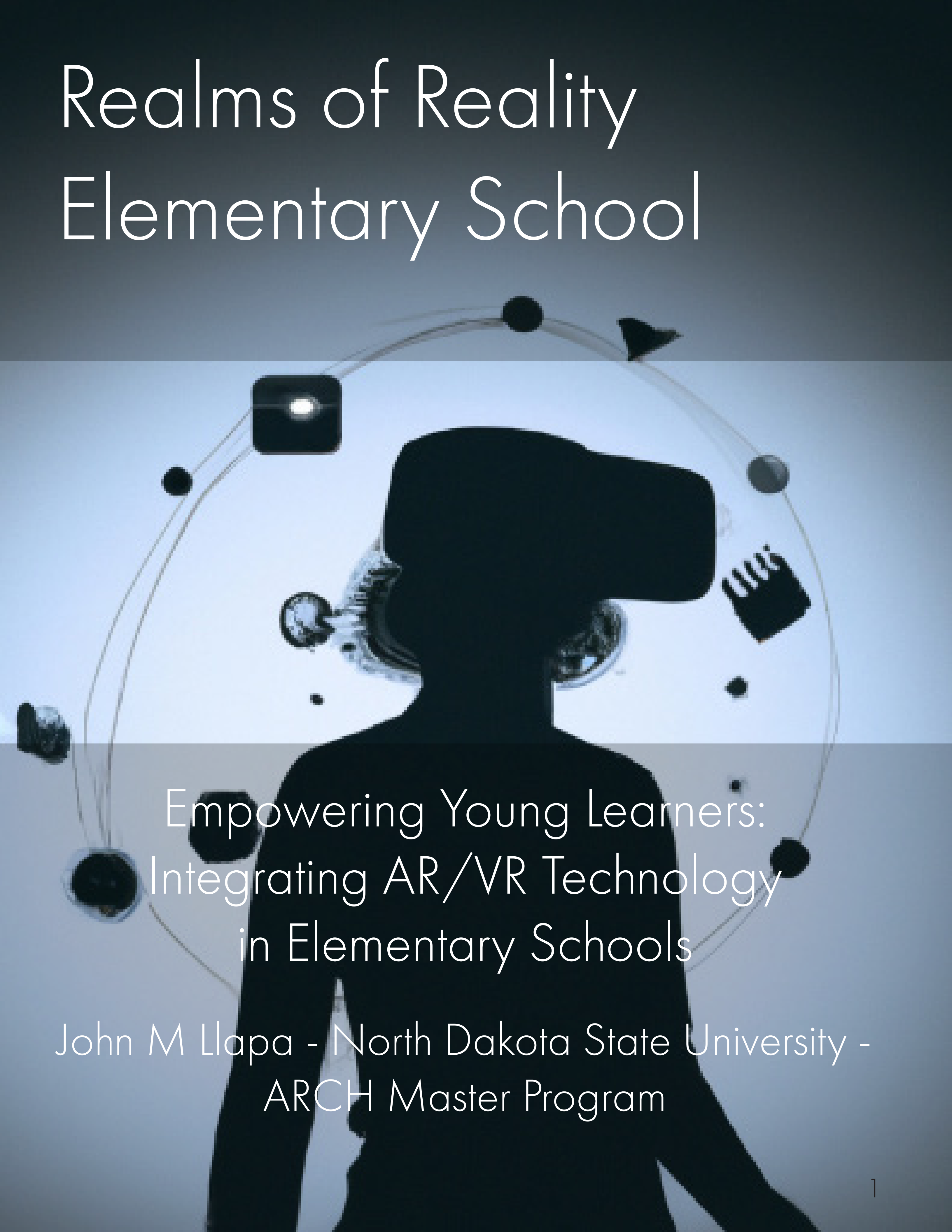

Realms of Reality Elementary School

Empowering Young Learners: Integrating AR/VR Technology in Elementary Schools

John M Llapa - North Dakota State University - ARCH Master Program

AR and VR BENIFITS TO EDUCATION

A Design Thesis Submitted to the
Department of Architecture
North Dakota State University

By:
John M Llapa

In Partial Fulfillment of the Requirements
for the Degree of
Master of Architecture

Ganapathy Mahalingam
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Thesis Committee Chair

May, 2023
Fargo, North Dakota

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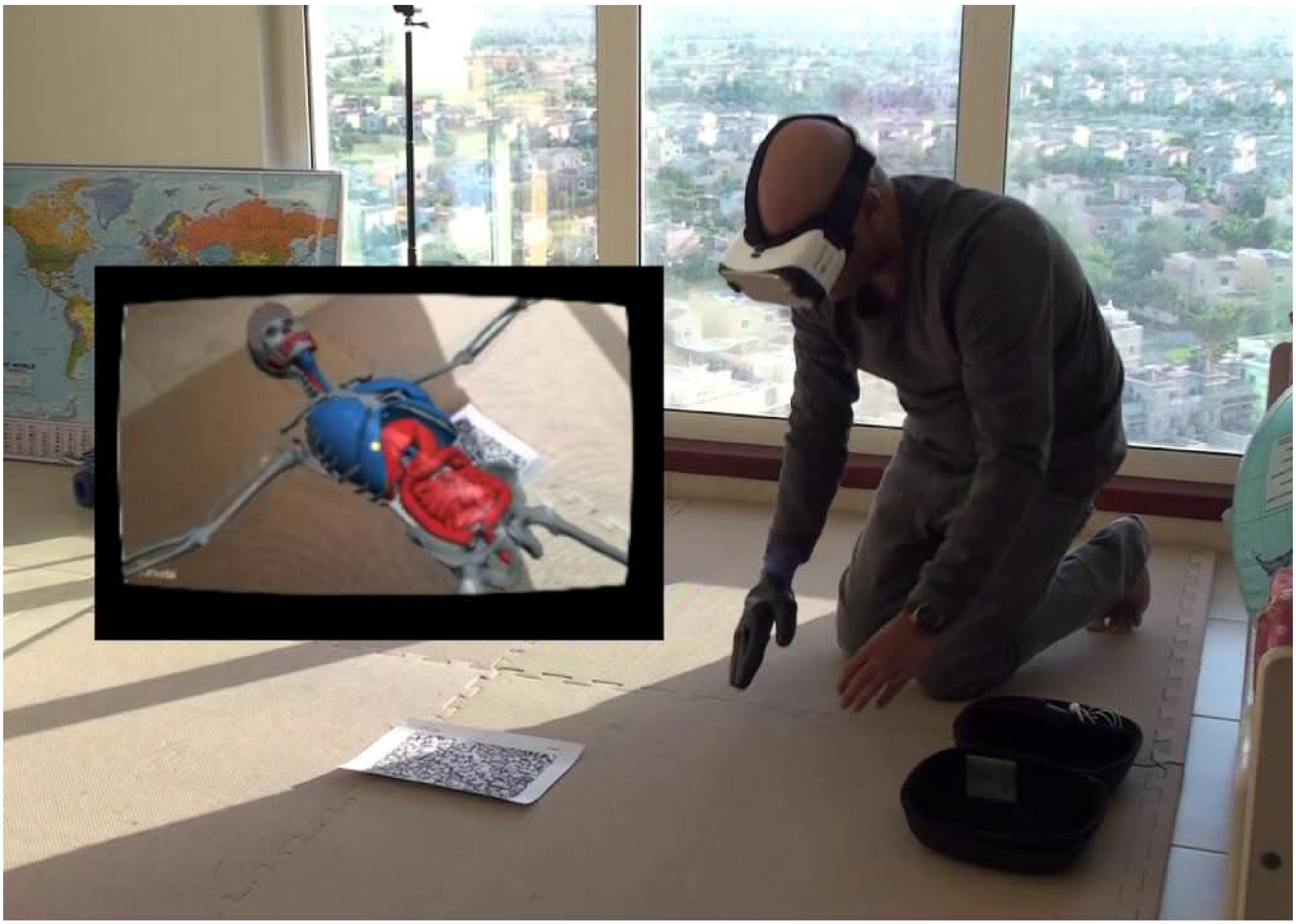


Figure 03 | VR Use in Neuroscience | MAR360

Thesis Abstract

An analytical re-imagining of the K-12 educational model in tandem with AR and VR technologies through architecture has the ability to redefine the success of the next generation of minds. Technology is constantly evolving at an extraordinary rate. The K-12 facilities have been slowly incorporating newer technologies to aid students, but have not yet implemented AR and VR. This thesis attempts to design a new K-12 facility to improve upon academic efficiency among students. This will be achieved by conducting experiments in which differently designed rooms will be used to evaluate whether the room benefits the students in any way.

Thesis Narrative

I believe that the education system is crucial for the development of young minds. It is here that teachers can spark inquisitiveness in children and boost their curiosity. We are living in the age of technology and school districts across the board have been implementing technology to better the quality of education. This has been achieved through the use of SmartBoards, Projectors, Chromebooks, E-books, and many other things. I am passionate about technology and education. I believe that the resources that my K-12 schools had given me allowed me to further pursue my interests and foster my sense of curiosity. I am currently curious to see what the next technology will be that is implemented within schools to further the quality of education. I am passionate about further research on how VR and/or AR may be able to aid teachers, students, and even family members. See the different ways that these technologies may change the classroom design, merge and amplify the current curriculum, help aid in collaboration, further the younger generations' knowledge about the technology itself, and many other things. We live in an exciting time where we are just now seeing VR and AR being used in certain industries/professions. We should soon begin thinking about incorporating this bleeding-edge technology into the schools to better equip the younger generations with the knowledge that will certainly help them and even society years down the road.

Project Typology

This thesis aims to be a K-12 facility. Specifically, a high school. Here is where the exploration of how architecture can help with the overall design of the built environment. Uncovering research and theories behind the current layouts, materials, and circulation. Allowing for the further development of an ideal/optimal design of multiple rooms that become harmonious. Looking closely at the principles for lecture halls, auditoriums, labs, flex spaces, classrooms, and central areas will be imperative to determining how AR and VR can be incorporated best within the education curriculum. The precedent that I have set forth for this thesis revolves around how architecture can work in tandem with AR and VR technologies to further enhance the learning process.

Major Project Elements

The project's emphasis consists of developing schools that will change the educational environment. Allowing students to grow and enjoy their education. Discovering how spatial thinking can help students in the classroom will help define certain parameters for how the classroom spaces should be laid out and designed.

VR/AR Labs

- VR and AR workstations
- Large breakout space for class demo
- General Access

Makers Space

- Encourage physical project making
- Classroom for education and trades

Common Area

- Creates a central hub
- Encourages interactions

User/Client Descriptions

USER GROUPS

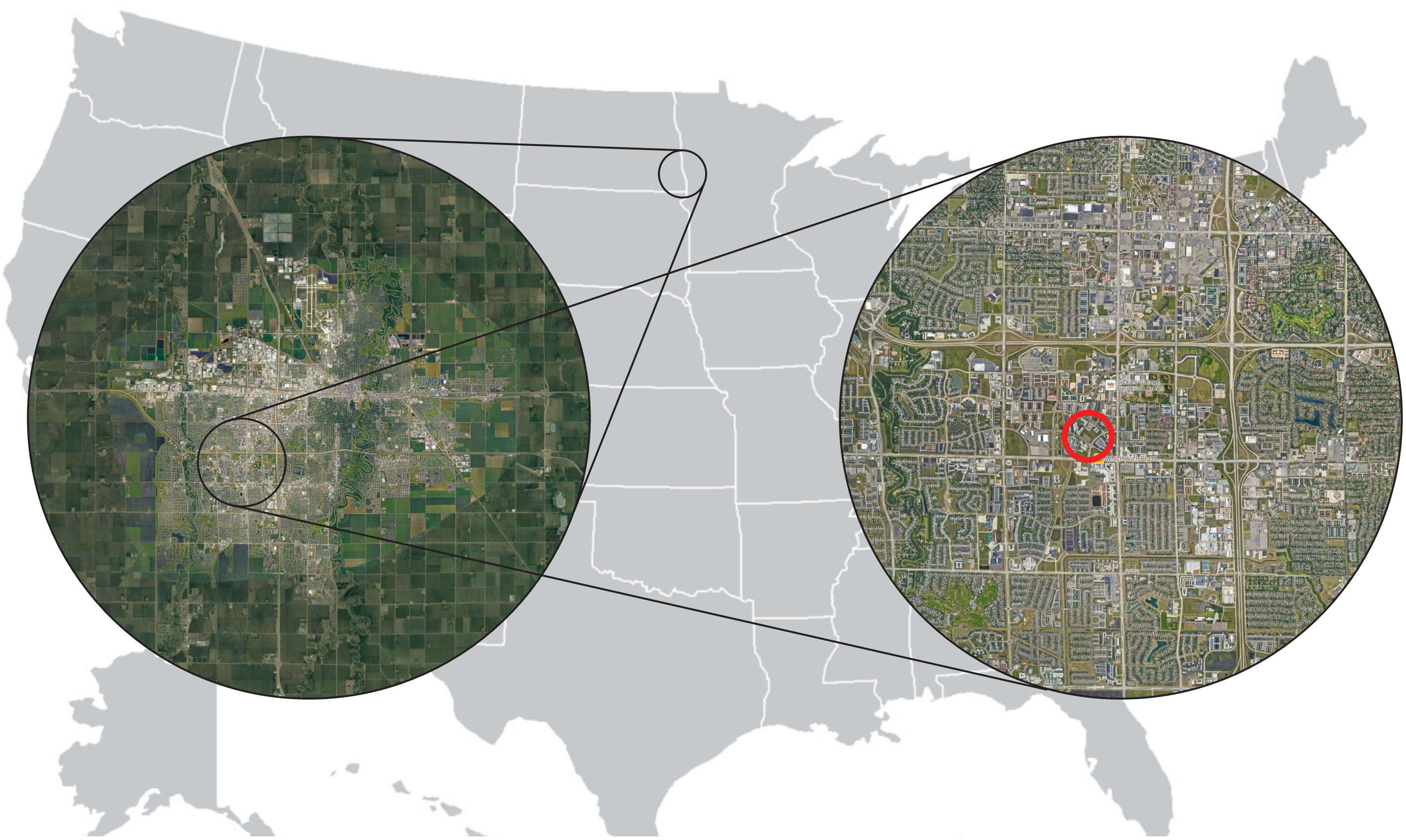
- Office Employees
- Teachers/Instructors
- Medical Practitioners
- Students
- Janitorial Employees
- Security Employees
- Counselors
- Cafeteria Employees
- Technology Employees
- General Staff(Library, Woodshop, etc.)
- Community Members

CONSIDERATIONS

- Technology Labs:
  - Server room
  - Proper spatial needs
  - Circulation
  - Safe storage
  - Daylighting
  - Electrical usage

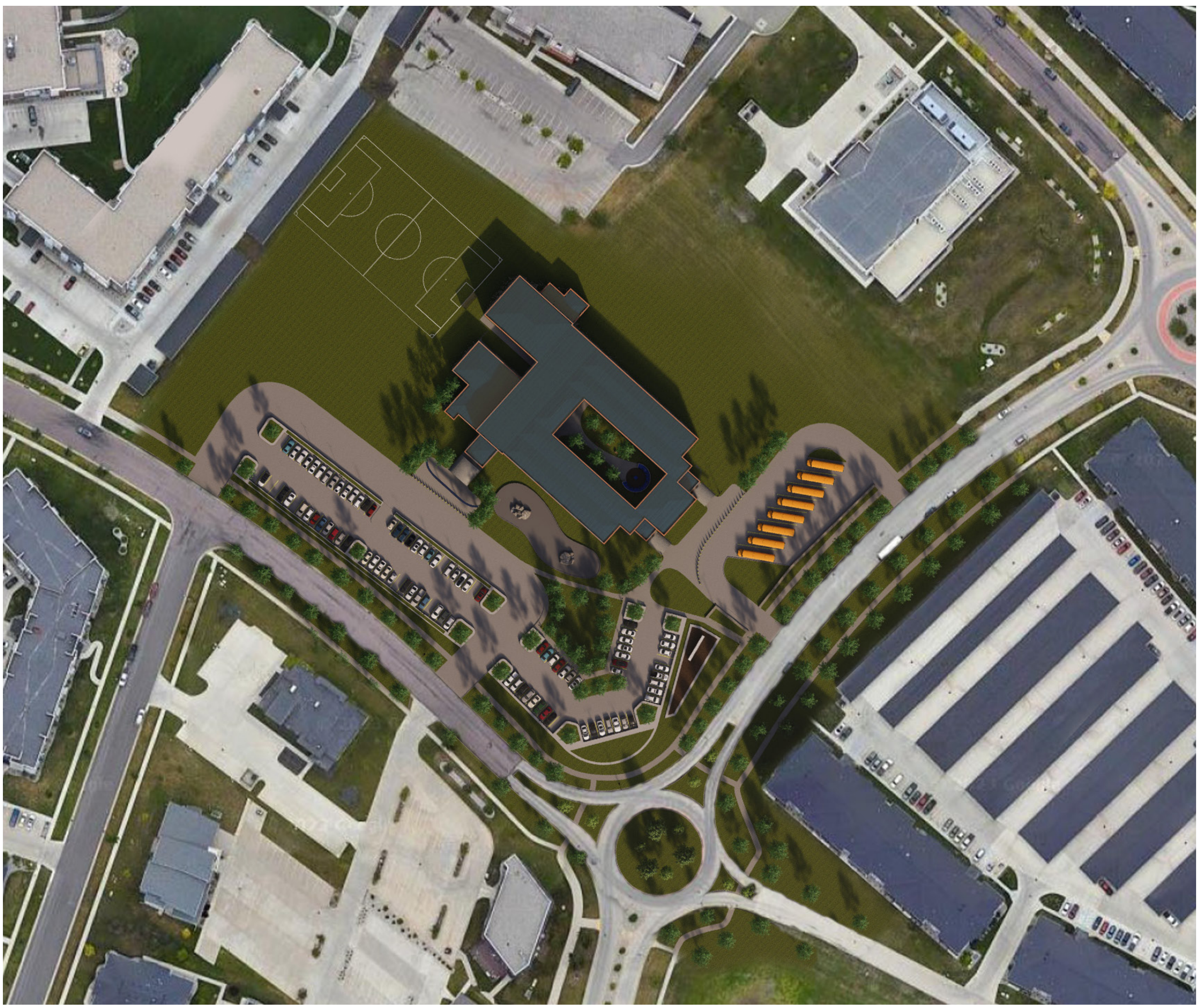
The Site

The elementary school is situated in Fargo, North Dakota, west of I-29 and south of I-94. The location was chosen due to the city's southwest expansion, which necessitated the construction of additional elementary schools. Presently, the student-to-teacher ratio is the highest in the elementary schools of this expanding southwest region. Realms of Reality Elementary School aims to serve as an intermediate school for grades 3-5 in this district, as the current elementary school has a teacher-to-student ratio of 17 to 1. This move would help lower the ratio and provide a more personalized learning experience.



The Site

The site address is 4651 30th Ave S, Fargo, North Dakota. Brandt Drive South is located to the east and 30th Ave South to the south of the site. These two roads serve as the primary way for traffic to flow around the site. This influenced the placement of my site entrances. I wanted to ensure that bus traffic doesn't affect the drop-off traffic and vice versa. This is why the two different parking lot areas are on two separate sides of the site. Allowing for all busses during morning dropoff and afternoon pickup to remain on the east side of the site and all vehicular traffic to happen on the west side.



Project Empasis

The project's emphasis consists of developing schools that will change the educational environment. Allowing students to grow and enjoy their education. Discovering how spatial thinking can help students in the classroom will help define certain parameters for how the classroom spaces should be laid out and designed.

1. Cultivate spatial thinking in young minds

2. Allow access to modern technology

3. Create a sense of community

Project Justification

This project is important to my because I am passionate about architecture, education, and technology. Curiosity is an extraordinary characteristic to have. Simply, by having a strong sense of curiosity one can elevate their life through education and technology. Referring to the general welfare of our society this thesis will help define the framework for the designs of K-12 schools. Which will elevate the quality of learning that can be provided to students. Allowing them to further enjoy their education and become more curious themselves. Which is what we would like to see in the future. An increase in higher education recipients and a bigger educated workforce.

Goals of the Thesis Project

Theoretical, physical, and social goals of the project:

1. [Physical] Create new special rooms purely for the purpose of encouraging curiosity and allowing access to current technology.

2. [Theoretical] How can architecture aid in the cultivation and practice of spatial thinking.

3. [Social] Establish a main common area where individuals are excited to meet and talk with their peers.

3. [Social] Create an atmosphere that encourages collaboration.

Plan for Proceeding

Upon completion of the proposal and virtual reality test, I may begin to move forward in the programming phase of design. While at the same time determining the appropriate project site.

Utilizing programs such as Rhino 7, Grasshopper, AutoCAD, Unreal Engine 5, and Adobe Suites, I will begin developing a 3D model of the site and context. Allowing me to then begin the programming of the project. Shortly after followed with the conceptual design phase.

Once far enough into my design process, I will begin creating conceptual massing and spatial diagrams. This will be aided by the previous research I have completed up to this point. Eventually leading me to the structure, HVAC, Electrical, and plumbing of the project.

Definition of Research Direction

The process used to arrive at a research conclusion

1. Complete IQ test which will inform me as to how much AR and VR can help students stay engaged and develop spatial thinking abilities

2. Researching case studies will inform me of possible different solutions which will aid in the development of this project

3. Upon the completion of the initial research, the information I have gathered will allow me to begin the conceptual design phase

4. Utilizing programming iterations, site analysis, and prior information, I can then begin will mass modeling iterations.

5. Eventually all of this prep work will lead me to a 3D model that will be generated in Revit and Rhino.

Documentation of the Design Process

DOCUMENTATION COMPILATION / Document creation

Medium for design investigation:
Computer representation
Hand sketching
Hand modeling

Software

Investigation
- Autodesk Revit
- Unreal Engine
- Rhino 7

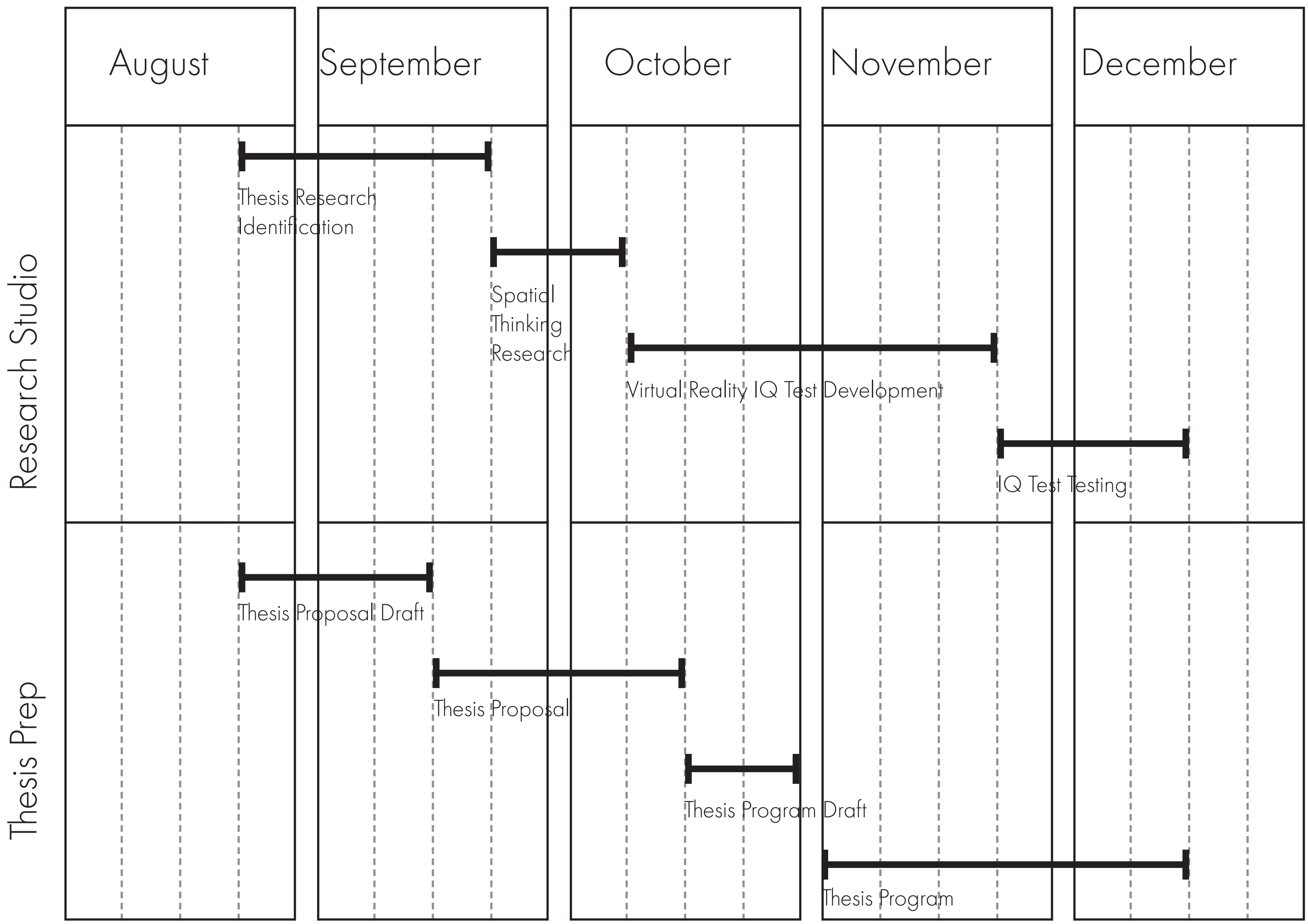
Representation
- Adobe Photoshop
- Adobe Illustrator
- Adobe Premiere Pro
- Adobe InDesign
- Adobe After Effects

Design Preservation Methods:
- Feedback from advisor(s)
- Research Material Documentation
- Computer files backed up weekly
- Thesis book updated weekly as per schedule

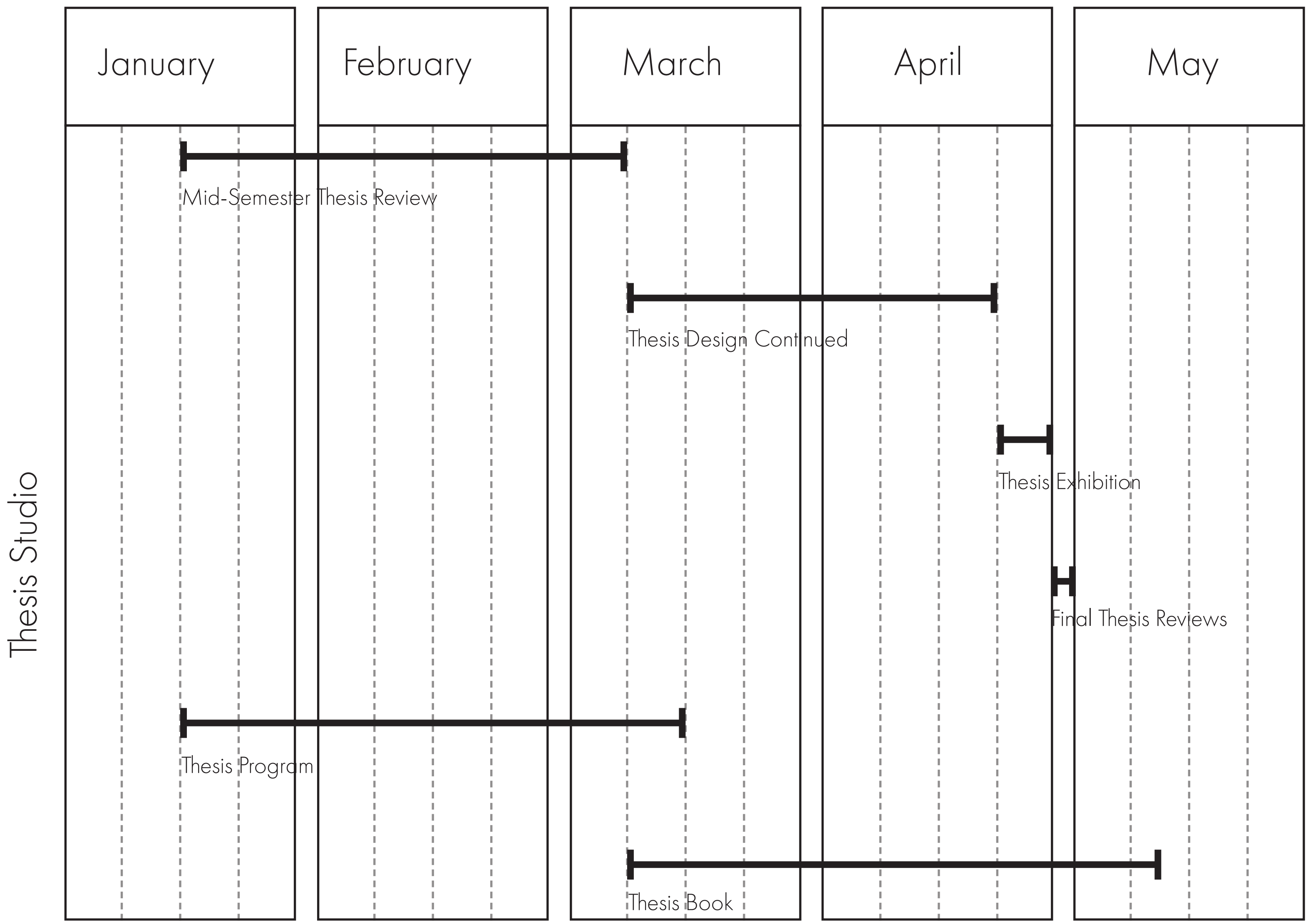
Publication of Material:
- NDSU Institutional Repository
- Hard cover book format

Documentation Organization:
File Labeling: Year-Llapa_Thesis_Phase_Name

Thesis Project Schedule



Thesis Project Schedule



The Research

Precedent Research

Before selecting case studies I did personal research and developed a virtual reality IQ test. To explore how this technology can benefit users.

When selecting the following case studies for precedent research, four major factors were given consideration:

1.) Typology

2.) Context

3.) Student Body

4.) Defining Characteristics

The following projects were given special consideration for precedent research:

- Case Study 01
- Case Study 02
- Case Study 03

Case Study 01

Figure 08 | Canyon View High School | DLR Group

Case Study 01

Canyon View High School

Client: Agua Fria Union High School District #216
Location: Waddell, AZ
Area: 237,000 SF
Students: 1800

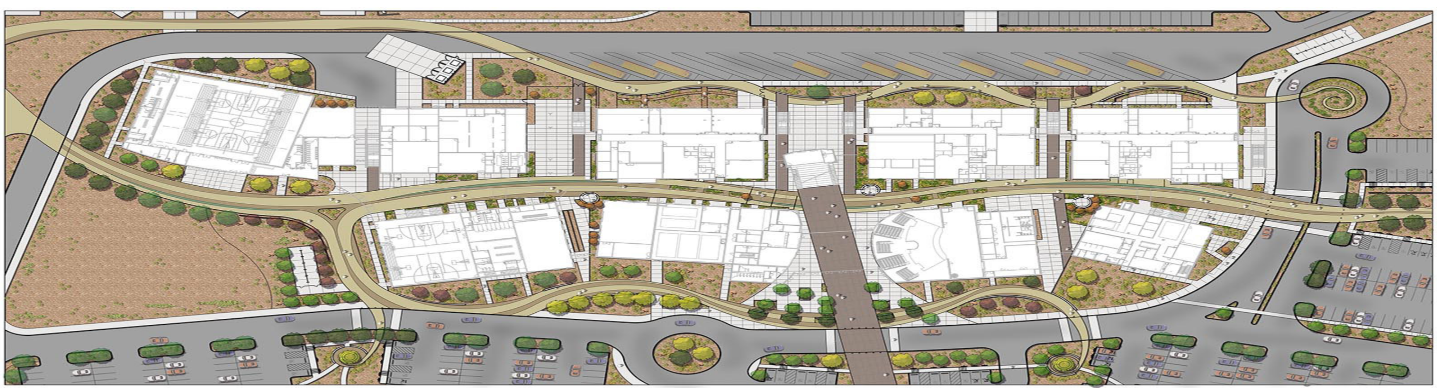


Figure 09 | CVHS Floor Plan | LoganSimpson

Case Study 02

Figure 10 | Dobyns-Bennett HS | Perkins & Will

Case Study 02

Dobyns-Bennett High School

Client: Kingsport City Schools
Location: Waddell, AZ
Area: 70,000 SF

Figure 11 | Three-Story Atrium | Perkins & Will

Case Study 03

Figure 12 | Eastwood High School | DLR Group

Case Study 03

Eastwood High School

Client: Ysleta Independent School District
Location: El Paso, TX
Area: 302,000 SF
Students: 2,500

Figure 13 | Main Enterance | DLR Group

Historical Context

In 1956 Cinematographer Morton Heilig created Sensorama, which was the first VR machine. It was a large booth that could fit up to four people at a time. It combined technologies to stimulate all the senses: a full-color 3D video, audio, vibrations, smell, and atmospheric effects, such as wind. This was done using scent producers, a vibrating chair, stereo speakers, and a stereoscopic 3D screen. Leilig thought that the Sensorama was the "cinema of the future" and he wanted to fully immerse people in their films. Six short films were developed for it.

In 1968 Sutherland, with his student Bob Sproull, created the first virtual reality head-mounted display (HMD), named The Sword of Damocles. This head mount connected to a computer rather than a camera and was quite primitive as it could only show simple virtual wire-frame shapes. These 3D models changed perspective when the user moved their head due to the tracking system. It was never developed beyond a lab project because it was too heavy for users to comfortably wear; it had to be strapped in because it was suspended from the ceiling.

In 1985 Jaron Lanier and Thomas Zimmerman founded VPL Research, Inc. This company is known as the first company to sell VR goggles and gloves. They developed a range of VR equipment, such as the DataGlove, EyePhone HMD, and the Audio Sphere.

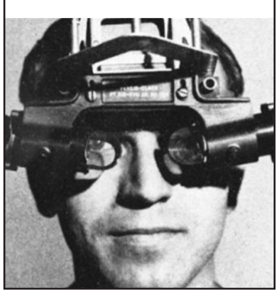
In 1991 Antonio Media, a NASA scientist, designed a VR system to drive the Mars robot rovers from Earth in supposed real-time despite signal delays between the planets. This system is called "Computer Simulated Teleportation". The Virtuality Group launched Virtuality. These were VR arcade machines where gamers could play in a 3D gaming world. This was the first mass-produced VR entertainment system. A Virtuality pod featured VR headsets and real-time immersive stereoscopic 3D images. Some of the machines could be networked together for multi-player games. Eventually, some of The very popular arcade games, like Pac-Man, had a VR version.

1956:

Sensorama

1968:

The Sword of Damocles

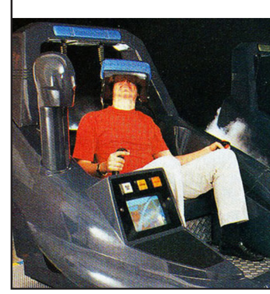


1985:

VPL Research, Inc.

1991:

Virtuality



Historical Context

In 2012 Oculus initiated a Kickstarter campaign to fund the Rift's development. Oculus set its Kickstarter goal at $250,000 but blasted through that in less than 24 hours. The campaign would go on to raise more than $2.4 million. 9,522 backers contributed to the campaign, and without their help, Oculus may have never taken off as it did.

In 2019 the HoloLens 2 was released. The HoloLens 2 are a combination of waveguide and laser-based stereoscopic & full-color mixed reality smartglasses developed and manufactured by Microsoft. The glasses have many features such as hand tracking, voice control, eye tracking, spatial mapping, and a large field of view.

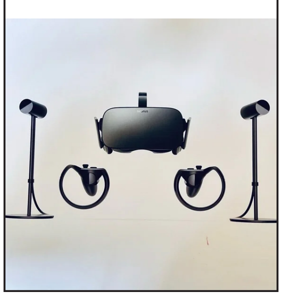
In 2020 The Oculus Quest 2 was unveiled during the Facebook Connect 7 event. The product comes with a VR headset and two motion controllers. The controllers and player location are tracked by the headset while also allowing for hand tracking. The headset no longer needs to be tethered with a cable to a computer. It can run stand-alone off the internet.

In 2023 Virtuix, a provider of virtual reality gaming technology solutions, has announced the launch of the Omni One, a unique omnidirectional treadmill that enables players to walk or run in any direction through virtual environments.

In the last 70 years, we are able to see the evolution of these technologies. Now more than ever it feels right to consider integrating these new tools within schools to enhance students' learning abilities.

2012:

Oculus Rift Kickstarter



2019:

HoloLens 2

2020:

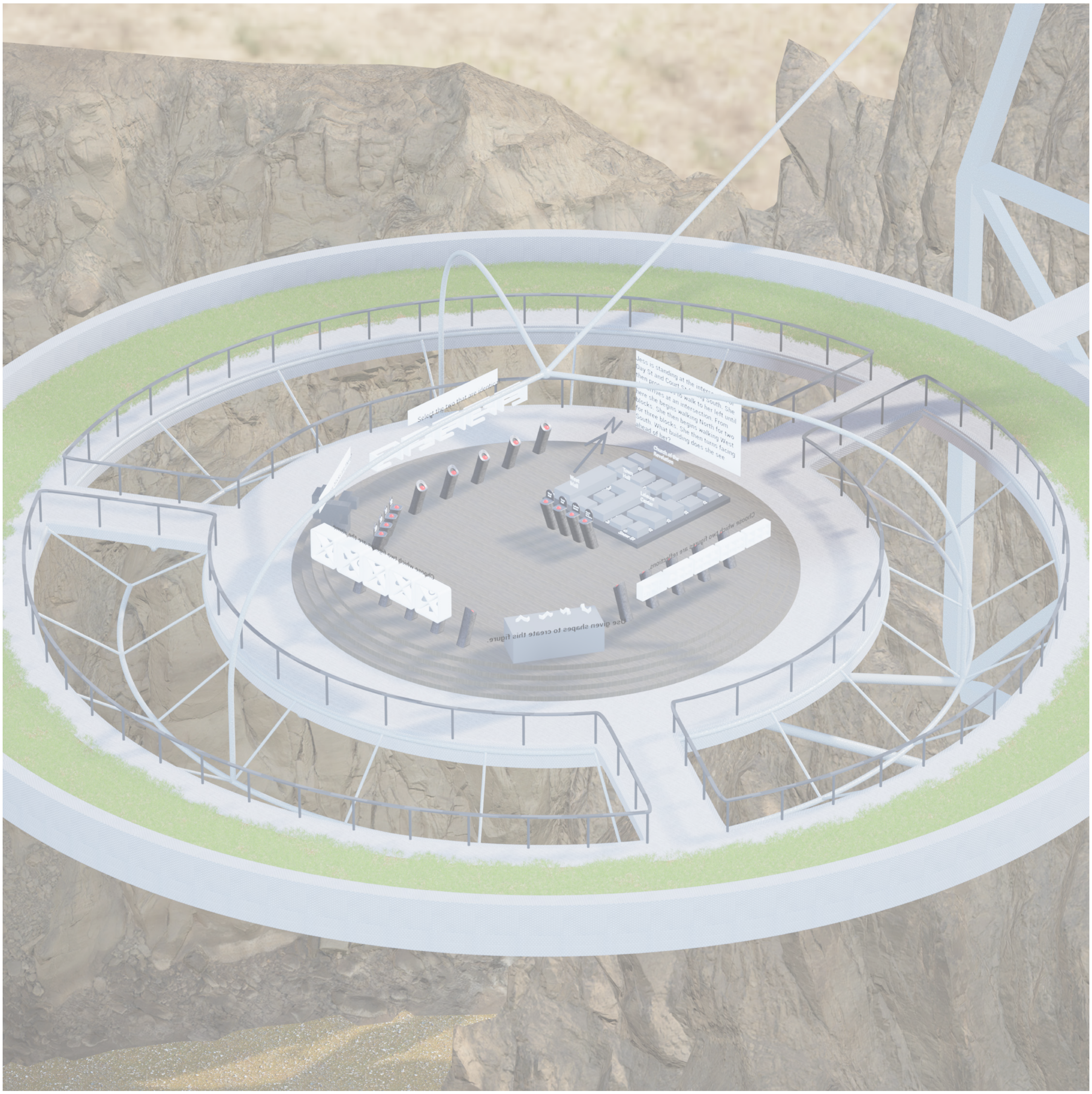
Oculus Quest 2

2023:

Omni One

Increasing Spatial Reasoning Ability: The Strengths and Weaknesses Between Virtual Reality and Paper/ Pencil Testing

Increasing Spatial Reasoning Ability

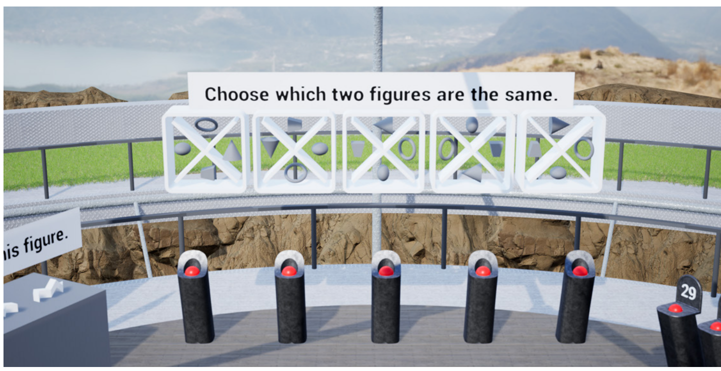


Virtual Reality Test

For the virtual reality test participants needed to complete six questions. Each of the questions was designed to activate participants' spatial reasoning skills.

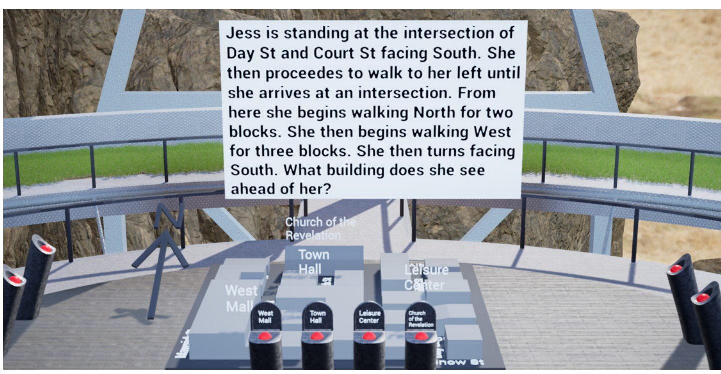
Group Rotation (GR)
Reflections (RF)
Map/Plan (MP)
Block Counting (BC)
Visual Comparison (VC)
Combining Shapes (CS)

Participants were given the option to perform this test either standing or sitting. Once started the participants had ten minutes to complete all six questions. The multiple-choice questions had buttons that participants were able to press to finalize their answers. The combining shapes question required participants to pick up and manipulate objects to create a shape.

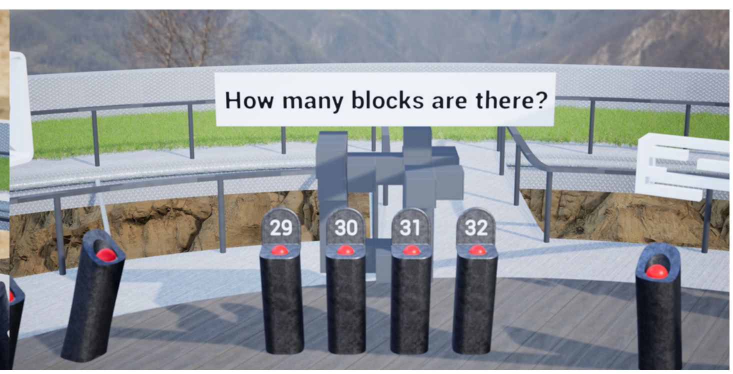


Group Rotation (GR)

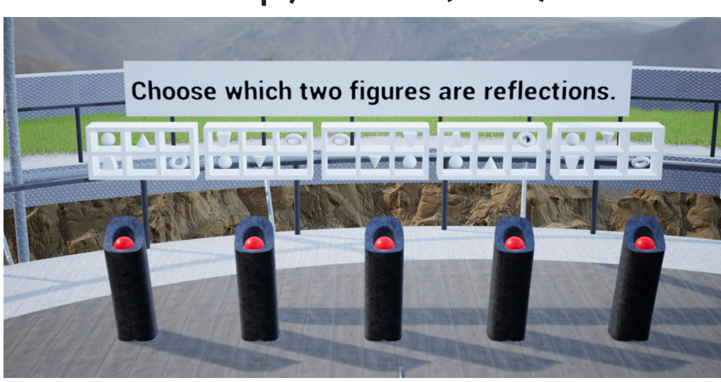
Reflections (RF)



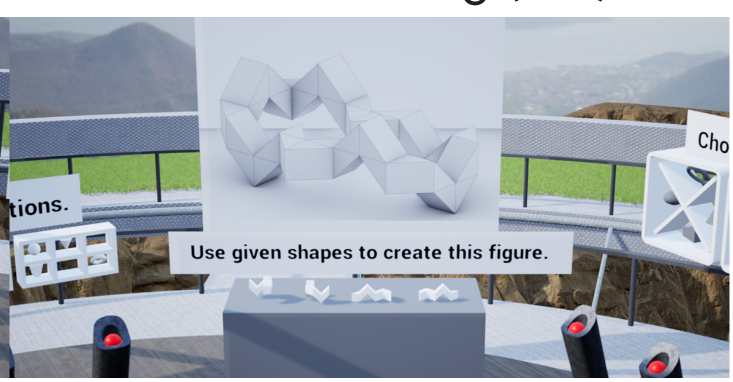
Map/Plan (MP)



Block Counting (BC)



Visual Comparison(VC)



Combining Shapes (CS)

Paper/Pencil Test

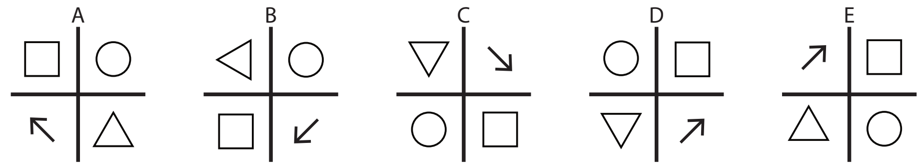
For the paper/pencil test, the participants had to complete the same types of questions from the virtual reality test.

The participants were given a ten-minute timer to complete the six questions. In order to compare their spatial reasoning skills. Participants were not allowed to draw notes on the test. This forced them to do everything mentally which is comparable to the virtual reality test.

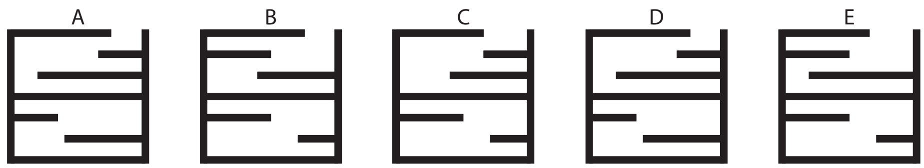
Half of the participants started by taking the paper-pencil test. This allowed for two groups of participants to form allowing for a deeper analysis of the data.

The entire experiment took thirty minutes. With a five-minute introduction, ten-minute test, five-minute break, and final ten-minute test.

Question 01: Circle the two identical figures.



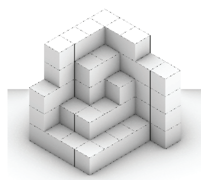
Question 02: Which two figures are identical?



Question 03: Identify what building Lisa is in front of on the map.

Lisa is standing on Mount Street facing south. She then proceedes to walk to her left until she reaches an intersection. Upon reaching the intersection she begins walking along Oak Park the same way she has been until she reaches another intersection. From here she decided to walk a block south toward South Road. She then proceedes to walk west for three blocks. At the new intersection she begins heading north until she finds the first building to her east. What building is she in front of? ______________________

Question 04: How many blocks are there?



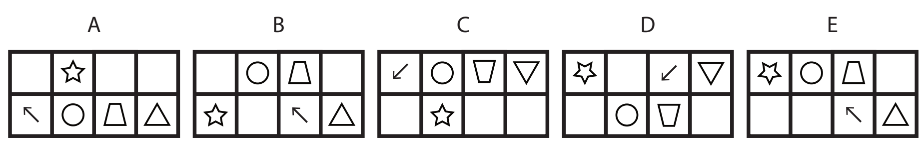
A.) 62

B.) 64

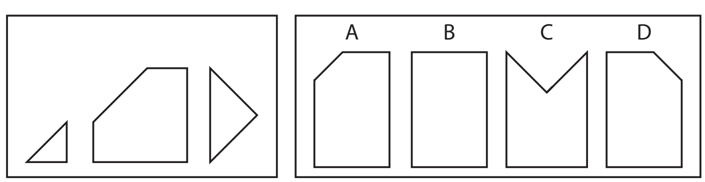
C.) 68

D.) 70

Question 05: Which two figures are the reflection of one another?



Question 06: From the given shapes what is the possible solution?



Research Results

Upon examination of the test as a whole. There is an unbalance of question composition for the type of combining shape. The paper test consisted of three simple 2D shapes that participants had to manipulate in their minds. In the virtual reality test, participants were given four complex 3D shapes they had to try and manually arrange.

Those who took the paper test first had higher scores on the virtual reality test when compared to participants that took the virtual reality test first.

Sixty-six percent of the participants scored better on the paper test, regardless of which test was given first.

Only one of the participants scored higher on the virtual reality test. He was the only participant to immerse himself in the virtual environment. This means he was standing up, walking around, and crouching. This was different from other participants who remained seated for the virtual portion

In the chart, the ones represent a question answered correctly. A total is then given below to help determine which test performed better.

For the paper/pencil test participants scored higher on the visual comparison, block counting, and combining shapes questions. However, the question of the combining shape is null.

For the virtual reality test participants scored higher on the group rotation question. While tieing with the map/plan question.

Between the two tests. Only the paper/pencil test was able to achieve a perfect score. The type of question that was answered correctly for all participants was visual comparison.

Research Results

Paper Test

GR	VC	MP	BC	RF	CS
1	1	1	0	0	1
1	1	1	0	1	1
0	1	0	1	0	1
1	1	0	1	1	1
1	1	1	1	1	1
1	1	0	0	1	0
1	1	1	1	1	1
0	1	1	0	0	1
1	1	0	1	1	1
7	9	5	5	6	8

VR Test

GR	VC	MP	BC	RF	CS
1	0	1	0	0	0
1	1	0	0	1	0
0	1	0	1	0	0
1	0	1	0	1	0
1	1	1	0	1	0
1	1	0	0	1	0
1	1	1	0	1	0
1	1	1	0	1	1
1	1	0	0	1	0
8	7	5	1	7	1

The Design

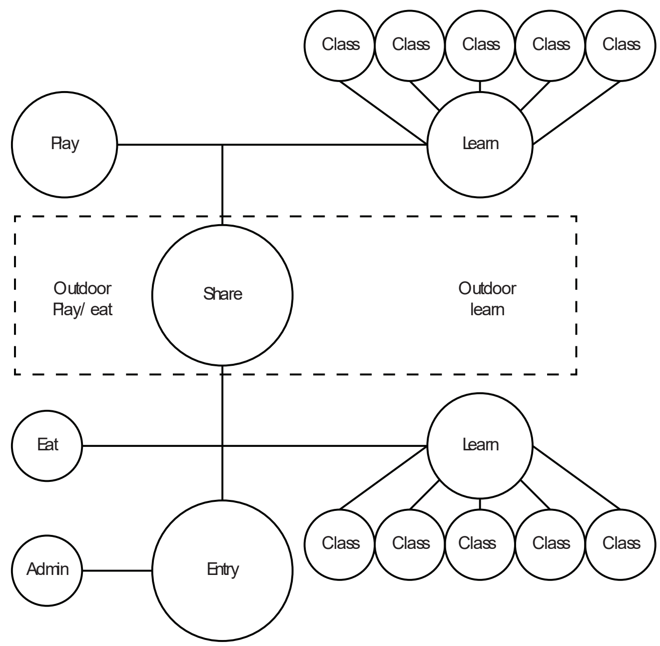
Program

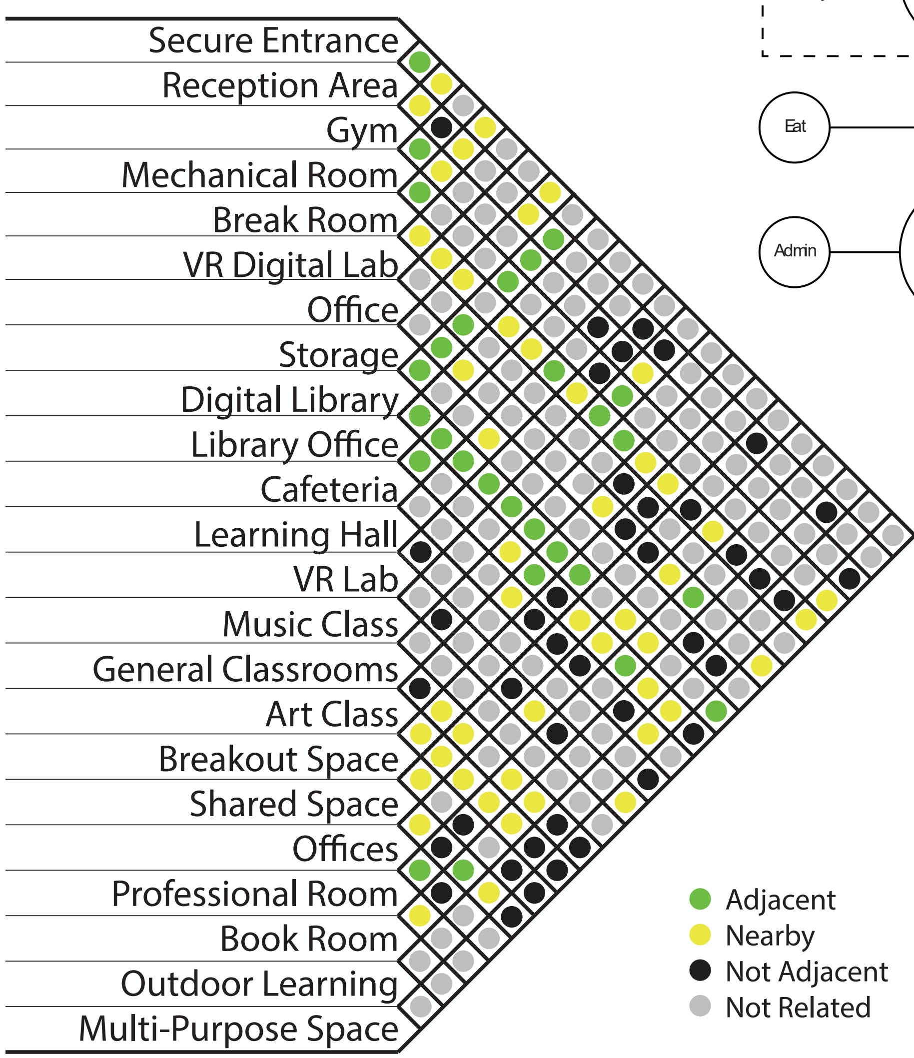
Spatial Interaction Matrix:

- Aided in determining the placement of spaces

Streamline Version:

- Simplify the program into core areas
- Expand the core areas into the program needs

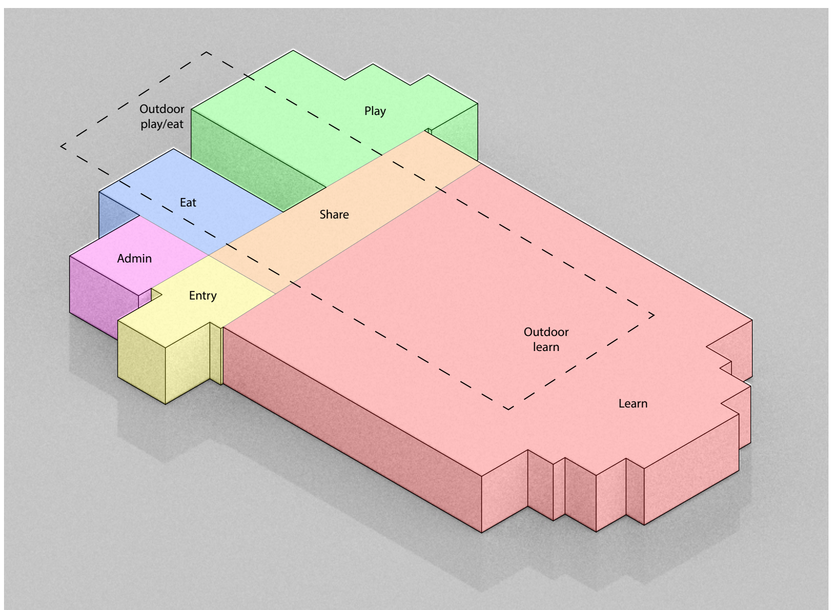




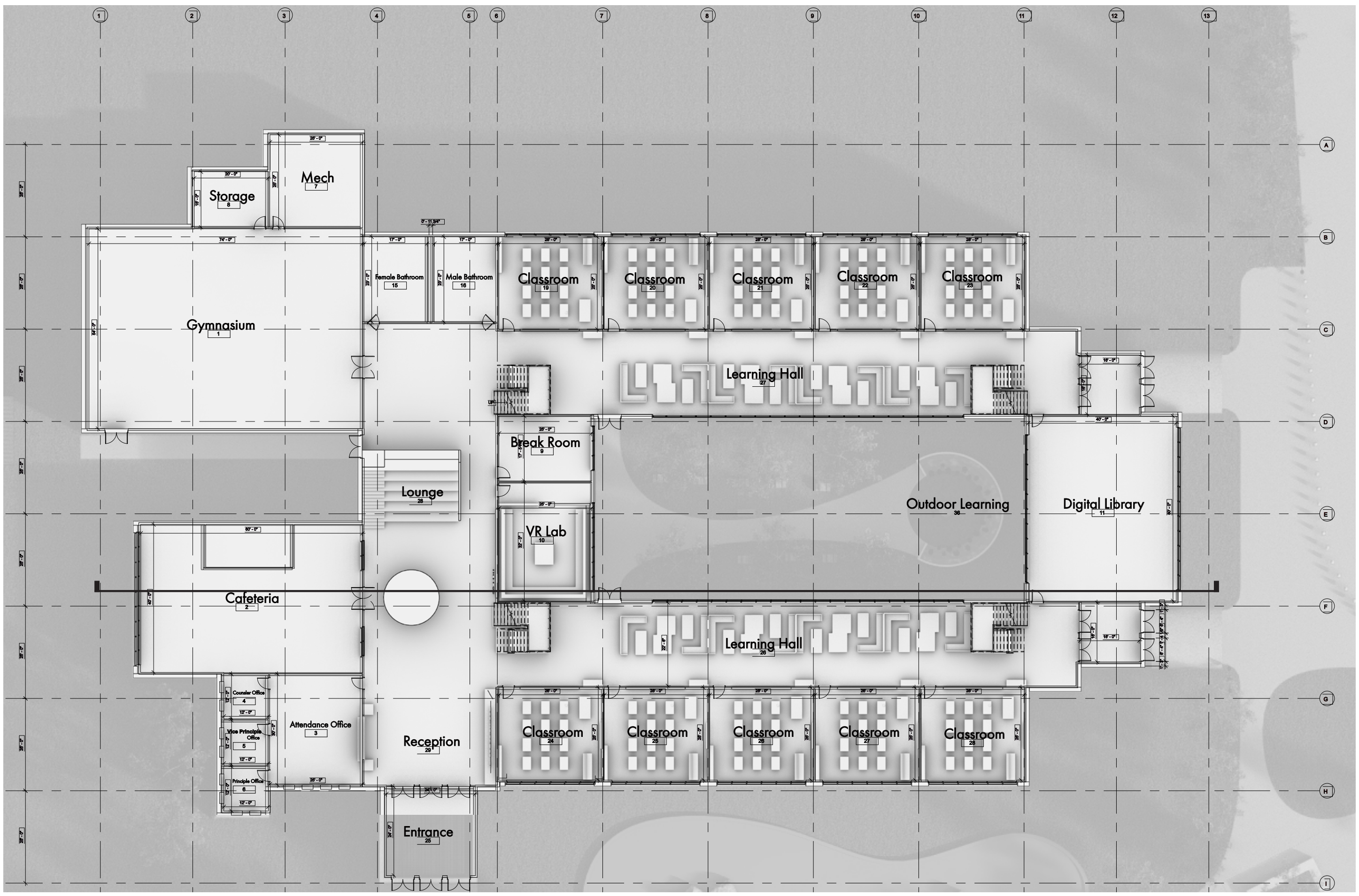
Spatial Concept

Key Areas:

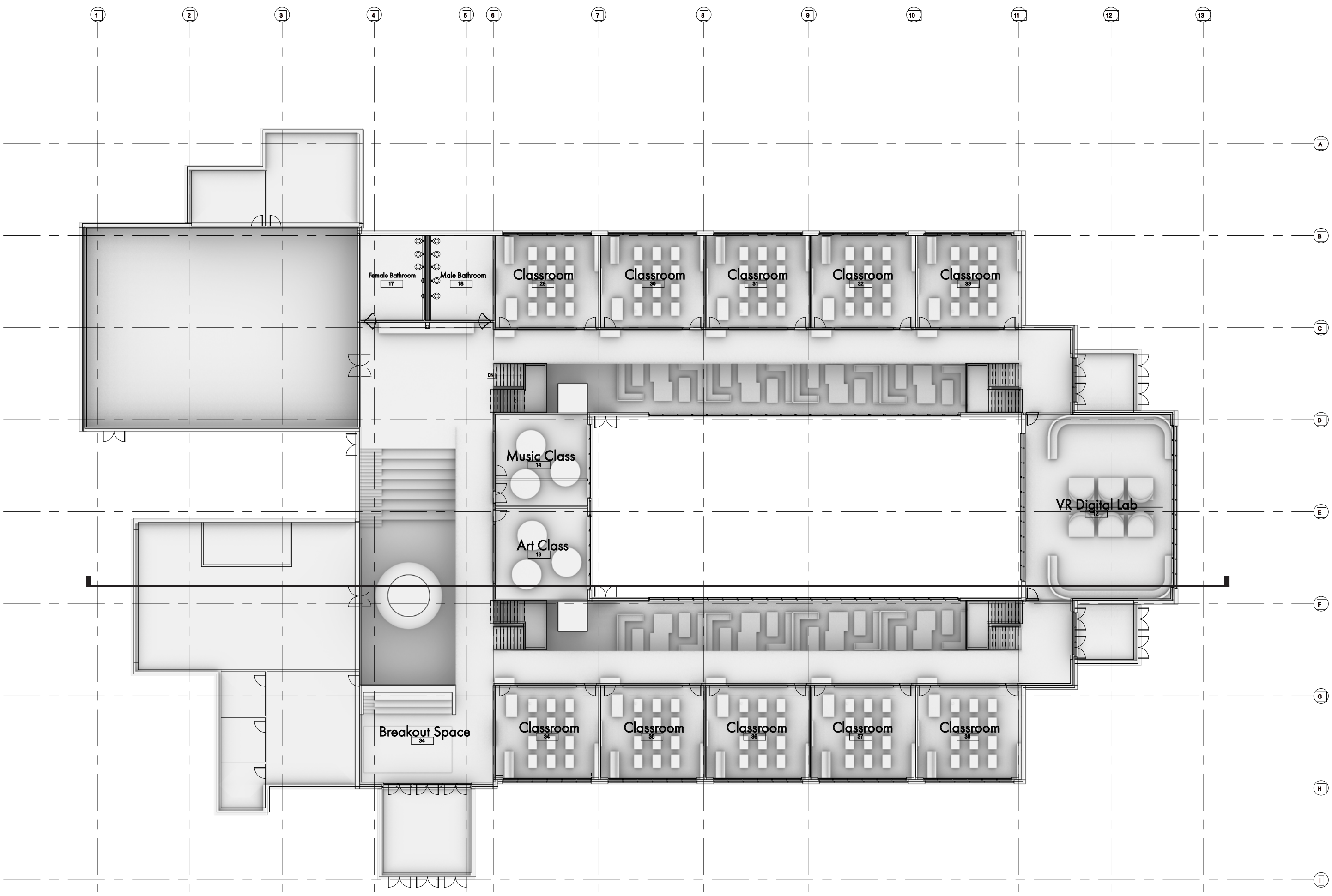
- Sharable spaces are placed centrally
- Learning area placed equal distance from the bus and parent drop off
- Play area placed north-east corner with access to green space
- The administration is located next to the main entrance to ensure security
- Outdoor learning is placed within the learning core area



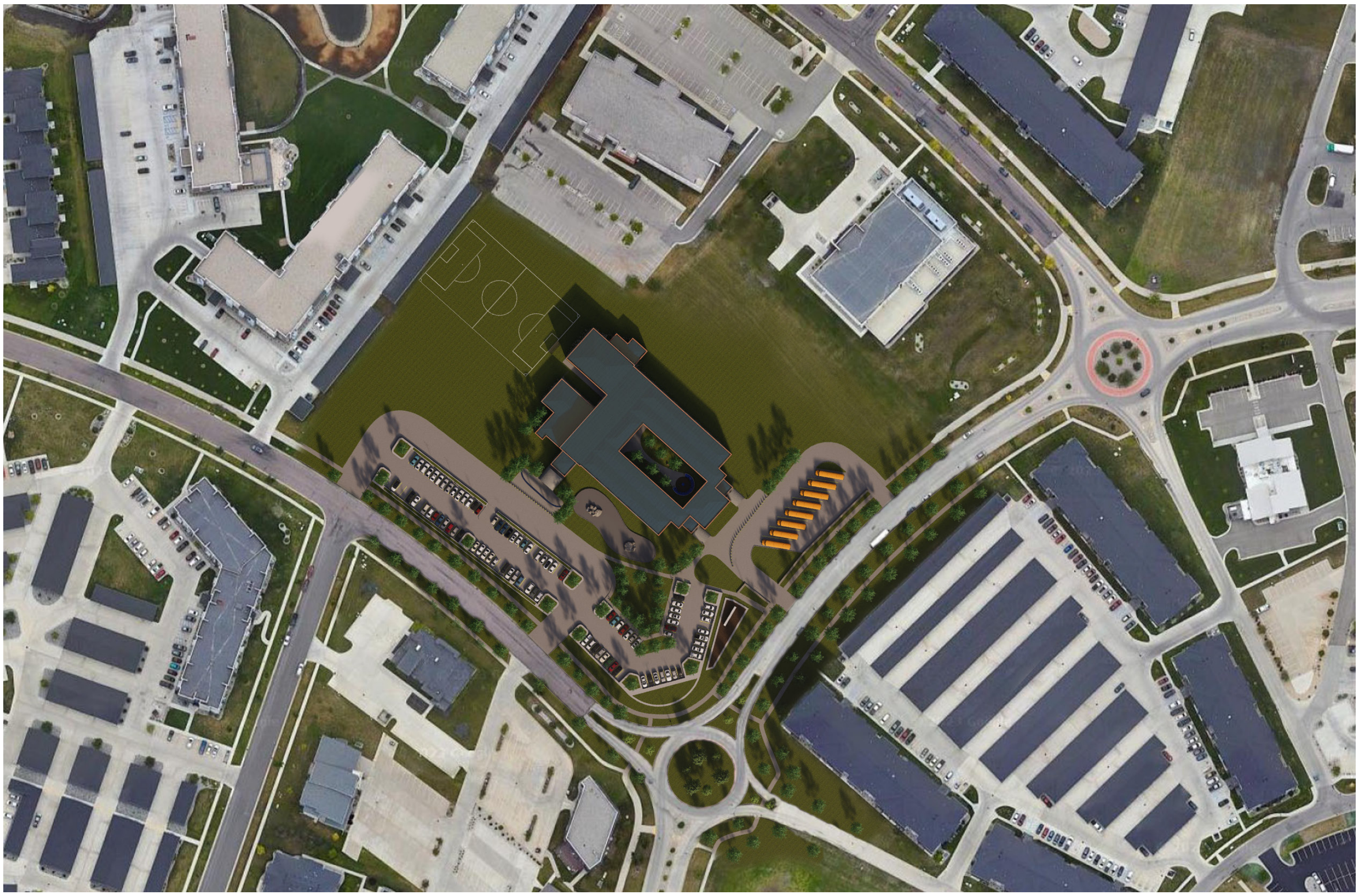
Level 01 Floor Plan



Level 02 Floor Plan



Site Plan



Key Integrations of AR and VR Technology

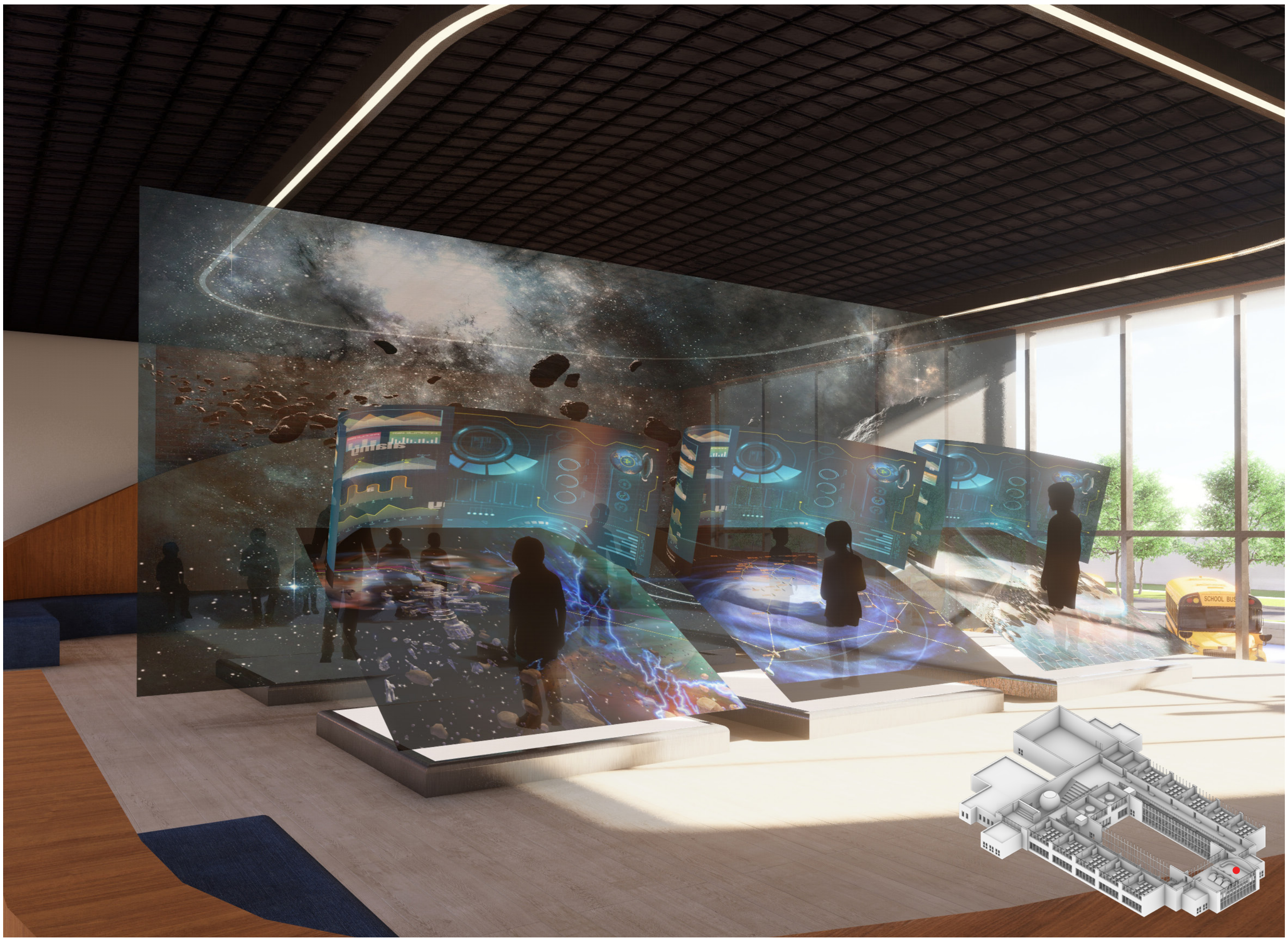
Enterance

Learning Hall

Learning Hall

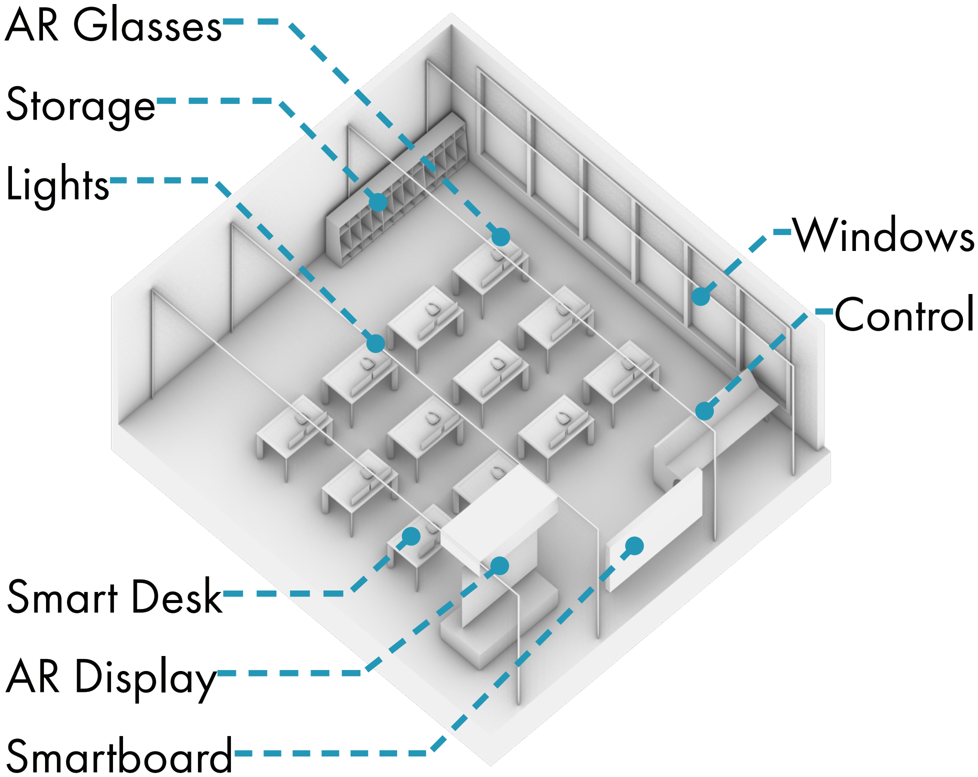
Outdoor Learning

VR Digital Lab



AR Classroom

Students have AR glasses that project to two monitors at the edge of their smart desks. The smart desk has a digital touch screen for taking notes. The teacher is able to control the students' glasses and smart table from the control panel on their desks. Ensuring that students stay interested in the learning topic. An AR display is placed at the front of the classroom where the main portion of the learning will take place. With the student's AR glasses, they are able to have 3D objects of the learning material in front of them while being able to manipulate what they see.

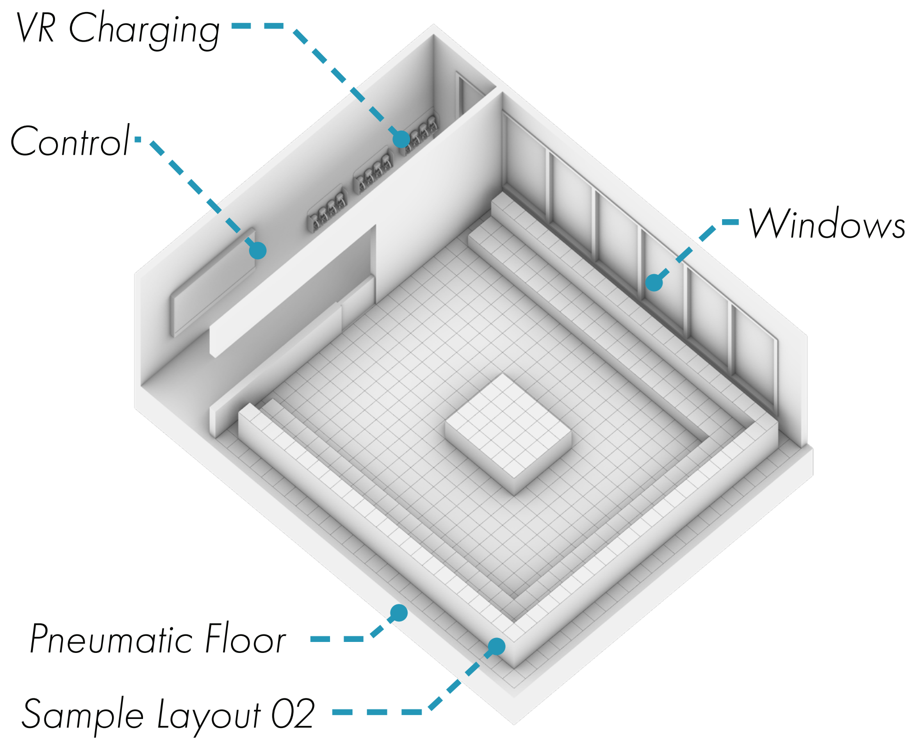


AR Classroom

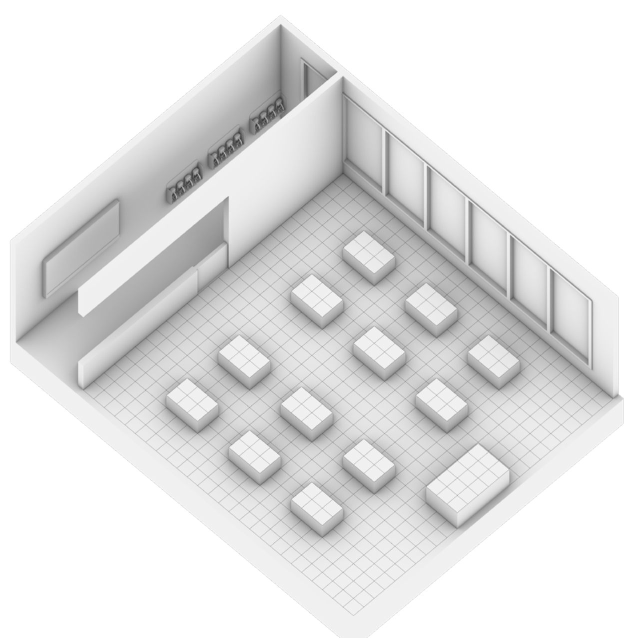
VR Simulation Lab

This lab is designed to create an adaptive room that works in tangent with VR headsets. The floor is comprised of 1′x1′ square tiles that can be controlled to create new seating. At the control panel teachers are able to set the layout of the room from a preset list. Types of classes that would use this lab include science, social studies, language arts, and math.

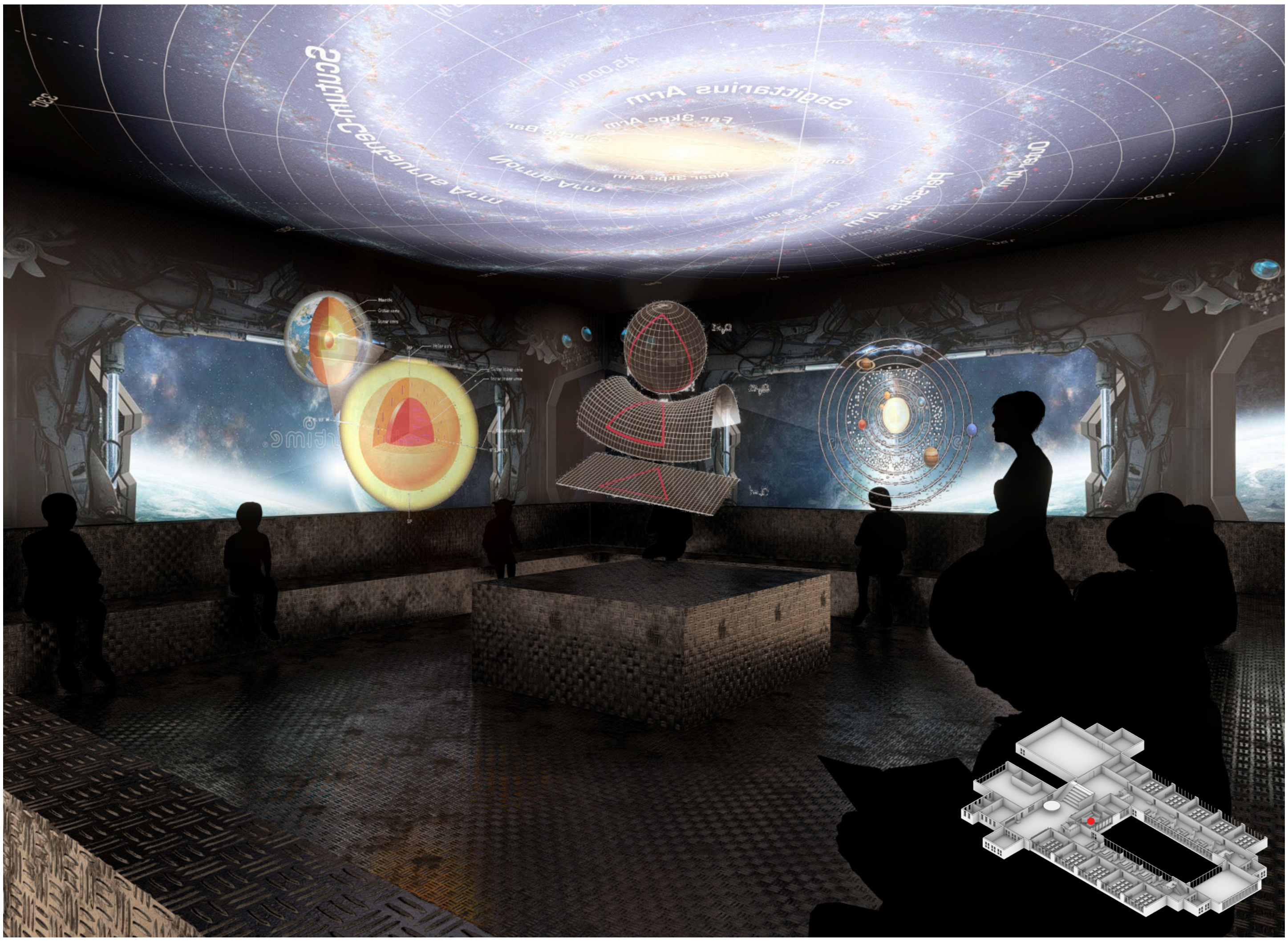
Cricle Layout



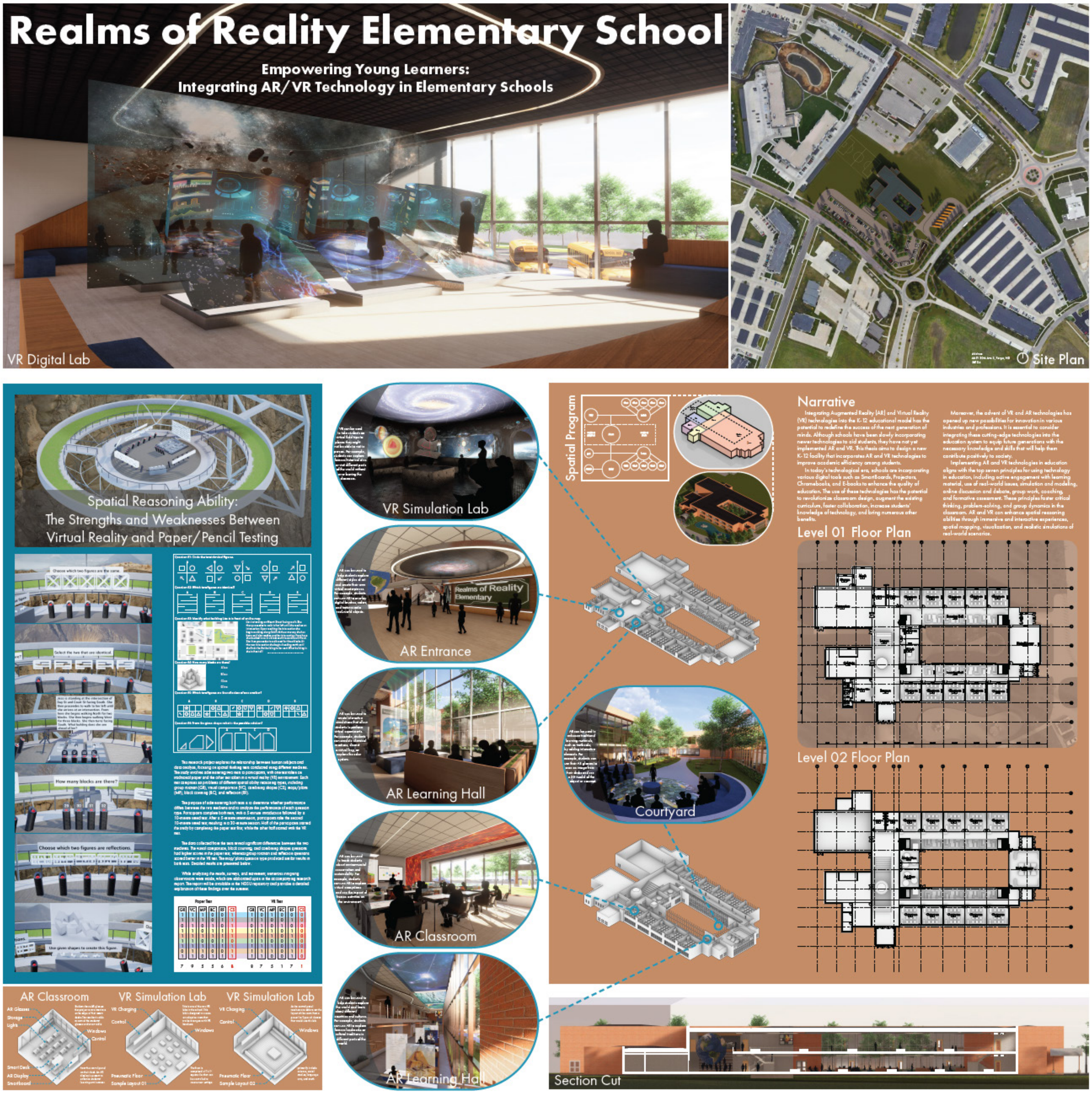
Grid Layout



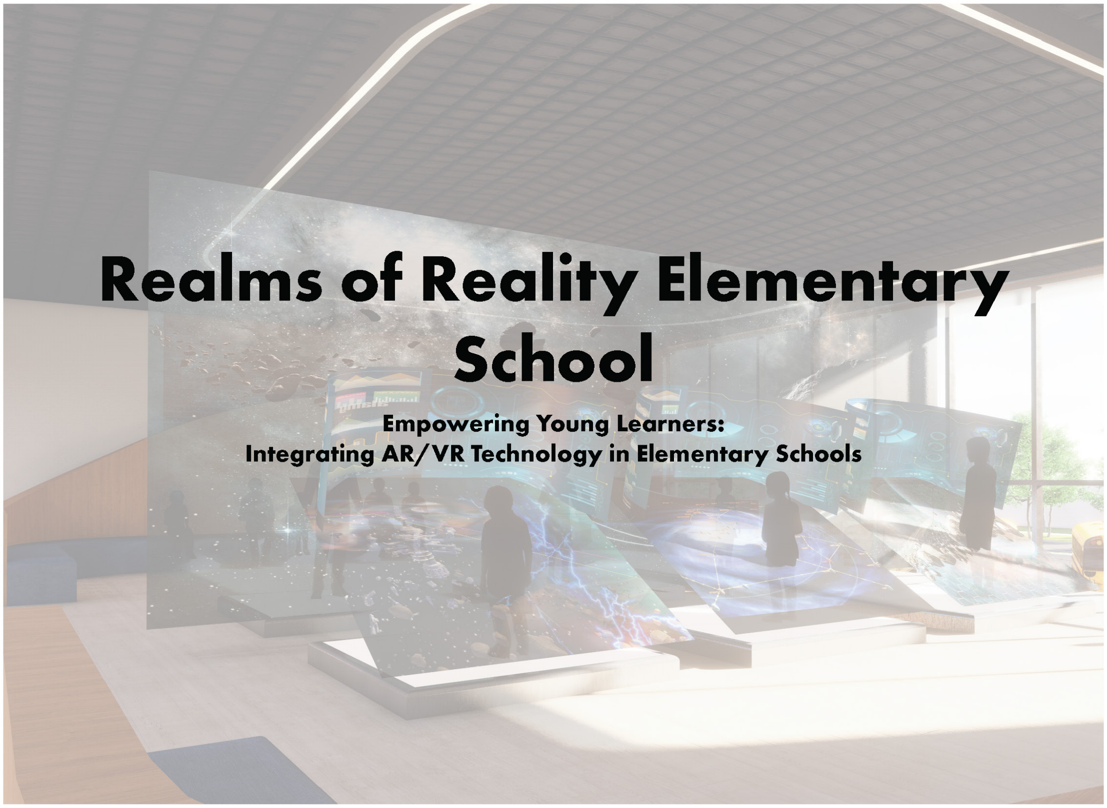
VR Simulation Lab



Thesis Exhibit Boards



Presentation Slides



Narrative

Over time, numerous changes have occurred, particularly in the technology field, which has experienced rapid growth in the 21st century. In recent years, Augmented Reality (AR) and Virtual Reality (VR) technologies have advanced significantly, and it's essential to equip the younger generation with the necessary tools to succeed in life. Ultimately, the objective of this project is to enhance students' spatial reasoning skills, which will have a positive impact on their overall education experience.

Presentation Slides

History of Virtual Reality (VR) and Augmented Reality (AR)

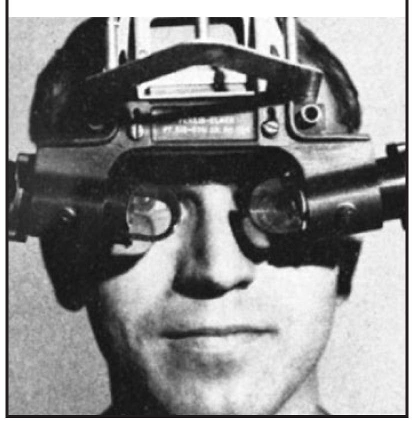
History

1956:

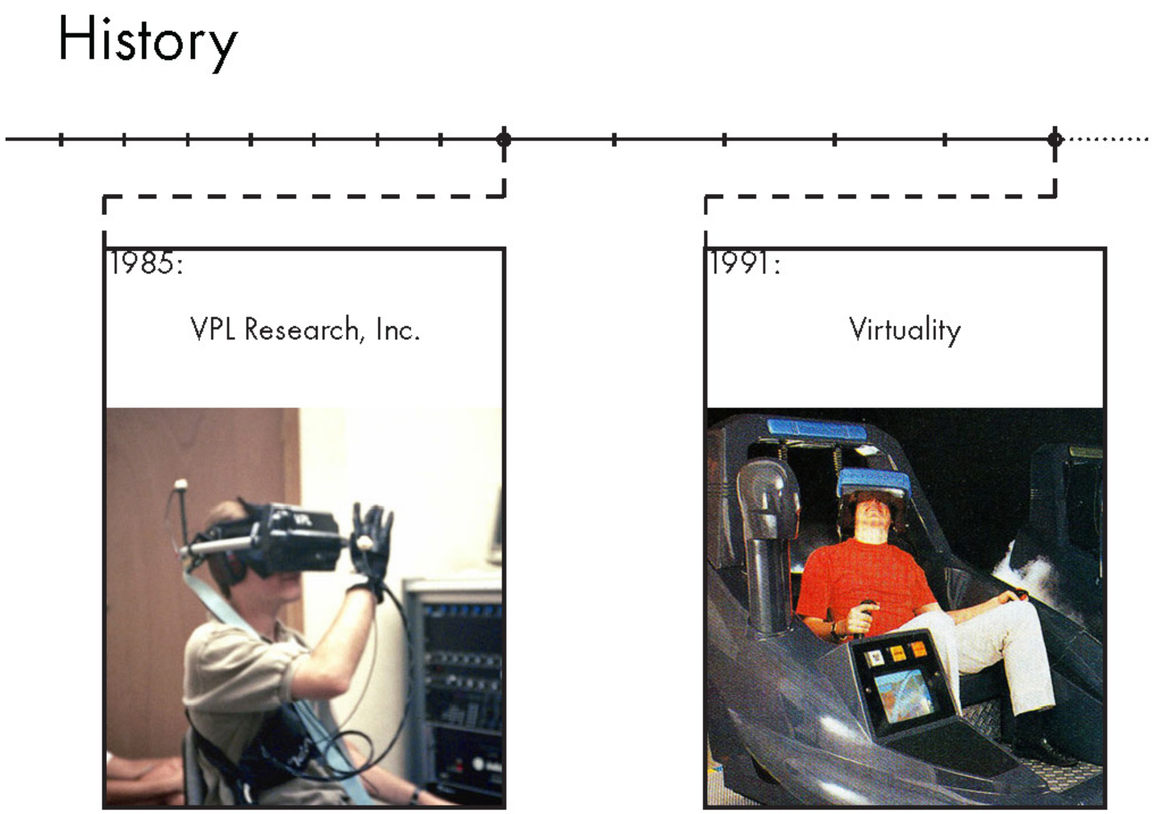
Sensorama

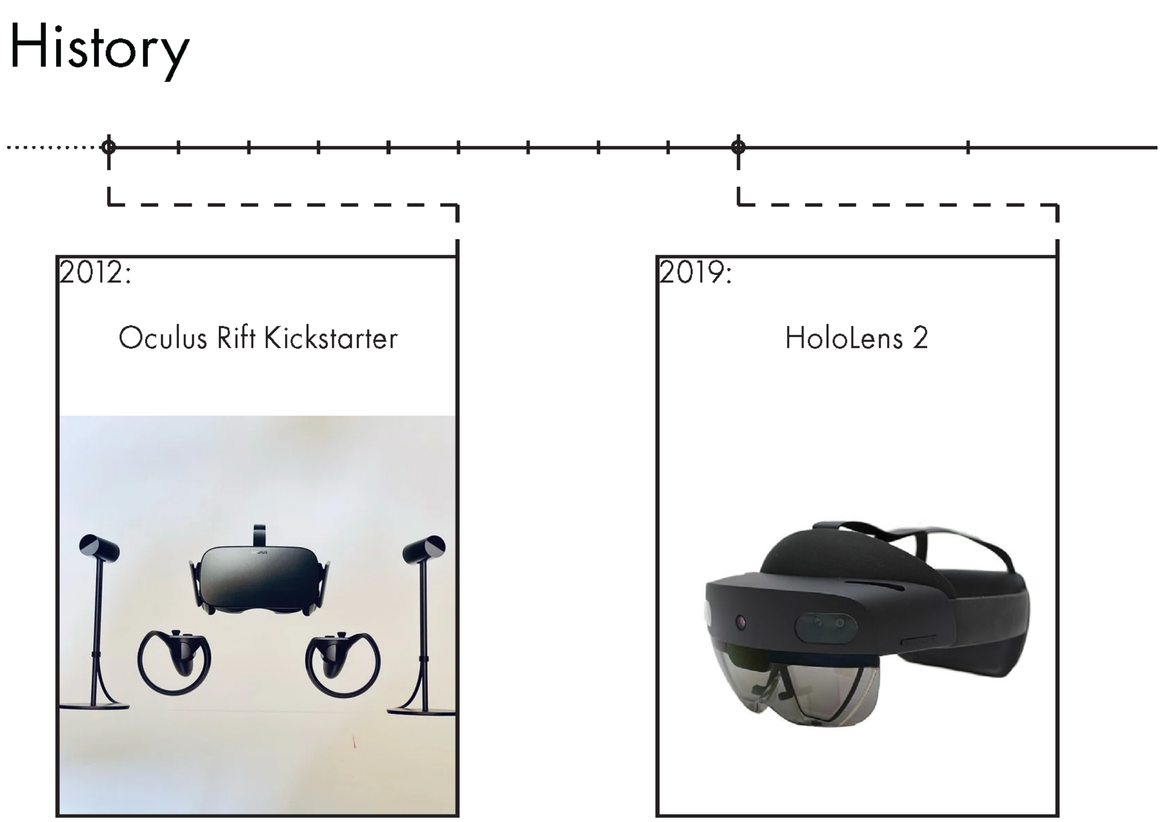
1968:

The Sword of Damocles



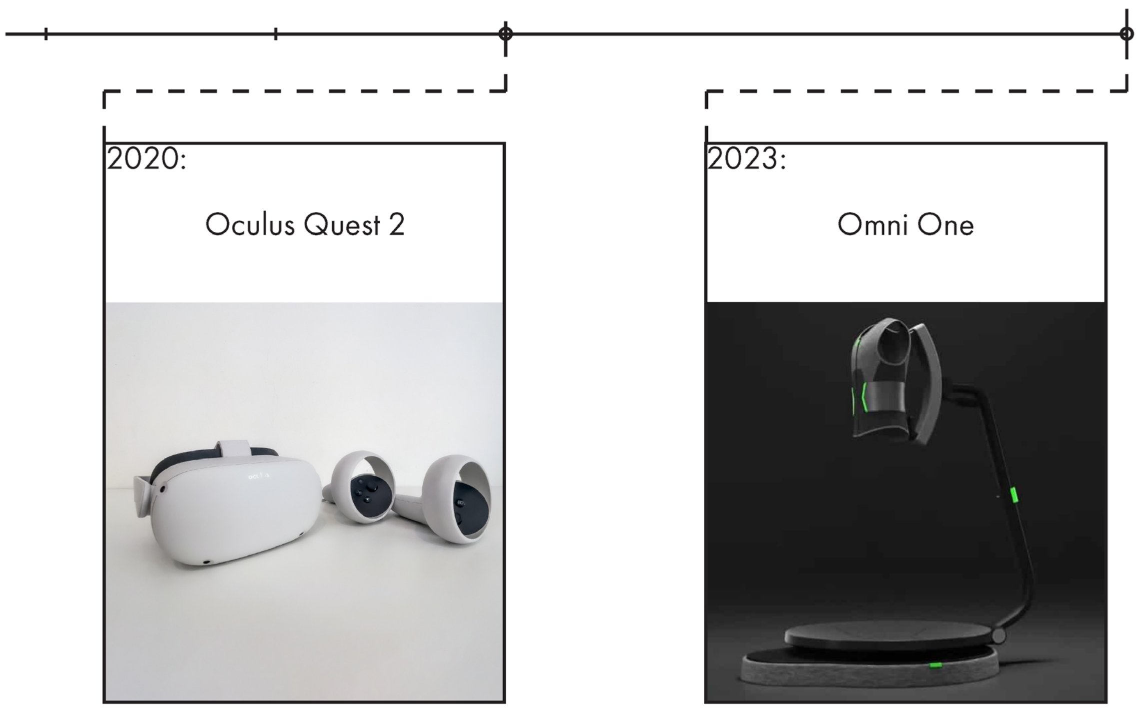
Presentation Slides





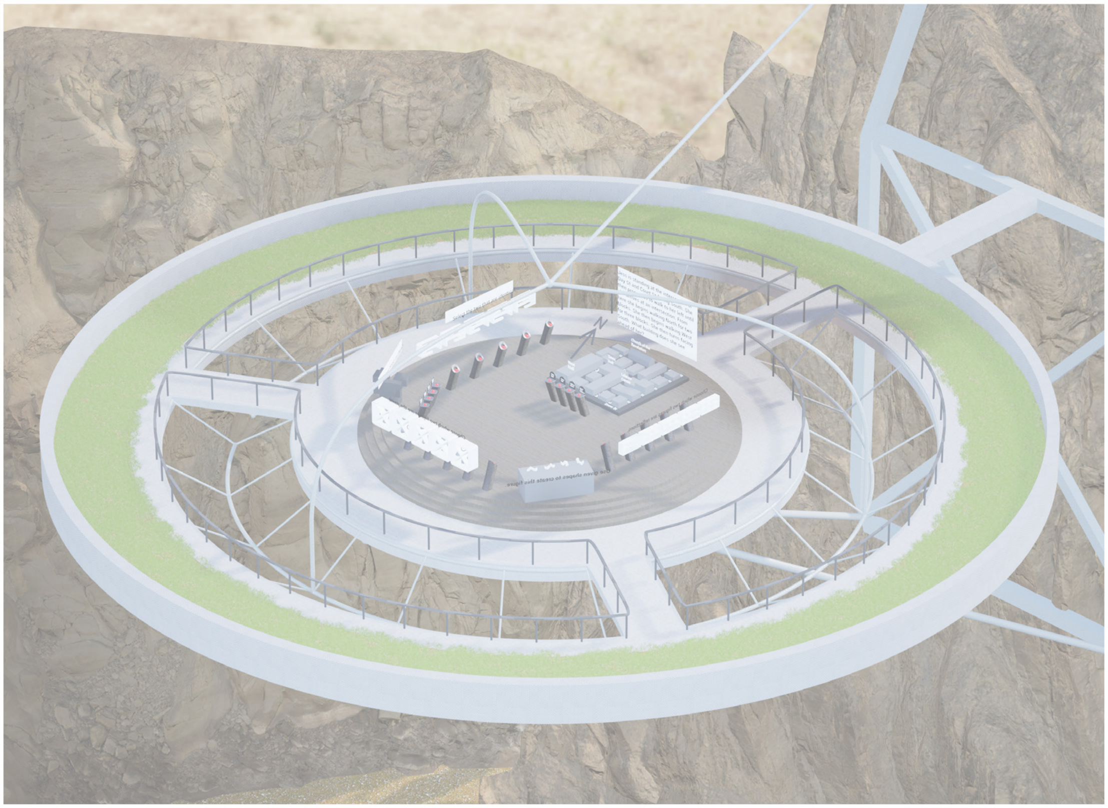
Presentation Slides

History



**Increasing Spatial Reasoning Ability:
The Strengths and Weaknesses
Between Virtual Reality and Paper/
Pencil Testing**

Presentation Slides



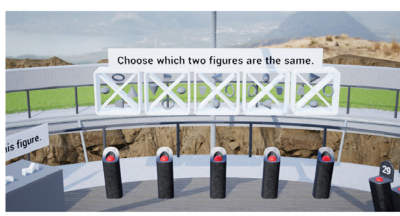
Virtual Reality Test

For the virtual reality test participants needed to complete six questions. Each of the questions was designed to activate participants' spatial reasoning skills.

Group Rotation (GR)
Reflections (RF)
Map/Plan (MP)
Block Counting (BC)
Visual Comparison (VC)
Combining Shapes (CS)

Participants were given the option to perform this test either standing or sitting. Once started the participants had ten minutes to complete all six questions. The multiple-choice questions had buttons that participants were able to press to finalize their answers. The combining shapes question required participants to pick up and manipulate objects to create a shape.

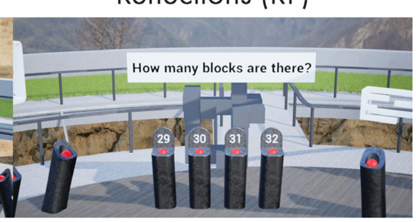
An advantage that the virtual reality test provides is its visualizations which aren't possible in the traditional classroom. Which increases the students' engagement and interest.



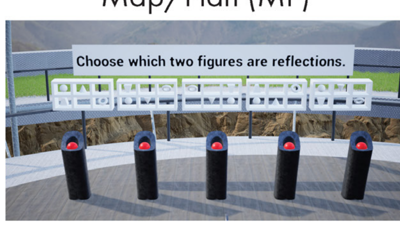
Group Rotation (GR)

Reflections (RF)

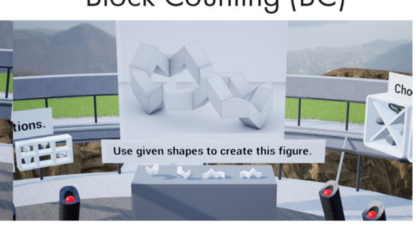
Map/Plan (MP)



Block Counting (BC)



Visual Comparison(VC)



Combining Shapes (CS)

Presentation Slides

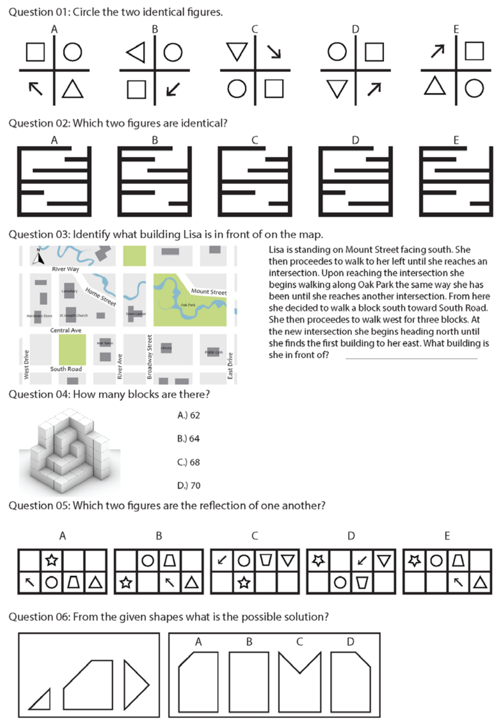
Paper/Pencil Test

For the paper/pencil test, the participants had to complete the same types of questions from the virtual reality test.

The participants were given a ten-minute timer to complete the six questions. In order to compare their spatial reasoning skills. Participants were not allowed to draw notes on the test. This forced them to do everything mentally which is comparable to the virtual reality test.

Half of the participants started by taking the paper-pencil test. This allowed for two groups of participants to form allowing for a deeper analysis of the data.

The entire experiment took thirty minutes. With a five minute introduction, ten-minute test, five-minute break, and final ten-minute test.



Research Results

Upon examination of the test as a whole. There is an unbalance of question composition for the type of combining shape. The paper test consisted of three simple 2D shapes that participants had to manipulate in their minds. In the virtual reality test, participants were given four complex 3D shapes they had to try and manually arrange.

Those who took the paper test first had higher scores on the virtual reality test when compared to participants that took the virtual reality test first.

Sixty-six percent of the participants scored better on the paper test, regardless of which test was given first.

Only one of the participants scored higher on the virtual reality test. He was the only participant to immerse himself in the virtual environment. This means he was standing up, walking around, and crouching. This was different from other participants who remained seated for the virtual portion

Paper Test

GR	VC	MP	BC	RF	CS
1	1	1	0	0	1
1	1	1	0	1	1
0	1	0	1	0	1
1	1	0	1	1	1
1	1	1	1	1	1
1	1	0	0	1	0
1	1	1	1	1	1
0	1	1	0	0	1
1	1	0	1	1	1
7	9	5	5	6	8

VR Test

GR	VC	MP	BC	RF	CS
1	0	1	0	0	0
1	1	0	0	1	0
0	1	0	1	0	0
1	0	1	0	1	0
1	1	1	0	1	0
1	1	0	0	1	0
1	1	1	0	1	0
1	1	1	0	1	1
1	1	0	0	1	0
8	7	5	1	7	1

In the chart, the ones represent a question answered correctly. A total is then given below to help determine which test performed better.

For the paper/pencil test participants scored higher on the visual comparison, block counting, and combining shapes questions. However, the question of the combining shape is null.

For the virtual reality test participants scored higher on the group rotation question. While tieing with the map/plan question.

Between the two tests. Only the paper/pencil test was able to achieve a perfect score. The type of question that was answered correctly for all participants was visual comparison.

Presentation Slides

Oculus Quest

Key Features:

- High Resolution
- 6GB RAM
- Touch controllers
- Hand tracking
- Wireless
- Oculus Link

Key Integration:

- VR Simulation Lab
- VR Digital Lab

HoloLens 2

Key Features:

- Immersive display
- Hand and eye tracking
- Voice Control
- Lightweight and comfortable
- Long battery life

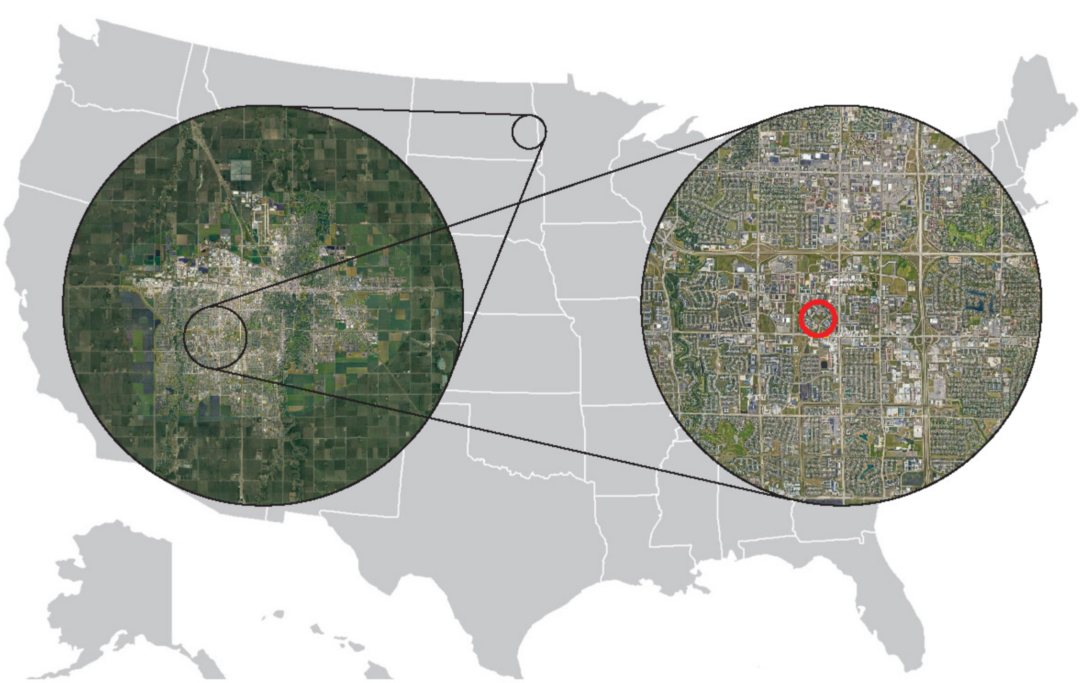
Key Integrations:

- Hallways
- Classrooms
- Labs
- Shared spaces
- Breakout spaces

Presentation Slides

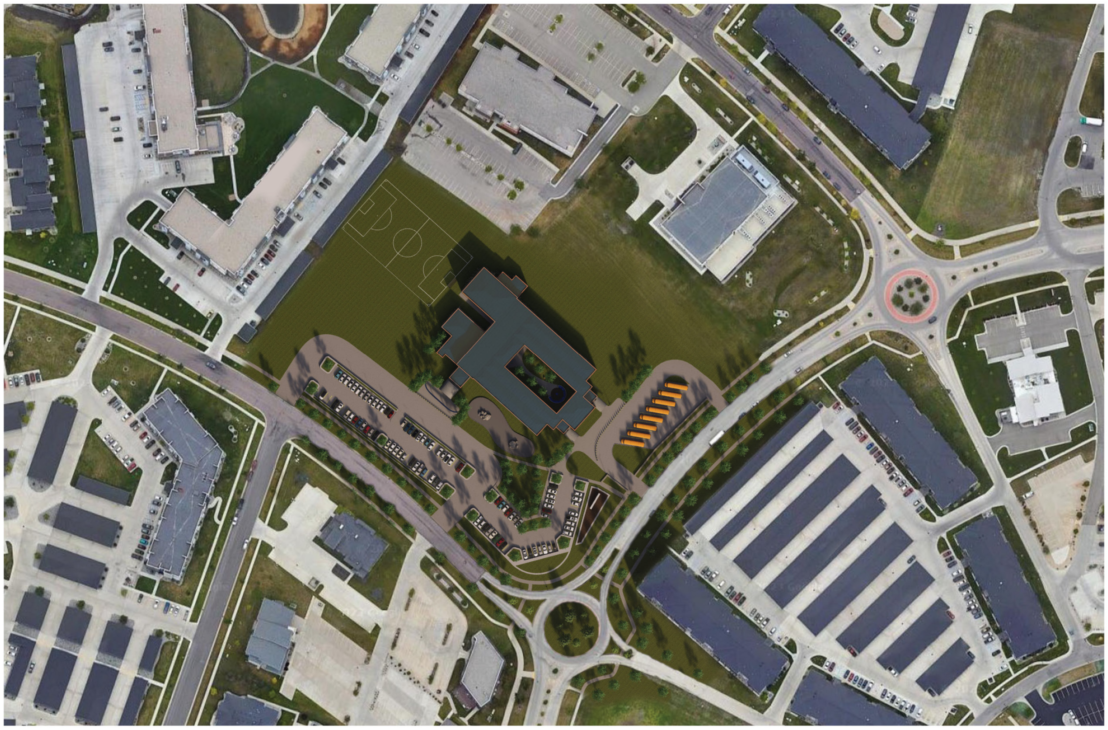
Design Solution

Location

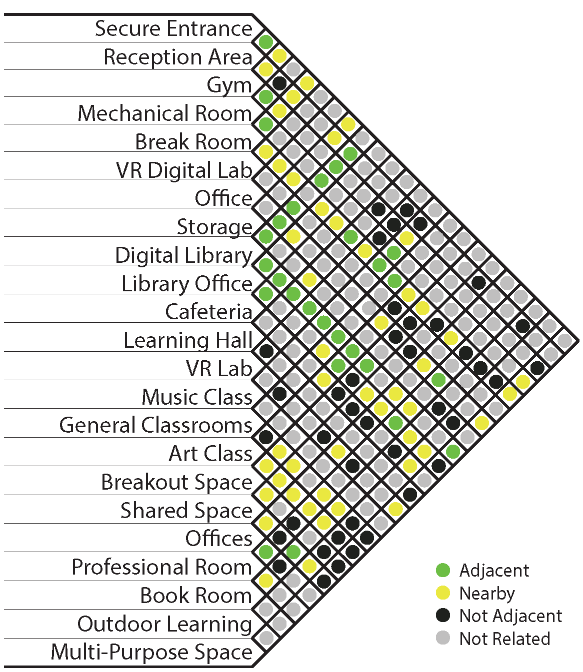


Presentation Slides

Site



Program

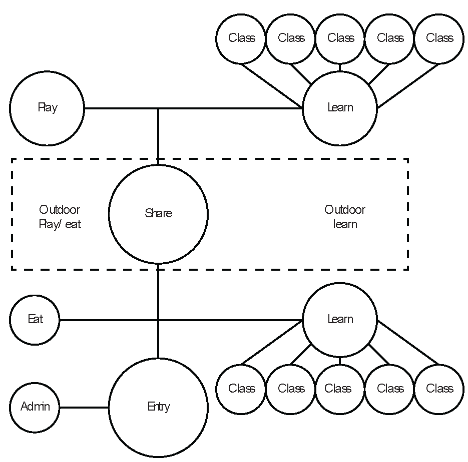


Spatial Interaction Matrix:

- Aided in determining the placement of spaces

Streamline Version:

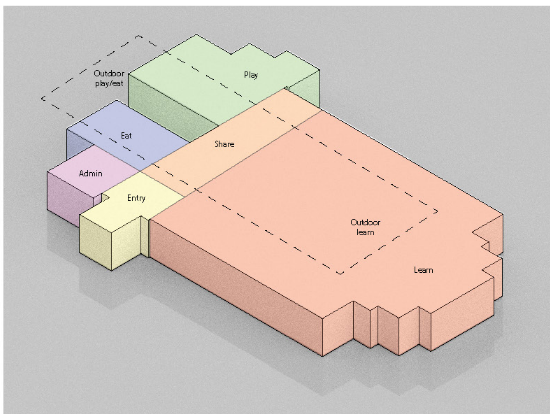
- Simplify the program into core areas
- Expand the core areas into the program needs



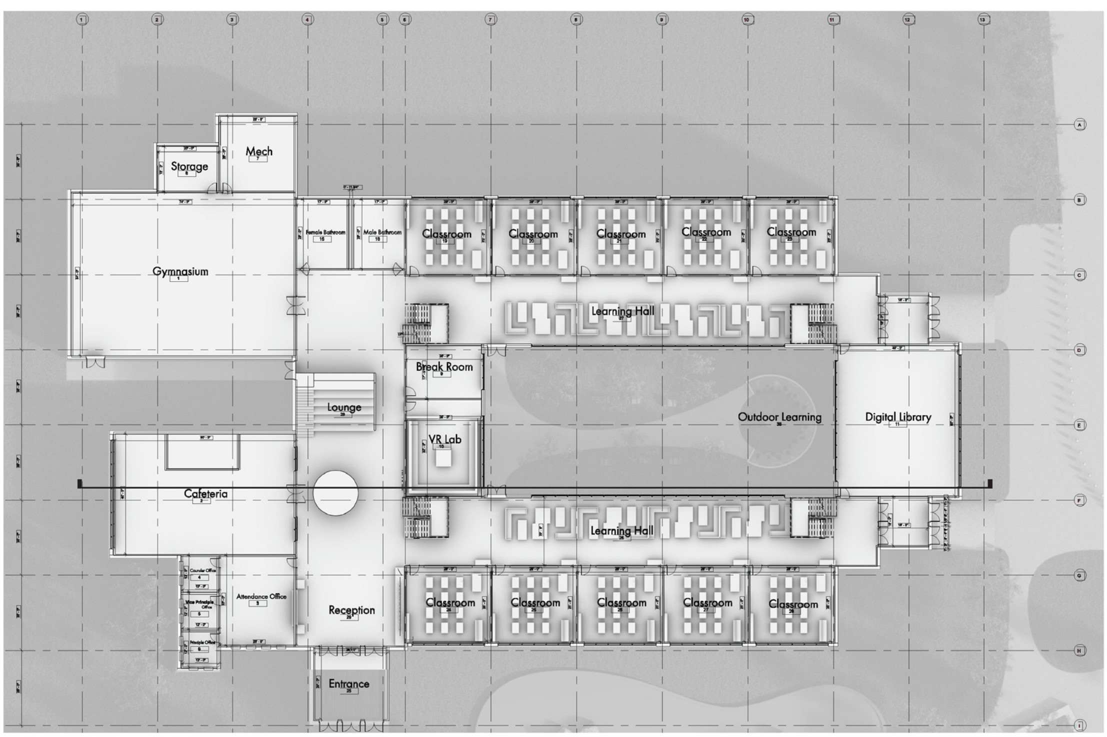
Presentation Slides

Spatial Concept

Key Areas:
- Sharable spaces are placed centrally
- Learning area placed equal distance from the bus and parent drop off
- Play area placed north-east corner with access to green space
- The administration is located next to the main entrance to ensure security
- Outdoor learning is placed within the learning core area

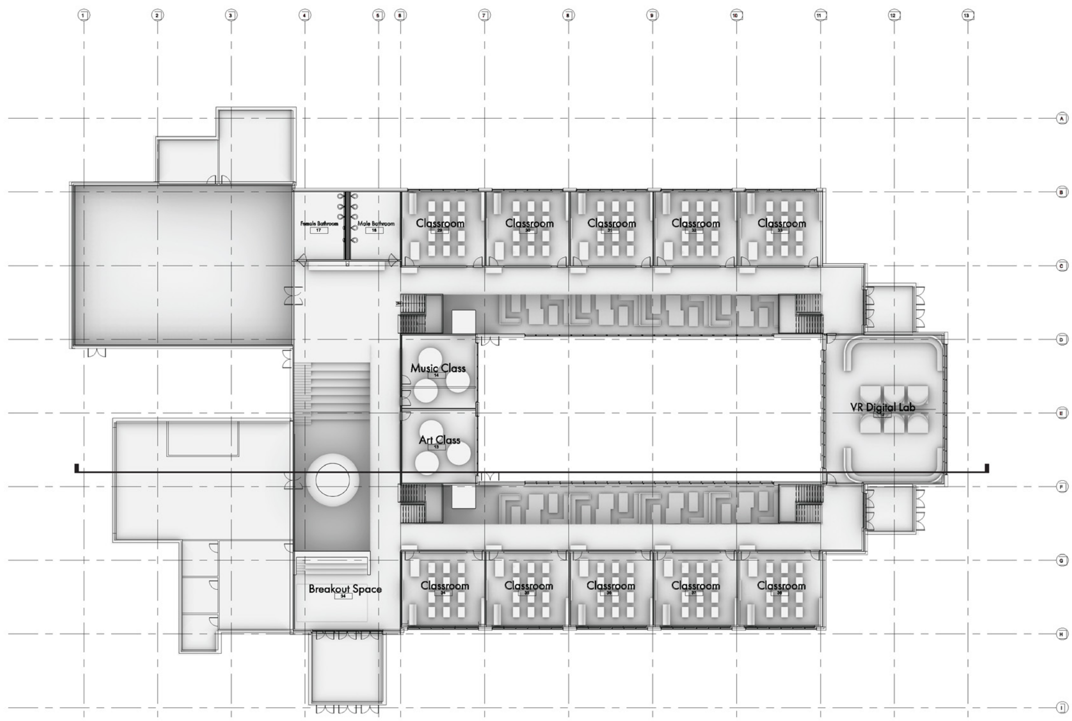


Level 01 Floor Plan



Presentation Slides

Level 02 Floor Plan



Key Integrations of AR and VR Technology

Presentation Slides

Entrance

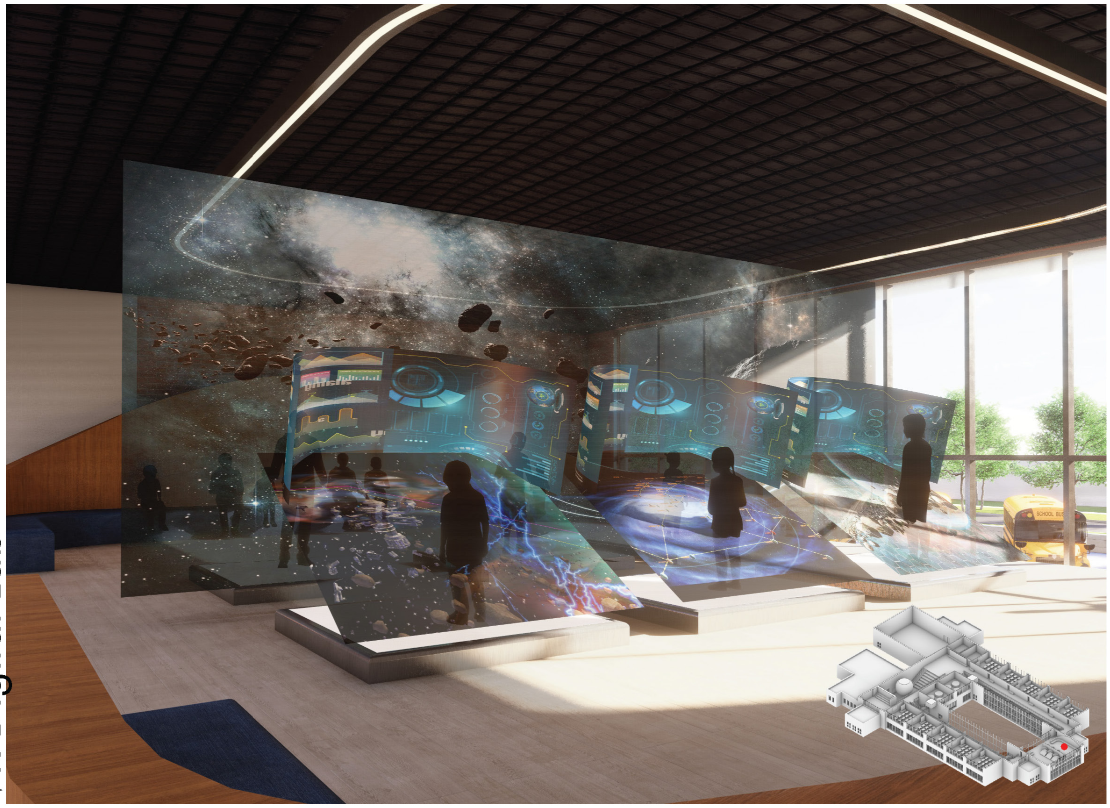
Learning Hall

Presentation Slides

Learning Hall

Outdoor Learning

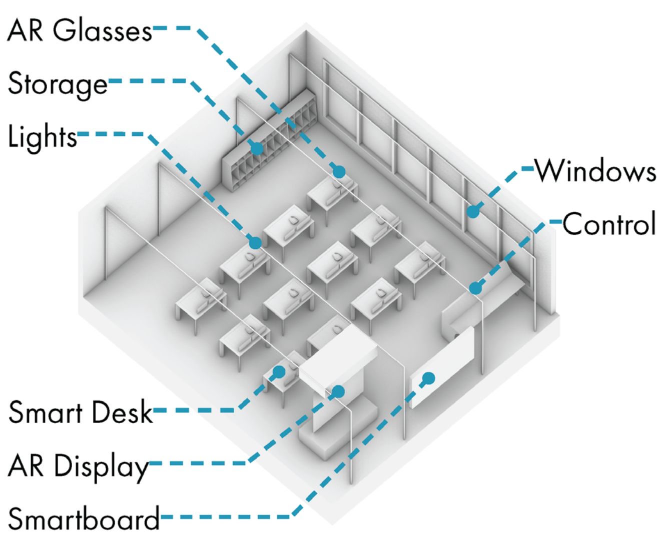
Presentation Slides



VR Digital Lab

AR Classroom

Students have AR glasses that project to two monitors at the edge of their smart desks. The smart desk has a digital touch screen for taking notes. The teacher is able to control the students' glasses and smart table from the control panel on their desks. Ensuring that students stay interested in the learning topic. An AR display is placed at the front of the classroom where the main portion of the learning will take place. With the student's AR glasses, they are able to have 3D objects of the learning material in front of them while being able to manipulate what they see.



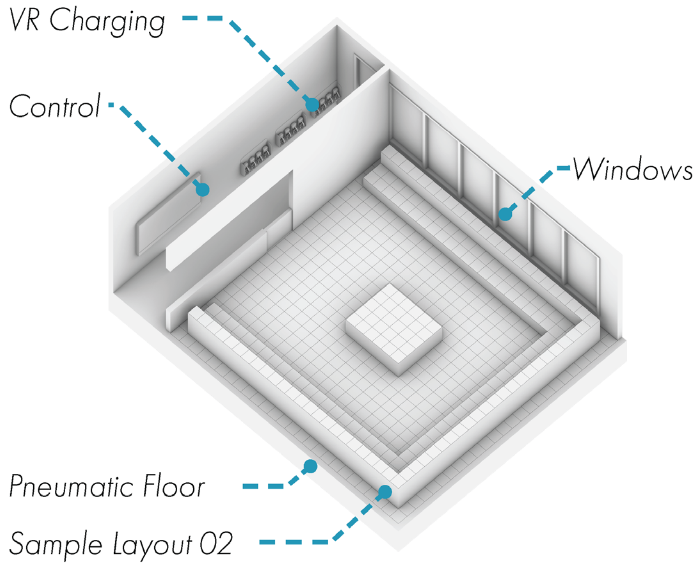
Presentation Slides

AR Classroom

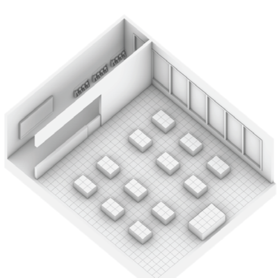
VR Simulation Lab

This lab is designed to create an adaptive room that works in tangent with VR headsets. The floor is comprised of 1'x1' square tiles that can be controlled to create new seating. At the control panel teachers are able to set the layout of the room from a preset list. Types of classes that would use this lab include science, social studies, language arts, and math.

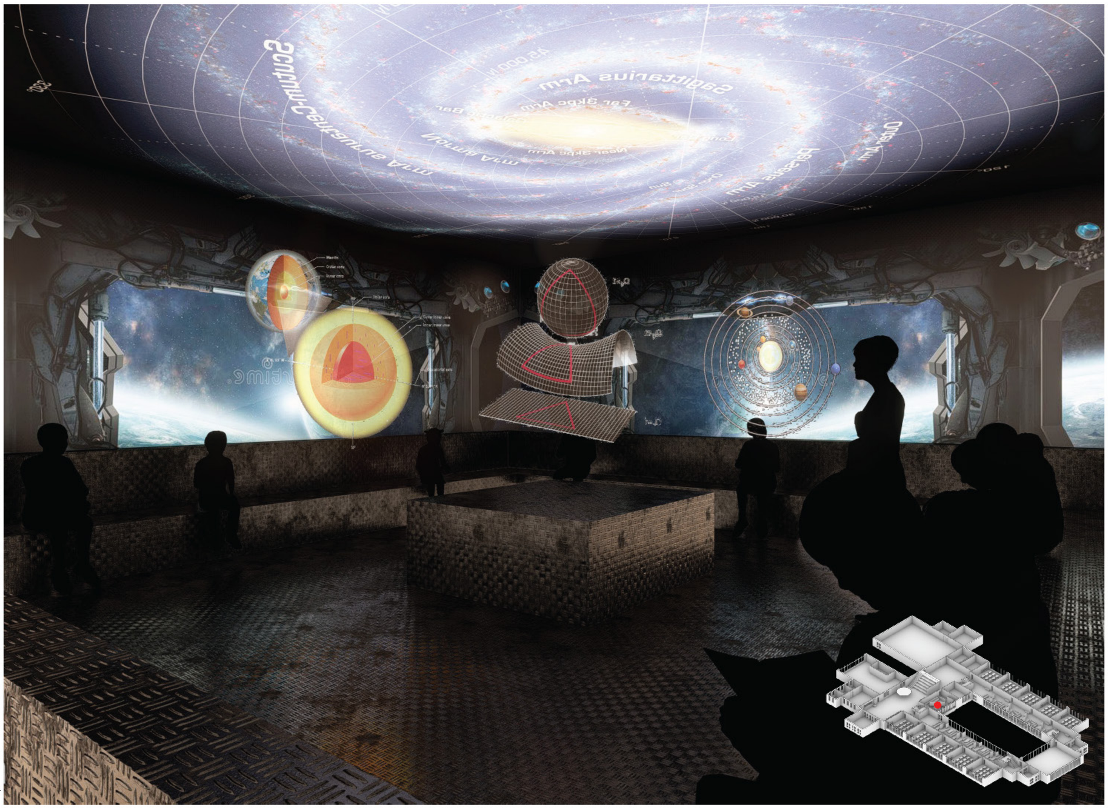
Cricle Layout



Grid Layout



Presentation Slides



VR Simulation Lab

Conclusion

Integrating AR and VR technologies into elementary schools offers enhanced learning experiences, increased student engagement, and improved learning outcomes. These technologies provide access to remote learning opportunities, exposure to potential career paths, and the development of spatial reasoning abilities through interaction with digital 3D objects. Overall, integrating AR and VR technologies into elementary schools creates a more engaging and effective learning environment that prepares students for the future.

Thesis Appendix

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Thesis Appendix

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Previous Studio Experience

2ND YEAR
Fall: Milton Yergens
Land Artist Studio | Fargo, North Dakota
Studio designed for a land artist
Boathouse | Minneapolis, Minnesota
Design for a row team to train and compete

Spring: Cindy Urness
Dwelling | Marfa, Texas
Design of a small community with various ammeties
Birdhouse | Fargo, North Dakota
Design for a specific bird with respect to Pritzker Prize winner
Multi-Purpose Apartments | Fargo, North Dakota
Design of a low-rise multi-functional apartment

3RD YEAR
Fall: Alenjery Niloufar
Memory Machine | Theoretical
Representation of injustices within education
Nigerian Memorial and Muesum | Port Harcourt, Nigeria
Design that responded to the history and heartache of Nigeria

Spring: Emily Guo
The Grid | Miami, Florida
Design that responded to Covid-19 and creating a community

4TH YEAR
Fall: Mark Barnhouse
Pristina Plaza | Miami, Florida
Design of a highrise that responds to its context

Spring: David Crutchfield
1900 Housing | Fargo, North Dakota
Low income housing with