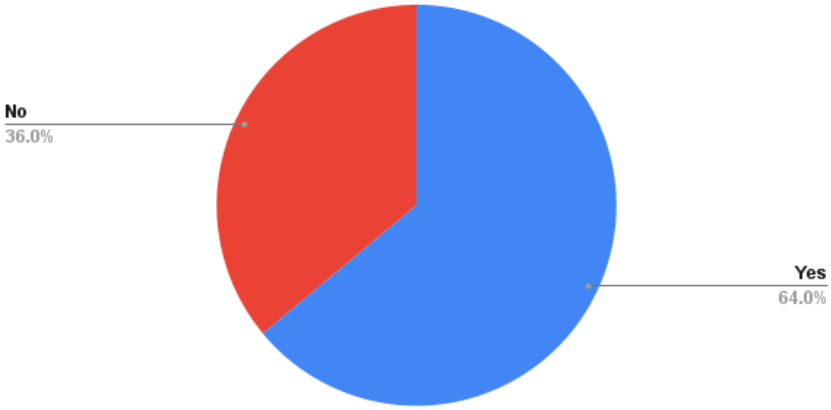
5. To what extent do you feel prepared for assessments (e.g., exams, quizzes) on the topic of combinational circuits?.



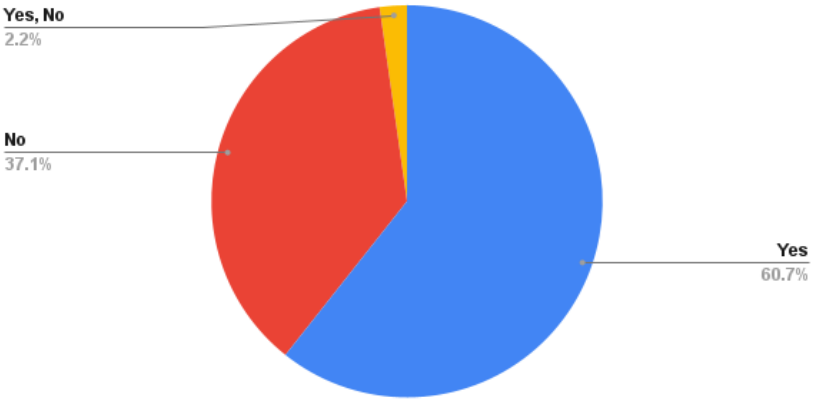
6. Share your feedback on what resources or support would have helped you perform better in your assessments related to

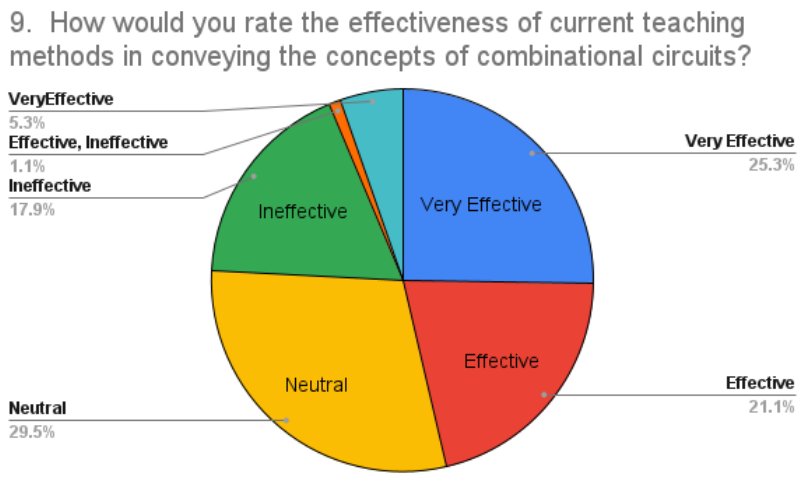


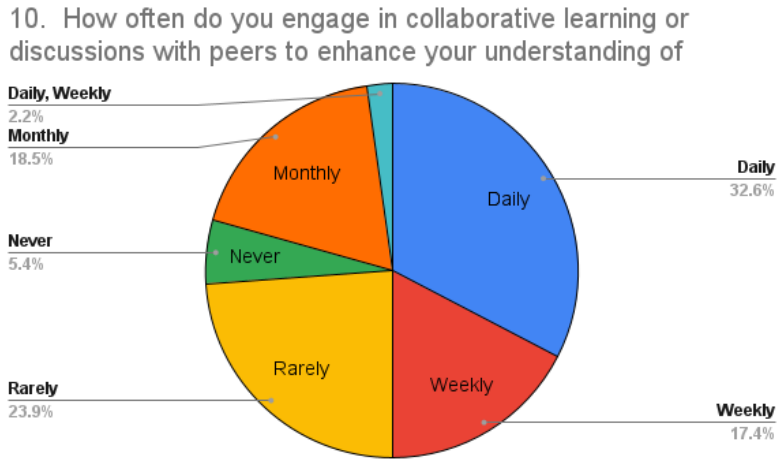
7. Have you explored any external resources (books, online tutorials, etc.) to supplement your understanding of



8. Are there any suggestions or changes you would recommend to improve the teaching approach or materials for understanding

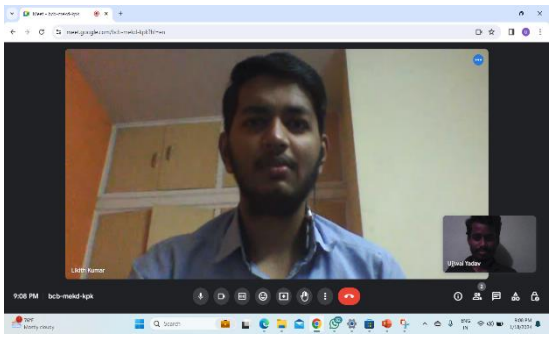


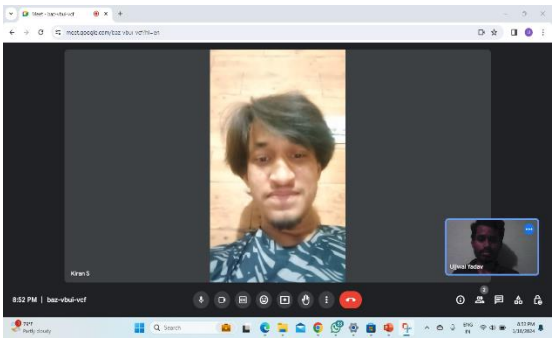




The survey showed that most people feel somewhat confident in their understanding of combinational circuits, with some finding specific parts like Boolean Algebra harder to grasp. Many think hands-on sessions are helpful, and most can name real-life uses for combinational circuits. While many feel ready for tests on the topic, some don't. Textbooks and online tutorials are popular resources, and most students have ideas to improve how combinational circuits are taught. Around 60% have looked for extra help outside of class, and about half think the current teaching methods are effective. Some talk about combinational circuits with peers every day, showing collaboration is important for learning. These results tell us how students feel about learning combinational circuits and suggest ways to make it easier and more effective for everyone.

1.5.2 Customer Interaction photos





1.5.3 Customer Interview's details

During the customer interview phase, we engaged in comprehensive data collection to gain insights into the perceptions and experiences of our target audience regarding combinational circuits. This involved conducting interviews with classmates, seniors, and super seniors within our college campus. Additionally, we extended our reach by sharing a Google Form with students from other colleges to gather a diverse range of perspectives. To accommodate remote participation, we also conducted virtual interviews via Google Meet. Through these interviews, we aimed to understand the challenges, preferences, and suggestions related to the subject matter, topics, and teaching methods associated with combinational circuits. By leveraging various interview methods and platforms, we ensured a thorough and inclusive approach to gathering valuable customer insights for our project.

The individuals we interviewed expressed enthusiasm about the prospect of incorporating AR and VR technology into the learning of combinational circuits. They believed that leveraging these immersive technologies could significantly enhance the clarity and enjoyment of understanding complex circuitry concepts. Many highlighted the potential for AR and VR to provide a clearer visualization of circuits, making abstract concepts more tangible and accessible. Additionally, there was a consensus that interactive simulations and gamification elements within AR and VR environments could increase engagement and motivation among students. Collaborative features were also deemed valuable, with participants emphasizing the benefits of peer interaction and knowledge sharing.

1.5.4 Secondary sources of Information

In our pursuit of understanding our customers better, we turn to additional sources that provide valuable insights beyond direct interactions. Here's a breakdown of what we cover in this section:

- Industry Reports and Publications:

  Exploring reports and articles related to our target audience, offering insights from experts and academics in the field.

- Market Trends and Analysis:

  Examining market trends and analyses from reliable sources to understand the broader industry landscape.

- User Reviews and Feedback:

  Compiling user reviews from various platforms to learn from others' experiences with similar products or services.

- Academic Research:

  Exploring relevant academic research to stay informed about studies related to our project focus.

- Customer Feedback on Similar Solutions:

  Studying feedback from customers who have used similar solutions, extracting valuable insights into their experiences.

- News and Press Releases:

  Staying updated on industry developments, challenges, and innovations through news articles and press releases.

These secondary sources help us gather a broader understanding of our customers and industry, ensuring a well-rounded and informed approach to empathy building and solution design.

CHAPTER 2

DEFINE

2.1 Introduction to Problem Statement

Learning about combinational circuits can be hard because they're really complex. The usual way of teaching them doesn't always help students really understand what's going on. Combinational circuits involve digital stuff that can be tough to understand with regular teaching methods. The big problem is that these circuits are kind of abstract, which means it's hard for students to see how they work and where they fit in real life. So, to make learning easier, we're trying out new ways of teaching using cool technology like Augmented Reality (AR) and Virtual Reality (VR).

Figure 32.1.1 Students Engaged in AR VR Technology

These technologies can change the game in how students learn about combinational circuits. Our goal is to make learning fun and engaging by using AR and VR tech through Unity. This change could make learning more exciting for students.

2.2 How Might We Questions

Enhancing Visualization:

1. How might we design immersive AR and VR simulations that accurately depict the behavior of combinational circuits?

2. How might we utilize AR and VR technology to provide dynamic, three-dimensional representations of logic gates and circuit components?

3. How might we enhance the clarity of abstract concepts in combinational circuits through interactive visualizations and animations?

4. How might we incorporate real-time feedback mechanisms in AR and VR environments to help students understand the consequences of different circuit configurations?

5. How might we optimize user interfaces in AR and VR applications to ensure intuitive navigation and interaction with combinational circuit simulations?

Engagement & Interactivity:

1. How might we gamify the learning experience within AR and VR platforms to increase student motivation and participation in combinational circuits education?

2. How might we design interactive challenges and puzzles in AR and VR environments to reinforce understanding and retention of combinational circuit concepts?

3. How might we incorporate storytelling elements into AR and VR simulations to contextualize the significance of combinational circuits in real-world applications?

4. How might we leverage gamification techniques such as rewards, badges, and leaderboards to encourage continuous learning and progression in combinational circuits understanding?

Collaborative Learning:

1. How might we create virtual collaborative spaces within AR and VR environments to foster peer-to-peer learning and collaboration in understanding combinational circuits?

2. How might we design group-based activities and projects within AR and VR simulations to promote teamwork and problem-solving skills in combinational circuits education?

3. How might we implement features for sharing and reviewing circuit designs collaboratively within AR and VR applications to encourage feedback and iteration among students?

4. How might we develop guided tutorials within AR and VR applications to assist students in understanding and navigating circuit design concepts?

2.3 Design Thinking challenges Identified

Challenge 1: Abstract Hurdles

Issue: Combinational Circuits involve complex abstract concepts, posing difficulties for learners in visualization.

Impact: Limits the effective understanding and application of digital logic elements.

Challenge 2: Traditional Teaching Gaps

Issue: Traditional teaching methods struggle to connect theoretical knowledge with practical hands-on application.

Impact: Students may lack a tangible grasp of real-world applications of combinational circuits.

Challenge 3: Engagement Obstacles

Issue: Conventional materials often fail to engage students, resulting in limited interaction with combinational circuits.

Impact: Diminished enthusiasm and interest, impeding the overall learning experience.

Challenge 4: Learning Style Diversity

Issue: Diverse learning styles among students make it challenging to tailor educational approaches effectively.

Impact: Some students may find it difficult to connect with and comprehend combinational circuit concepts.

CHAPTER 3

IDEATE

3.1 Introduction to Ideation

Ideation is the creative process of generating, developing, and refining ideas. It's a crucial phase in problem-solving and innovation, where diverse concepts are explored and combined to find novel solutions. Ideation involves fostering an open and collaborative environment that encourages the free flow of ideas, aiming to break away from conventional thinking and spark innovative approaches.

Figure 3.1 Ideation

Understanding Ideation:

Ideation is like a creative brainstorming session where we come up with new and interesting ideas. In our case, with combinational circuits, it means thinking of cool ways to make learning about digital logic more exciting. We want to find ways to turn tricky concepts into fun and interactive experiences, using cool technologies like Augmented Reality (AR) and Virtual Reality (VR).

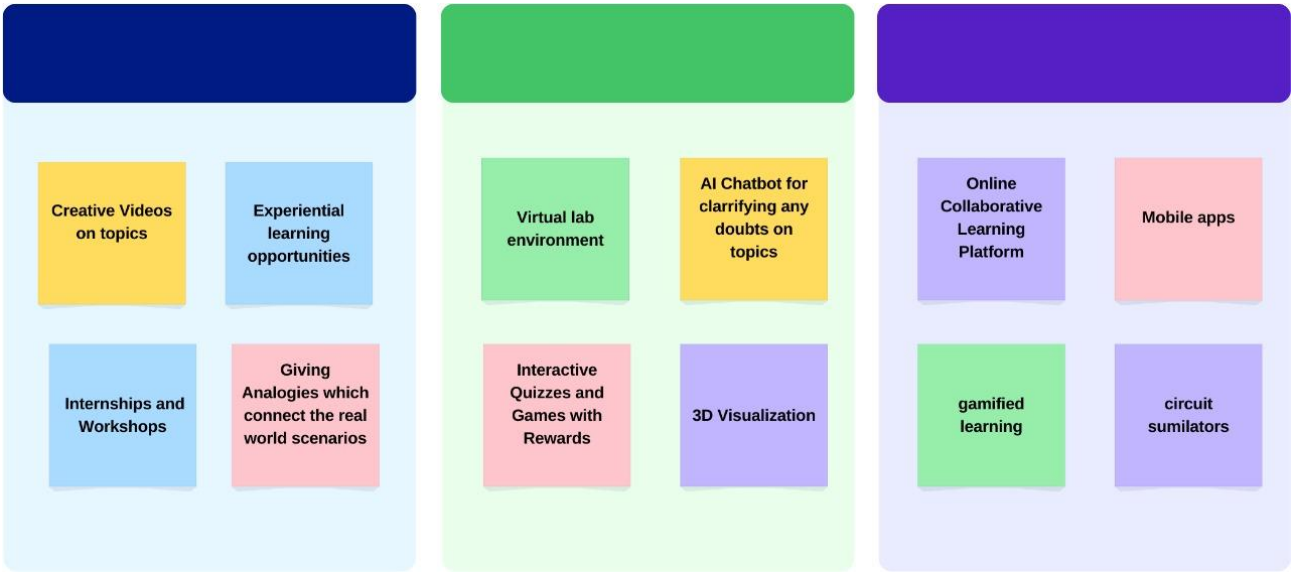
Why Ideation for Combinational Circuits?

Ideation for combinational circuits is all about finding smart and engaging ways to help students understand these digital logic things better. We're exploring methods and tricks, especially using AR and VR, to make abstract ideas feel real and easy to learn.

What to Expect in this Chapter:

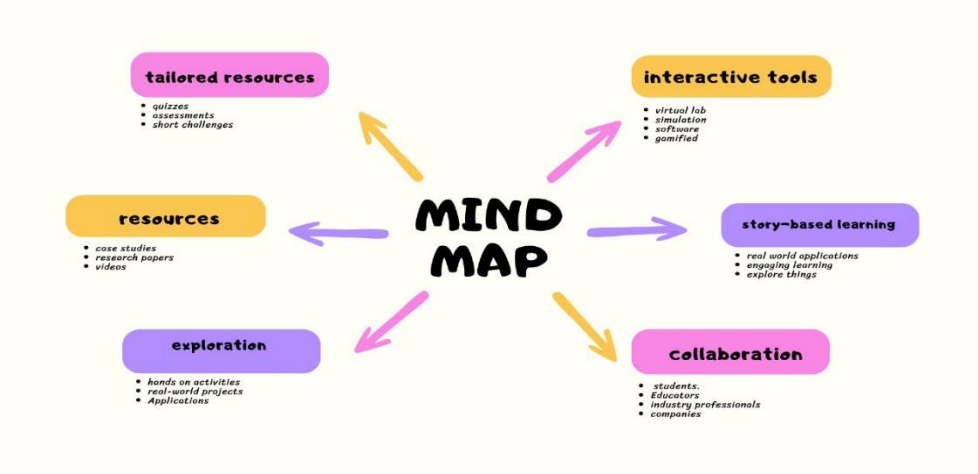
This chapter is like a guide to our creative process. We'll share the methods and cool techniques we're using to come up with imaginative solutions for the challenges we found in studying combinational circuits. Our goal is to break the usual ways of thinking, create an environment where new ideas can grow, and bring some awesome, innovative ideas to make learning about combinational circuits a fantastic experience for students.

3.2 Ideation Techniques used (Affinity Maps)



An affinity map is a visual tool used in design thinking to organize and synthesize large amounts of qualitative data, such as observations, insights, or ideas, into meaningful clusters or themes. It helps teams identify patterns, trends, and commonalities within the data to gain deeper insights and inform decision-making. In the context of using AR and VR technology to enhance combinational circuit learning, we utilized affinity mapping to group and analyze student feedback, observations, and ideas, revealing valuable insights that guided the development of innovative solutions.

Mind Map



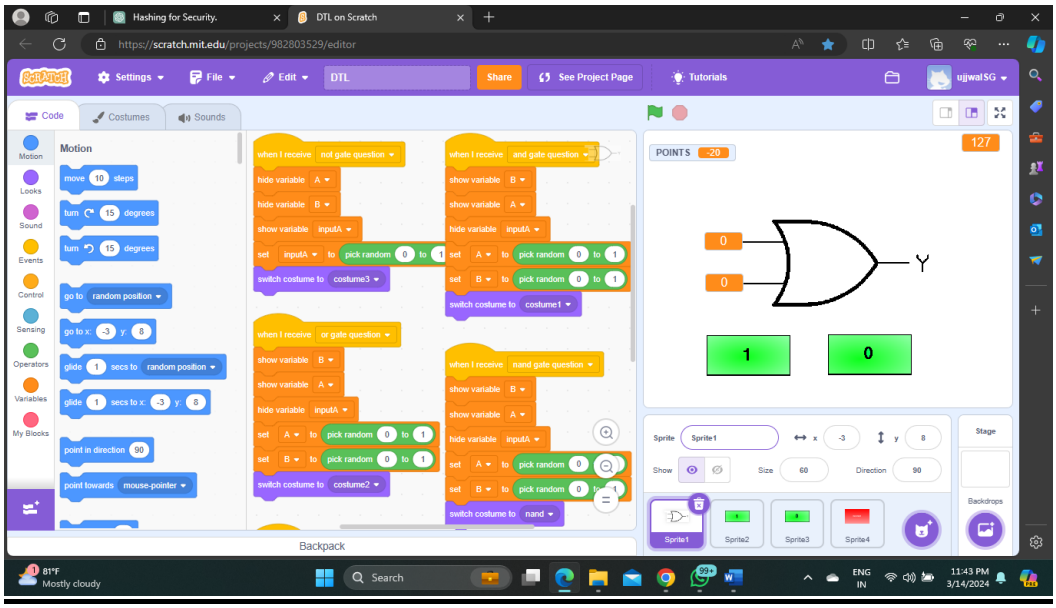
Story Board


story board
Imagine calculating the total cost of items in a shopping cart. We need a system to add up the prices quickly and accurately.
can combinational circuits can solve this.
introduces the concept of a full-adder for more complex calculations
a simulated scenario where multiple items need to be added in a shopping cart.
Taylor starts sketching a circuit diagram, applying the half-adder concept.
works on circuit to handle multiple inputs and calculates the total cost.
thinks how adders in combinational circuits can solve real-world problems efficiently.
expresses gratitude for the hands-on learning experience.

CHAPTER 5

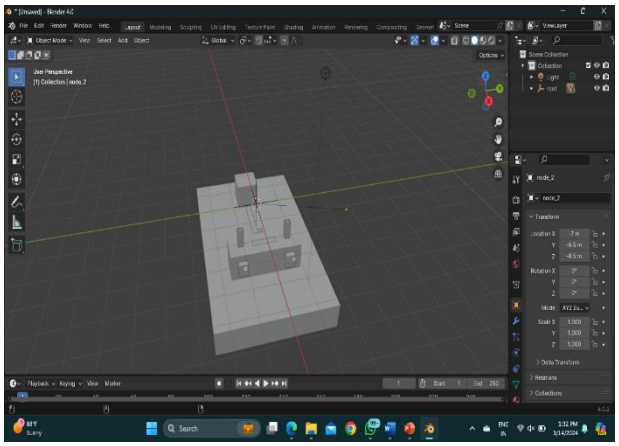
PROTOTYPE

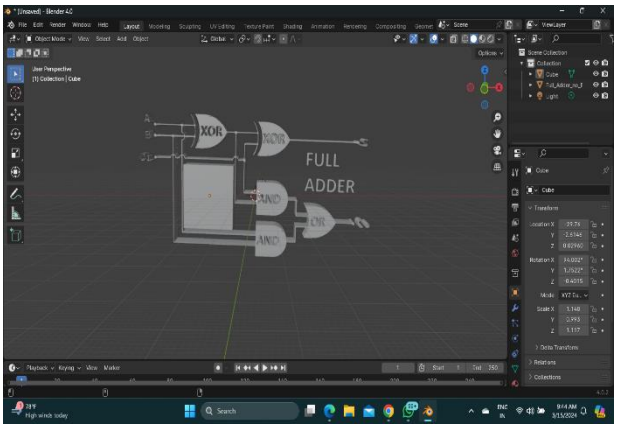
Games on logic gates



- **Engages students in a fun and interactive way to learn about logic gates.**
- **Provides hands-on experience in applying theoretical knowledge to practical scenarios.**
- **Encourages problem-solving skills and critical thinking as students navigate through challenges in the game.**
- **Visualizes abstract concepts of logic gates, making them more tangible and easier to understand for students.**

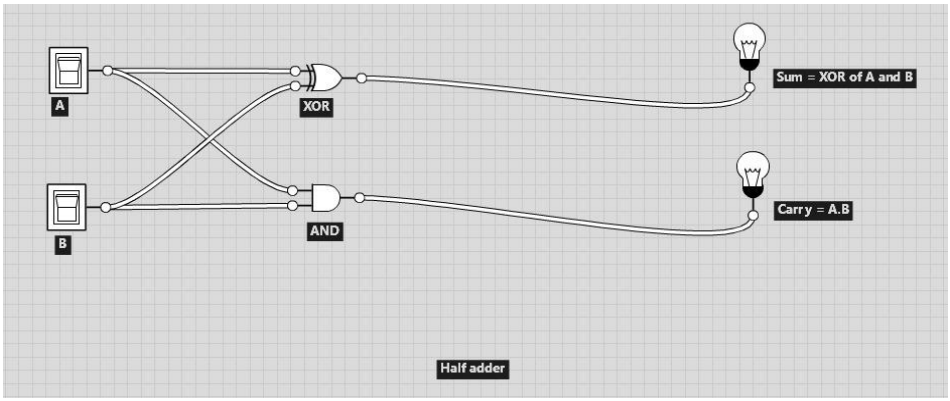
3D Models of Circuits

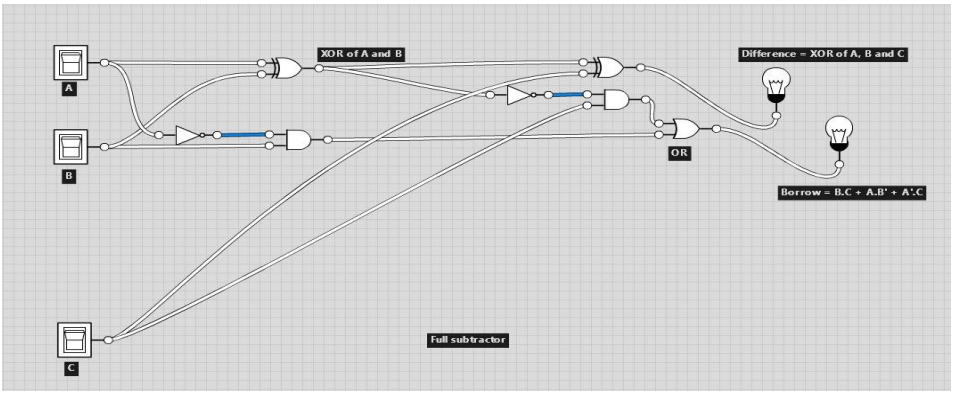




- Enhances students' visualization skills by representing circuits in a three-dimensional format.
- Allows students to explore circuits from different perspectives, aiding in better comprehension.
- Provides a more immersive learning experience compared to traditional two-dimensional diagrams.
- Facilitates the identification of components and their spatial relationships within a circuit.

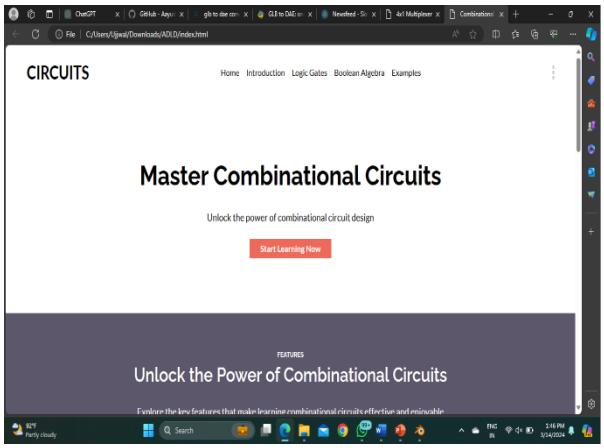
Circuit Simulation for Better Understanding

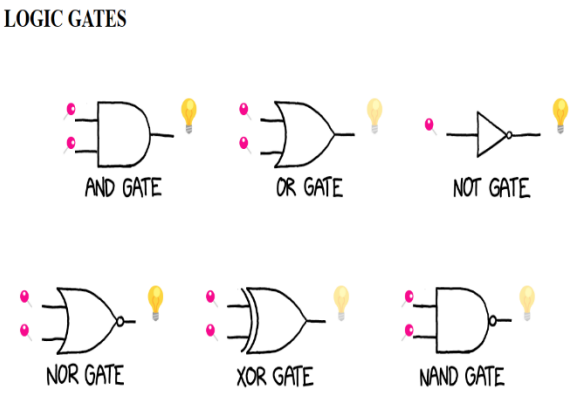




- Helps students grasp the concept of input-output relationships in combinational circuits.
- Allows students to observe real-time changes in circuit behavior based on input changes, reinforcing theoretical concepts.
- Provides a safe environment for students to test circuit designs without the risk of damaging physical components.

Interactive Websites





Inputs		Outputs	
A	0	Sum	0
B	0	Carry	0
Carry In	0		

- Provides accessible resources for students to access information and practice circuit concepts.
- Offers interactive tutorials, quizzes, and exercises to reinforce learning objectives.
- Enables students to learn at their own pace and revisit concepts as needed.
- Facilitates collaboration and knowledge-sharing among students through online forums and discussion boards.

Animated Videos

- Animated videos can break down intricate concepts into step-by-step explanations, guiding students through the logic behind combinational circuits.

Conclusion

In this project, we delved into the fascinating realm of combinational circuits, exploring their fundamental principles, design methodologies, and practical applications. Through meticulous study and experimentation, we have gained invaluable insights into the intricate workings of these circuits and their pivotal role in modern digital systems.

Furthermore, we embarked on practical exercises to reinforce our understanding, leveraging simulation tools and hardware prototypes to construct and analyze diverse combinational circuits. These endeavors not only honed our technical proficiency but also provided us with firsthand experience in troubleshooting and optimizing circuit performance.