# Virtual Interactive Management (VIM)Pilot

## Virtual Reality for TxDOT's Practical Supervision and Progressive Discipline Training Courses

Workforce Development, Human Resources Division

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## Introduction

The Texas Department of Transportation's (TxDOT's) Workforce Development (WFD) Section in the Human Resources Division partnered with the University of Texas Dallas Center for Simulation and Synthetic Humans to create Virtual Reality (VR) training scenarios with the use of Virtual Humans (VH) to accompany our Progressive Discipline and Practical Supervision training courses. The VR scenario's provide guided and supportive hands-on training and represent a new way to deploy and conduct training that is both a physical experience and a simulation of the Situational Supervisor Model (Director, Persuader, Collaborator, Delegator), Counseling, Coaching, Difficult Conversations, and End of Year Career Conversations. The goal is to augment current in-person instruction and workshops of these training courses and provide employees with a safe space to practice these leadership skills.

## Background & Overview

TxDOT has seen the rise of VR and Augmented Reality (AR) training continue to evolve over the last few years. This project represents TxDOT's attempt to explore VR options for the management and supervisory staff of the workforce. We selected our Practical Supervision and Progressive Discipline training courses as the basis for our experiment because the leadership competencies they address are key areas of focus related to TxDOT's organizational strategies.

This project started in Summer 2021 under the program management of the Center for Simulation and Synthetic Humans at the University of Texas at Dallas. TxDOT's Workforce Development served as subject matter experts to help develop the scenarios to be used in the project. The development of the scenarios followed a project plan that included market research and the development of a hardware plan, training curriculum design which included a curriculum development plan, training interface design and framework, training curriculum development, conversion to computer-based training curriculum, implementation, evaluation, and conclusions. The training curriculum developed is done so as computer-based training content within the Unity game engine. The project was completed by executing the computer programming of the scenarios, integrating a mixed methods-based data collection plan, creating an initial system prototype, implementing a prototype testing plan, revising, completing design-based iterations from internal testing and SME feedback, identifying alpha field testing groups, developing modifications to the system based on alpha field testing of the prototype, and developing final modifications to the system based on beta field testing. Upon completion of course material development in the Spring 2022, results were analyzed from the alpha and beta testing. By Winter 2022, we closed the project and completed this report.

## Methodology

### Planning

At the inception of this project a thorough instructional systems design project plan was developed. The plan includes major milestones scheduled over the course of 2021 and 2022 and serves as the overall framework for this project. An overview of the project management plan is shown below and depicts the timeline of the project:

- Planning: **Project Management Plan** (July, August 2021)
- Market Research: **Hardware Plan** (October 2021)
- Training Curriculum Design: **Curriculum Development Plan** (October 2021)
- Training Interface Design: **Interface Design Framework** (November, December 2021)
- Training Curriculum Development: **Finalized Training Curriculum** (January 2022)
- Training Curriculum Development Conversion: **Computer-Based Training Curriculum** (February – July 2022)
- Training Curriculum Implementation: **Rollout Information** (August 2022)
- Training Evaluation: **Summary Report/Accompanying Information** (September 2022)
- Project **Conclusion** (October 2022)

### Market Research

Following the development of the project plan, market research was conducted, and a hardware plan was developed to analyze potential hardware options including mobile devices, standalone virtual reality (VR), and standalone augmented reality (AR). The plan contains a breakdown for each type of device, as well as specific devices within that category that looked promising for this project. The breakdown for each category includes the price of the device, hardware specifications, content distribution options, accessibility limitations, security requirements, and a pros/cons list. A summary of the market research follows.

<u>Mobile Devices</u>

<u>Phone AR</u>:

Cell phones have become the most accessible and researched platform for AR because of their portability and power. Research for mobile device AR is the most prominent because of how common and familiar they are to the general population. The phone's rear facing camera is used for the AR experience and there are two mainstream forms of tracking. Mobile AR has many uses, including marketing, education, and training thus making it a potentially powerful tool to enhance the existing TXDOT practical supervision and progressive discipline training.

**Phone VR**:
Phone VR is the most accessible point of entry into VR due to the large number and ubiquitous nature of cell phones. With cardboard headsets phone VR can be an efficient and inexpensive way to provide VR to many users. Users may interact with the VR experience by aligning a viewing reticle with an object in the experience, or have a Bluetooth enabled controller for user input within the VR application. Mobile VR is another option to enhance existing TXDOT training curricula.

**Potential Platform Devices – Cardboard and Plastic Headsets:**

**Cardboard**

- The following site offers various cardboard models to choose from starting at $8.95 - $39.95. ARVR.google.com.

**Plastic Headsets**

- **Device 1 - KnoxLabs:** knoxlabs.com
  This is a very simplistic but inexpensive and easy to setup model. This is a good headset option for remote training. This headset also gives the ability to attach a headband, so you are not required to hold the device while using it. It works well for all modern phones, and it also works well for people with glasses. Price Per Unit: $14.99. Headband Price: $4.75.

- **Device 2 - ReTrak Utopia 360:** ReTrak Utopia 360.com
  This unit has a higher price point and is created from a hard plastic material as opposed to cardboard. This is also a good headset option for remote training and comes packaged with an elastic headband and Bluetooth remote. Price Per Unit: $34.99

- **Device 3 - MaxboxVR:** MaxboxVR.com
  This company offers an expansive list of compatible mobile devices for their cardboard headsets, as well as branding options for their cardboard templates. A TXDOT branded headset is an option. There are several different headset options – the unit information listed on the next page is their standard unit price.
  - Price Per Unit: $8.68 (100 Units)
  - Price Per Unit: $8.68 (100 Units)
  - Price Per Unit: $8.64 (200 Units)
  - Price Per Unit: $8.41 (300 Units)
  - Price Per Unit: $7.98 (400 Units)
  - Price Per Unit: $6.92 (500 Units)

## Additional Platform Device - Bluetooth Controller

One aspect to keep in mind is how the user controls the device while it is positioned within the headset. While it is possible to interact with the device by hand when it rests within the headset, it quickly becomes tedious to use touch navigation. A Bluetooth controller is recommended for ease of access. It also may be possible to select elements using your vision and pressing a corresponding button on your phone while looking at a UI (user interface) element, but this option will have to be explored during development.

Finding a hardware developer that sells an inexpensive Bluetooth remote themselves can be challenging. Almost all Bluetooth remotes are sold through Amazon or another reseller. If buying in bulk and straight from the developer, the Satechi Bluetooth Multimedia Remote is recommended. Price Per Unit: $34.99. satechi.net.

**Summary of Pros and Cons of Cardboard and Plastic Headsets:**

| Pros | Cons |
|---|---|
| ▪ Compatible with nearly every recent smart phone<br>▪ Most portable<br>▪ Inexpensive<br>▪ Light<br>▪ Lowest level of entry | ▪ Limited functionality<br>▪ Performance reliant on phone<br>▪ Limited interactivity |

**Table 1**: Pros and Cons of Cardboard and Plastic Headsets

## Mobile Device Breakdown

**Marker-based tracking:** This mode requires optical markers, such as QR codes, to trigger the AR features. By pointing your mobile camera at one of these barcodes, the application recognizes it and superimposes the digital image on the screen. Through the camera, the application can read physical markers on a surface for the application to place the virtual object in the real world.

**Marker-less tracking:** This mode is premised on object recognition. AR applications that work based on marker-less tracking are triggered when they recognize certain real-world features. In the case of Snapchat, that real-world object is your face.

There are several other components that work with the camera for accurate tracking.

- The **depth sensor** is used to measure depth and distance from the anchor to the mobile device.
- The **gyroscope** detects the angle and position of your phone, like if it is rotated.
- The **proximity sensor** measures how far and close something is, such as a physical marker which can initiate the AR experience once the camera detects a sensor at the desired distance.
- The **accelerometer** detects changes in rotation, movement, and velocity. It works in tandem with the gyroscope.
- The **light sensor** measures brightness captured in the camera lens. All of these components are utilized to create an accurate and engaging AR experience.

The two major AR software are ARKit, by Apple, and ARCore, by Android. They both use the same core technologies for their AR experience. Others include, Vuforia, Wikitude, and ARToolKit.

- **Environment understanding**: This allows your phone to detect prominent feature points and flat surfaces to map its surroundings out. In doing so, the system can then place virtual objects accurately on these surfaces.
- **Motion Tracking**: This lets your phone determine its position relative to its environment. Virtual objects can then be planted on their designated spots on the image.
- **Light estimation:** This gives your phone the ability to perceive the environment's current lighting condition. Virtual objects can then be placed in the same lighting conditions to enhance realism.

**Content Distribution, Accessibility, and Security:**

Google offers a software development kit for developing cardboard applications for both Android and iOS, using Unity which supports both. Through this development kit you can develop and distribute an application securely for download. You can export through an internal server and download directly onto the phone for immediate use, or you can upload the application to the iOS and Android store platforms. Unity, having the ability to create a build for both Android and iOS, would be the most effective method to distribute the application for the widest consumer base. Security is limited to the capabilities of the user's device (their phone).

**Stand Alone Virtual Reality**

Standalone units such as the HTC Vive, HTC Vive Focus 3, or Meta Quest 2 offer a much more engaging experience in VR, allowing the users to interact with objects within the world to a much higher degree using physics and other complex systems, not possible on mobile phone platforms.

Potential Platform Device - HTC Vive

Starting Price: $699. Required PC: $800.

The HTC Vive is a PC tethered VR headset that offers the most power of the VR devices because it uses the hardware within the hosted PC. It features outward-inward tracking via infrared sensor units that border the established play space designated by the user. It requires a moderately powerful PC to run well.

- Recommended Computer Specs
  - **Graphics:** NVIDIA® GeForce® GTX 1060 **or** AMD Radeon™ RX 480 equivalent or better
  - **Processor:** Intel® Core™ i5-4590 or AMD FX™ 8350, equivalent or better
  - **Memory:** 4 GB RAM or more
  - **Video out:** HDMI 1.4, DisplayPort 1.2 or newer
  - **USB ports**: 1x USB 2.0 or better port
  - **Operating system:** Windows® 7 SP1, Windows® 8.1 or later, Windows® 10

- VIVE Specs
  - **Screen**: Dual AMOLED 3.6'' diagonal
  - **Resolution**: 1080 x 1200 pixels per eye (2160 x 1200 pixels combined)
  - **Refresh rate**: 90 Hz
  - **Field of view**: 110 degrees
  - **Safety features**: Chaperone play area boundaries and front-facing camera
  - **Sensors**: SteamVR Tracking, G-sensor, gyroscope, proximity
  - **Connections**: HDMI, USB 2.0, stereo 3.5 mm, Power, Bluetooth
  - **Input**: Integrated microphone
  - **Eye Relief**: Interpupillary distance and lens distance adjustment
- Controller specs
  - **Sensors**: SteamVR Tracking
  - **Input**: Multifunction trackpad, Grip buttons, dual-stage trigger, System button, Menu button
  - **Use per charge**: Approx. 6 hours
  - **Connections**: Micro-USB charging port

- Content Distribution:

  The HTC Vive uses supported applications and is launched through either the onboard headset overlay or launched on the host computer.

- Accessibility:

  The HTC Vive is the most limited option for VR in terms of usability and accessibility because of the required physical sensors that drive the physical play space for the VR application, along with the tethered cable to a host PC.

- **Security:**
  The HTC Vive uses Viveport, its native launching software, as well as Steam VR, a 3rd party game platform, which allows for added security through user account creation. There is also the option to launch directly through a compatible PC application.

**Summary of Pros and Cons of HTC Vive Headset:**

| Pros | Cons |
| --- | --- |
| ▪ One of the more powerful VR headsets on the market currently<br>▪ Accurate tracking<br>▪ Good online support<br>▪ Allows full body tracking | ▪ Higher price point<br>▪ Tethered to PC and designated play space<br>▪ Requires base stations for hand tracking |

**Table 2:** Pros and Cons of HTC Vive Headset

**Potential Platform Device - HTC Vive Focus 3**
Starting Price: $1300
The HTC VIVE Focus 3 is an untethered VR headset that uses inside out tracking.

- **VIVE Specs**
  - **Screen:** Dual 2.88-inch LCD Panels
  - **Resolution:** 2448 x 2448 pixels per eye
  - **Refresh Rate:** 90 Hz
  - **Field of View:** 120 degrees
  - **Safety Features:** Proximity Sensor
  - **Connections:** 2x USB 3.2 Gen-1 Type-C Peripheral Ports, Bluetooth 5.2 + BLE, Wi-Fi 6+6E
  - **Input:** Dual Integrated Microphones, Headset Button
  - **Eye Relief:** Interpupillary Distance Range of 57mm to 72mm, Patented Quick Release Head Strap Design

- **Controller Specifications**
  - **Sensors:** Hall Sensors on Trigger and Grip Buttons, Capacitive Sensors on Trigger, Joystick, and Thumb-Rest Area, G-Sensor, Gyroscope

- **Input:** Ergonomic Grip Button, Analog Trigger Button, AB/XY Buttons, System/Menu Buttons, Joystick
- **User Per Charge:** Approx. 15 hours.
- **Connections:** USB-C

**Summary of Pros and Cons of HTC Vive Focus 3 Headset:**

| Pros | Cons |
|---|---|
| ▪ One of the more powerful VR headsets on the market currently<br>▪ Accurate tracking<br>▪ Ergonomic<br>▪ Untethered | ▪ Higher price point |

Table 2: Pros and Cons of HTC Vive Focus 3 Headset

**Potential Platform Device - Meta Quest 2:** Starting Price: $399.
The Meta Quest 2 is a powerful, wireless standalone unit with inward-outward tracking, hand tracking, and a competent processor. This unit comes with 128GB of space. There is also a 256GB option ($429).

- **Meta Quest 2 Technical Specs:**
  - **VR Category**: All-in-one VR
  - **Tracking**: Oculus Insight inside-out tracking
  - **Input**: Two Oculus Touch controllers
  - **Resolution**: 1832x1920 per eye
  - **Display Panel**: Fast-switch LCD
  - **Audio**: Integrated positional audio
  - **Processor**: Qualcomm® Snapdragon™ XR2 Platform
  - **Battery Life**: ~2-3 hours
  - **Storage**: 128GB or 256GB
  - **Supported Usage Modes**: Seated, standing, room scale
  - **Glasses Friendly**: Comfortable to wear with glasses or RX inserts

- **Content Distribution:**
  The Meta Quest 2 features its own store platform as well as OS. However, the user can activate developer mode in the settings, allowing for the installation of 3rd party software, such as games and other media.

- **Accessibility:**
  The Meta Quest 2 is a Facebook platform device and requires an active Facebook account to use the headset. All content bought through the Oculus Store platform will be tied to the associated Facebook account.

- **Security:**
  With the mandatory login with a Facebook account, security and privacy with the Quest 2 is questionable due to Facebook's track record of data collection.

Summary of Pros and Cons of Meta Quest 2 Headset:

| Pros | Cons |
|---|---|
| ▪ Portable<br>▪ Powerful for size<br>▪ Accurate tracking<br>▪ Good online support<br>▪ Reasonable price<br>▪ Works standalone or connected to PC | ▪ Locked by mandatory Facebook account<br>▪ Data collection and privacy<br>▪ Limited storage space |

Table 3: Pros and Cons of Meta Quest 2 Headset

## Stand Alone Augmented Reality

### Recommended Platform Device - Microsoft HoloLens 2

Starting Price: $3,500

The Microsoft HoloLens 2 is another one of the major standalone AR Devices. The HoloLens 2 also features a head-mounted display, like the HTC Vive, although it delivers AR as opposed to VR. The HoloLens is powered by an internal battery within the unit. Its interface includes hand gestures, eye tracking, and voice commands.

### Technical Specs

- Display
  - Optics: See-through holographic lenses (waveguides)
  - Resolution: 2k 3:2 light engines
  - Holographic density: >2.5k radiants (light points per radian)
  - Eye-based rendering: Display optimization for 3D eye position
- Sensors
  - Head tracking: 4 visible light cameras
  - Eye tracking: 2 IR cameras
  - Depth: 1-MP time-of-flight (ToF) depth sensor
  - IMU: Accelerometer, gyroscope, magnetometer
  - Camera: 8-MP stills, 1080p 30 video
- Audio and speech
  - Microphone array: 5 channels
  - Speakers: Built-in spatial sound

- **Human understanding**
  - Hand tracking: Two-handed fully articulated model, direct manipulation
  - Eye tracking: Real-time tracking
  - Voice: Command and control on-device; natural language with internet connectivity
  - Windows Hello: Enterprise-grade security with iris recognition
- **Environment understanding**
  - 6DoF tracking: World-scale positional tracking
  - Spatial Mapping: Real-time environment mesh
  - Mixed Reality Capture: Mixed hologram and physical environment photos and videos
- **Compute and connectivity**
  - SoC: Qualcomm Snapdragon 850 Compute Platform
  - HPU: Second-generation custom-built holographic processing unit
  - Memory: 4-GB LPDDR4x system DRAM
  - Storage: 64-GB UFS 2.1
  - Wi-Fi: Wi-Fi: Wi-Fi 5 (802.11ac 2x2)
  - Bluetooth: 5
  - USB: USB Type-C
- **Fit**
  - Single size
  - Fits over glasses
  - Weight: 566g
- **Software**
  - Windows Holographic Operating System
  - Microsoft Edge
  - Dynamics 365 Remote Assist
  - Dynamics 365 Guides
  - 3D Viewer
- **Power**
  - Battery life: 2–3 hours of active use
  - Charging: USB-PD for fast charging
  - Cooling: Passive

**Content Distribution, Accessibility, and Security:**

The Microsoft HoloLens 2 can have applications deployed manually to the device by a user or they can be downloaded from the Microsoft store platform. The device runs on an internal battery making it a very accessible and mobile solution for AR applications. The HoloLens 2 is a self-contained Windows computer that has all the common Windows security packages including the Windows defender firewall. Windows updates are automatically installed as well to ensure the device always has the most up to date security packages from Microsoft.

**Summary of Pros and Cons of Microsoft HoloLense 2 Headset:**

| Pros | Cons |
|---|---|
| ▪ Quality projection<br>▪ Great interactivity<br>▪ Included Windows Security | ▪ Low Field of View<br>▪ Low battery life<br>▪ Higher price point |

**Table 4:** Pros and Cons of Microsoft HoloLense 2 Headset

## Recommendations

For a lighter and more mobile AR/VR application, mobile devices are the most efficient and cost-effective option. If a more advanced VR technology is preferred, the HTC Vive Focus 3 allows for a high-fidelity virtual reality experience at the cost of setup time, mobility, and a much higher price point. The Meta Quest 2 is another standalone VR option, being one of the most inexpensive standalone options, but requires a mandatory Facebook account to access. Similarly, the HoloLens 2 offers a high-fidelity augmented reality experience that is mobile and easy to setup but is very expensive per unit compared to the mobile options. After discussions, the team selected the Spectre, Meta, and HTC Vive Focus 3 for this experiment.

## Training Curriculum Design

After the completion of the market research and development of the hardware plan, the next step in the project plan was to establish the curriculum development design plan. As mentioned, TxDOT's Practical Supervision and Progressive Discipline training courses were selected as the basis of this experiment because the leadership competencies they address are key areas of focus related to TxDOT's organizational strategies. Practical Supervision provides practical tools and techniques for supervising employees. Topics include multi-generational workforce, team building, Situational Supervisor Model, GROW Coaching, Performance Management, and Leadership and Motivation. Progressive Discipline provides supervisors with the knowledge and skills to effectively handle poor employee performance including techniques for counseling employees, proper documentation strategies, and how to initiate a disciplinary action.

The goal with the scenario development was to provide TxDOT leaders with real-world scenarios they might encounter and provide them with a safe space to practice handling various situations with the use of the VR space using VH's in the VIM system. The scenario topics in the plan include situational supervision, the difference between Counseling, Coaching, and Mentoring, the Skill/Will of employees, GROW Coaching, Career Conversations, and Implementing Disciplinary Action.

The curriculum development plan contains detailed specifications for each aspect of the scenario's development including location of the scene, number of characters, and scenario details. The final scenarios used in programming include Situational Supervision – Module 1, Coaching and Counseling an Employee – Module 2, Difficult Conversations – Module 3, and End of Year Career Conversations – Module 4.

0. <u>Tutorial (Similar to the Practical Supervision Video):</u>

Scene: Supervisor Office

Characters: 1 Virtual Human HR Representative

The user is placed in a virtual replication of the Practical Supervision video – where they play one of the new supervisors and are speaking to a Virtual Human (VH) HR representative in VR. It is an introduction to the system and the HR representative explains the various training scenarios they are about to undergo. There is not much interactivity at this point, but it is a good use of the video replication as a tutorial to get the users more familiar with VR, get them acclimated to using the device/system, make sure everything is working within the system, introduce some of the VH characters, and overall help them feel more comfortable in the VR space.

## 1. The Situational Supervision Model: Supervisor Styles and When to Use Them

The user is presented a collection of problems from various employees and must select the best suited supervisor style for the situation. The user is informed on the efficiency of their choice and its effect on the employee.

**Scene: Supervisor Office**

**Characters: 4 total. 2 male and 2 female.**

Break into 4 scenarios: Director, Persuader, Collaborator, Delegator

- Director: A reassigned employee is having a hard time adapting to their newly assigned task. The user should be polite, but direct and to point, on what the expectations are for the employee's task.

- Persuader: An employee cannot complete a computer related task because they are not experienced with the required software. Explain the task in detail and give them a good resource on how to learn the required skills for the job.

- Collaborator: A senior employee was assigned a task that they would be a good fit for, but the employee feels as if they are overqualified for it. Convince them of the importance of their task, why they were assigned to this task, and work with them on completing the task.

- Delegator: You have called one of your mid-level managers to meet with you and discuss proposed solutions to a specific situation.

## 2. Differences Between Counseling and Coaching:

The user is spoken to by a VH describing their situation, and the user must choose the best option from the 3 types: counseling and coaching. There will be 3 scenarios where a VH comes up with a work-related issue. Would counseling or coaching be the best method to solve it?

**Scene: Supervisor Office**

**Characters: 3 total. A mix of male and female**

- Counseling:
  - You've called this employee to your office because they've missed the last two milestones for turning in an important report. You establish a goal and set a time to follow up on that goal.
- Coaching:
  - You've noticed a communication issue with one employee's work as a traffic flagger and asked them to meet with you and resolve it.

3. <u>Skill/Will:</u>
The user is spoken to by a VH describing their situation, and the user must choose the best of 4 options based on their perceived skill/will. There will be 4 types of VH to coach. How would you assess their skill and will, and what will you say to them?

Scene: Supervisor Office

Characters: 4 total. A mix of male and female (could be the same characters as previous training)

- <u>Low Skill, Low Will</u>: A VH consults you about a work task but feels no sense of urgency regarding it nor their ability to do it. Firmly **direct** them by telling them what to do and how to do it.
- <u>Low Skill, High Will</u>: A new hire is eager to get to work despite their lack of ability. Helpfully **guide** them by giving them a task and teaching them how to do it.
- <u>High Skill, Low Will</u>: A longtime employee is feeling unsatisfied with their work. Help **excite** them by providing a sense of purpose for their work.
- <u>High Skill, High Will</u>: A longtime employee is eager to get started on a new task. **Delegate** a task to them that you know they can confidently accomplish.

4. <u>Performance Review (Career Conversation) Practice:</u>
The user must give a short performance review (conduct a career conversation) with various VH's. The user is given several VH employee reviews and notes from the past year from one of their managers, as well as self-evaluations from the VH employees themselves. These reviews and notes indicate how well the managers believe the VH's have performed over the past year. The self-evaluations indicate how the VH employees think of their own work over the past year. The user must review this information and conduct a short performance review (career conversation) with the VH choosing from predetermined, scripted responses. The user is scored based on how well they understood the situation and if they chose an appropriate response.

Scene: Standard Office

Characters: 2 total. A mix of male and female
- <u>Employee #1:</u> This employee has performed well. They have met regularly with you for their Touchpoint meetings every other month, and they have not missed any Touchpoints. Throughout the year, this employee has discussed their progress on assigned projects, and they have turned in all projects on time. They have successfully overcome any challenges they encountered on projects and with teams,

and they have discussed their career goals, development opportunities, and accomplishments with you in their previous Touchpoint meetings.

- Employee #2: This employee shows room for improvement, even though they are a capable employee. They have only met with you for three out of their six Touchpoint meetings throughout the year, and they never rescheduled the other three Touchpoints. They also have not regularly discussed their progress with you on their assigned projects. They blame others for their lack of production, and they have turned in several projects late. This employee does not get along with other team members, and they have not completed any professional development activities, other than the required mandatory training.

## 5. Counseling Employees Regarding Difficult Conversations:

The user must counsel several employees on various topics. The user must discuss the associated issue with the VH, identify/analyze why the problem is occurring, and come up with a logical solution to combat the issue.

Scene: Standard Office

Characters: 3 total. A mix of male and female

- Employee #1: You've noticed that this employee often arrives late for work. They work in finance to approve purchase orders and travel-related expenses. Although the scheduling of their work hours might be somewhat flexible, they have an existing, agreed-upon schedule that they no longer seem to be following. This has become problematic for the semi-weekly 9am team meetings. You've called them in to discuss the matter directly.
- Employee #2: You've been informed that this employee was seen playing games on their phone during last week's Quarterly Safety Training. You've called them in to discuss the matter directly.
- Employee #3: You've called this employee in because they are not completing their current assignments. This is a recurring issue. They are already on an improvement plan, but no improvement has been observed. This indicates that the situation has escalated in severity.

## 6. Implementing Disciplinary Action:

The user is presented with several situations with VH employees that require disciplinary action. The user must assess the VH's job performance and come up with the correct type of discipline given the circumstances.

Scene: Standard Office

**Characters: 3 total. A mix of male and female**

- **<u>Employee #1:</u>**
  You notice that this employee often takes extra time during their allocated lunch hours - not much time, it's usually around fifteen minutes. You have met with them previously to discuss this issue and they ensured you that it would not happen again, but this is still a common occurrence. Discuss this issue with them and choose which disciplinary action to take.
- **<u>Employee #2:</u>**
  This employee is frequently on their phone and not completing their assigned tasks. Their last two assignments were barely on time and of very poor quality. You consistently have to spend a substantial amount of time to fix their mistakes. Discuss this issue with them and choose which disciplinary action to take.
- **<u>Employee #3:</u>**
  This employee did not show up for work last week and neglected to respond to your emails and phone calls. They show up today and begin working as if nothing has happened. As you approach them to ask them to come into your office, you overhear them say to another employee, "See, they didn't do anything. I got paid for a free week off. I'll probably just get a slap on the wrist." Discuss this issue with them and choose which disciplinary action to take.

As the scenarios were being developed, dialogue maps were created and used to map all the scenarios and their associated response options within the virtual reality interface.

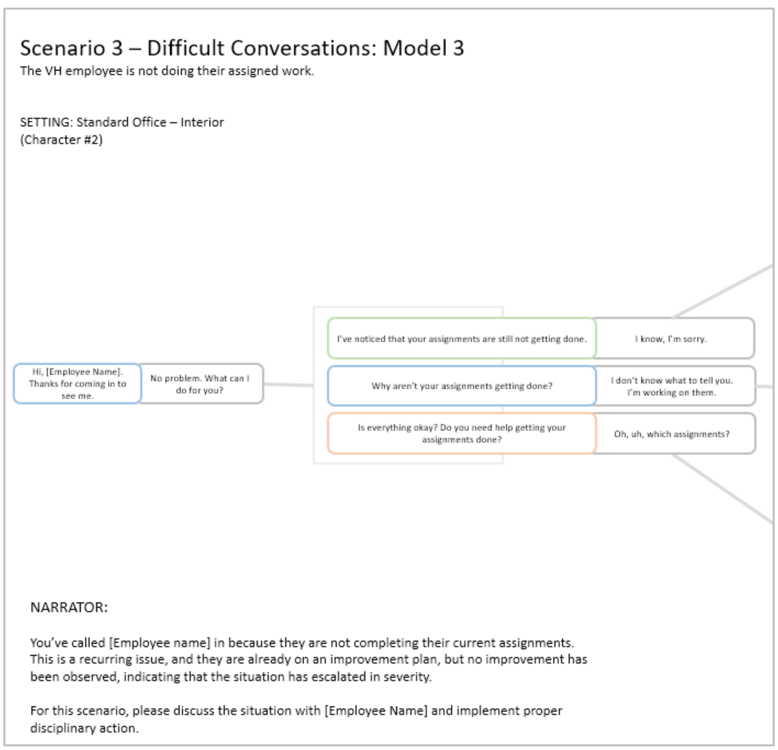



*Figure 1* Sample Dialogue Map

## Training Interface Design

After the initial detailed curriculum development plan was established, the next step in the project plan was to establish the training interface design framework. The training interface design includes elements such as game-based learning, simulation, mini games, reward system, multiplayer, tutorial design, individual/group-based scenarios, level of interactivity, and virtual humans. The framework includes complete storyboarding for graphics, characters, user interface, text, and other media. The framework includes a programming development plan using a mixed methods-based data collection plan for internal testing and external review that gathered SME approval of the interfaced design approach.

### <u>Gamification Overview</u>

Gamification is defined as “the use of game design elements in non-game contexts,” (Deterding et al., 2011). These game design elements may include scoring, badges, or unlockable rewards, used with the intention of increasing player motivation as well as creating long-term engagement (Sardi et al., 2017).


*Figure 2* Duo Lingo

Duo Lingo is a language learning app that features gamification examples such as a progression bar, unlockable lessons, and leveling system by completing consequential lessons.

### <u>Gamification of TXDOT Workforce Development VR Scenarios</u>

#### <u>Selection Interface</u>

For the main menu, there is a circular menu which allows for a clear separation of interactable menu elements, as well as ample room for text legibility. The main menu is where the user selects which scenario they would like to practice. The user turns their head to look at the menu option they wish to interact with, utilizing an interface mechanic known as gaze control. Looking at a menu option will highlight it, and the highlighted option may then be selected by reaching up and pressing the button on the top right side of the virtual reality (VR) headset. The user will double confirm to launch their selection, or they are also given the option to go back by selecting the top right back arrow indicator on the selected menu option. When the user looks at one of the interactable menu elements it also shows achievements they've unlocked during previous practice, indicated by badge icons located at the bottom left of each section. We discuss the badge system in more detail later in this report. An example of this interface is presented below in Figure 3.

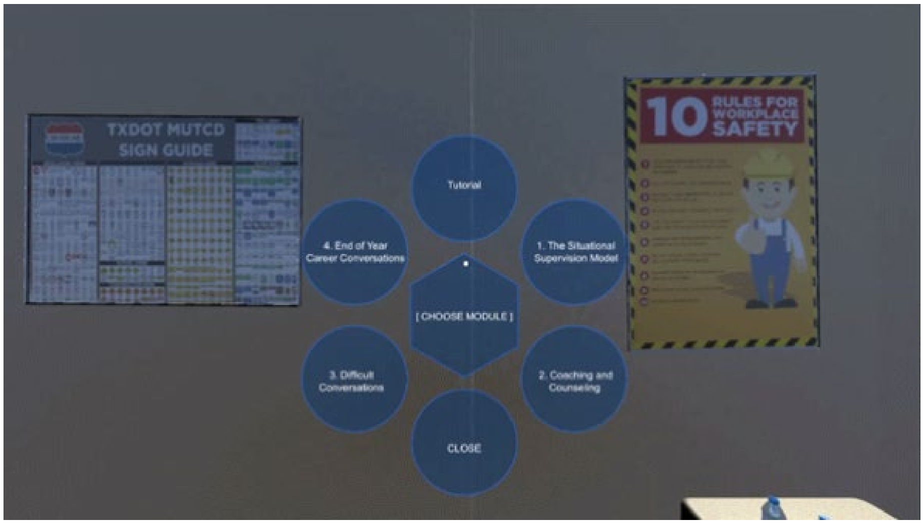



*Figure 3.* Above is an example of a user navigating the main menu using gaze control in VR. This is an example of the user double confirming selections to navigate deeper into the menu or selecting the back arrow to retract their selection choices.

## Scores and Feedback

To gamify our TXDOT VR Training, we use a scoring system (Page 23) that is individualized by each scenario within a module. Each VR scenario consists of several dialogue choices. Each choice is internally categorized as either optimal, less optimal, or not optimal, and awards a number of points.

- An optimal answer is worth 2 points.
- A less optimal answer is worth 1 point.
- A not optimal answer is worth 0 points.

If the user chooses several non-optimal answers in a row, or if the conversation path descends beyond a point of reasonable recovery, an **early ending** may occur. During an early ending, the narrator returns to remind the user of their current goal, suggest an adjustment, and then restart the scenario. This allows the user to make different choices on their next attempt.

**Total number of points available for each scenario are presented below:**

**Scoring Tables for Each Scenario:**

| | | |
|---|---|---|
| **Scenario 1: Collaborator**<br>Perfect score: 11 pts<br>Evaluations:<br>11 points = **Perfect!**<br>9 – 10 points = **Excellent!**<br>6 – 8 points = **Good Work!**<br>3 – 5 points = **Keep Practicing!**<br>Below 3 points = **Needs Improvement** | **Scenario 2: Coaching**<br>Perfect score: 13 pts<br>Evaluations:<br>13 points = **Perfect!**<br>11 – 12 points = **Excellent!**<br>8 – 10 points = **Good Work!**<br>4 – 7 points = **Keep Practicing!**<br>Below 4 points = **Needs Improvement** | **Scenario 4: End-of-Year Career Conversation 1**<br>Perfect score: 24 pts<br>Evaluations:<br>24 points = **Perfect!**<br>19 - 23 points = **Excellent!**<br>13 – 18 points = **Good Work!**<br>7 – 12 points = **Keep Practicing!**<br>Below 7 points = **Needs Improvement** |
| **Scenario 1: Delegator**<br>Perfect score: 4 pts<br>Evaluations:<br>4 points = **Perfect!**<br>3 points = **Keep Practicing!**<br>2 points = **Needs Improvement** | **Scenario 2: Counseling**<br>Perfect score: 10 pts<br>Evaluations:<br>10 points = **Perfect!**<br>5-7 points =**Good Work**<br>3-4 points – **Keep Practicing!**<br>Below 3 points = **Needs Improvement** | **Scenario 4: End-of-Year Career Conversation 2**<br>Perfect score: 24 pts<br>Evaluations:<br>24 points = **Perfect!**<br>19 - 23 points = **Excellent!**<br>13 – 18 points = **Good Work!**<br>7 – 12 points = **Keep Practicing!**<br>Below 7 points = **Needs Improvement** |
| **Scenario 1: Director**<br>Perfect score: 12 pts<br>Evaluations:<br>12 points = **Perfect!**<br>9 – 11 points = **Excellent!**<br>6 – 8 points = **Good Work!**<br>3 – 5 points = **Keep Practicing!**<br>Below 3 points = **Needs Improvement** | **Scenario 3: Difficult Conversations – Model 1**<br>Perfect score: 23 pts<br>Evaluations:<br>23 points = **Perfect!**<br>18 - 22 points = **Excellent!**<br>12 – 17 points = **Good Work!**<br>7 – 11 points = **Keep Practicing!**<br>Below 7 points = **Needs Improvement** | |
| **Scenario 1: Persuader**<br>Perfect score: 11 pts<br>Evaluations:<br>11 points = **Perfect!**<br>9 – 10 points = **Excellent!**<br>6 – 8 points = **Good Work!**<br>3 – 5 points = **Keep Practicing!**<br>Below 3 points = **Needs Improvement** | **Scenario 3: Difficult Conversations – Model 2**<br>Perfect score: 15 pts<br>Evaluations:<br>15 points = **Perfect!**<br>12 – 14 points = **Excellent!**<br>8 – 11 points = **Good Work!**<br>4 – 7 points = **Keep Practicing!**<br>Below 4 points = **Needs Improvement** | |
| | **Scenario 3: Difficult Conversations – Model 3**<br>Perfect score: 15 pts<br>Evaluations:<br>15 points = **Perfect!**<br>12 – 14 points = **Excellent!**<br>8 – 11 points = **Good Work!**<br>4 – 7 points = **Keep Practicing!**<br>Below 4 points = **Needs Improvement** | |

Table 5: Scoring Tables for Each Scenario

## Scenario Screen

The scenario screen places the user in a new environment with the virtual coworker with whom they interact with. As shown below in Figure 4, During the course of the scenario, the user has a user interface prompt to select an answer for the training scenario.

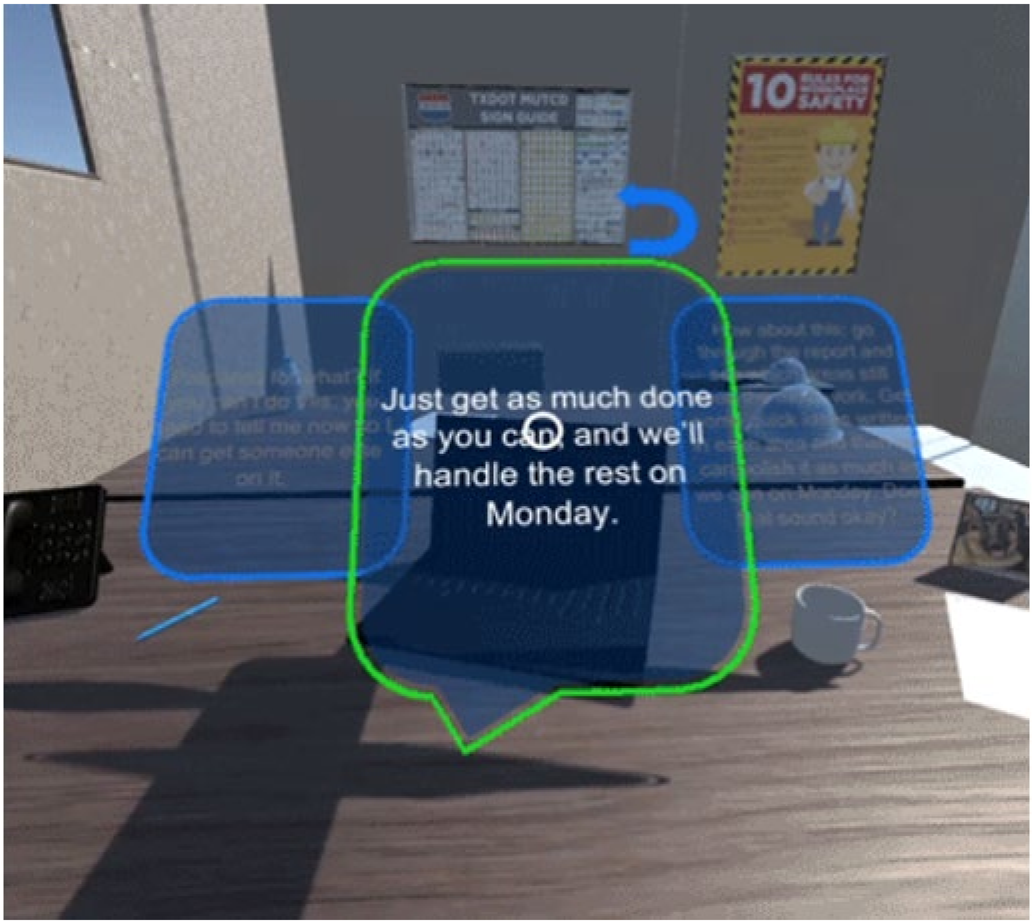



*Figure 4* This is an example of a user selecting a dialogue choice using gaze control within a VR environment. The final version includes a virtual employee sitting across from the user and responding to dialogue choices.

## Real Time Stimulus for Scoring

At the beginning of each scenario, the user is informed of how many points they need for a perfect score. As the scenario proceeds, users receive visual feedback immediately upon confirming their dialogue selection. This manifests in-scenario as a colored highlight and visual flash around the border based upon the answer quality of the selected dialogue option. For example, if the user selects an optimal answer, a green highlight will briefly appear around the border of the dialogue window, as displayed in Figure 4 above.

## Results

As shown in Figure 5, at the end of the scenario, the user is shown their results in the VR headset. A window appears that lists the points earned on each question, as well as total score depending on the scenario. The user also receives an evaluation, depending on their total score. To the right is an example of the results screen.

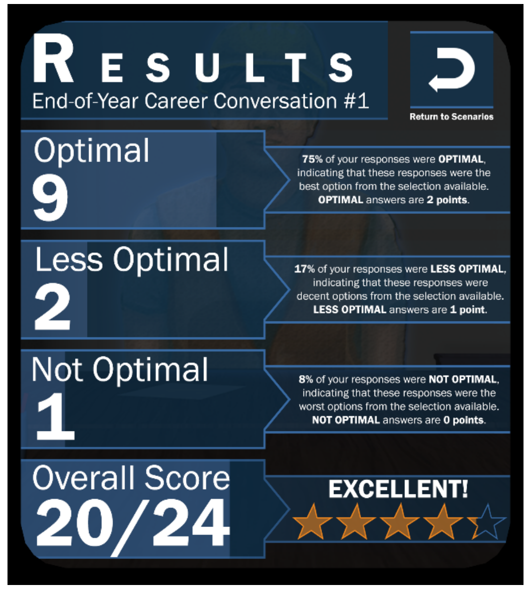



*Figure 5.* The results screen appears after a scenario has been completed and shows total score, evaluation, and a breakdown of individual answer scores.

## Progress Meter

To give an indication of real time progress, an on-screen meter, as shown in Figure 6, is visible throughout each scenario, indicating the percentage of the scenario that is complete and how much longer the scenario will continue. This meter can be referenced by the user at any time to quickly gauge their overall progress.


*Figure 6.* The progress meter will illustrate the user's overall progress through individual scenarios.

## Badges

Upon completion of a module the user unlocks associated badges to demonstrate their mastery of each specified scenario focus. This gamification method is introduced to appeal to users that want to view their progression in skill, gaining merit awards for their outstanding performances. Three tiers of awards can be received upon completion of each scenario based on the user's overall evaluation. Bronze is awarded for completion of a scenario, silver for acquiring an evaluation of "Good Work!" or higher, and gold for reaching "Perfect!". These badge achievements are viewable at the main menu.

*Figure 7.* To the right are the badges that can be unlocked, starting with bronze for completing a scenario, progressing to silver for an evaluation of "Good Work!" or higher, and last gold for achieving a "Perfect!" score.

## Training Curriculum Development and Conversion

Curriculum development is the broad theoretical framework used to design, create, and deliver learning content, with the process being iterative. One process may overlap another, or one process may work in tandem with another. As the design phase of the training curriculum for this project was winding down, the development phase was started.

The finished training product includes training curriculum designed and developed to TxDOT standards for adult learning that include objectives written to Mager Standards tied to Bloom's taxonomy of cognitive learning. The training curriculum developed is computer-based training content within the Unity game engine. The programing conversion including training interface design, and gamification was completed by students and staff at the University of Texas Dallas Center for Simulation and Synthetic Humans.

## Implementation

The implementation phase of curriculum development refers to the actual delivery of the instruction whether it is classroom-based, lab-based, or computer based. The purpose of this phase is effective and efficient delivery of instruction. This phase promotes the learners understanding of material and support the students' mastery of learning objectives. During this phase, the initial system prototype, and prototype testing was implemented using the Spectre, Meta, and Vive Focus 3 headsets.

The alpha field-testing groups were identified, schedules for the experiment were created, and testing took place in Fall 2022. The field-testing groups were comprised of employees in three locations across the state of Texas: Yoakum, Dallas, and Austin (Figure 8).

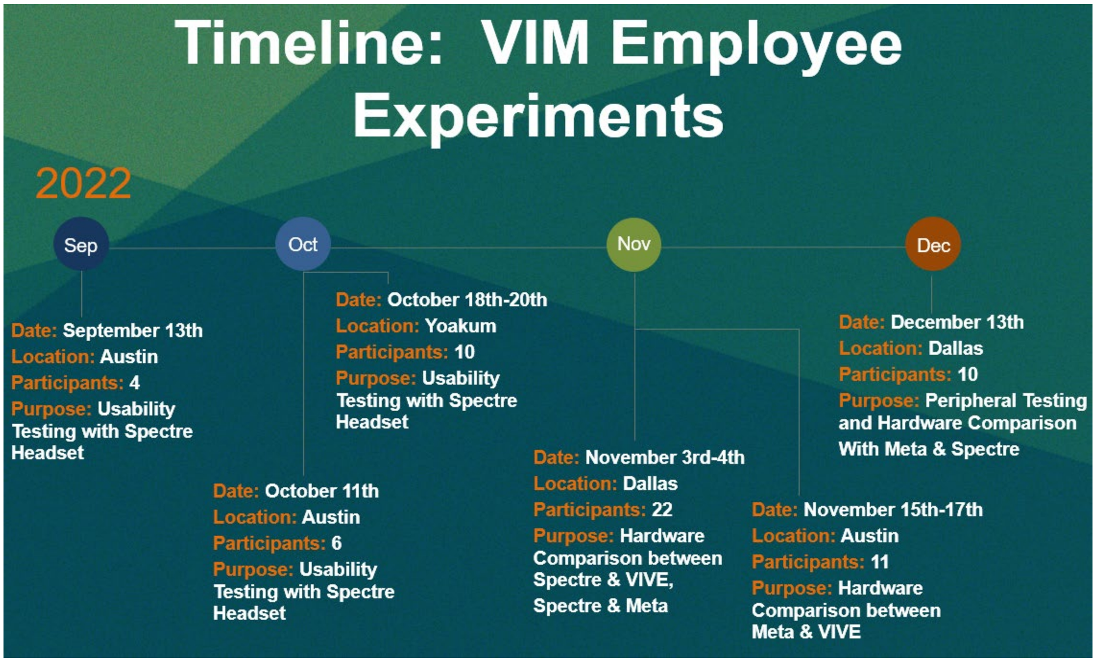



*Figure 8* Timeline: VIM Employee Experiments.

## Evaluation

Pre and post surveys (Appendix A and B) were used in the alpha testing which measure the participants in three of the four levels detailed by the Kirkpatrick behavior-based learning objectives model: reaction, learning, and behavior (Smidt, Balandin, Sigafoos, & Reed, 2009). Results, the fourth level of the Kirkpatrick model will be assessed through follow up research (Smidt, Balandin, Sigafoos, & Reed, 2009). VIM also includes the three levels mentioned in the Mager model that focus on performance-based learning objectives: performance, conditions, criteria. (Conley, Lutz, & Miller, 2017). Learning objectives were clearly communicated to the user for each scenario through audio and/or graphic interfaces. Overall, using the Kirkpatrick and Mager models simultaneously provides a holistic perspective of the employees' performance and the training outcome. Including the two models in the experiment allows participants to demonstrate their knowledge and skills through workplace behavior and allows researchers to measure performance in terms of employees' goals.

In addition to the behavior-based questions on the pre and post surveys, also included was a usability survey that assesses the participants' reactions to the virtual employees and the overall system. Overall, the surveys evaluate the participants' understanding of the material, the practical application of the training in their workplace, and their achievement of the learning objectives.

Methods of Overall Assessment: Methods of assessment are presented below:

Reaction: What did users indicate on pre-and post-surveys? Did they have positive impressions of the system?

Learning Outcomes: How did users score on their dialogue choices? How did they rate their knowledge on pre- and post-surveys?

Behavior: How do user scores compare from the beginning to the end of the rollout? Did users indicate long-term learning gains on surveys?

Results: After some time, have users applied these experiences in the workplace? What did they take away from the program?

Data Collection Method: Tested in the pilot, surveys were collected through Redcap on the participants' study-provided iPhone.

Data Collection from VIM Interaction: A variety of interaction data is available from the gameplay and is discussed next.

The alpha testing at each location was designed to test usability with each device, the Spectre, Vive Focus 3, and Meta, conduct peripheral testing, and complete a hardware comparison. In addition, the testing was conducted to determine if the training and modality meet the learning objectives.

<u>**Meeting Learning Objectives – Module1?**</u>

Employees found that the VIM System met learning objectives for Module 1 (Situational Supervision Model). Employees who completed module one across all devices:

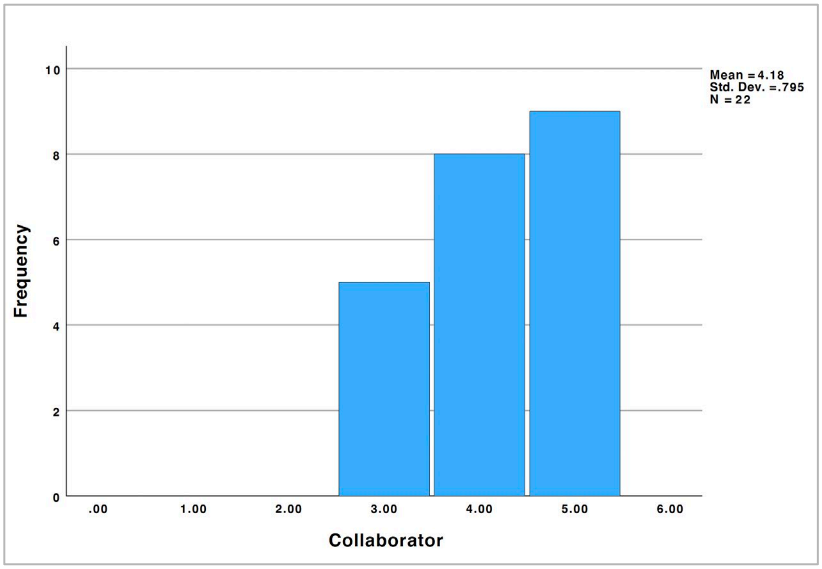
On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to use the **collaborator** supervision style preference?

**Collaborator Supervision Style**

n=22

Mean=4.18

Mode=5



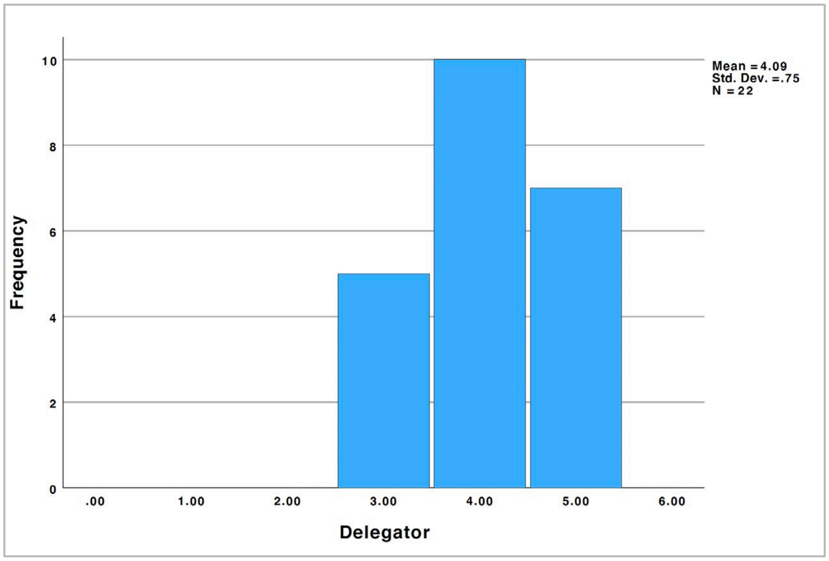

On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to use the **delegator** supervision style?

**Delegator Supervision Style**

n=22

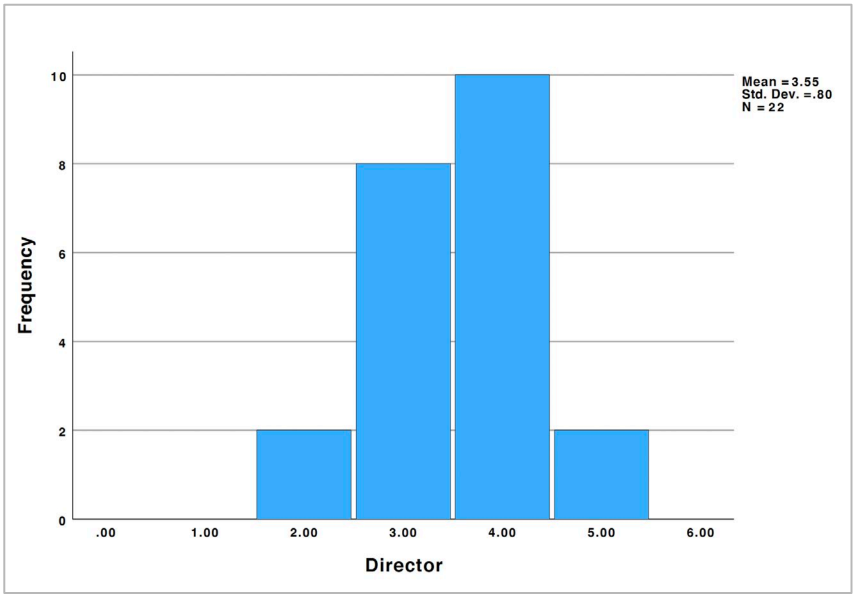
Mean=4.09

Mode=4



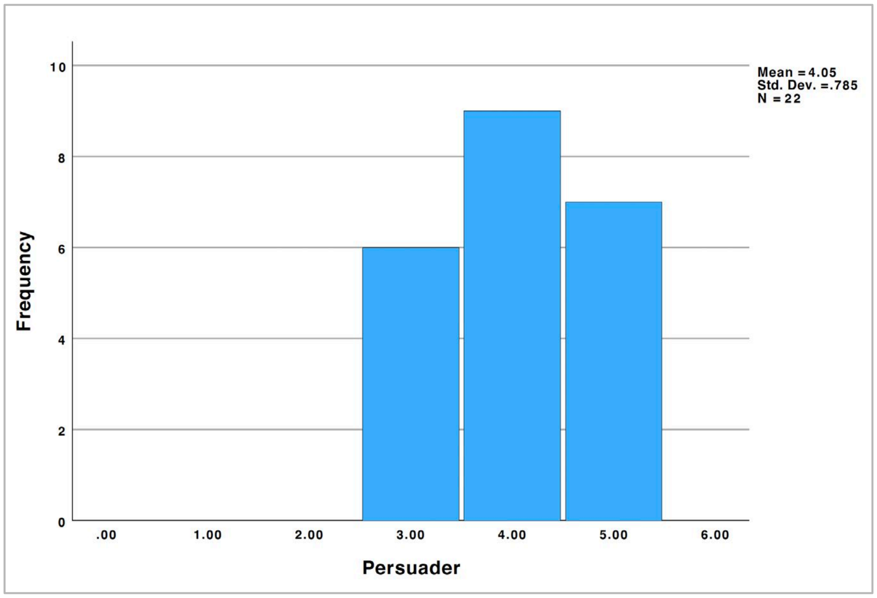
On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to use the **director** supervision style preference?

**Director Supervision Style**
n=22
Mean=3.55
Mode=4




On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to use the persuader supervision style preference?

**Persuader Supervision Style**
n=22
Mean=4.05
Mode=4

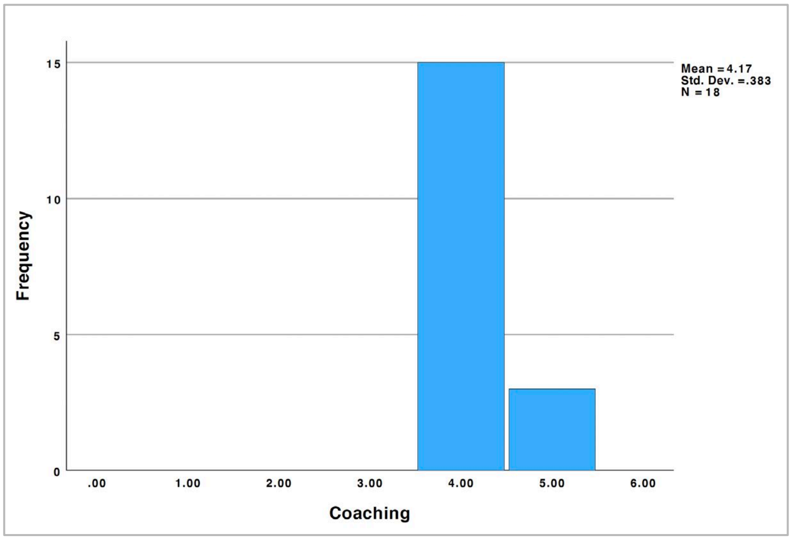


## Meeting Learning Objectives – Module 2 - 4?

Employees found that the VIM System met learning objectives for Modules 2-4 (Coaching an Employee, Counseling an employee, Difficult Conversations, and End of Year Conversations). Employees who completed modules 2-4 across all devices:

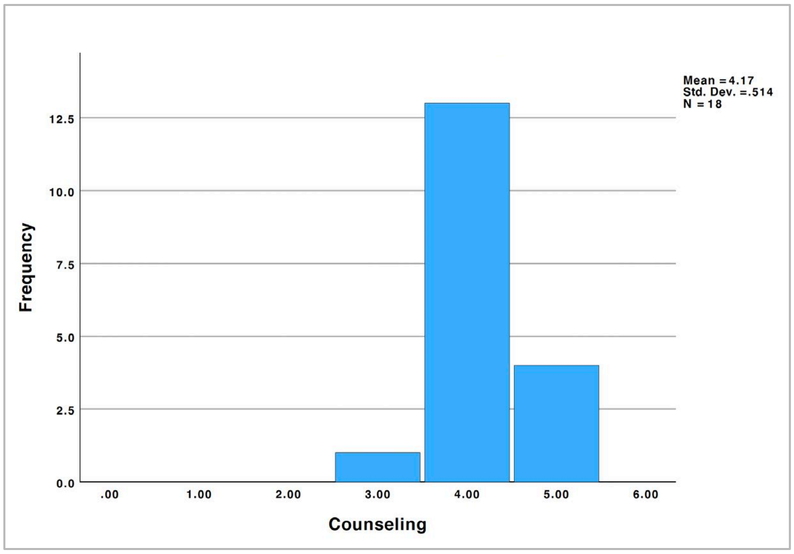
On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to **coach** an employee in the appropriate situation?

**Coaching an Employee**
n=18
Mean=4.17
Mode=4



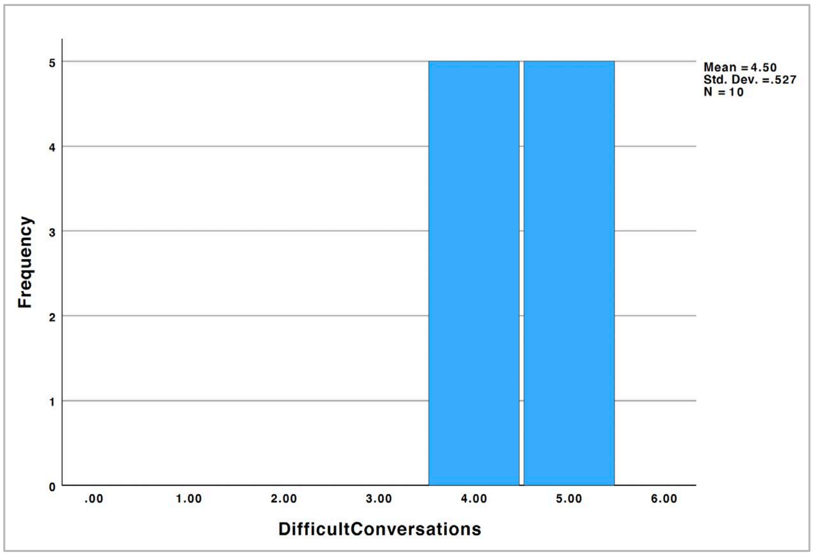

On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to **counsel** an employee in the appropriate situation?

**Counseling an Employee**
n=18
Mean=4.17
Mode=4



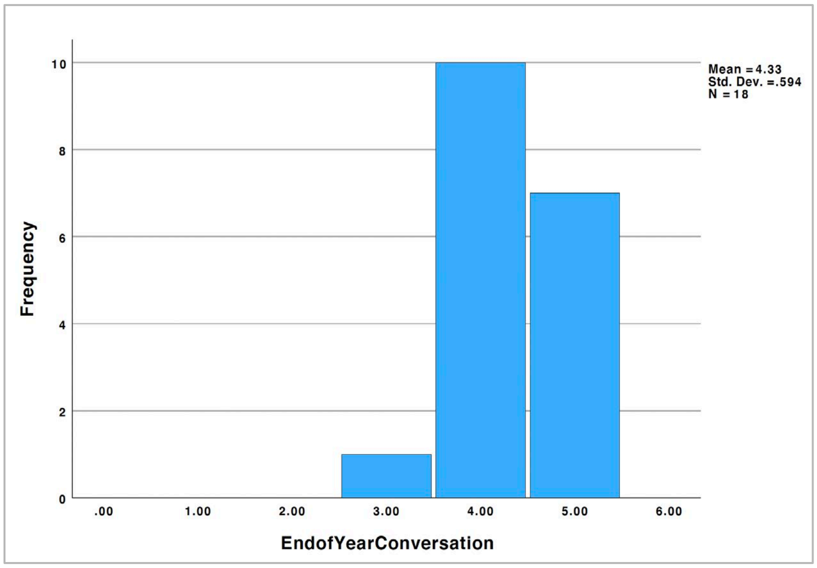
On a scale of 1 to 5 (1 being the least and 5 being the most), how confident are you in your ability to have a **difficult conversation** with an employee?

**Difficult Conversations**
n=10
Mean=4.5
Mode=4, 5



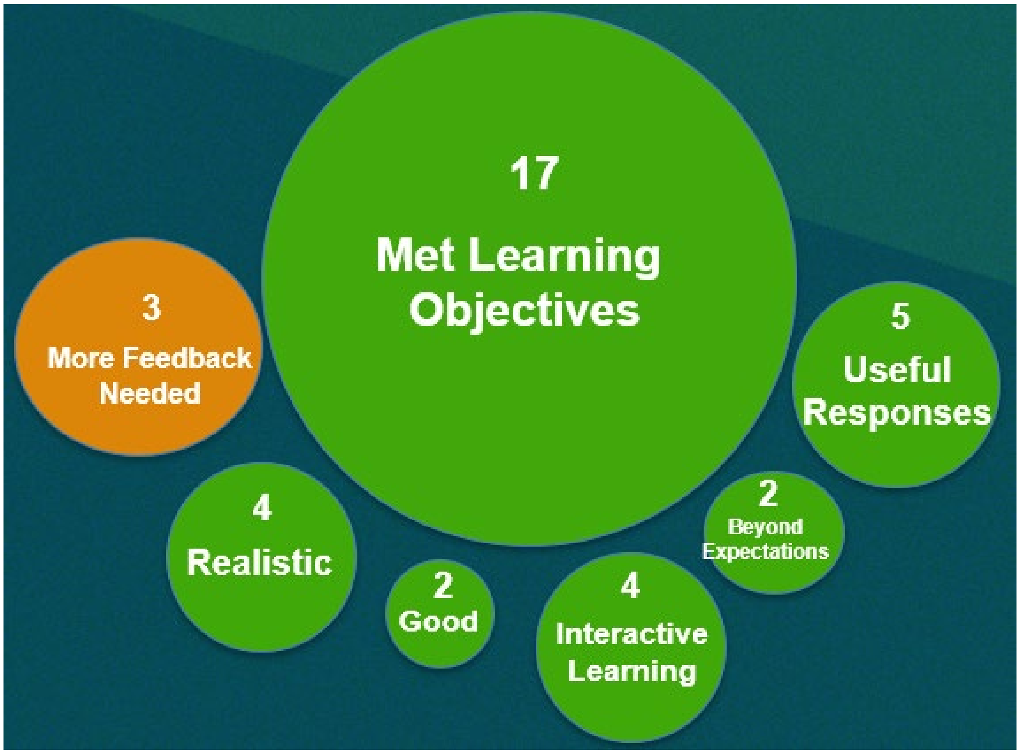

On a scale of 1 to 5 (1 being the least and 5 being the most), how confident are you in your ability to have an **End of Year Career Conversation** with an employee?

**End of The Year Conversations**
n=18
Mean=4.33
Mode=4



Qualitative data supports that employees found that the VIM System met learning objectives.

All employees, n=63:

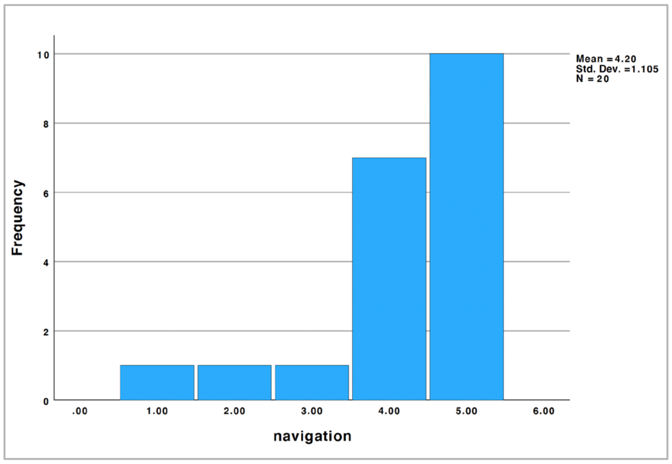


## Navigation Course Integration

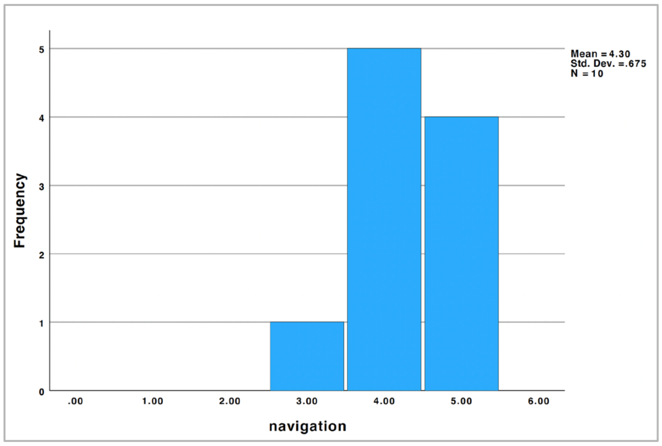
The following items include the representative user interface (UI) findings. Employees feedback on the navigation of the material:

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), it was easy for me to **navigate through the system**.

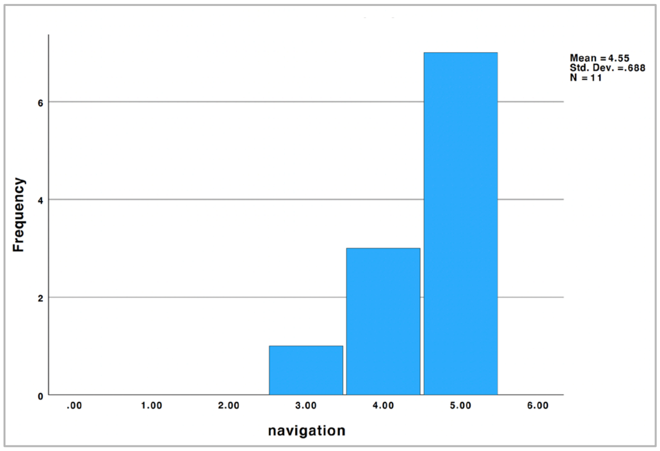
**SPECTRE**
n=20
Mean=4.20
Mode=5




**META**
n=10
Mean=4.30
Mode=4



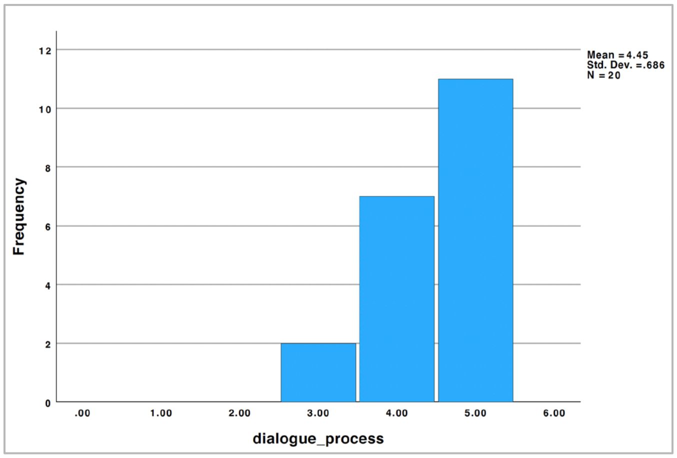

**VIVE**
n=11
Mean=4.55
Mode=5



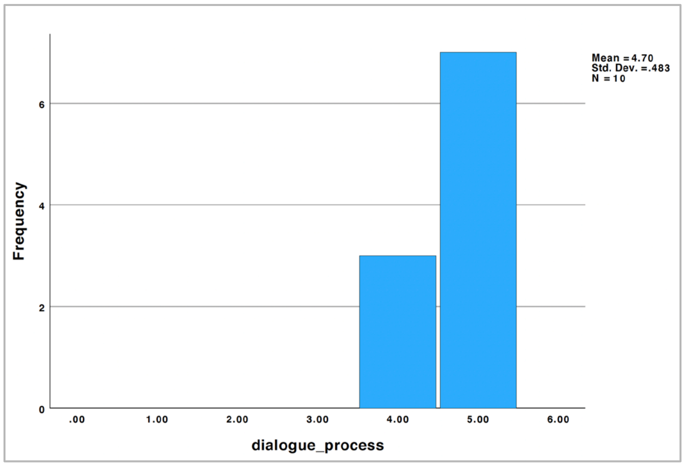
__Dialogue Selection Process__
Employees feedback on the dialogue selection process:

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), it was easy for me to understand the **dialogue selection process.**

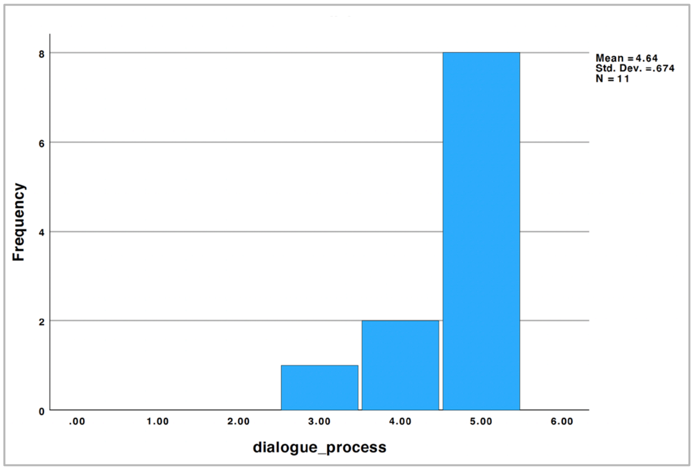
**SPECTRE**
n=20
Mean=4.45
Mode=5




**META**
n=10
Mean=4.70
Mode=5




**VIVE**
n=11
Mean=4.64
Mode=5

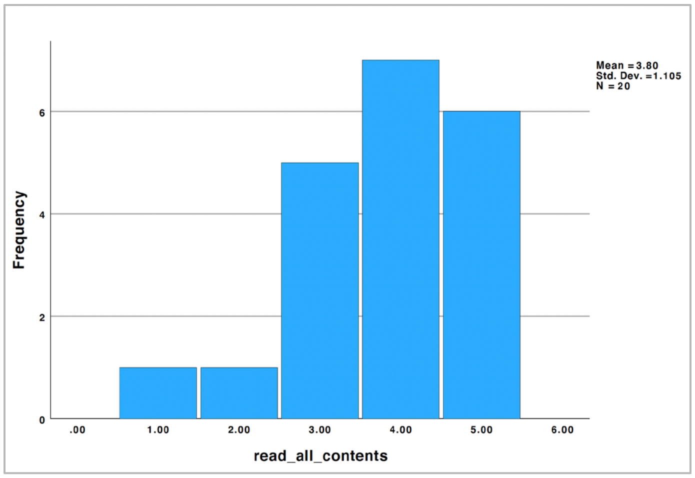


## Easy to Read Content

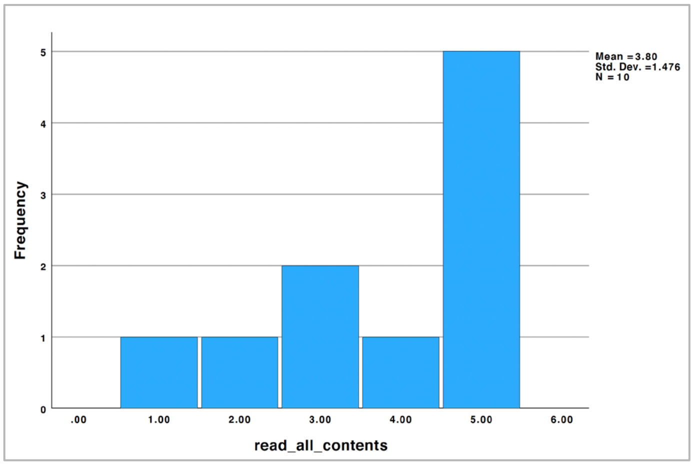
Employees feedback – Easy to read content:

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), it was **easy for me to read** all of the content provided by the Virtual Interactive Management (VIM) application.

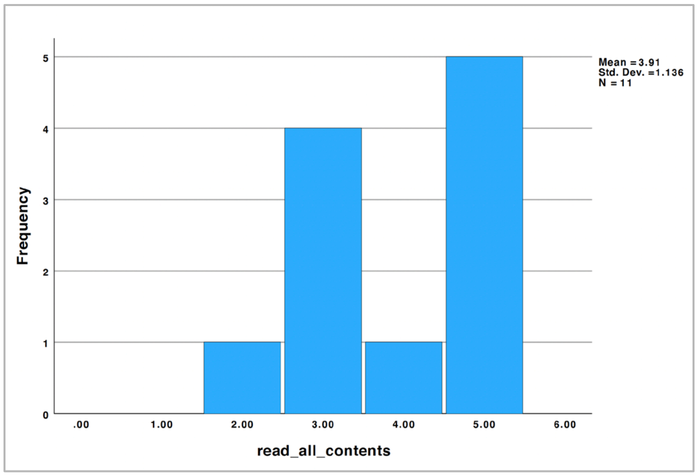
**SPECTRE**
n=20
Mean=3.80
Mode=4




**META**
n=10
Mean=3.80
Mode=5

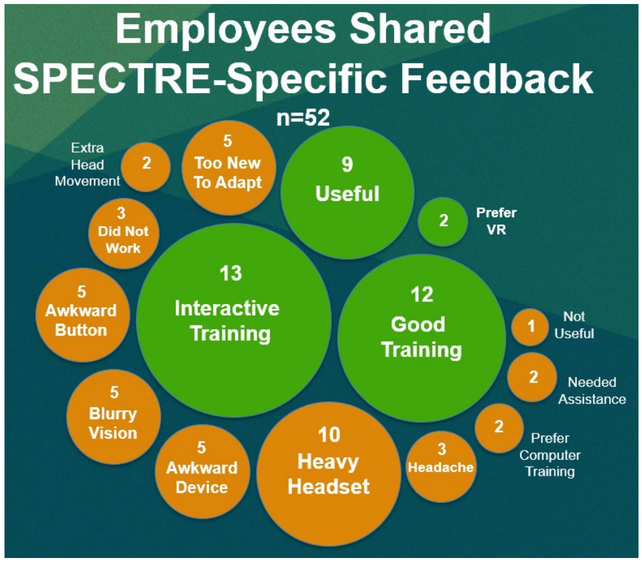


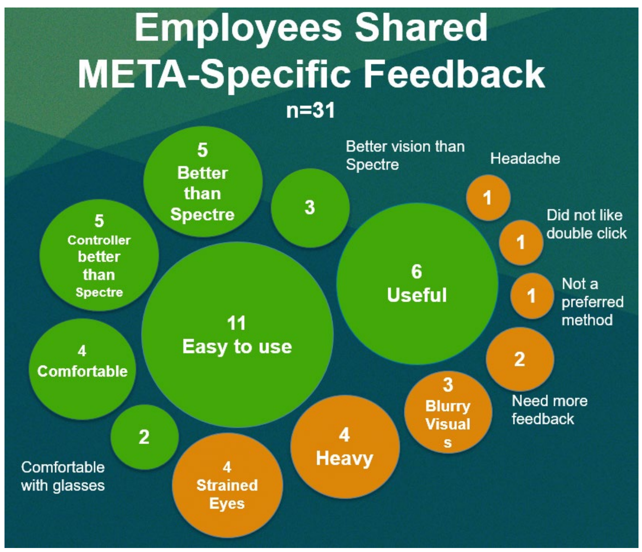

**VIVE**
n=11
Mean=3.91
Mode=5

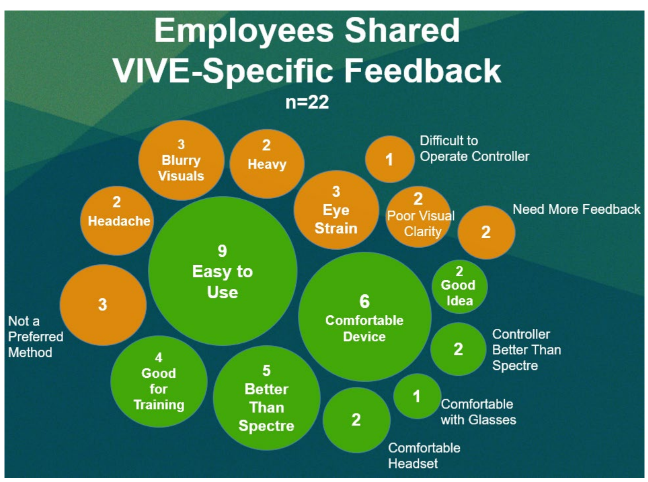


## Overall Qualitative Feedback

The overall qualitative feedback for the experiment is displayed below. Employees provided a positive overall evaluation of the UI (User Interface) elements.



## System Usability Scale (SUS) Findings

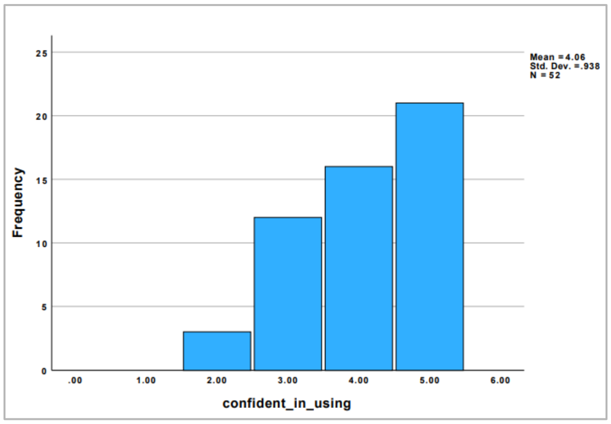
The System Usability Scale (SUS) is a reliable tool for measuring the usability of hardware, software, websites, cellphones and more. The SUS is a 10-item questionnaire with 5 response options (strongly disagree – strongly agree). The scale is used to measure the usability of the hardware in this experiment.

## Confidence Using System

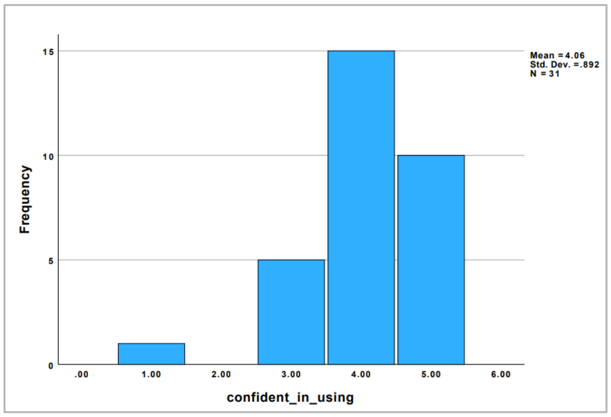
Employees feedback –Confidence with using VIM while learning TxDOT curriculum:

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), I felt very **confident using VIM.**

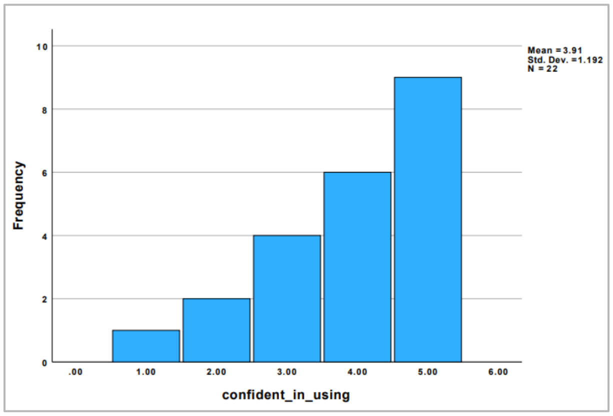
**SPECTRE**
n=52
Mean=4.06
Mode=5




**META**
n=31
Mean=4.06
Mode=4




**VIVE**
n=22
Mean=3.91
Mode=5

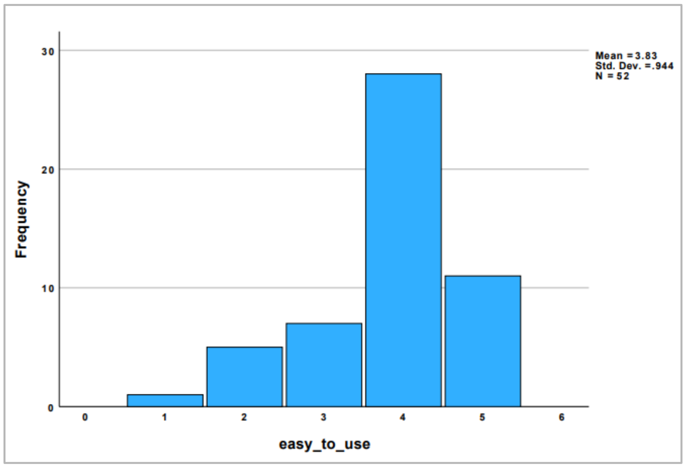


## Ease of Use

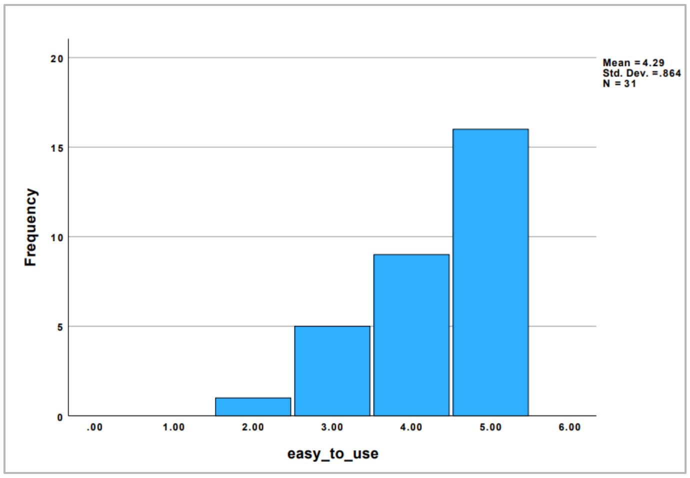
Employees feedback –Ease of use with the system:

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), I thought that **VIM was easy to use**.

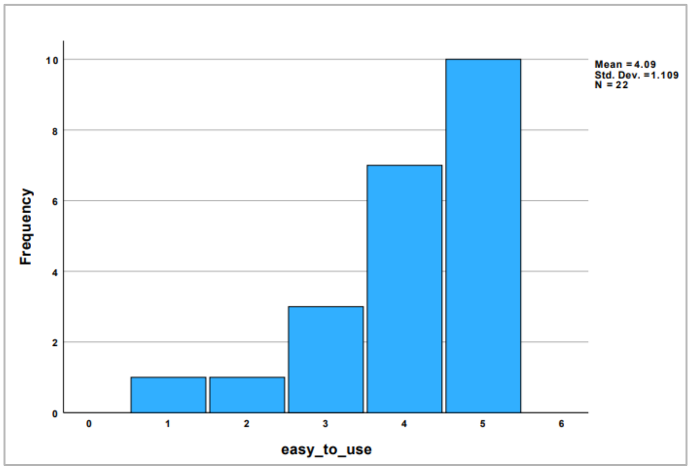
**SPECTRE**
n=52
Mean=3.83
Mode=4




**META**
n=31
Mean=4.29
Mode=5




**VIVE**
n=22
Mean=4.09
Mode=5

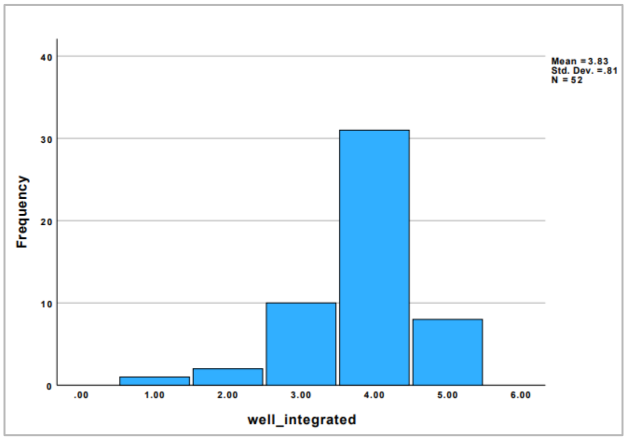


## Functions Were Well Integrated

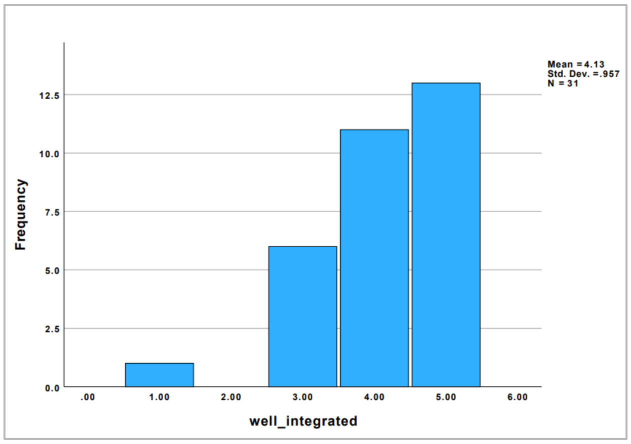
Employees feedback –Functions of the system were well integrated:

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), I found that various **functions in VIM were well integrated.**

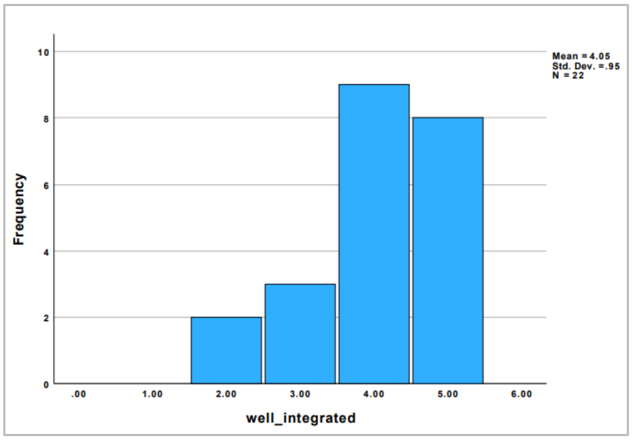
**SPECTRE**
n=52
Mean=3.83
Mode=4




**META**
n=31
Mean=4.13
Mode=5




**VIVE**
n=22
Mean=4.05
Mode=4

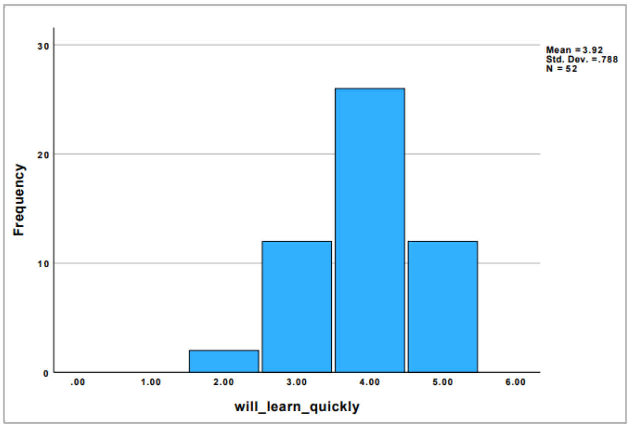


## Learn Quickly Using the VIM System

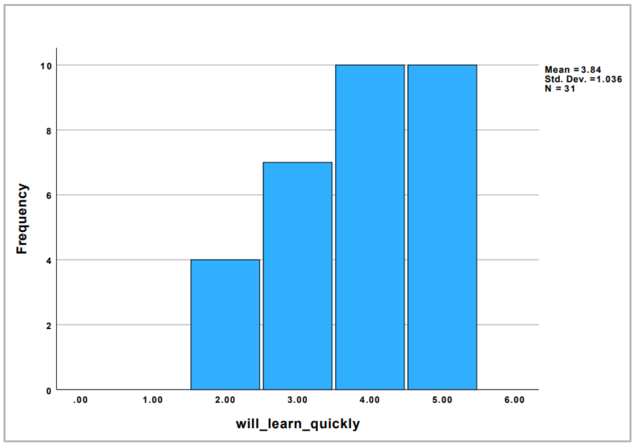
Employees feedback –Learn quickly:

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), I thought that I will **learn quickly with the VIM System.**

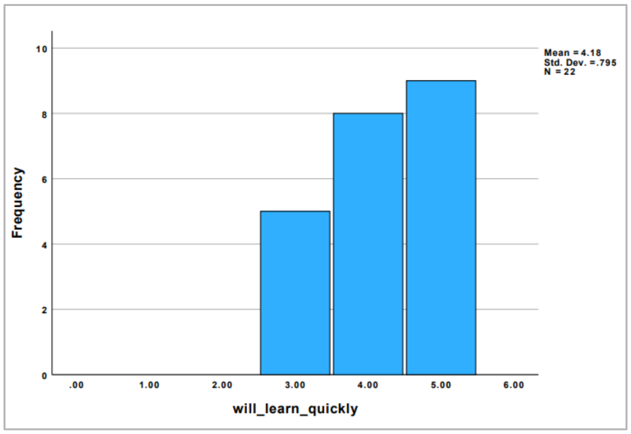
**SPECTRE**
n=52
Mean=3.92
Mode=4




**META**
n=31
Mean=3.84
Mode=4, 5




**VIVE**
n=22
Mean=4.18
Mode=5



The initial SUS differences across devices with **factory configuration** were not statistically significant. A one-way ANOVA, equal variances violated, revealed that the SUS scores differences are not statistically significant between SPECTRE (M=69.66, S=15.37), META (M=66.78, S=8.33) and VIVE (M=71.02, S=12.16). F(2, 92)=.57, MSE=179.87, p=.568, partial eta squared=.012, alpha=.05

**SPECTRE**
**n=52**

| SUS Mean | 69.66 |
|---|---|
| Standard Deviation | 15.37 |

**Rating: Above Average/Good**

Most Favorably Scored Questions:

1. I felt very confident using VIM.
2. Most people would learn to use VIM very quickly.

Least Favorably Scored Questions:

1. I think that I would like to use VIM frequently.
2. I found VIM awkward to

**META**
**n=21**

| SUS Mean | 66.78 |
|---|---|
| Standard Deviation | 8.33 |

**Rating: Below Average/OK**

Most Favorably Scored Questions:

1. I needed to learn a lot of things before I could get going with VIM.
2. I felt very confident using VIM.
3. I thought the headset was easy to use.

Least Favorably Scored Questions:

1. I think that I would like to use VIM frequently.
2. I think that I would need assistance to be able to use VIM.

**VIVE**
**n=22**

| SUS mean | 71.02 |
|---|---|
| Standard Deviation | 12.16 |

**Rating: Above Average/Good**

Most Favorably Scored Questions:

1. I thought there was too much inconsistency in VIM.
2. Most people would learn to use VIM very quickly.
3. I needed to learn a lot of things before I could get going with VIM.

Least Favorably Scored Questions:

1. I think that I would like to use VIM frequently.
2. I think that I would need assistance to be able to use VIM.

The SUS breakdown by **demographics: age, gender, role (field vs. office)** are not statistically significant:

**SPECTRE**
**n=52**

| Age | N | Mean | Std. Dev. |
|---|---|---|---|
| 18-29 | 3 | 72.51 | 12.99 |
| 30-39 | 14 | 72.32 | 17.64 |
| 40-49 | 14 | 71.61 | 13.96 |
| 50-59 | 17 | 66.02 | 15.46 |
| 60+ | 4 | 66.87 | 17.12 |
| Total | 52 | 69.66 | 15.37 |

| Gender | N | Mean | Std. Dev. |
|---|---|---|---|
| Male | 40 | 69.75 | 15.93 |
| Female | 12 | 69.37 | 13.99 |
| Total | 52 | 69.66 | 15.37 |

| Role | N | Mean | Std. Dev. |
|---|---|---|---|
| Field | 13 | 75.96 | 16.12 |
| Office | 32 | 68.04 | 15.01 |
| Other | 7 | 65.35 | 14.25 |
| Total | 52 | 69.66 | 15.37 |

**META**
**n=21**

| Age | N | Mean | Std. Dev. |
|---|---|---|---|
| 18-29 | 1 | 57.52 | . |
| 30-39 | 7 | 66.42 | 5.17549 |
| 40-49 | 6 | 72.08 | 9.67169 |
| 50-59 | 5 | 66.51 | 9.11729 |
| 60+ | 2 | 57.52 | 0 |
| Total | 21 | 66.78 | 8.33452 |

| Gender | N | Mean | Std. Dev. |
|---|---|---|---|
| Male | 16 | 66.56 | 8.45946 |
| Female | 5 | 67.51 | 8.83883 |
| Total | 21 | 66.78 | 8.33452 |

| Role | N | Mean | Std. Dev. |
|---|---|---|---|
| Field | 2 | 61.25 | 5.3033 |
| Office | 17 | 67.52 | 8.97044 |
| Other | 2 | 66.25 | 1.76777 |
| Total | 21 | 66.78 | 8.33452 |

**VIVE**
**n=22**

| Age | N | Mean | Std. Dev. |
|---|---|---|---|
| 18-29 | 3 | 75.83 | 1.44 |
| 30-39 | 4 | 73.12 | 14.34 |
| 40-49 | 8 | 71.56 | 15.29 |
| 50-59 | 5 | 66.00 | 10.40 |
| 60+ | 2 | 70.00 | 14.14 |
| Total | 22 | 71.02 | 12.17 |

| Gender | N | Mean | Std. Dev. |
|---|---|---|---|
| Male | 17 | 70.29 | 12.28 |
| Female | 5 | 73.50 | 12.82 |
| Total | 22 | 71.02 | 12.17 |

| Role | N | Mean | Std. Dev. |
|---|---|---|---|
| Field | 4 | 80.00 | 7.07 |
| Office | 15 | 70.33 | 12.88 |
| Other | 3 | 62.50 | 6.61 |
| Total | 22 | 71.02 | 12.17 |

## Iterative Design Research

A statistically significant difference between the META and VIVE devices was discovered across two factors: **The fit of the headset and the adjustability of headset straps**.

| Question | Meta Mean | VIVE Mean | Meta SD | VIVE SD | Significance |
|---|---|---|---|---|---|
| The headset fit properly on my head. | 3.40 | 4.30 | 1.26 | 0.67 | p=0.034* |
| The straps on the headset were easy to adjust. | 4.00 | 4.80 | 1.24 | 0.63 | p=0.005* |

**Table 6:** Headset Adjustment and Fit

There was no statistically significant difference between the META and VIVE devices across all other system factors: **Weight, System Setup, Navigations, Controller, SUS, UI Elements**.

## Changes to the Configuration

The team replaced META's factory head strap with an adjustable head strap, which greatly improved the META SUS score:

META with the Adjustable Head Strap

**Factory Configuration n=21**

| SUS Mean | 66.78 |
|---|---|
| Standard Deviation | 8.33 |

**Rating: Below Average**

**With Adjustable Strap n=10**

| SUS Mean | 84.5 |
|---|---|
| Standard Deviation | 12.79 |

**Rating: Excellent**

**Aggregate Score n=31**

| SUS mean | 71.02 |
|---|---|
| Standard Deviation | 12.16 |

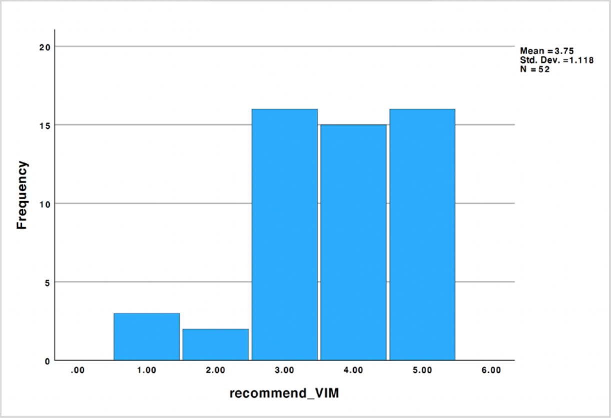
**Rating: Above Average**

The SUS differences between the META with adjustable head strap, SPECTRE, and VIVE are statistically significant. A one-way ANOVA, equal variances assumed, revealed that the SUS scores differences are statistically significant between SPECTRE (M=69.66, S=15.37), META with adjustable head strap (M=84.50, S=12.79) and VIVE (M=71.02, S=12.16).

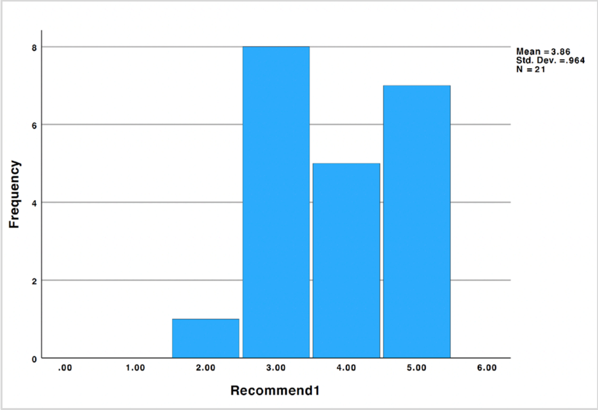
The adjustable headset strap also resulted in the increased recommendations of META by employees.

On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree), I would recommend VIM to others.

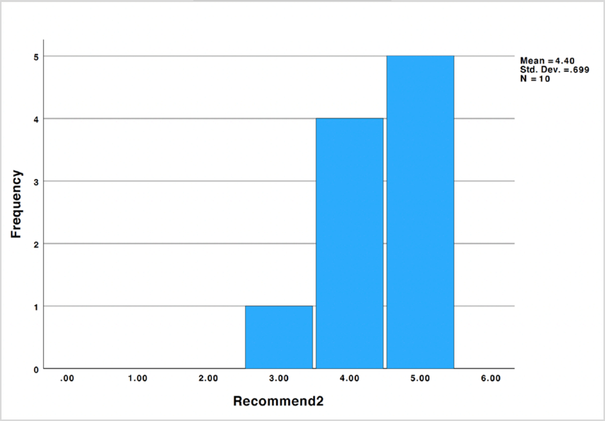
**SPECTRE**
n=52
Mean=3.75
Mode=3, 5



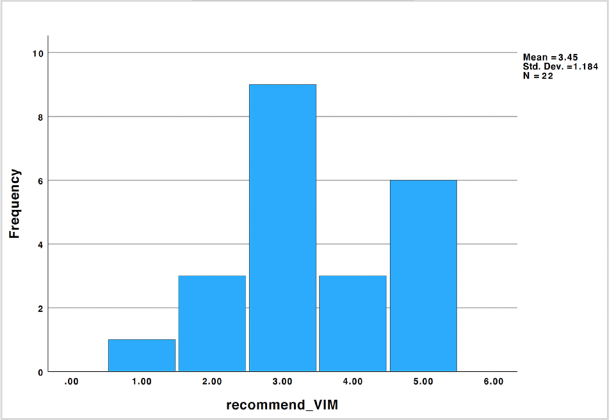

**META**
n=21
Mean=3.86
Mode=3




**META**
n=10
Mean=4.40
Mode=5




**VIVE**
n=22
Mean=3.45
Mode=3



## Conclusions & Implications

This project represents TxDOT's attempt to explore VR options for the management and supervisory staff of our workforce. The design of this VR project is such that it provides hands-on training to augment current in-person instruction. The simulations provide a realistic environment where the learner is placed in an immersive environment to test application of knowledge and are provided adaptive feedback based off each learner's unique performance with intrinsic motivation for learners to replay until mastery is obtained. Thus, it provides a safe space for learners to practice what they have learned in class. As noted earlier, we selected our Practical Supervision and Progressive Discipline training courses as the basis for our experiment because the leadership competencies they address are key areas of focus related to TxDOT's organizational strategies. The project followed a pattern of revising, completing design-based iterations from internal testing and SME feedback, and developing modifications to the system based on alpha field testing of the prototype. The iterative design approach for device enhancement improved the META SUS score and the score for employees recommending the META headset. META SUS analysis with enhancements was statistically significant and this configuration qualified as an excellent system.

Employees found that VIM met learning objectives across all modules tested. Employees also provided a positive evaluation of UI elements. From the System Usability Scale, employees were confident in using the VIM System, found the VIM System easy to use and well-integrated across different devices, and found that they would learn quickly using the VIM System. SUS score differences between devices with factory-configuration are not statistically significant. The experiment resulted in the SPECTRE for home delivery and the enhanced META configuration for classroom use.

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Smidt, A., Balandin, S., Sigafoos, J., & Reed, V. (2009). The Kirkpatrick model: A useful tool for evaluating training outocmes. *JOurnal of Inteelectual and Developmental Disability, 34*(3), 266-274.

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# Virtual Interactive Management Pilot

## Appendix

Workforce Development, Human Resources Division

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## Appendix A:  Pre-Survey



# pre-survey TXDOT

| | |
|---|---|
| Record ID | ________________________ |
| 1. Please specify your ethnicity. | ◯ White<br>◯ Black or African American<br>◯ American Indian or Alaska Native<br>◯ Asian<br>◯ Native Hawaiian or Pacific Islander Hispanic or Latino<br>◯ Other |
| 2. To which gender do you most identify? | ◯ Male<br>◯ Female<br>◯ Non-binary / third gender<br>◯ Prefer not to say |
| 3. What is your age? | ________________________ |
| 4. What is the highest education level you have achieved? | ◯ Doctorate Degree (PhD.)<br>◯ Professional Degree (MD; JD; etc.)<br>◯ Master's Degree (MS; MA; etc.)<br>◯ College Graduate (4 year)<br>◯ Some College Vocational/Technical School (2 year)<br>◯ Vocational/Technical School (2 year)<br>◯ High school or equivalent<br>◯ Other |
| 6. Have you previously received supervisor training? | ◯ Yes<br>◯ No |
| 7. If you have received supervisor training, from where did you receive it? | ◯ TXDOT<br>◯ Other |
| If other, please specify from where | ________________________ |
| 8. Have you used Virtual Reality (VR) for training/education? | ◯ Yes<br>◯ No |
| If yes, which device? | ________________________ |
| 9. Have you used VR for entertainment? | ◯ Yes<br>◯ No |
| If yes, which device? | ________________________ |

| | |
|---|---|
| 10. Have you used VR for anything other than training/education or entertainment? | ◯ Yes<br>◯ No |
| If yes, which device? | ______________________ |

**11. On a scale of 1 to 5 (1 being the least and 5 being the most) , how comfortable are you using VR-based training.**

| 1 | 2 | 3 | 4 | 5 | Do not know |
|---|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

**12. On a scale of 1 to 5 (1 being the least and 5 being the most), how comfortable are you using computer-based training.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

**13. On a scale of 1 to 5 (1 being the least and 5 being the most), how much do you trust virtual simulation to represent real life.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

**14. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to use the correct supervisor style in the correct situation.**

***note: How familiar are these terms to TXDOT employees ?**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Collaborator | ◯ | ◯ | ◯ | ◯ | ◯ |
| Delegator | ◯ | ◯ | ◯ | ◯ | ◯ |
| Director | ◯ | ◯ | ◯ | ◯ | ◯ |
| Persuador | ◯ | ◯ | ◯ | ◯ | ◯ |

**15. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to coach an employee in the appropriate situation?**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

**16. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to counsel an employee in the appropriate situation?**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

**17. On a scale of 1 to 5 (1 being the least and 5 being the most), how confident are you in your ability to have a difficult conversation with an employee?**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

**18. On a scale of 1 to 5 (1 being the least and 5 being the most), how confident are you in your ability to have an End of Year Career Conversation with an employee?**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

## Appendix B: Post-Survey



# post-survey TXDOT

Record ID ______________________

**1. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to use the correct supervisor style in the correct situation?**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Collaborator | ○ | ○ | ○ | ○ | ○ |
| Delegator | ○ | ○ | ○ | ○ | ○ |
| Director | ○ | ○ | ○ | ○ | ○ |
| Persuader | ○ | ○ | ○ | ○ | ○ |

**2. On a scale of 1 to 5 (1 being the least and 5 being the most), how confident are you in your ability to use the correct supervisor style in the correct situation?**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

3. Are there any aspects of implementing different supervision styles that are still not clear to you? ______________________

**4. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to coach an employee in the appropriate situation?**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

5. Are there any aspects of implementing coaching that are still not clear to you? ______________________

**6. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to counsel an employee in the appropriate situation?**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

7. Are there any aspects of implementing counseling that are still not clear to you? ______________________

**8. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability to counsel an employee during a difficult conversation?**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | ○ | ○ | ○ | ○ | ○ |

**9. On a scale of 1 to 5 (1 being the least and 5 being the most), how would you rate your ability for conducting an End of the Year Career Conversation?**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | ○ | ○ | ○ | ○ | ○ |

**10. On a scale of 1 to 5 (1 being least and 5 being most), how likely will you be using the learnings from today's experiment in your workplace?**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | ○ | ○ | ○ | ○ | ○ |

11. Did the training meet the expected learning objectives? Please explain in what way.

________________________________

## Usability Survey



# Usability TXDOT

Record ID ______________________________

**The following questions are based on the Virtual Interactive Management (VIM) device which was used during the experiment.**

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**1. I was comfortable using the VIM device for the entire duration of the training.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**2. I had little/no trouble setting up the VIM device.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**3. The VIM device was as good as I expected.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**4. I was comfortable with the device even with my glasses on.**

| 1 | 2 | 3 | 4 | 5 | Not Applicable |
|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**5. It was not hard for me to move my head to select options.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

| On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)<br><br>6. It was easy for me to read all the content provided on the device. | | | | | |
|---|---|---|---|---|---|
| | 1 ◯ | 2 ◯ | 3 ◯ | 4 ◯ | 5 ◯ |

| On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)<br><br>7. It was easy to select the answer choice with the single button on the device. | | | | | |
|---|---|---|---|---|---|
| | 1 ◯ | 2 ◯ | 3 ◯ | 4 ◯ | 5 ◯ |

| On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)<br><br>8. It was easy for me to select the module on the main menu. | | | | | |
|---|---|---|---|---|---|
| | 1 ◯ | 2 ◯ | 3 ◯ | 4 ◯ | 5 ◯ |

| On a scale of 1 to 5 ( 1 being Strongly Disagree and 5 being Strongly Agree)<br><br>9. I had no difficulty choosing the scenario on the device. | | | | | |
|---|---|---|---|---|---|
| | 1 ◯ | 2 ◯ | 3 ◯ | 4 ◯ | 5 ◯ |

| On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)<br><br>10. The scenarios presented were relatable to daily situations. | | | | | |
|---|---|---|---|---|---|
| | 1 ◯ | 2 ◯ | 3 ◯ | 4 ◯ | 5 ◯ |

| On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)<br><br>11. Navigating back to the main menu or previous page was not difficult. | | | | | |
|---|---|---|---|---|---|
| | 1 ◯ | 2 ◯ | 3 ◯ | 4 ◯ | 5 ◯ |

| On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)<br><br>12. I could hear the virtual employee clearly. | | | | | |
|---|---|---|---|---|---|
| | 1 ◯ | 2 ◯ | 3 ◯ | 4 ◯ | 5 ◯ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**13. I could hear the narrator clearly.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**14. It was easy to understand the speech of the virtual employee.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**15. It was easy to understand the speech of the narrator.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**16. Badges encouraged me to perform better.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**17. The concept of Badges was well-explained by the narrator.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**18. Badges kept me engaged throughout the training.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**19. I was motivated to obtain the Gold Badge.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**20. It was easy for me to understand my overall progress through the Progress Meter.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**21. Receiving immediate results through the virtual interface was useful.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

22. What did you like about the VIM device?

23. What didn't you like about the VIM device?

24. What do you want to improve about the VIM device?

**On a scale of 1 to 5 (1 being Strongly Disagree and 5 being Strongly Agree)**

**25. I would recommend the VIM device to others for training.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

26. What is the reason for your answer choice in the previous question (no. 25) ?