# REQUEST FOR PROPOSAL #R10-1157 FOR: VIRTUAL REALITY HARDWARE AND SOFTWARE

May 22, 2023

## Section Two:

Proposal Submission, Questionnaire and Required Forms

# Proposal Form Checklist

## The following documents must be submitted with the Proposal

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**The below documents can be found in Section 2; Proposal Submission and Required Bid Forms and must be submitted with the proposal. Please note Proposal Form 1 is a separate attachment (attachment B)**.

**PROPOSAL PRICING:** Attachment B is provided separately in a Microsoft Excel file and is required to complete your price proposal.

☐ **PROPOSAL FORM 1: ATTACHMENT B - PRICING**

### QUESTIONNAIRE & EVALUATION CRITERIA:

☐ **PROPOSAL FORM 2: QUESTIONNAIRE & EVALUATION CRITERIA**

### OTHER REQUIRED PROPOSAL FORMS:

☐ **PROPOSAL FORM 3: CERTIFICATIONS AND LICENSES**

☐ **PROPOSAL FORM 4: CLEAN AIR AND WATER ACT**

☐ **PROPOSAL FORM 5: DEBARMENT NOTICE**

☐ **PROPOSAL FORM 6: LOBBYING CERTIFICATION**

☐ **PROPOSAL FORM 7: CONTRACTOR CERTIFICATION REQUIREMENTS**

☐ **PROPOSAL FORM 8: ANTITRUST CERTIFICATION STATEMENTS**

☐ **PROPOSAL FROM 9: IMPLEMENTATION OF HOUSE BILL 1295**

☐ **PROPOSAL FROM 10: BOYCOTT CERTIFICATION AND TERRORIST STATE CERTIFICATION**

☐ **PROPOSAL FORM 11: RESIDENT CERTIFICATION**

☐ **PROPOSAL FORM 12: FEDERAL FUNDS CERIFICATION FORM**

☐ **PROPOSAL FORM 13: ADDITIONAL ARIZONA CONTRACTOR REQUIREMENTS**

☐ **PROPOSAL FORM 14: OWNERSHIP DISCLOSURE FORM (N.J.S. 52:25-24.2)**

☐ **PROPOSAL FORM 15: NON-COLLUSION AFFIDAVIT**

☐ **PROPOSAL FORM 16: AFFIRMATIVE ACTION AFFIDAVIT (P.L. 1975, C.127)**

☐ **PROPOSAL FORM 17: C. 271 POLITICAL CONTRIBUTION DISCLOSURE FORM**

☐ **PROPOSAL FORM 18: STOCKHOLDER DISCLOSURE CERTIFICATION**

☐ **PROPOSAL FORM 19: GENERAL TERMS AND CONDITIONS ACCEPTANCE FORM**

☐ **PROPOSAL FORM 20: EQUALIS GROUP ADMINISTRATION AGREEMENT**

☐ **PROPOSAL FORM 21: OPEN RECORDS POLICY ACKNOWLEDGEMENT AND ACCEPTANCE**

☐ **PROPOSAL FORM 22: VENDOR CONTRACT AND SIGNATURE FORM**

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**PROPOSAL FORM 1: ATTACHMENT B – PRICING**

Pricing should be entered in the attachment B Excel form provided in this RFP packet. Please reference Section 1, Part B, Instructions to Proposers, for more information on how to complete pricing.

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**PROPOSAL FORM 2: QUESTIONNAIRE & EVALUATION CRITERIA**

**Instructions:**
Respondents should incorporate their questionnaire responses directly into the green cells below. Failure to provide responses in this format may result in the proposal being deemed as non-responsive at the sole discretion of Region 10.

Respondents may incorporate additional documents as part of their response which may be utilized by Region 10 as part of the evaluation. Additional documents must be consolidated as part of this Section 2 at the end of your response.

Region 10 has associated the evaluation criteria with the question that most closely aligns with that respective evaluation criteria. Region 10 reserves the right at its sole discretion to base its evaluation and specific evaluation criteria on any part of the respondent's proposal.

| Evaluation Criteria | Question | Answer |
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| **Basic Information** | | |
| Required information for notification of RFP results | *What is your company's official registered name?* | Lobaki, Inc |
| | *What is the mailing address of your company's headquarters?* | 736 South President Street #106<br>Jackson, MS 39201 |
| | *Who is the main contact for any questions and notifications concerning this RFP response, including notification of award? Provide name, title, email address, and phone number.* | Sanford Moore<br>Immersive Consultant<br>Sanford@lobaki.com<br>601-624-5375 |
| **Products/Pricing (30 Points)** | | |
| Coverage of products and services | No answer is required. Region 10 will utilize your overall response and the products/services provided in Attachment B to make this determination | |
| Ability of offered products and services to meet the needs requested in the scope | No answer is required. Region 10 will utilize your overall response and the products/services provided in Attachment B to make this determination | |
| Pricing for all available products and services, including warranties if applicable | *Does the respondent agree to offer all future product and services at prices that are proportionate to contract pricing offered herein?* | Yes |
| | *Does pricing submitted include the required administrative fee?* | Yes |

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| | *Do you offer any other promotions or incentives for customers? If yes, please describe.* | Yes, there are regular and various promotions and incentive packages offered throughout the year. For instance, we regularly run an "end of quarter" sales promotion for all outstanding proposals/quotes. |
| Ability of Customers to verify that they received contract pricing | *Were all products/lines/services and pricing being made available under this contract provided in the attachment B and/or Appendix B, pricing sections?* | Yes |
| | *Outline your pricing strategy provided in Attachment B. If utilizing a list price, please indicate where agencies can find the list and your methodology for determining that list price.* | The pricing strategy utilized by Lobaki is to offer full services and minimal rates. We have found that VR/AR is so new that our users need support to realize the benefits of technology We provide in-person classes, an assigned account manager for each account and IT tracked metrics, or virtual if needed. We price this low by keeping our cost low by operating out of low costs centers like Jackson MS. Our gross margin approximates those in highly competitive industries. |
| Payment methods | *Define your invoicing process and methods of payments you will accept. Please include the overall process for agencies to make payments* | Lobaki sets up installations on a school basis and uses POs to organize this. Once the installation has been accomplished it will invoice and expected payment within 30 Days. Lobaki prefers ACH payment but flexible as to the specific method. |
| Other factors relevant to this section as submitted by the Respondent | No answer is required. Region 10 will utilize your overall response and the products/services provided in Attachment B to make this determination | |
| **Performance Capability (25 Points)** | | |
| Product quality and features | *Please provide a high-level overview of the products and services being offered and how they address the scope being requested herein.* | The product that Lobaki owns is identical to the scope of services requested. Lobaki provides packages of virtual reality hardware, appropriate educational software, instructor onboarding/training/professional development, and technical support to school districts and other entities that utilize Lobaki's services. Lobaki's focus is to ensure that our product and hardware is utilized to its full potential. Our Software Content covers a wide range of topics from K12 Academic and STEM subjects to College and Career Readiness. Our content is immersive and engaging with the ability to convey hard subjects in a visual and captivating manner.<br><br>One of our Main two products include our Immersive Institute, I2, which contains our K12 Academic catalogs and Career and Technical Education content. This curriculum standard aligned content is organized and built in a way to be teacher friendly but student focused.<br><br>Our other main product is Lobaki Launchpad, L2, is a VR Developer and Digital Artistry training academy which encapsulates and teaches all the career paths inside the gaming development and virtual reality industries. This training program also includes a collaboration platform which allows for students to work on real world projects and graduate with a portfolio and work experience. We also hold 2 internships each summer exclusively for promising students from our family of Lobaki Launchpad customers. |
| | *Describe any safety features your hardware and/or software features. This should include physical safety for hardware and any data and privacy safeguards for software.* | Lobaki uses industry-standard hardware for all our deployments, which include several safety features for our users. Physical safety features include: the ability to create a virtual play area so that the user doesn't collide with objects or people in their vicinity; controller wrist straps to prevent users from accidentally throwing/releasing their controllers; silicone face shields and other wipe-friendly surfaces that can be |

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| | | easily disinfected between uses; secure head straps to ensure that the hardware sits securely and comfortably on the users' heads (upgraded head straps with a more precise fit may be included at an additional cost); and lockable storage carts that prevent users from accessing the headsets in unsafe ways without supervision.<br>Regarding users' data and privacy, Lobaki does not collect any identifying information for any of its end users. Our collaboration platform creates anonymized debug logs of certain events triggered by a user within a session. These logs are written to the end user's device and are never sent to Lobaki or any other third party. Lobaki will provide the privacy policies of any additional vendors included in the delivered product bundle.<br><br>Lobaki utilizes a mobile device management system (MDM) that allows for secure remote management of any VR devices connected to our platform. This system offers enterprise-grade security by fully complying with the SOC2 security framework and should offer full ISO27001 compliance by the end of 2023.<br>Lobaki's collaboration platform may include links to third-party websites, plug-ins and applications. Clicking on these links or enabling external connections may allow third parties to collect or share data about you. Lobaki does not control these third-party websites, and we are not responsible for their privacy statements. As a result, Lobaki encourages the end users of our software to read the privacy policy of every website they may visit while using our platform. |
| | *Outline how your products compare to those of your competitors.* | Lobaki differentiates itself from the competition in a multitude of ways. One of our key differences is that all our interactive virtual reality modules and content is completely made in-house by USA developers and employees. Another difference is that our content is aligned with all available national educational standards with teacher resources to make it easier for school implementation and lesson planning. Another key difference is that we provide in-person and virtual training to all our clients with dedicated and personal account management. |
| | *What is the guaranteed uptime for any software being offered? Describe any remedies in your company's Service Level Agreement for unplanned downtime.* | Our mobile device manager (MDM) and content delivery system has offered 100% uptime from January 2022 to present. Our collaboration platform has offered greater than 99% uptime from January 2022 to present. Our platform also features standalone (fully offline) versions of all our virtual experiences, on which we guarantee 100% uptime. Lobaki notifies all clients of any planned downtime in our systems within 48 hours of the start of the downtime. |
| | *States Covered - Respondent must indicate any and all states or geographies where products and services are being offered. If your services are limited to a certain area, please be specific on the area your services are provided.* | Lobaki provides service to the continental USA |
| | *List the number and location of offices, or service centers for all states being proposed in solicitation* | 1 location<br>736 S President St<br>Jackson, MS 39201 |
| | *If your company offers custom software development for VR applications, please describe your development process and capabilities.* | Lobaki's development team holds itself to a high standard of quality that reflects our principle of providing the best content on the market. We adhere to the Agile Development framework for our projects that allows us to follow an iterative internal development cycle prior to deployment. Prior to beginning development, members from both our sales and development teams meet with the client to ensure their core values and expectations are represented. We then use this information to create a comprehensive project plan for the client to review and approve. |

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| | | Lobaki's development team has a well-defined library of internal tools and resources that allow us to produce new content quickly, efficiently, and at a high standard of quality. We ensure that multiple individuals beyond our development team review a product before it is delivered to the client. Additionally, Lobaki is open to implementing any moves, adds or changes that the client may request after delivery of the product, but any new development not reflected in the original client agreement may warrant a new Statement of Work.<br><br>Because our development process uses industry-standard tools (e.g. Unity and Unreal Engine), our custom-developed content is device-agnostic, meaning it can be configured to run on nearly any brand of hardware a client may use. Some of our many capabilities include (but are not limited to): 3D environment and world-building; 3D character animation, multiplayer event replication, full-body avatar design/customization, real-time avatar simulation, object/tool animation and simulation, physics simulation, particle effects, matching exercises, embedded quiz functionality, virtual measurement tools, classroom management functionality, real-time audio analysis, voice acting/narration, sound design/SFX, graphic design, motion graphics/VFX, 2D videography/editing, and 360 videography/editing. |
| | *Outline any other capabilities not already addressed.* | In addition to our Immersive Institute and Lobaki Launchpad, we offer custom solutions for enterprises, 360 recruitment videos, and 3D model rendering. |
| Product system requirements and accessibility | *For any hardware offered, describe any basic system requirements necessary for the hardware to function, as well as any integrations and compatibility features with third party products.* | Our collaboration platform requires a minimum upload speed of 4 Mbps and a minimum download speed of 20 Mbps. However, we recommend a minimum upload speed of 10 Mbps and a minimum download speed of 50 Mbps.<br><br>Our content is built to run entirely on mobile headsets (e.g., Meta Quest) without the need for any additional computing power. These headsets must meet the following minimum hardware requirements: an Android-based operating system of at least v7.1.1; a Qualcomm Snapdragon 835 or better processor; 5GB of RAM; and 16GB of available storage.<br><br>Our collaboration platform may also be run on a PC that meets the following minimum hardware requirements: Windows 10 operating system or higher; Intel Core i5 or better; 8GB RAM; NVIDIA GeForce GTX 970 graphics card or better; 9 GB of available disk space. |
| | *For any software offered, describe any basic system requirements necessary for the hardware to function, as well as any integrations and compatibility features with third party products.* | Our collaboration platform requires a minimum upload speed of 4 Mbps and a minimum download speed of 20 Mbps. However, we recommend a minimum upload speed of 10 Mbps and a minimum download speed of 50 Mbps.<br><br>Our content is built to run entirely on mobile headsets (e.g., Meta Quest) without the need for any additional computing power. These headsets must meet the following minimum hardware requirements: an Android-based operating system of at least v7.1.1; a Qualcomm Snapdragon 835 or better processor; 5GB of RAM; and 16GB of available storage.<br><br>Our collaboration platform may also be run on a PC that meets the following minimum hardware requirements: Windows 10 operating system or higher; Intel Core i5 or better; 8GB RAM; NVIDIA GeForce GTX 970 graphics card or better; 9 GB of available disk space. |

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| | *For any of your products, describe whether being connected to the internet is necessary for the function of the product or any product features.* | Our programs can be run with or without internet connection. Any use of the collaboration platform inherently requires internet connection; however, we also offer fully offline standalone versions of all CGI-based experiences and content featured on the collaboration platform. Some 360 video-based experiences may rely on streaming to view, and would therefore require an active internet connection.<br><br>Our mobile device manager (MDM) requires an internet connection to remotely manage the headsets and fetch new content. New content regularly gets added to our catalog and deployed through this MDM, so we recommend at least periodically connecting the headsets to the internet to ensure this new content can be fetched. However, an active internet connection is not required to use any already-installed standalone experiences. |
| Case studies/independent research demonstrating effectiveness | *Provide any independent research or case studies demonstrating the effectiveness of your program in preparing students for college or a career, or for improving student outcomes generally.* | Please see the attached documents included in Addendum |
| Customer service/problem resolution | *Describe your company's Customer Service Department (hours of operation, how you resolve issues, number of service centers, etc.).* | Lobaki's Customer Support team is reachable 24/7 by email with dedicated in-person office hours Monday- Friday from 8am to 6pm CDT. Lobaki believes in providing dedicated customer support and tech support to all clients for the duration of their contract. Our customer support tickets are given the highest priority within the company and are resolved in the order in which they are received. We maintain constant communication and provide updates throughout the whole support process to ensure that our clients are aware and informed of our progress as we resolve the issue. Our support team resides in our home office in Jackson, MS and can offer in-person tech support with 48 hours notice. |
| Financial condition of vendor | *Demonstrate your financial strength and stability with meaningful data. This could include, but is not limited to, such items as financial statements, SEC filings, credit & bond ratings, letters of credit, and detailed refence letters* | [redacted] |
| | *What was your annual sales volume over last three (3) years?* | [redacted] |
| Contract implementation / Customer training | *Describe training or support you provide to help agencies understand how to utilize the spaces and technology equipment being installed.* | We provide on-site, remote training, and email support to provide a 360 and immersive understanding of the technology being installed and utilized. Our dedicated Account Management Department provides proactive updates on the utility of the hardware/software as it applies to the different workforce, career pathways and academic fields of study. We are constantly updating our Immersive Institute catalog, and subsequently notify our clients of the additional content(s) and ways it is applied into a lesson plan. |
| History of meeting product and services timeline | *Outline the process for timeline for product pickup, delivery, and any other applicable capabilities not already addressed.* | I2 and L2 products: Procurement-Delivery can take anywhere from 2-4 weeks depending on size.<br>I2 products are set up at Lobaki and then delivered to the client at the client's requested date and time.<br>L2 products are shipped directly to the client and Lobaki Specialists are sent out to perform the install and setup at the client's requested date and time |
| Other factors relevant to this section as submitted by the Respondent | *Describe the capacity of your company to provide management reports, i.e. consolidated billing by location, time and attendance reports, etc. for each eligible agency* | Lobaki currently tacks many of the same metrics on industry proven IT systems. In most cases complying with any of your needs will probably require nothing more than setting up a new account. It's hard to imagine this installation needing something more but our systems are based upon relational Data Bases and can be retrofitted quickly. |

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| | *Provide your safety record, safety rating, EMR and worker's compensation rate where available.* | Our Safety Record is 100%, no injuries during business. To date, no Worker's Compensation Claims have ever been filed. |
| **Qualification and Experience (25 Points)** | | |
| Respondent reputation in the marketplace | *Provide a link to your company's website* | www.lobaki.com |
| | *Please provide a brief history of your company, including the year it was established.* | Lobaki was founded in 2016 to "change lives through technology" by teaching students in underprivileged communities how to develop virtual reality software. It has since adapted to being a full-service virtual reality provider to schools, school districts, community colleges, insittues of higher learning, workforce development centers, and private enterprises. Lobaki is very proud to report that 100% of its software is designed and built in the USA. |
| Past relationship with Region 10 ESC and/or Region 10 ESC members | *Have you worked with Region 10 in the past? If so, what was the timeframe for that work?* | No |
| Experience and qualification of key employees | *Please provide contact information and resumes for the person(s) who will be responsible for the following areas. Region 10 requests contacts to cover the following:*<br>** Executive Support*<br>** Account Manager*<br>** Contract Manager*<br>** Marketing*<br>** Billing, reporting & Accounts Payable* | Kevin Loud, President<br>Executive Support<br>Kevin@lobaki.com<br>Over 16 Years of experience as a CFO and over 40 years of experience in the Finance industry<br><br>Sanford Moore, Immersive Consultant<br>Account Manager<br>Sanford@lobaki.com<br>8 years experience in B2B sales and software consulting<br><br>Ricky Ricardo, Director of Business Development<br>Contract Manager<br>Ricky@lobaki.com<br>15 years of IT and business development experience in the software industry<br><br>Kris Johnson, Director of Marketing<br>Marketing<br>Kris@lobaki.com<br>12 years of experience in Business and Consumer Marketing with focus on Brand Development, Product Marketing, and Product Placement. |

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| | | Janis Klise, Director of HR & Accounting<br>Billing, Reporting and Accounts Payable<br>Janis@lobaki.com<br>Over 40 years of experience in Business Accounting and Corporate accounting. |
| Past experience working with the public sector | *What are your overall public sector sales, excluding Federal Government, for last three (3) years?* | [redacted] |
| | *What is your strategy to increase market share in the public sector?* | We market almost exclusively to public school districts, community colleges, institutions of higher learning, and workforce development centers. |
| Past litigation, bankruptcy, reorganization, state investigations of entity or current officers and directors | *Provide information regarding whether your firm, either presently or in the past, has been involved in any litigation, bankruptcy, or reorganization.* | [redacted] |
| Minimum of 5 public sector customer references relating to the products and services within this RFP | *Provide a minimum of five (5) customer references for product and/or services of similar scope dating within the past 3 years. Please try to provide references for K12, Higher Education, City/County and State entities. Provide the entity; contact name & title; city & state; phone number; years serviced; description of services; and annual volume* | Jackson State University<br>Almesha Campbell<br>Assistant Vice President for Research and Economic Development<br>almesha.l.campbell@jsums.edu<br>601-979-6347<br>Project Description – Custom content creation of a Civil Rights experience to historical accuracy as provided by content experts. Custom content creation of STEM related experience. Lobaki Launchpad users as well. Ongoing partnership.<br><br>Coahoma Community College<br>Dr. Larry Webster<br>Dean of Administration, Career and Technical Education<br>lwebster@coahomacc.edu<br>662-627-2571 ext 4220<br>Project Description – Custom content creation of various CTE courses to teach areas of Carpentry, CDL, Auto Body, Electrical, Welding, and Wiring. Ongoing partnership.<br><br>Neshoba County Schools<br>Dana McLain<br>Work-Based Learning Coordinator<br>dmclain@neshobacentral.com |

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| | | 601-604-2283<br>Project Description- Implemented our Immersive institute for the use of Career exploration and training. Ongoing partnership.<br><br>Jackson Public School District<br>Rajeeni Clay<br>Executive Director of School Support<br>rclay@jackson.k12.ms.us<br>601-960-8707<br>Project Description- District wide implementation of Immersive institute for K12 academic and STEM enrichment. Ongoing partnership.<br><br>**Riverfield Country Day School**<br>Jennifer Kesselring<br>Division Head<br>jkesselring@riverfield.org<br>918-693-2270<br>Tulsa, OK<br>Customer from 2021-present<br>Purchased VR software for 45 headsets, worked with teachers and school administration to successfully integrate VR into curriculum for several classes and grade levels. Ongoing Partnership. |
| Certifications in the Industry | *Provide a copy of all current licenses, registrations and certifications issued by federal, state and local agencies, and any other licenses, registrations or certifications from any other governmental entity with jurisdiction, allowing Respondent to perform the covered services including, but not limited to licenses, registrations or certifications. M/WBE, HUB, DVBE, small and disadvantaged business certifications and other diverse business certifications, as well as manufacturer certifications for sales and service must be included if applicable* | There are no applicable licenses for our industry, other than degree specific fields. |

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| Company profile and capabilities | *What best describes your position in the distribution channel? (Manufacturer, Authorized Distributor, Value-Add Reseller, Other* | Software Development and content services-direct channel to customer<br>Hardware-authorized distributor |
| Other factors relevant to this section as submitted by the Respondent | *If your company is a privately held organization, please indicate if the company is owned or operated by anyone who has been convicted of a felony. If yes, a detailed explanation of the names and conviction is required.* | N/A |
| | Provide a copy of all current licenses, registrations and certifications issued by federal, state and local agencies, and any other licenses, registrations or certifications from any other governmental entity with jurisdiction, allowing Respondent to perform the covered services. These will be provided in the space provided in Form 6. No answer is required here. | |
| **MWBE Status and/or Program Capabilities (10 Points)** | | |
| MWBE status, subcontractor plan, and/or joint venture program | *Please indicate whether you hold any diversity certifications, including, but not limited to MWBE, SBE, DBE, DVBE, HUB, or HUBZone* | No |
| | *Do you currently have a diversity program in place, such as a Mentor Protégé Program or subcontractor program? If you have a diversity program, please describe it and indicate whether you plan to offer your program or partnership through Equalis Group?* | Yes. We plan on utilizing a 3rd party contractor that is of Texas domiciled MWBE status.<br>We currently utilize an in-house diversity program modeled after the DEI Standards. |
| | Please attach any certifications you have as part of your response to Form 6. | |
| Good faith efforts to involve MWBE subcontractors in response | *Did your company contact MWBEs or minority chambers of commerce by telephone, written correspondence, or trade associations at least one week before the due date of this RFP to provide information relevant to this opportunity and to determine whether any MWBEs were interested in subcontracting and/or joint ventures?* | We researched several companies within the MWBE's directory in order to establish a 3rd party contractor should we receive this bid to have a contractor available for implementation of this bid. |
| Demonstrated ongoing MWBE program | *Outline your subcontractor strategy and efforts your organization takes to include MWBE subcontractors in future work, including but not limited to efforts to reach out to individual MWBE businesses, minority chambers of commerce, and other minority business and trade associations.* | Lobaki seeks out MWBE businesses to partner with. The company currently has an agreement with the Mississippi Band of Choctaw Indians and related companies that represent the Mississippi Band of Choctaw Indians. |
| **Commitment to Service Equalis Group Members (10 Points)** | | |
| Marketing plan, capability, and commitment | *Detail how your organization plans to market and promote this contract upon award, including how this contract will fit into your* | Lobaki plans to market this contract through a comprehensive press release and work with Equalis to best optimize the marketing push to comply with any school district requirements for media presentation. We would identify individual schools as partners to us through our social media channels |

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| | *organization's current go-to-market strategy in the public sector.* | and website blog. We will make a concerted effort to have in-person demonstrations with any interested parties. |
| | *Detail how your organization will train your sales force and customer service representatives on this contract to ensure that they can competently and consistently present the contract to public agency customers and answer any questions they might have concerning it.* | All Lobaki salespersons and customer service representatives are experts on our products and services. We have a detailed and engaging onboarding curriculum for new hires and outside contractors. We will have monthly meetings with all stakeholders outlining reports of updates, activity, proactive utility of the software, successful highlights of other customers, implementation strategies, and new product roll out. Regular surveys of current customers to determine best usage of our products and services. |
| | *Acknowledge that your organization agrees to provide its company logo(s) to Region 10 ESC and Equalis Group and agrees to provide permission for reproduction of such logo in marketing communications and promotions* | Yes |
| Ability to manage a cooperative contract | *Describe the capacity of your company to report monthly sales through this agreement to Equalis Group.* | The company utilizes streamlined computer-based accounting systems. It has always maintained high standards in financial reporting integrity as well as speed. Internal financials are distributed no later than 15 days after month's end and it sees no difficulty meeting any reasonable request of this bid. |
| | *Identify any contracts with other cooperative or government group purchasing organizations of which your company is currently a part of:* | N/A |
| Commitment to supporting agencies to utilize the contract | *If awarded a contract, how would you approach agencies in regards to this contract? Please indicate how this would work for both new customers to your organization, as well as existing.* | Lobaki would do a full marketing outreach campaign to the agencies of Region 10 ESC in order to appropriately educate those agencies on the products, their usage, and services they now have access to through the master agreement with ESC. This would involve virtual or in-person meetings and demonstrations as well as an extensive FAQs document. |
| Other factors relevant to this section as submitted by the Respondent | *Provide the number of sales representatives which will work on this contract and where the sales representatives are located.* | 3, all located in Jackson, MS. If selected, Lobaki would contract with an MWBE partner to help facilitate the delivery, installation, training, and support of the hardware and software. |
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**PROPOSAL FORM 3: CERTIFICATIONS AND LICENSES**

Provide a copy of all current licenses, registrations and certifications issued by federal, state and local agencies, and any other licenses, registrations or certifications from any other governmental entity with jurisdiction, allowing Respondent to perform the covered services including, but not limited to licenses, registrations or certifications. M/WBE, HUB, DVBE, small and disadvantaged business certifications and other diverse business certifications, as well as manufacturer certifications for sales and service must be included if applicable.

**PROPOSAL FORM 4: CLEAN AIR WATER ACT**

I, the Vendor, am in compliance with all applicable standards, orders or regulations issued pursuant to the Clean Air Act of 1970, as Amended (42 U.S. C. 1857 (h), Section 508 of the Clean Water Act, as amended (33 U.S.C. 1368), Executive Order 117389 and Environmental Protection Agency Regulation, 40 CFR Part 15 as required under OMB Circular A-102, Attachment O, Paragraph 14 (1) regarding reporting violations to the grantor agency and to the United States Environment Protection Agency Assistant Administrator for the Enforcement.

Potential Vendor: ______Lobaki, Inc__________________________________________

Title of Authorized Representative: ____Kevin Loud, President __________

Mailing Address: __736 S. President St #106 Jackson, MS 30201__________________________

Signature: ______________________________________________________________________

**PROPOSAL FORM 5: DEBARMENT NOTICE**

I, the Vendor, certify that my company has not been debarred, suspended or otherwise ineligible for participation in Federal Assistance programs under Executive Order 12549, “Debarment and Suspension”, as described in the Federal Register and Rules and Regulations.

Potential Vendor: _____Lobaki, Inc_______________________________________________________

Title of Authorized Representative: ____Kevin Loud, President __________________

Mailing Address: _736 S. President St #106 Jackson, MS 39201____________________

Signature: ________________________________________________________________

**PROPOSAL FORM 6: LOBBYING CERTIFICATION**

Submission of this certification is a prerequisite for making or entering into this transaction and is imposed by Section 1352, Title 31, U.S. Code. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Any person who fails to file the required certification shall be subject to civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

The undersigned certifies, to the best of his/her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of a Federal contract, the making of a Federal grant, the making of a Federal loan, the entering into a cooperative agreement, and the extension, continuation, renewal, amendment, or modification of a Federal contract, grant, loan, or cooperative agreement.

2. If any funds other than Federal appropriated funds have been or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract or cooperative agreement, the undersigned shall complete and submit Standard Form LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all covered sub-awards exceeding $100,000 in Federal funds at all appropriate tiers and that all sub-recipients shall certify and disclose accordingly.

______________________________
Signature of Respondent

6/30/2023
______________________________
Date

**PROPOSAL FORM 7: CONTRACTOR CERTIFICATION REQUIREMENTS**

## Contractor's Employment Eligibility

By entering the contract, Contractor warrants compliance with the Federal Immigration and Nationality Act (FINA), and all other federal and state immigration laws and regulations. The Contractor further warrants that it is in compliance with the various state statutes of the states it will operate this contract in.

Participating Government Entities including School Districts may request verification of compliance from any Contractor or subcontractor performing work under this Contract. These Entities reserve the right to confirm compliance in accordance with applicable laws.

Should the Participating Entities suspect or find that the Contractor or any of its subcontractors are not in compliance, they may pursue any and all remedies allowed by law, including, but not limited to: suspension of work, termination of the Contract for default, and suspension and/or debarment of the Contractor. All costs necessary to verify compliance are the responsibility of the Contractor.

The Respondent complies and maintains compliance with the appropriate statutes which requires compliance with federal immigration laws by State employers, State contractors and State subcontractors in accordance with the E-Verify Employee Eligibility Verification Program.

Contractor shall comply with governing board policy of the Region 10 ESC Participating entities in which work is being performed.

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## Fingerprint & Criminal Background Checks

If required to provide services on school district property at least five (5) times during a month, contractor shall submit a full set of fingerprints to the school district if requested of each person or employee who may provide such service. Alternately, the school district may fingerprint those persons or employees. An exception to this requirement may be made as authorized in Governing Board policy. The district shall conduct a fingerprint check in accordance with the appropriate state and federal laws of all contractors, subcontractors or vendors and their employees for which fingerprints are submitted to the district. Contractor, subcontractors, vendors and their employees shall not provide services on school district properties until authorized by the District.

The Respondent shall comply with fingerprinting requirements in accordance with appropriate statutes in the state in which the work is being performed unless otherwise exempted.

Contractor shall comply with governing board policy in the school district or Participating Entity in which work is being performed.

_______________________________ 6/30/2023

Signature of Respondent Date

**PROPOSAL FORM 8: ANTITRUST CERTIFICATION STATEMENTS**
**(Tex. Government Code § 2155.005)**

I affirm under penalty of perjury of the laws of the State of Texas that:

(1) I am duly authorized to execute this contract on my own behalf or on behalf of the company, corporation, firm, partnership or individual (Company) listed below;

(2) In connection with this proposal, neither I nor any representative of the Company has violated any provision of the Texas Free Enterprise and Antitrust Act, Tex. Bus. & Comm. Code Chapter 15;

(3) In connection with this proposal, neither I nor any representative of the Company has violated any federal antitrust law; and

(4) Neither I nor any representative of the Company has directly or indirectly communicated any of the contents of this proposal to a competitor of the Company or any other company, corporation, firm, partnership or individual engaged in the same line of business as the Company.

**VENDOR _Lobaki, Inc________________________________**

**ADDRESS __736 S. President St. #106 Jackson, MS 39201**

______________________________

______________________________

**PHONE** ____601-624-5375______________

**FAX** ______________________________

**RESPONDANT**

Sanford Moore
______________________________
Signature

Sanford Moore
______________________________
Printed Name

Immersive Consultant
______________________________
Position with Company

**AUTHORIZING OFFICIAL**

______________________________
Signature

Kevin Loud
______________________________
Printed Name

President
______________________________
Position with Company

## PROPOSAL FORM 9: IMPLEMENTATION OF HOUSE BILL 1295

**Certificate of Interested Parties (Form 1295):**

In 2015, the Texas Legislature adopted House Bill 1295, which added section 2252.908 of the Government Code. The law states that a governmental entity or state agency may not enter into certain contracts with a business entity unless the business entity submits a disclosure of interested parties to the governmental entity or state agency at the time the business entity submits the signed contract to the governmental entity or state agency. The law applies only to a contract of a governmental entity or state agency that either (1) requires an action or vote by the governing body of the entity or agency before the contract may be signed or (2) has a value of at least $1 million. The disclosure requirement applies to a contract entered into on or after January 1, 2016.

The Texas Ethics Commission was required to adopt rules necessary to implement that law, prescribe the disclosure of interested parties form, and post a copy of the form on the commission's website. The commission adopted the Certificate of Interested Parties form (Form 1295) on October 5, 2015. The commission also adopted new rules (Chapter 46) on November 30, 2015, to implement the law. The commission does not have any additional authority to enforce or interpret House Bill 1295.

**Filing Process:**

Staring on January 1, 2016, the commission will make available on its website a new filing application that must be used to file Form 1295. A business entity must use the application to enter the required information on Form 1295 and print a copy of the completed form, which will include a certification of filing that will contain a unique certification number. An authorized agent of the business entity must sign the printed copy of the form and have the form notarized. The completed Form 1295 with the certification of filing must be filed with the governmental body or state agency with which the business entity is entering into the contract.

The governmental entity or state agency must notify the commission, using the commission's filing application, of the receipt of the filed Form 1295 with the certification of filing not later than the 30th day after the date the contract binds all parties to the contract. The commission will post the completed Form 1295 to its website within seven business days after receiving notice from the governmental entity or state agency.

Information regarding how to use the filing application will be available on this site starting on January 1, 2016.
https://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm

**PROPOSAL FORM 10: BOYCOTT CERTIFICATION AND TERRORIST STATE CERTIFICATION**

## BOYCOTT CERTIFICATION

Respondents must certify that during the term of any Agreement, it does not boycott Israel and will not boycott Israel. “Boycott” means refusing to deal with, terminating business activities with, or otherwise taking any action that is intended to penalize, inflict economic harm on, or limit commercial relations specifically with Israel, or with a person or entity doing business in Israel or in an Israeli-controlled territory, but does not include an action made for ordinary business purposes.

Does vendor agree? ______________________________________
(Initials of Authorized Representative)

## TERRORIST STATE CERTIFICATION

In accordance with Texas Government Code, Chapter 2252, Subchapter F, REGION 10 ESC is prohibited from entering into a contract with a company that is identified on a list prepared and maintained by the Texas Comptroller or the State Pension Review Board under Texas Government Code Sections 806.051, 807.051, or 2252.153. By execution of any agreement, the respondent certifies to REGION 10 ESC that it is not a listed company under any of those Texas Government Code provisions. Responders must voluntarily and knowingly acknowledge and agree that any agreement shall be null and void should facts arise leading the REGION 10 ESC to believe that the respondent was a listed company at the time of this procurement.

Does vendor agree? ______________________________________
(Initials of Authorized Representative)

## PROPOSAL FORM 11: RESIDENT CERTIFICATION

This Certification Section must be completed and submitted before a proposal can be awarded to your company. This information may be placed in an envelope labeled "Proprietary" and is not subject to public view. In order for a proposal to be considered, the following information must be provided. Failure to complete may result in rejection of the proposal:

As defined by Texas House Bill 602, a "nonresident Bidder" means a Bidder whose principal place of business is not in Texas, but excludes a contractor whose ultimate parent company or majority owner has its principal place of business in Texas.
Texas or Non-Texas Resident

- ☐ I certify that my company is a **"resident Bidder"**
- ☑ I certify that my company qualifies as a **"nonresident Bidder"**

If you qualify as a "nonresident Bidder," you must furnish the following information:

What is your resident state? (The state your principal place of business is located.)

Lobaki, Inc
736 S. President St. #106
Jackson, MS 39201

## PROPOSAL FORM 12: FEDERAL FUNDS CERTIFICATION FORM

When a participating agency seeks to procure goods and services using funds under a federal grant or contract, specific federal laws, regulations, and requirements may apply in addition to those under state law. This includes, but is not limited to, the procurement standards of the Uniform Administrative Requirements, Cost Principles and Audit Requirements for Federal Awards, 2 CFR 200 (sometimes referred to as the "Uniform Guidance" or "EDGAR" requirements). All Vendors submitting proposals must complete this Federal Funds Certification Form regarding Vendor's willingness and ability to comply with certain requirements which may be applicable to specific participating agency purchases using federal grant funds. This completed form will be made available to participating agencies for their use while considering their purchasing options when using federal grant funds. Participating agencies may also require Vendors to enter into ancillary agreements, in addition to the contract's general terms and conditions, to address the member's specific contractual needs, including contract requirements for a procurement using federal grants or contracts.

**For each of the items below, Vendor should certify Vendor's agreement and ability to comply, where applicable, by having Vendor's authorized representative complete and initial the applicable lines after each section and sign the acknowledgment at the end of this form.** If a vendor fails to complete any item in this form, Region 10 ESC will consider the Vendor's response to be that they are unable or unwilling to comply. A negative response to any of the items may, if applicable, impact the ability of a participating agency to purchase from the Vendor using federal funds.

**1. Vendor Violation or Breach of Contract Terms:**

Contracts for more than the simplified acquisition threshold currently set at $150,000, which is the inflation adjusted amount determined by the Civilian Agency Acquisition Council and the Defense Acquisition Regulations Council (Councils) as authorized by 41 USC 1908, must address administrative, contractual, or legal remedies in instances where contractors violate or breach contract terms, and provide for such sanctions and penalties as appropriate.

Any Contract award will be subject to Region 10 ESC General Terms and Conditions, as well as any additional terms and conditions in any Purchase Order, participating agency ancillary contract, or Member Construction Contract agreed upon by Vendor and the participating agency which must be consistent with and protect the participating agency at least to the same extent as the Region 10 ESC Terms and Conditions.

The remedies under the Contract are in addition to any other remedies that may be available under law or in equity. By submitting a Proposal, you agree to these Vendor violation and breach of contract terms.

Does vendor agree? ______________________________

(Initials of Authorized Representative)

**2. Termination for Cause or Convenience:**

When a participating agency expends federal funds, the participating agency reserves the right to immediately terminate any agreement in excess of $10,000 resulting from this procurement process in the event of a breach or default of the agreement by Offeror in the event Offeror fails to: (1) meet schedules, deadlines, and/or delivery dates within the time specified in the procurement solicitation, contract, and/or a purchase order; (2) make any payments owed; or (3) otherwise perform in accordance with the contract and/or the procurement solicitation. participating agency also reserves the right to terminate the contract immediately, with written notice to offeror, for convenience, if participating agency believes, in its sole discretion that it is in the best interest of participating agency to do so. Offeror will be compensated for work performed and accepted and goods accepted by participating agency as of the termination date if the contract is terminated for convenience of participating agency. Any award under this procurement process is not exclusive and participating agency reserves the right to purchase goods and services from other offerors when it is in participating agency's best interest.

Does vendor agree? ___________________________________

(Initials of Authorized Representative)

**3. Equal Employment Opportunity:**

Except as otherwise provided under 41 CFR Part 60, all participating agency purchases or contracts that meet the definition of "federally assisted construction contract" in 41 CFR Part 60-1.3 shall be deemed to include the equal opportunity clause provided under 41 CFR 60-1.4(b), in accordance with Executive Order 11246, "Equal Employment Opportunity" (30 FR 12319, 12935, 3 CFR Part, 1964-1965 Comp., p. 339), as amended by Executive Order 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and implementing regulations at 41 CFR Part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."

The equal opportunity clause provided under 41 CFR 60-1.4(b) is hereby incorporated by reference. Vendor agrees that such provision applies to any participating agency purchase or contract that meets the definition of "federally assisted construction contract" in 41 CFR Part 60-1.3 and Vendor agrees that it shall comply with such provision.

Does vendor agree? ___________________________________

(Initials of Authorized Representative)

**4. Davis-Bacon Act:**

When required by Federal program legislation, Vendor agrees that, for all participating agency prime construction contracts/purchases in excess of $2,000, Vendor shall comply with the Davis-Bacon Act (40 USC 3141-3144, and 3146-3148) as supplemented by Department of Labor regulations (29 CFR Part 5, "Labor Standards Provisions Applicable to Contracts Covering Federally Financed and Assisted Construction"). In accordance with the statute, Vendor is required to pay wages to laborers and mechanics at a rate not less than the prevailing wages specified in a wage determinate made by the Secretary of Labor. In addition, Vendor shall pay wages not less than once a week.

Current prevailing wage determinations issued by the Department of Labor are available at www.wdol.gov. Vendor agrees that, for any purchase to which this requirement applies, the award of the purchase to the Vendor is conditioned upon Vendor's acceptance of the wage determination.

Vendor further agrees that it shall also comply with the Copeland "Anti-Kickback" Act (40 USC 3145), as supplemented by Department of Labor regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each contractor or subrecipient must be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he or she is otherwise entitled.

Does vendor agree? ___________________________________

(Initials of Authorized Representative)

**5. Contract Work Hours and Safety Standards Act:**

Where applicable, for all participating agency contracts or purchases in excess of $100,000 that involve the employment of mechanics or laborers, Vendor agrees to comply with 40 USC 3702 and 3704, as supplemented by Department of Labor regulations (29 CFR Part 5). Under 40 USC 3702 of the Act, Vendor is required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week. The requirements of 40 USC 3704 are applicable to construction work and provide that no laborer or mechanic must be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

Does vendor agree? ___________________________________

(Initials of Authorized Representative)

**6. Right to Inventions Made Under a Contract or Agreement:**

If the participating agency's Federal award meets the definition of "funding agreement" under 37 CFR 401.2(a) and the recipient or subrecipient wishes to enter into a contract with a small business firm or nonprofit organization regarding the substitution of parties, assignment or performance or experimental, developmental, or research work under that "funding agreement," the recipient or subrecipient must comply with the requirements of 37 CFR Part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by the awarding agency.

Vendor agrees to comply with the above requirements when applicable.

Does vendor agree? ___________________________________

(Initials of Authorized Representative)

**7. Clean Air Act and Federal Water Pollution Control Act:**

Clean Air Act (42 USC 7401-7671q.) and the Federal Water Pollution Control Act (33 USC 1251-1387), as amended –Contracts and subgrants of amounts in excess of $150,000 must contain a provision that requires the non-Federal award to agree to comply with all applicable standards, orders, or regulations issued pursuant to the Clean Air Act (42 USC 7401-7671q.) and the Federal Water Pollution Control Act, as amended (33 USC 1251-1387). Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).

When required, Vendor agrees to comply with all applicable standards, orders, or regulations issued pursuant to the Clean Air Act and the Federal Water Pollution Control Act.

Does vendor agree? ___________________________________

(Initials of Authorized Representative)

**8. Debarment and Suspension:**

Debarment and Suspension (Executive Orders 12549 and 12689) – A contract award (see 2 CFR 180.220) must not be made to parties listed on the government-wide exclusions in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR Part 1966 Comp. p. 189) and 12689 (3CFR Part 1989 Comp. p. 235), "Debarment and Suspension." SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared ineligible under statutory or regulatory authority other than Executive Order 12549.

Vendor certifies that Vendor is not currently listed on the government-wide exclusions in SAM, is not debarred, suspended, or otherwise excluded by agencies or declared ineligible under statutory or regulatory authority other than Executive Order 12549. Vendor further agrees to immediately notify the Cooperative and all participating agencies with pending purchases or seeking to purchase from Vendor if Vendor is later listed on the government-wide exclusions in SAM, or is debarred, suspended, or otherwise excluded by agencies or declared ineligible under statutory or regulatory authority other than Executive Order 12549.

Does vendor agree? ______________________________

(Initials of Authorized Representative)

**9. Byrd Anti-Lobbying Amendment:**

Byrd Anti-Lobbying Amendment (31 USC 1352) -- Vendors that apply or bid for an award exceeding $100,000 must file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 USC 1352. Each tier must also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the non-Federal award. As applicable, Vendor agrees to file all certifications and disclosures required by, and otherwise comply with, the Byrd Anti-Lobbying Amendment (31 USC 1352).

Does vendor agree? ______________________________

(Initials of Authorized Representative)

**10. Procurement of Recovered Materials:**

For participating agency purchases utilizing Federal funds, Vendor agrees to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act where applicable and provide such information and certifications as a participating agency may require to confirm estimates and otherwise comply. The requirements of Section 6002 include procuring only items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR Part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition, where the purchase price of the item exceeds $10,000 or the value of the quantity acquired during the preceding fiscal year exceeded $10,000; procuring solid waste management services in a manner that maximizes energy and resource recovery, and establishing an affirmative procurement program for procurement of recovered materials identified in the EPA guidelines.

Does vendor agree? ______________________________

(Initials of Authorized Representative)

**11. Profit as a Separate Element of Price:**

For purchases using federal funds in excess of $150,000, a participating agency may be required to negotiate profit as a separate element of the price. See, 2 CFR 200.323(b). When required by a participating agency, Vendor agrees to provide information and negotiate with the participating agency regarding profit as a separate element of the price for a particular purchase. However, Vendor agrees that the total price, including profit, charged by Vendor to the participating agency shall not exceed the awarded pricing, including any applicable discount, under Vendor's Cooperative Contract.

Does vendor agree? ______________________________

(Initials of Authorized Representative)

**12. Domestic Preference**

Vendor must be prepared to provide a comprehensive list of the number of goods, products, and/or materials (including but not limited to iron, aluminum, steel, cement, and other manufactured products) being used for specific purchase orders under the contract award which were produced in the United States upon request to Region 10 ESC or any Equalis member who intends to use this contract with federal funds.

Does vendor agree? ______________________________

(Initials of Authorized Representative)

**13. Prohibition on Certain Telecommunications and Video Surveillance Services or Equipment**

Vendor agrees that recipients and subrecipients are prohibited from obligating or expending loan or grant funds to procure or obtain, extend or renew a contract to procure or obtain, or enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system from companies described in Public Law 115-232, section 889. Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country are also prohibited.

Does vendor agree? ______________________________

(Initials of Authorized Representative)

**14. General Compliance and Cooperation with Participating Agencies:**

In addition to the foregoing specific requirements, Vendor agrees, in accepting any Purchase Order from a participating agency, it shall make a good faith effort to work with participating agencies to provide such information and to satisfy such requirements as may apply to a particular participating agency purchase or purchases including, but not limited to, applicable recordkeeping and record retention requirements.

Does vendor agree? ______________________________________________

(Initials of Authorized Representative)

**15. Applicability to Subcontractors**

Offeror agrees that all contracts it awards pursuant to the Contract shall be bound by the foregoing terms and conditions.

Does vendor agree? ________________________________________

(Initials of Authorized Representative)

By signature below, I certify that the information in this form is true, complete, and accurate and that I am authorized by my company to make this certification and all consents and agreements contained herein.

_Lobaki, Inc_____________________________________________

Company Name

_______________________________________________________

Signature of Authorized Company Official

__Kevin Loud_____________________________________________

Printed Name

President_______________________________________________

Title

_6/30/2023_______________________________________________

Date

## PROPOSAL FORM 13: ADDITIONAL ARIZONA CONTRACTOR REQUIREMENTS

**AZ Compliance with Federal and state requirements:** Contractor agrees when working on any federally assisted projects with more than $2,000.00 in labor costs, to comply with all federal and state requirements, as well as Equal Opportunity Employment requirements and all other federal and state laws, statutes, etc. Contractor agrees to post wage rates at the work site and submit a copy of their payroll to the member for their files. Contractor must retain records for three years to allow the federal grantor agency access to these records, upon demand. Contractor also agrees to comply with the Arizona Executive Order 75-5, as amended by Executive Order 99-4.
When working on contracts funded with Federal Grant monies, contractor additionally agrees to comply with the administrative requirements for grants, and cooperative agreements to state, local and federally recognized Indian Tribal Governments.

**AZ Compliance with workforce requirements:** Pursuant to ARS 41-4401, Contractor and subcontractor(s) warrant their compliance with all federal and state immigration laws and regulations that relate to their employees, and compliance with ARS 23-214 subsection A, which states, …"every employer, after hiring an employee, shall verify the employment eligibility of the employee through the E-Verify program"
Region 10 ESC reserves the right to cancel or suspend the use of any contract for violations of immigration laws and regulations. Region 10 ESC and its members reserve the right to inspect the papers of any contractor or subcontract employee who works under this contract to ensure compliance with the warranty above.

**AZ Contractor Employee Work Eligibility:** By entering into this contract, contractor agrees and warrants compliance with A.R.S. 41-4401, A.R.S. 23-214, the Federal Immigration and Nationality Act (FINA), and all other Federal immigration laws and regulations. Region 10 ESC and/or Region 10 ESC members may request verification of compliance from any contractor or sub contractor performing work under this contract. Region 10 ESC and Region 10 ESC members reserve the right to confirm compliance. In the event that Region 10 ESC or Region 10 ESC members suspect or find that any contractor or subcontractor is not in compliance, Region 10 ESC may pursue any and all remedies allowed by law, including but not limited to suspension of work, termination of contract, suspension and/or debarment of the contractor. All cost associated with any legal action will be the responsibility of the contractor.

**AZ Non-Compliance:** All federally assisted contracts to members that exceed $10,000.00 may be terminated by the federal grantee for noncompliance by contractor. In projects that are not federally funded, Respondent must agree to meet any federal, state or local requirements as necessary. In addition, if compliance with the federal regulations increases the contract costs beyond the agreed on costs in this solicitation, the additional costs may only apply to the portion of the work paid by the federal grantee.

**Registered Sex Offender Restrictions (Arizona):** For work to be performed at an Arizona school, contractor agrees that no employee or employee of a subcontractor who has been adjudicated to be a registered sex offender will perform work at any time when students are present, or reasonably expected to be present. Contractor agrees that a violation of this condition shall be considered a material breach and may result in the cancellation of the purchase order at the Region 10 ESC member's discretion. Contractor must identify any additional costs associated with compliance to this term. If no costs are specified, compliance with this term will be provided at no additional charge.

**Offshore Performance of Work Prohibited:** Due to security and identity protection concerns, direct services under this contract shall be performed within the borders of the United States.

**Terrorism Country Divestments:** In accordance with A.R.S. 35-392, Region 10 ESC and Region 10 ESC members are prohibited from purchasing from a company that is in violation of the Export Administration Act. By entering into the contract, contractor warrants compliance with the Export Administration Act.

The undersigned hereby accepts and agrees to comply with all statutory compliance and notice requirements listed in this document.

6/30/2023

Signature of Respondent Date

**PROPOSAL FORM 14: OWNERSHIP DISCLOSURE FORM (N.J.S. 52:25-24.2)**
Pursuant to the requirements of P.L. 1999, Chapter 440 effective April 17, 2000 (Local Public Contracts Law), the Respondent shall complete the form attached to these specifications listing the persons owning 10 percent (10%) or more of the firm presenting the proposal.

**Company Name:** Lobaki, Inc

**Street:** 736 S President Street #106

**City, State, Zip Code:** Jackson, MS 39201

***Complete as appropriate:***
*I ________________________________________ , certify that I am the sole owner of ______________________________________ , that there are no partners and the business is not incorporated, and the provisions of N.J.S. 52:25-24.2 do not apply.*
***OR:***
*I* Kevin Loud *, a partner in* Lobaki, Inc *, do hereby certify that the following is a list of all individual partners who own a 10% or greater interest therein. I further certify that if one (1) or more of the partners is itself a corporation or partnership, there is also set forth the names and addresses of the stockholders holding 10% or more of that corporation's stock or the individual partners owning 10% or greater interest in that partnership.*
***OR:***
*I ________________________________________ , an authorized representative of _______________________________ , a corporation, do hereby certify that the following is a list of the names and addresses of all stockholders in the corporation who own 10% or more of its stock of any class. I further certify that if one (1) or more of such stockholders is itself a corporation or partnership, that there is also set forth the names and addresses of the stockholders holding 10% or more of the corporation's stock or the individual partners owning a 10% or greater interest in that partnership.*

**(Note: If there are no partners or stockholders owning 10% or more interest, indicate none.)**

| Name | Address | Interest |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

I further certify that the statements and information contained herein, are complete and correct to the best of my knowledge and belief.

_______________________________ 6/30/2023

***Authorized Signature and Title*** ***Date***

**PROPOSAL FORM 15: NON-COLLUSION AFFIDAVIT**
**Company Name:**
**Street:**
**City, State, Zip Code:**

*State of New Jersey*

*County of ________________________*

*I, ____________________________ of the ___________________________*
*Name City*

*in the County of ____________________________, State of ___________________________________ of full age, being duly sworn according to law on my oath depose and say that:*

*I am the _____________________________ of the firm of _____________________________________*
*Title Company Name*

*the Respondent making the Proposal for the goods, services or public work specified under the Harrison Township Board of Education attached proposal, and that I executed the said proposal with full authority to do so; that said Respondent has not directly or indirectly entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free, competitive bidding in connection with the above proposal, and that all statements contained in said bid proposal and in this affidavit are true and correct, and made with full knowledge that the Harrison Township Board of Education relies upon the truth of the statements contained in said bid proposal and in the statements contained in this affidavit in awarding the contract for the said goods, services or public work.*

*I further warrant that no person or selling agency has been employed or retained to solicit or secure such contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, except bona fide employees or bona fide established commercial or selling agencies maintained by*

______________________________________ _________________________________________
*Company Name* *Authorized Signature & Title*

Subscribed and sworn before me

this ______ day of ______________, 20____

__________________________________________
Notary Public of New Jersey
My commission expires , 20____

SEAL

**PROPOSAL FORM 16: AFFIRMATIVE ACTION AFFIDAVIT (P.L. 1975, C.127)**
**Company Name: ____________________________________________________________**
**Street: _____________________________________________________________________**
**City, State, Zip Code: ________________________________________________________**

***Bid Proposal Certification:***
*Indicate below your compliance with New Jersey Affirmative Action regulations. Your proposal will be accepted even if you are not in compliance at this time. No contract and/or purchase order may be issued, however, until all Affirmative Action requirements are met.*

***Required Affirmative Action Evidence:***
*Procurement, Professional & Service Contracts (Exhibit A)*
*Vendors must submit with proposal:*
1. *A photo copy of their Federal Letter of Affirmative Action Plan Approval* __________
   *OR*
2. *A photo copy of their Certificate of Employee Information Report* __________
   *OR*
3. *A complete Affirmative Action Employee Information Report (AA302)* __________

***Public Work – Over $50,000 Total Project Cost:***
*A. No approved Federal or New Jersey Affirmative Action Plan. We will complete Report Form AA201-A upon receipt from the Harrison Township Board of Education* __________

*B. Approved Federal or New Jersey Plan – certificate enclosed* __________

*I further certify that the statements and information contained herein, are complete and correct to the best of my knowledge and belief.*

_____________________________________________________________ _________________
***Authorized Signature and Title*** ***Date***

***P.L. 1995, c. 127 (N.J.A.C. 17:27)***
***MANDATORY AFFIRMATIVE ACTION LANGUAGE***

***PROCUREMENT, PROFESSIONAL AND SERVICE CONTRACTS***

During the performance of this contract, the contractor agrees as follows:

The contractor or subcontractor, where applicable, will not discriminate against any employee or applicant for employment because of age, race, creed, color, national origin, ancestry, marital status, sex, affectional or sexual orientation. The contractor will take affirmative action to ensure that such applicants are recruited and employed, and that employees are treated during employment, without regard to their age, race, creed, color, national origin, ancestry, marital status, sex, affectional or sexual orientation. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Public Agency Compliance Officer setting forth provisions of this non-discrimination clause.

The contractor or subcontractor, where applicable will, in all solicitations or advertisement for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to age, race, creed, color, national origin, ancestry, marital status, sex, affectional or sexual orientation.

The contractor or subcontractor, where applicable, will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer advising the labor union or workers' representative of the contractor's commitments under this act and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

The contractor or subcontractor, where applicable, agrees to comply with any regulations promulgated by the Treasurer pursuant to P.L. 1975, c. 127, as amended and supplemented from time to time and the Americans with Disabilities Act.

The contractor or subcontractor agrees to attempt in good faith to employ minority and female workers trade consistent with the applicable county employment goal prescribed by N.J.A.C. 17:27-5.2 promulgated by the Treasurer pursuant to P.L. 1975, C.127, as amended and supplemented from time to time or in accordance with a binding determination of the applicable county employment goals determined by the Affirmative Action Office pursuant to N.J.A.C. 17:27-5.2 promulgated by the Treasurer pursuant to P.L. 1975, C.127, as amended and supplemented from time to time.

The contractor or subcontractor agrees to inform in writing appropriate recruitment agencies in the area, including employment agencies, placement bureaus, colleges, universities, labor unions, that it does not discriminate on the basis of age, creed, color, national origin, ancestry, marital status, sex, affectional or sexual orientation, and that it will discontinue the use of any recruitment agency which engages in direct or indirect discriminatory practices.

The contractor or subcontractor agrees to revise any of it testing procedures, if necessary, to assure that all personnel testing conforms with the principles of job-related testing, as established by the statutes and court decisions of the state of New Jersey and as established by applicable Federal law and applicable Federal court decisions.

The contractor or subcontractor agrees to review all procedures relating to transfer, upgrading, downgrading and lay-off to ensure that all such actions are taken without regard to age, creed, color, national origin, ancestry, marital status, sex, affectional or sexual orientation, and conform with the applicable employment goals, consistent with the statutes and court decisions of the State of New Jersey, and applicable Federal law and applicable Federal court decisions.

The contractor and its subcontractors shall furnish such reports or other documents to the Affirmative Action Office as may be requested by the office from time to time in order to carry out the purposes of these regulations, and public agencies shall furnish such information as may be requested by the Affirmative Action Office for conducting a compliance investigation pursuant to Subchapter 10 of the Administrative Code (NJAC 17:27).

________________________________________________

Signature of Procurement Agent

**PROPOSAL FORM 17: C. 271 POLITICAL CONTRIBUTION DISCLOSURE FORM**

**Public Agency Instructions**

This page provides guidance to public agencies entering into contracts with business entities that are required to file Political Contribution Disclosure forms with the agency. **It is not intended to be provided to contractors.** What follows are instructions on the use of form local units can provide to contractors that are required to disclose political contributions pursuant to N.J.S.A. 19:44A-20.26 (P.L. 2005, c. 271, s.2). Additional information is available in Local Finance Notice 2006-1 (https://www.nj.gov/dca/divisions/dlgs/resources/lfns_2006.html).

1. The disclosure is required for all contracts in excess of $17,500 that are **not awarded** pursuant to a "fair and open" process (N.J.S.A. 19:44A-20.7).
2. Due to the potential length of some contractor submissions, the public agency should consider allowing data to be submitted in electronic form (i.e., spreadsheet, pdf file, etc.). Submissions must be kept with the contract documents or in an appropriate computer file and be available for public access. **The form is worded to accept this alternate submission.** The text should be amended if electronic submission will not be allowed.
3. The submission must be **received from the contractor and** on file at least 10 days prior to award of the contract. Resolutions of award should reflect that the disclosure has been received and is on file.
4. The contractor must disclose contributions made to candidate and party committees covering a wide range of public agencies, including all public agencies that have elected officials in the county of the public agency, state legislative positions, and various state entities. The Division of Local Government Services recommends that contractors be provided a list of the affected agencies. This will assist contractors in determining the campaign and political committees of the officials and candidates affected by the disclosure.
   a) The Division has prepared model disclosure forms for each county. They can be downloaded from the "County PCD Forms" link on the Pay-to-Play web site at https://www.state.nj.us/dca/divisions/dlgs/programs/pay_2_play.html They will be updated from time-to-time as necessary.
   b) A public agency using these forms **should edit them to properly reflect the correct legislative district**(s). As the forms are county-based, **they list all legislative districts** in each county. **Districts that do not represent the public agency should be removed from the lists.**
   c) Some contractors may find it easier to provide a single list that covers all contributions, regardless of the county. These submissions are appropriate and should be accepted.
   d) The form may be used "as-is", subject to edits as described herein.
   e) The "Contractor Instructions" sheet is intended to be provided with the form. It is recommended that the Instructions and the form be printed on the same piece of paper. The form notes that the Instructions are printed on the back of the form; where that is not the case, the text should be edited accordingly.
   f) The form is a Word document and can be edited to meet local needs, and posted for download on web sites, used as an e-mail attachment, or provided as a printed document.
5. It is recommended that the contractor also complete a "Stockholder Disclosure Certification." This will assist the local unit in its obligation to ensure that contractor did not make any prohibited contributions to the committees listed on the Business Entity Disclosure Certification in the 12 months prior to the contract. (See Local Finance Notice 2006-7 for additional information on this obligation) A sample Certification form is part of this package and the instruction to complete it is included in the Contractor Instructions. **NOTE: This section is not applicable to Boards of Education.**

**C. 271 POLITICAL CONTRIBUTION DISCLOSURE FORM**
**Contractor Instructions**

Business entities (contractors) receiving contracts from a public agency that are NOT awarded pursuant to a "fair and open" process (defined at N.J.S.A. 19:44A-20.7) are subject to the provisions of P.L. 2005, c. 271, s.2 (N.J.S.A. 19:44A-20.26). This law provides that 10 days prior to the award of such a contract, the contractor shall disclose contributions to:

1. any State, county, or municipal committee of a political party
2. any legislative leadership committee*
3. any continuing political committee (a.k.a., political action committee)
4. any candidate committee of a candidate for, or holder of, an elective office:
    1. of the public entity awarding the contract
    2. of that county in which that public entity is located
    3. of another public entity within that county
    4. or of a legislative district in which that public entity is located or, when the public entity is a county, of any legislative district which includes all or part of the county. The disclosure must list reportable contributions to any of the committees that exceed $300 per election cycle that were made during the 12 months prior to award of the contract. See N.J.S.A. 19:44A-8 and 19:44A-16 for more details on reportable contributions.

N.J.S.A. 19:44A-20.26 itemizes the parties from whom contributions must be disclosed when a business entity is not a natural person. This includes the following:

5. individuals with an "interest" ownership or control of more than 10% of the profits or assets of a business entity or 10% of the stock in the case of a business entity that is a corporation for profit
6. all principals, partners, officers, or directors of the business entity or their spouses
7. any subsidiaries directly or indirectly controlled by the business entity
8. IRS Code Section 527 New Jersey based organizations, directly or indirectly controlled by the business entity and filing as continuing political committees, (PACs). When the business entity is a natural person, "a contribution by that person's spouse or child, residing therewith, shall be deemed to be a contribution by the business entity." [N.J.S.A. 19:44A-20.26(b)] The contributor must be listed on the disclosure. Any business entity that fails to comply with the disclosure provisions shall be subject to a fine imposed by ELEC in an amount to be determined by the Commission which may be based upon the amount that the business entity failed to report. The enclosed list of agencies is provided to assist the contractor in identifying those public agencies whose elected official and/or candidate campaign committees are affected by the disclosure requirement. It is the contractor's responsibility to identify the specific committees to which contributions may have been made and need to be disclosed. The disclosed information may exceed the minimum requirement. The enclosed form, a content-consistent facsimile, or an electronic data file containing the required details (along with a signed cover sheet) may be used as the contractor's submission and is disclosable to the public under the Open Public Records Act. The contractor must also complete the attached Stockholder Disclosure Certification. This will assist the agency in meeting its obligations under the law.

**NOTE: This section does not apply to Board of Education contracts.**

* N.J.S.A. 19:44A-3(s): "The term "legislative leadership committee" means a committee established, authorized to be established, or designated by the President of the Senate, the Minority Leader of the Senate, the Speaker

of the General Assembly or the Minority Leader of the General Assembly pursuant to section 16 of P.L.1993, c.65 (C.19:44A-10.1) for the purpose of receiving contributions and making expenditures."

**C. 271 POLITICAL CONTRIBUTION DISCLOSURE FORM**

Required Pursuant To N.J.S.A. 19:44A-20.26

**This form or its permitted facsimile must be submitted to the local unit no later than 10 days prior to the award of the contract.**

**Part I – Vendor Information**

| | | | |
|---|---|---|---|
| Vendor Name: | | | |
| Address: | | | |
| City: | | State: | Zip: |

The undersigned being authorized to certify, hereby certifies that the submission provided herein represents compliance with the provisions of N.J.S.A. 19:44A-20.26 and as represented by the Instructions accompanying this form.

_________________________ _____________________ _____________________

Signature Printed Name Title

**Part II – Contribution Disclosure**

Disclosure requirement: Pursuant to N.J.S.A. 19:44A-20.26 this disclosure must include all reportable political contributions (more than $300 per election cycle) over the 12 months prior to submission to the committees of the government entities listed on the form provided by the local unit.

☐ Check here if disclosure is provided in electronic form.

| **Contributor Name** | **Recipient Name** | **Date** | **Dollar Amount** |
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☐ Check here if the information is continued on subsequent page(s)

**Continuation Page**
C. 271 POLITICAL CONTRIBUTION DISCLOSURE FORM
Required Pursuant To <u>N.J.S.A.</u> 19:44A-20.26
Page ___ of ______

Vendor Name:

| **Contributor Name** | **Recipient Name** | **Date** | **Dollar Amount** |
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☐ Check here if the information is continued on subsequent page(s)

**List of Agencies with Elected Officials Required for Political Contribution Disclosure**
**<u>N.J.S.A.</u> 19:44A-20.26**
**County Name:**
State: Governor, and Legislative Leadership Committees
Legislative District #s:
State Senator and two members of the General Assembly per district.

County:

| | | |
|---|---|---|
| Freeholders | County Clerk | Sheriff |
| {County Executive} | Surrogate | |

Municipalities (Mayor and members of governing body, regardless of title):

**USERS SHOULD CREATE THEIR OWN FORM, OR DOWNLOAD FROM** WWW.NJ.GOV/DCA/LGS/P2P **A COUNTY-BASED, CUSTOMIZABLE FORM.**

PROPOSAL FORM 18: STOCKHOLDER DISCLOSURE CERTIFICATION

**Name of Business:**

☑ I certify that the list below contains the names and home addresses of all stockholders holding 10% or more of the issued and outstanding stock of the undersigned.

**OR**

☐ I certify that no one stockholder owns 10% or more of the issued and outstanding stock of the undersigned.

**Check the box that represents the type of business organization:**

☐ Partnership
☑ Corporation
☐ Sole Proprietorship
☐ Limited Partnership
☐ Limited Liability Corporation
☐ Limited Liability Partnership
☐ Subchapter S Corporation

**Sign and notarize the form below, and, if necessary, complete the stockholder list below.**

Stockholders:

| | |
|---|---|
| Name: Keum Loud<br>Home Address: 736 S. President St. Jackson, MS 39201 | Name:<br>Home Address: |
| Name:<br>Home Address: | Name:<br>Home Address: |
| Name:<br>Home Address: | Name:<br>Home Address: |
| Subscribed and sworn before me this 30 day of June, 2023<br>(Notary Public) Nicole Reilly Notary Public State of Mississippi Rankin County Notary ID# 344004 My Commission Expires 10/30/2026<br>My Commission expires: | (Affiant)<br>Keum Loud, President<br>(Print name & title of affiant)<br>(Corporate Seal) |

**PROPOSAL FORM 19:  GENERAL TERMS AND CONDITIONS ACCEPTANCE FORM**

*Signature on the Vendor Contract Signature form certifies complete acceptance of the General Terms and Conditions in this solicitation, except as noted below (additional pages may be attached, if necessary).*

**Check one of the following responses to the General Terms and Conditions:**

☑ We take no exceptions/deviations to the general terms and conditions

(*Note: If none are listed below, it is understood that no exceptions/deviations are taken.)*

☐ We take the following exceptions/deviations to the general terms and conditions.  All exceptions/deviations must be clearly explained. Reference the corresponding general terms and conditions that you are taking exceptions/deviations to.  Clearly state if you are adding additions terms and conditions to the general terms and conditions.  Provide details on your exceptions/deviations below:

(*Note: Unacceptable exceptions shall remove your proposal from consideration for award. Region 10 ESC shall be the sole judge on the acceptance of exceptions/deviations and the decision shall be final.*)

## PROPOSAL FORM 20: EQUALIS GROUP ADMINISTRATION AGREEMENT

# Requirements for Master Agreement To be administered by Equalis Group

**Attachment A, Equalis Group Administrative Agreement** is used in administering Master Agreements with Region 10 and is preferred by Equalis Group. Redlined copies of this agreement should not be submitted with the response. Should a respondent be recommended for award, this agreement will be negotiated and executed between Equalis Group and the respondent. **Respondents must select one of the following options for submitting their response**.

- [X] Respondent agrees to all terms and conditions outlined in each of the Administration Agreement.
- [ ] Respondent wishes to negotiate directly with Equalis Group on terms and conditions outlined in the Administration Agreement. Negotiations will commence after sealed Proposals are opened and Region 10 has determined the respondent met all requirements in their response and may be eligible for award.

## PROPOSAL FORM 21: OPEN RECORDS POLICY ACKNOWLEDGEMENT AND ACCEPTANCE

**OPEN RECORDS POLICY ACKNOWLEDGMENT AND ACCEPTANCE**

Be advised that all information and documents submitted will be subject to the Public Information Act requirements governed by Chapter 552 of the Texas Government Code.

Because contracts are awarded by a Texas governmental entity, all responses submitted are subject to release as public information after contracts are executed. If a Respondent believes that its response, or parts of its response, may be exempted from disclosure to the public, the Respondent must specify page-by-page and line-by-line the parts of the response, which it believes, are exempted from disclosure. In addition, the Respondent must specify which exception(s) are applicable and provide detailed reasons to substantiate the exception(s). Respondent must provide this information on the "Acknowledgement and Acceptance to Region 10 ESC's Public Information Act Policy" form found on the next page of this solicitation. Any information that is unmarked will be considered public information and released, if requested under the Public Information Act.

The determination of whether information is confidential and not subject to disclosure is the duty of the Office of Attorney General (OAG). Region 10 ESC must provide the OAG with the information requested in order for the OAG to render an opinion. In such circumstances, Respondent will be notified in writing that the material has been requested and delivered to the OAG. Respondent will have an opportunity to make arguments to the OAG in writing regarding the exception(s) to the TPIA that permit the information to be withheld from public disclosure. Respondents are advised that such arguments to the OAG must be specific and well-reasoned--vague and general claims to confidentiality by the Respondent are generally not acceptable to the OAG. Once the OAG opinion is received by Region 10 ESC, Region 10 ESC must comply with the opinions of the OAG. Region 10 ESC assumes no responsibility for asserting legal arguments on behalf of any Respondent. Respondents are advised to consult with their legal counsel concerning disclosure issues resulting from this procurement process and to take precautions to safeguard trade secrets and other proprietary information.

After completion of award, these documents will be available for public inspection.

**Signature below certifies complete acceptance of Region 10 ESC's Open Records Policy, except as noted below (additional pages may be attached, if necessary). Check one of the following responses to the Acknowledgment and Acceptance of Region 10 ESC's Open Records Policy below:**

☐ We acknowledge Region 10 ESC's Public Information Act policy and declare that no information submitted with this proposal, or any part of our proposal, is exempt from disclosure under the Public Information Act.

(*Note: All information believed to be a trade secret or proprietary must be listed below. It is further understood that failure to identify such information, in strict accordance with the instructions below, will result in that information being considered public information and released, if requested under the Public Information Act.)*

☑ We declare the following information to be a trade secret or proprietary and exempt from disclosure under the Public Information Act.

*(Note: Respondent must specify page-by-page and line-by-line the parts of the response, which it believes, are exempt. In addition, Respondent must specify which exception(s) are applicable and provide detailed reasons to substantiate the exception(s).*

6/30/2023 ______________________ [signature] ______________________

*Date* *Authorized Signature & Title*

**PROPOSAL FORM 22: VENDOR CONTRACT AND SIGNATURE FORM**

The undersigned hereby proposes and agrees to furnish goods and/or services in strict compliance with the terms, specifications and conditions at the prices proposed within response unless noted in writing. The undersigned further certifies that he/she is an officer of the company and has authority to negotiate and bind the company named below and has not prepared this proposal in collusion with any other Respondent and that the contents of this proposal as to prices, terms or conditions of said proposal have not been communicated by the undersigned nor by any employee or agent to any person engaged in this type of business prior to the official opening of this proposal.

**VENDORS MUST SUBMIT THIS FORM COMPLETED AND SIGNED WITH THEIR RESPONSE TO BE CONSIDERED**

| | |
|---|---|
| Company name | Lobaki, Inc |
| Address | 736 S President Street #106, |
| City/State/Zip | Jackson, MS 39201 |
| Telephone No. | 601-624-5375 |
| Fax No. | n/a |
| Email address | Sanford@lobaki.com |
| Printed name | Sanford Moore |
| Position with company | Immersive Consultant |
| Authorized signature | Sanford Moore |

**Term of contract** ______**September 1, 2023**____**to** _____**August 31, 2026**______________

Unless otherwise stated, all contracts are for a period of three (3) years with an option to renew annually for an additional two (2) years if agreed to by Region 10 ESC. Vendor shall honor all administrative fees for any sales made based on the contract whether renewed or not.

_______________________________________________ ____________________

Region 10 ESC Authorized Agent Date

________________________________________

Print Name

**Equalis Group Contract Number** __________


Did you sign the vendor contract and signature form? **<u>If not, your Proposal will be rejected.</u>**

Region 10 will negotiate any exceptions and both parties will agree upon which exceptions will be accepted or altered before the Region 10 board votes to accept or reject the proposals.

# ATTACHMENT A – EQUALIS GROUP ADMINISTRATIVE AGREEMENT

**NOTE:** This agreement is provided as a model agreement which winning supplier will enter into upon award with Equalis Group. Respondents are asked not to respond with redlines for this model contract. Respondent should complete the Equalis Group Administration Agreement Declaration form found in section two of the Proposal Submission and Required Forms document. In this form, the respondent will need to indicate acceptance of these terms, or if they wish to negotiate.

THIS ADMINISTRATION AGREEMENT (this "**Agreement**"), effective as of Month Day, Year (the "**Effective Date**"), is entered into by and between Winning Supplier, ("**Winning Supplier**") and Equalis Group LLC, a Delaware limited liability company with its principal place of business at 5550 Granite Parkway, Suite 298, Plano, Texas 75024 ("**Equalis**"). Throughout this Agreement, Winning Supplier and Equalis are referred to interchangeably as in the singular "**Party**" or in the plural "**Parties.**"

## SECTION 1. RECITALS

**A.** Education Service Center, Region 10 ("**Region 10**") serves as a lead public agency (a "**Lead Public Agency**") for Equalis Group ("**Equalis Group**"), a national cooperative purchasing organization, by publicly procuring master group purchasing agreements for products and services to be made available to Equalis Group members ("**Equalis Group Member**" or "**Member**").

**B.** Region 10 issued request for proposal ("**RFP**") #Number on behalf of Region 10 and Equalis Group Members for definition of products and services solicited in the RFP ("**Products & Services**") and awarded a contract to Winning Supplier.

**C.** Region 10 and Winning Supplier entered into that certain master group purchasing agreement (the "**Master Agreement**") #contract number effective as of Month Day, Year to provide Products & Services to Equalis Group Members

**D.** The Master Agreement and this Agreement, together with all attachments, appendices, and exhibits hereto, constitutes the entire agreement between the Parties.

**E.** Equalis Group serves as the contract administrator of the Master Agreement on behalf of Region 10.

**F.** Equalis actively promotes Master Agreements to current and prospective Equalis Group Members (collectively "**Prospective Participants**") through a range of marketing, prospecting, and sales strategies, including, but not limitec to, marketing and sales collateral development, direct mail, web marketing, electronic communications, attendance at events, Winning Supplier sales representative training, and Winning Supplier field sales support (collectively, "**Equalis Services**") as more fully defined in **Appendix B**.

**G.** Any Prospective Participant who purchases Products & Services from Winning Supplier subject to the Master Agreement shall be considered a "**Program Participant**".

**H.** Winning Supplier desires to promote and expand its operations and increase the sales of its Products & Services to public sector, private sector, and non-profit organizations through Equalis Group.

# CERTIFICATE OF INTERESTED PARTIES

FORM 1295



Complete Nos. 1 - 4 and 6 if there are interested parties.
Complete Nos. 1, 2, 3, 5, and 6 if there are no interested parties.

**OFFICE USE ONLY**
**CERTIFICATION OF FILING**

1 **Name of business entity filing form, and the city, state and country of the business entity's place of business.**

Lobaki, Inc

Jackson, MS United States

2 **Name of governmental entity or state agency that is a party to the contract for which the form is being filed.**

Region 10 ESC

DRAFT

3 **Provide the identification number used by the governmental entity or state agency to track or identify the contract, and provide a description of the services, goods, or other property to be provided under the contract.**

RFP #R10-1157

Virtual Reality Hardware and Sofware services

| 4 Name of Interested Party | City, State, Country (place of business) | Nature of interest (check applicable) | |
|---|---|---|---|
| | | Controlling | Intermediary |
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5 **Check only if there is NO Interested Party.** [X]

6 **UNSWORN DECLARATION**

My name is Sanford Moore, and my date of birth is 05-30-1991.

My address is 2249 E. Northside Dr., Jackson, MS, 39211, USA.
(street) (city) (state) (zip code) (country)

I declare under penalty of perjury that the foregoing is true and correct.

Executed in Hinds County, State of MS, on the 30 day of June, 2023.
(month) (year)

Signature of authorized agent of contracting business entity
(Declarant)

***Testimonial from Neshoba County Schools:***

Our partnership with Lobaki has made such an impact throughout our career and technical education department. Students have been able to participate in career exploration, engage with immersive learning, and better understand the skills necessary in our area workforce. Implementation of VR has also allowed for enrichment across all curriculum content areas. Teachers can utilize VR to simulate experiences relevant to their curriculum. We are grateful for this partnership as we help to bring cutting edge experiences to our students across the school district.

As a person who works daily with VR, I cannot fathom having learned any other way than the Lobaki VR Academy. I was able to use it to get the skills needed to teach my VR Classes. Now that I have students in a VR setting, we also use it to teach them. Lobaki has done a tremendous job putting all the skills and information needed to get to work with VR and be successful at it. So glad we were introduced to Lobaki and do not think there is a better way of learning.

Don Regan | Business and Technology
Jackson Preparatory School
601.939.8612
dregan@jacksonprep.org

JACKSON PREP

our mission:
Jackson Preparatory School inspires and challenges students toward academic, athletic, and artistic excellence, instills personal integrity through biblical values, and equips students to pursue lives of distinction in service to society.

JACKSON PUBLIC SCHOOLS IMPLEMENT VIRTUAL REALITY DISTRICT WIDE WITH LOCAL JACKSON COMPANY LOBAKI

JACKSON, MS. FOR IMMEDIATE RELEASE (January 24, 2023) Jackson Public School District today announced its implementation of virtual reality technology into classrooms across the school system. This innovative learning tool is being embraced by schools across the country due to its benefits to the educational experience, including increased knowledge retention and reduced time to learn. With this technology, students will be able to experience hands-on learning in new ways, like going inside a plant cell or speaking to Civil Rights leaders as they tell their stories. Teachers are excited about the implementation of virtual reality and the accompanying teacher-focused resources provided by Lobaki, which allow for easy integration into their current required curriculum standards. “We have been interested in using virtual reality in our schools for quite some time now, as we are always looking to improve the educational experience,” says Dr. Rajeeni Scott, Executive Director of School Support for Jackson Public School District. “With the additional challenge of learning loss created by the COVID-19 pandemic, we knew it was time to implement this solution within our schools. After completing a national open bid process, Lobaki won the contract, due to their overall value, which includes pricing, content, installation, training, management systems, and support. As Mississippi’s only owned and operated virtual reality content creation company, the level of support from installation to training is unmatched. We know they aren’t going to drop off hardware and leave as other companies would – they are our next-door neighbors and fellow Mississippians. ”Lobaki shares in the excitement of this implementation with the district. “As one of the oldest and largest school systems in the state of Mississippi, Jackson Public School District’s decision to implement virtual reality technology stands out as one of the largest implementations in the United States to date,” says Amber Coeur, CEO of Lobaki. “We are honored to have been selected as JPSD’s virtual reality provider. We share in their desire to improve the lives of their scholars and take the responsibility seriously.”

**About Jackson Public School District**

Jackson Public Schools is the second-largest school district in Mississippi, serving nearly 19,000 scholars, representing more than 80 percent of school-aged children in the state's capital and only urban municipality. Jackson, Mississippi has about 170,000 residents in an area of 104 square miles. There are 7 high schools, 10 middle schools, 31 elementary schools, and 4 special program schools comprising the District's 52 school sites. These schools are divided into 7 feeder patterns based on the high school receiving the area's scholars.

**About Lobaki**

Lobaki is transforming the learning process and experience with virtual reality technology. Thousands of learners across the country use immersive experiences created by Lobaki to learn faster and retain more information longer. K-12 schools, Community Colleges, Universities, major corporations, governments, and non-profits are using Lobaki to create, implement, and deploy meaningful learning experiences that bring hands-on learning to an unmatched level. By using all the senses, learners receive real-time feedback that engrains learning better than traditional learning methods. Along with Lobaki’s assessments and data insights portal, educators and trainers have actionable information to improve learning outcomes, and training efficacy while community leaders create impactful stories to drive economic development and community engagement. Located in Jackson, Mississippi, Lobaki is committed to addressing the “brain drain” by creating technology jobs and recruiting from local institutions.

To learn more about Lobaki and their virtual technology solutions, visit www.lobaki.com.

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**Contact:**
**support@lobaki.co**m
1-855-7LOBAKI

# ProcessAR: An augmented reality-based tool to create in-situ procedural 2D/3D AR Instructions

**Subramanian Chidambaram**, School of Mechanical Engineering Purdue University, United States, schidamb@purdue.edu (mailto:schidamb@purdue.edu)
**Hank Huang**, School of Electrical and Computer Engineering Purdue University, United States, huang670@purdue.edu (mailto:huang670@purdue.edu)
**Fengming He**, School of Electrical and Computer Engineering Purdue University, United States, he418@purdue.edu (mailto:he418@purdue.edu)
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Augmented reality (AR) is an efficient form of delivering spatial information and has great potential for training workers. However, AR is still not widely used for such scenarios due to the technical skills and expertise required to create interactive AR content. We developed ProcessAR, an AR based system to develop 2D/3D content that captures subject matter expert s (SMEs) environment object interactions in situ. The design space for ProcessAR was identified from formative interviews with AR programming experts and SMEs, alongside a comparative design study with SMEs and novice users. To enable smooth workflows, ProcessAR locates and identifies different tools/objects through computer vision within the workspace when the author looks at them. We explored additional features such as embedding 2D videos with detected objects and user adaptive triggers. A final user evaluation comparing ProcessAR and a baseline AR authoring environment showed that, according to our qualitative questionnaire, users preferred ProcessAR.

**CCS Concepts:** • **Human-centered computing** → **Mixed / augmented reality**;

**Keywords:** Augmented Reality; Authoring ; Tutorials; Computer Vision

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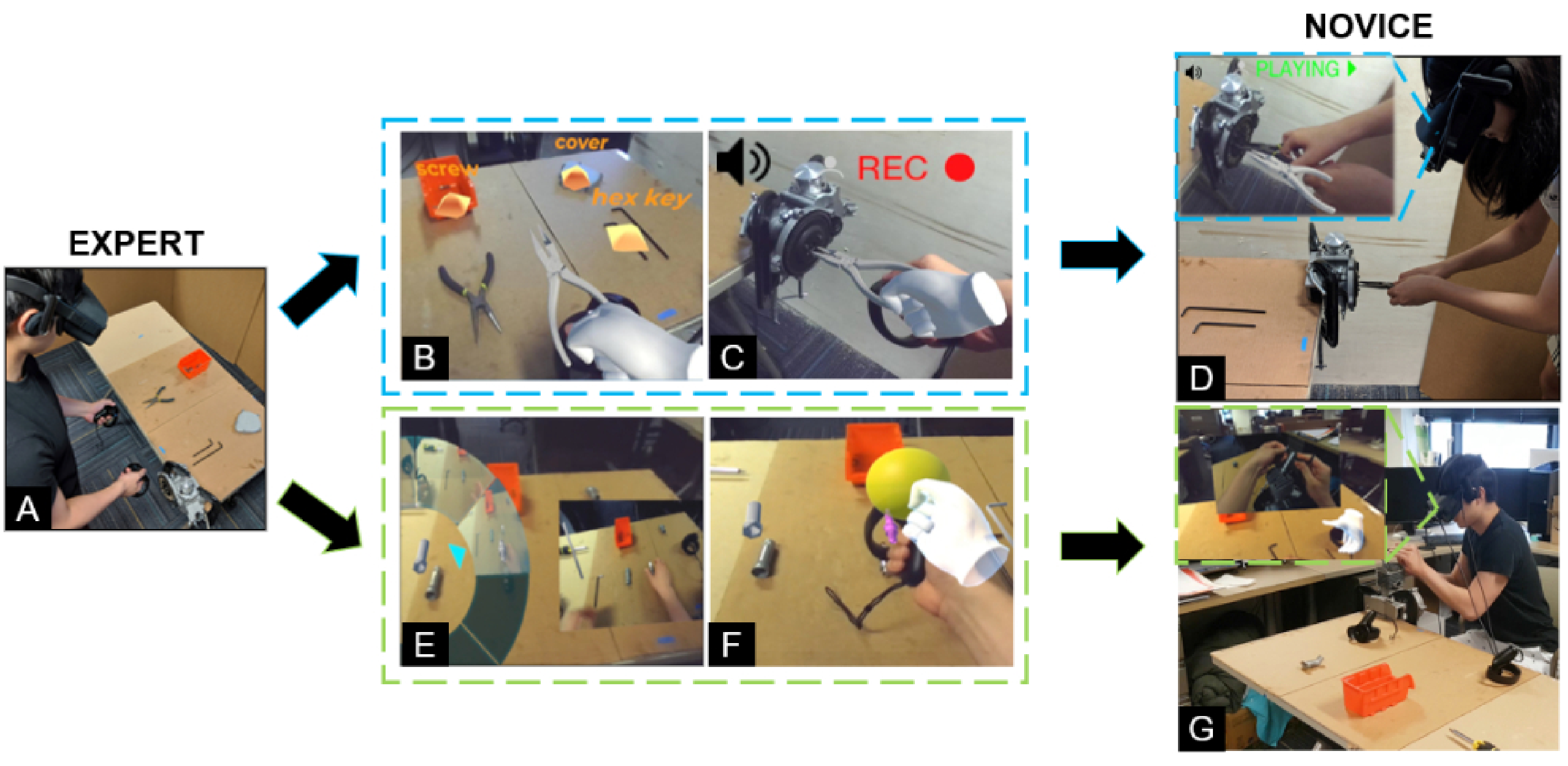


**Figure 1: A Subject Matter Expert (SME) creating AR instructions in-situ within AR (Fig A). ProcessAR detects the objects in the real world with computer vision and spawns the corresponding virtual tool (Fig B). The SME moves the virtual tools in real space, and the motion of this virtual tool is recorded along with audio to create an AR instructional checkpoint (Fig C). Embedding captured 2D videos within the AR work environment (Fig E & F). The created AR content in 3D (Fig D) and 2D (Fig G) is transferred to the novice user, who then performs the task.**

## 1 INTRODUCTION

Spatial ability has been defined as "the ability to generate, retain, retrieve, and transform well-structured visual images in spatial relations among objects or in space" [36, 68]. Such spatial abilities play a critical role in our everyday lives and also at work, in tasks such as assembly, tool-manipulation, and navigation. Augmented reality (AR) is a technology that superimposes computer-generated virtual models in real-time on a user's view of the real world. AR has been shown to be a reliable mode of instructional training, improving speed and reliability, minimizing errors, and reducing the cognitive load of the user [3, 37, 41], especially for spatially distributed instructions.

Many tasks in an industrial or manufacturing environment are spatial in nature. Critically, in many of these industrial sectors, companies are unable to keep up with getting new employees trained as fast as experienced people are retiring [13]. Often called the "*skills-gap*", the resulting problem has reduced the supply of well-trained workers for the manufacturing industry, which is widely recognized as a critical element to be addressed by future work-related research [29]. Currently there are three widely popular modalities of training employees in spatial tasks: one-on-one, paper/sketch-based, and video-based instruction, with AR being explored as a potential fourth alternative. The current approaches to instruction creation require capturing user actions through written instructions, sketches, pictures, and videos from the real world and require extensive editing to produce usable instructions. Only a few large corporations such as Boeing [5] and Lockheed [38] have been able to afford the widespread use of AR to train their workforce. One of the primary reasons for the lack of widespread use of AR can be attributed to the complexity and technical knowledge required to develop AR instructional systems. For work instructions, current authoring tools require AR programming experts working in tandem with subject matter experts (SMEs) to capture the relevant knowledge and skills.

AR applications often have to consider the location of the virtual objects relative to the variable environment, increasing the complexity of creating AR content [16]. In addition, knowledge of 3D modelling and animation are required if usable instruction sets are to be created by the author [41]. This is a tedious, time-consuming, expertise-intensive activity. It involves multi-person collaboration, which is not only costly but also a major impediment to AR content creation and widespread success of AR itself. However, by utilizing the unique position that AR occupies on the spectrum from virtual to reality, i.e., right in the middle between the two extremes, our work addresses a major part of the challenge of AR instruction creation, towards eventually removing such impediments.

We present ProcessAR, an AR-based system to develop 2D and 3D procedural instruction for asynchronous AR consumption by capturing user/expert actions. In this work our goal is to empower SMEs to directly author AR instructions, by reducing the complexity and easing the load required for creating AR content. We achieve this by using principles similar to programming by demonstration (PbD) [33]. Instead of performing the actions in a entirely virtual or entirely real environment, the expert authors demonstrate the actions by manipulating virtual tools or parts–identified by computer vision–overlaid onto the physical world.

Currently, many industries still use one-on-one training to train their employees for tasks such as machine operation and manufacturing. Although reliable, this mode of training is inefficient in terms of time, cost, and scalability. One-on-one training requires active feedback and communication between SMEs and novices. Past work such as Loki [67], Oda et al. [46], and Elvezio et al. [17] explored AR/VR based interfaces for remote one-on-one training in this area. However, unlike the synchronous nature of such instructions and training, ProcessAR explores the asynchronous nature of instructions, which relies on the ability to record and replay instructions at any time without the constant presence of an SME. Thus, ProcessAR requires a different set of interaction modalities relative to [46, 67].

By merging recent advancement in computer vision/AI algorithms such as You Only Look Once (YOLO) v1 [53], v2 [54], and v3 [55], the system does not need to know the a-priori position of virtual objects in the physical space, enabling the system to better and directly understand the current state of the environment. The user just looks at all the tools once in the beginning of the workflow, which enables the system to automatically identify the corresponding virtual tools to be overlaid. The virtual overlay enables the system then to automatically match the corresponding virtual objects with the real ones, eliminating the need for significant preprocessing, as required by previous work, such as AREDA [4], Fiorentino et al. [18], or Ong et al. [47]. Together with the Oculus Rift hardware, a ZED Mini [63] depth camera is used in our system to robustly determine the location of the tools/objects and eliminates the need for visual markers, unlike previous work such as Oda et al. [46].

ProcessAR also eliminates the need for transitioning between different modalities and interfaces to create and edit a video or a paper instruction. Working with SME spatial demonstrations and actions using virtual tools, ProcessAR directly enables authors to create AR content within an AR environment. Our aim with this work is to empower SMEs to create their own instructions through natural interactions within the environment and without the large time requirements. In this way, we are paving the way towards making AR content creation more accessible and intuitive for the community.

The main contributions of our work are:

- Developed a workflow which enables SMEs to asynchronously create AR content (3D and 2D) and simply through demonstration. More importantly, our workflow enables retention of tool-manipulation trajectories, in the form of positional and rotation information, which are key to successfully train new workers in complex spatio-temporal tasks.
- Developed an AR-based authoring platform which empowers SMEs to become content creators without technical AR authoring know-how.
- Comparative user evaluation of the system, with two set of studies providing insights on the usability of our system to create AR instructions, in comparison to traditional asynchronous instructional media.

# 2 RELATED WORK

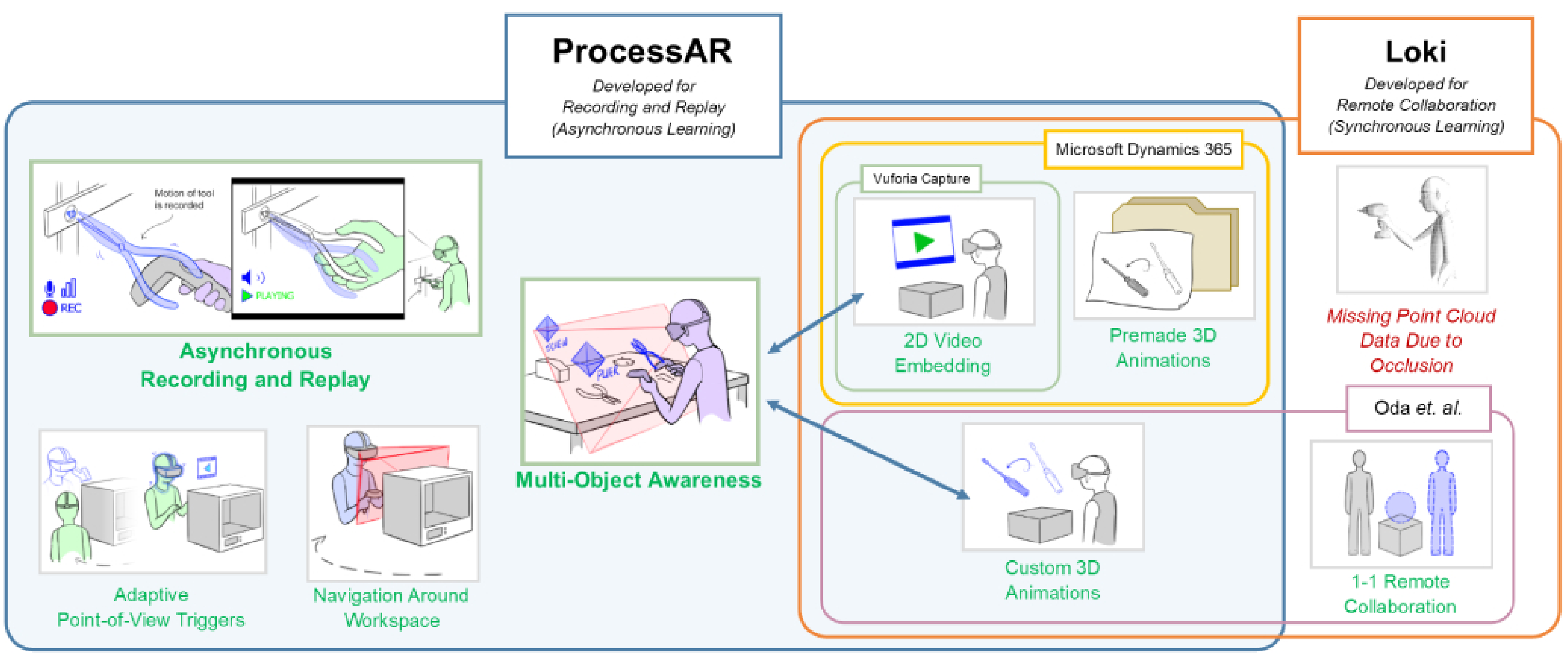


**Figure 2: Comparison of ProcessAR with respect to different dimensions of the design space occupied by various existing AR authoring system. This figure visualizes the various features of each system, highlighting both elements that are shared and unique to each system.**

## 2.1 AR for Assembly Instruction

For nearly two decades, mechanical assembly operations have been of particular interest to AR researchers [52, 59]. Much previous work [4, 20, 24, 26, 47, 65] has proposed different approaches to solve the problem of authoring assembly instructions. For simple assembly operations such as Duplo block [24] or model vise [4] assembly, visually portraying the initial and final state of an object before and after assembly operation might be enough. But for more complex tasks, including tool manipulation, where the same tool could be used in different orientations (such as an Allen key), or illustrating the speed or posture require to perform different operations, merely stating the initial and final state for tasks is insufficient. For successful assembly instructions of such complex tasks, the instruction set must deliver information of tool/object movement and orientation, both with respect to time within the work space. We call this "spatio-temporal instructions". ProcessAR supports embodied authoring, which leverages the spatial and temporal nature of object manipulations and user interactions with them, while simultaneously providing the ability to view the instruction from multiple perspectives (3D authoring). This is a key contribution of our work, because previous work has failed to capture position and orientation of tools, thus disregarding crucial information for training workers in complex spatial tasks. In this context, ProcessAR plays a crucial role in showing "how" to use tools, which has not being addressed by prior work [19, 39, 62, 69]. This is done by enabling the author to demonstrate tool interaction with the aid of a virtual tool, and captures such interaction for replay at a later time.

## 2.2 3D authoring

Although not designed for asynchronous learning environments, previous projects [46, 67] are capable of representing spatio-temporal 3D AR animation. However, these tools leverage only remote training and synchronous learning instead of an asynchronous modality–which requires a live instructor and therefore does not scale to many users. While many features, such as using virtual replicas for demonstration [46], embedding 2D content [39, 49], and point-of-view indication [64] have been explored and studied independently in the past, such as in Cao et al. [8], their synthesis has not been validated nor had insights been drawn from an integrated 2D & 3D AR in-situ authoring platform such as ProcessAR. Thus a thorough study of such an integrated system–as in ProcessAR–is necessary for this approach to be validated and to provide value to the HCI community. ProcessAR enables an integrated 3D/2D AR authoring environment, which presents a unique set of previously unexplored opportunities and challenges for tool interaction and manipulation.

Ong et al. [47] and Radkowski [51] present workflows that allow the user to use their bare hands to interact with virtual objects. While these preserve the natural and intuitive interactions our work desires to mimic, they rely on artificial markers placed around the hands. These markers are susceptible to occlusion and subsequent loss of tracking, preventing a robust implementation required for spatio-temporal tasks, especially in the workplace. Several examples such as AREDA [4, 46, 56] and Ha et al. [25] use line-of-sight markers, which can disrupt the task to be demonstrated. These approaches require significant pre-processing and are susceptible to occlusion by hands and other objects caused by limitations of computer vision systems [34], which is a major problem for the capture of smooth user interaction. ProcessAR is novel in that it preserves natural interaction by allowing the SME to create content through demonstration and bypasses occlusion issues by matching the physical objects with their virtual counterparts at all times.

## 2.3 AR through Motion Capture

Teach me how! [20] presents a PbD based AR authoring system that utilizes a Kinect depth sensor and a projector to understand and augment assembly for (only) 2D AR instructions. DemoDraw [11] is a system that translates speech and 3D joint motion into a series of key pose demonstrations and illustrations. YouMove [1] allows users to record and learn physical movement sequences, primarily for dance. Physio@Home [66] is a system that guides people through pre-recorded physiotherapy exercises using real time visual guides and multi-camera views. Another approach [32] is limited to capturing body motions. ProtoAR [43] enables users to create AR content with rapid physical prototyping using paper and Play-Doh. ProtoAR provides a new mobile cross-device multi-layer authoring and interactive capture tools to generate mobile screens and AR overlays from paper sketches, and quasi-3D content from 360-degree captures of clay models. All these approaches are limited to capturing and rendering body motion tasks, and are not concerned with hand-held manipulation of tools, which is essential for training in an industrial environment.

## 2.4 AR through 2D Video

Several other past systems in this space, such as PTC's Vuforia Capture [49] or [9], only capture 2D video, to be embedded later over the real world, and require significant post-processing, which can often be limiting and lose context, as described above. Similarly, and unlike ProcessAR, other approaches [10, 31] are limited to 2D video for instructional delivery and do not involve AR. The idea of obtaining AR instructions from video have been explored previously in Mohr et al. [41] and TutAR [16]. Such work is limited to generating AR for applications only to situations where a source video is available. Also, Mohr et al. [41] deals only with surface contact, while TutAR [16] requires manual user annotation during post-processing of the creation process.

Instead of providing 3D instructions, such as Goto et al. [23], Petersen et al. [48], multiple systems directly embed 2D videos into the environment. "YouDo, I-learn" [14] records object usage and replays the recorded video upon a gaze-based trigger. Due to the 2D nature of the videos, the separation between the screen and the location of the task leads to a higher mental effort for hand eye coordination [57].

With purely video-based knowledge sharing, users often miss the spatial nature of task instructions and can lack temporal context. To supply the missing information, video instructions often must be captured from multiple perspectives, then edited together for effective instruction. This requires time and expertise in video editing and transforming content between software tools. Ego-centric videos suffer from the same limitation. In contrast, well-authored 3D animated AR instructions created through ProcessAR are able to holistically and directly capture 3D tool operation, without requiring multiple perspectives. This reduces development time while maintaining quality of instructions.

## 2.5 AR through 2D Interfaces

Mohr et al. [40] explored the idea of extracting AR instructions from paper-based technical manuals but was only capable of generating tutorials from instructions with straight motions and where the source was available. Quick and easy editing or modifying instructions is not possible with their approach. Recent work Saquib et al. [57] presented an AR authoring environment to trigger a 2D augmented video performance. This work is currently only capable of delivering 2D AR animations which have been pre-programmed by the user in a 2D interface.

Unlike previous work such as [27, 39, 42, 49] which rely on post-processing through a PC app, ProcessAR does not rely on external processing tools. The elimination of additional pre- and post-processing steps supports faster content authoring. Compared to traditional methods, creating AR content within the ProcessAR platform enables expert users in a manufacturing environment to create 3D AR content quickly, more naturally, and intuitively.

# 3 DESIGN SPACE EXPLORATION

After exploring the past literature in this space from a research perspective, we interviewed 12 expert manufactures, educators, and AR programmers to identify the real world constraints that they currently face for large scale deployment of AR.

## 3.1 Formative Interview

The first interviewees were six subject experts in the area of manufacturing working for global firms, specializing in the manufacturing of trucks, electronics, telecommunication equipment, pharmaceutical machines, automobiles and engines. Additionally, we interviewed three educators in the area of manufacturing and three AR programmers. They shared their past experiences, current constraints and industry practices they face in their industry regarding training new employees, and what they expect from a product. We distilled and present the most relevant information here, which along with a preliminary design study to understand the users, were used to set a group of design goals.

The experts defined that *Spatial Tasks* in manufacturing environments usually are a series of diverse human-tooling and human-machine interaction tasks happening at various locations in a large spatial environment. They argued that although multiple tutoring modalities have been adopted in human worker training, it remains challenging to author tutorials for Spatial Tasks. Currently one of the most reliable ways to instruct someone is via one-on-one learning. However, they feel it severely limits their ability to grow or replace their quickly aging workforce and deal with high turn-over rates. The cost of scaling up one-on-one training to the required levels is much higher than most companies can afford. Hence, it is key to eliminate the reliance on the constant presence of the expert (i.e., a synchronous process) during training. Thus, an asynchronous system became an important part of our goals.

Other comments made by the experts which also supported the design of ProcessAR were:

- Another challenge for Spatial Task is the large space that has to be navigated between unit sub-tasks. That is, a user has to move within the work space.
- During training the experts emphasize a clean work environment, without clutter. As safety is an overarching requirement the employer would like to encourage this as a core value.
- A typical Spatial Task includes unit sub-tasks that hold significantly different attributes resulting in different requirements from a human worker. Thus a system that procedurally breaks down a task into sub tasks with vastly different attributes was explored.

## 3.2 Preliminary design study

To better understand the users interaction and strengths and weakness of different instructional media, we asked Expert users to create instructions for three different Spatial Tasks. We asked the users to create instructions as (1) paper/sketch based instructions, (2) videos, and (3) AR instructions. Initially we did consider one-on-one instructions; however, based on the formative interviews, where experts identified one-on-one to be highly inefficient in terms of time cost, we decided to exclude one-on-one instruction and to perform the study with the three other modes of instructional transfer to arrive at a fair comparison.

For this comparison we built a preliminary AR authoring system (from here on referred to as “baseline”) and compared it to the others options in terms of capability, usability, and ease-of-use with two lab-based studies. This baseline AR authoring system contained features described in section 4.4 and 4.5.1 of this paper. All other features where added based on design goals (section 3.4) obtained as a result of the observation from this preliminary design study and the formative interview described in section 3.1.

The first study was conducted with ten expert users (EUs) (all male) (see table 1), with expertise in spatial tasks such as Engine assembly, Bike repair, and Shelf installation to create procedural instructions. These tasks were chosen due to the spatial and procedural nature of the tasks. The engine assembly experts were recruited from the Formula SAE [30] team. Two of the bike experts were from a local bike club and the other expert had experience working at a bike repair store. The experts used for shelf installation were woodworking hobbyists. To validate the usability of instructions created, a second study was conducted on 16 (4 female, 12 male) novice users.


**Figure 3: Expert Users creating procedural instructions for assembling an engine (A), repairing a bike (B), and installing a shelf (C).**

**User Study 1:** Due to the embodied nature of AR instruction creation, we hypothesized that the time to create AR content would be lower compared to the other two modes, even if the EUs did not have AR experience prior to the study. We also believe that the system would lower the mental effort while authoring. The task for the experts was to assemble a 80cc gasoline motorbike engine (Refer fig.3 A), to remove and reinstall the front wheel of a bicycle (refer fig.3 B), and to install a shelf to a well-secured mock wall (refer fig.3 C), respectively. All EUs were paid a sum of US $60.

The EUs were first briefed about the study and asked to fill a pre-survey questionnaire. All EUs were familiar with tools such as Microsoft Word and PowerPoint. Two EUs reported having created video instructions before but not for this particular task. Three EUs reported having used VR HMDs for playing games. During the study the EUs were asked to create instructions in all three modes of instructional transfer (instruction mode was manipulated within-subjects). The study was split into three sessions, each of which lasted for 2 hours, conducted on different days to prevent fatigue.

**Session 1:** The EUs were asked to create paper-based instructions for the tasks. They were provided access to sketching tools, such as Autodesk Sketchbook [60] or Inkscape [28], and a Microsoft Surface Pro 6. They were also provided with a Pixel 3, for capturing images, a bogen 3036 tripod with a phone mount, a computer with common document editing tools such as Microsoft Word, PowerPoint, and GIMP [21]. All users were given the choice to receive 25 minutes of training on any of the above mentioned tools. None of the users utilized the optional training period citing familiarity with the tools of their choice. Hence session 1 was conducted without any training. All EUs worked alone with the help of the tripod for a different point of view, depending on the situation.

**Session 2:** The EUs were asked to create an instruction video. They were given access to the video editor Camtasia 9 [7]. All EUs underwent a 25 minute tutorial on the basic features of the video editor. As part of the training, all the EUs were asked to edit a sample to confirm their learning of the tool. A microphone, the Pixel 3, and tripod from session 1 were again provided to the users for video capture to create the instructions. Completion time (CT) was recorded for each user while they recorded the video, transferred the videos to a computer, and finally during editing. EU8 and EU9 recorded voice simultaneously and the rest of the users recorded their voice post-hoc and added them to the video later.

**Session 3:** The EUs were asked to create AR instructions. All users were given a 25 minute training prior to the task. The users were first exposed to Oculus Touch Basics [44]. Then, in order to train them to become familiar with interacting with virtual tools, such as grabbing and re-orienting, the users played a VR app called Wrench: Engine Building Demo [44] for 5 minutes. Finally, the users were exposed to ProcessAR for 15 mins as part of the training. For this, a one-on-one demo was provided on how to interact with the system. The trained users were then asked to create AR instructions using ProcessAR for the specific task of their expertise. Each of their demonstrations were then saved in the form of checkpoints (explained in section “Virtual Object Recording”).

Post Survey: After the three sessions were complete, the users were asked to complete a questionnaire containing a system usability survey [6] and a few questions on their preferences among the three modalities. They were also asked to rank-order the three modalities in terms of preference. Additionally, every user was asked to provide the reasoning behind their rank ordering and preferences. An equal number of uses rated using AR and video as their first preference, with Paper instructions being rated as the least preferred.

**Table 1:** Expert User's background information along with SUS Scores for the AR mode.

| User | Years of | Expertise | SUS |
|---|---|---|---|
| **Id** | **experience/Backgrounds** | | |
| 1 | 4-FSAE & Engine | Engine | 82.5 |
| 2 | 7-FSAE & Engine | Engine | 85 |
| 3 | 6-FSAE & Engine | Engine | 70 |
| 4 | 5-FSAE & Engine | Engine | 80 |
| 5 | 15-Assembly | Engine | 70 |
| 6 | 8-Bike Club | Bike | 67.5 |
| 7 | 8-Bike Club | Bike | 82.5 |
| 8 | 3-Bike Club | Bike | 67.5 |
| 9 | 11-Hobbyist | Shelf | 52.5 |
| 10 | 9-Hobbyist | Shelf | 75 |
| | | | **Avg-**73.25 |

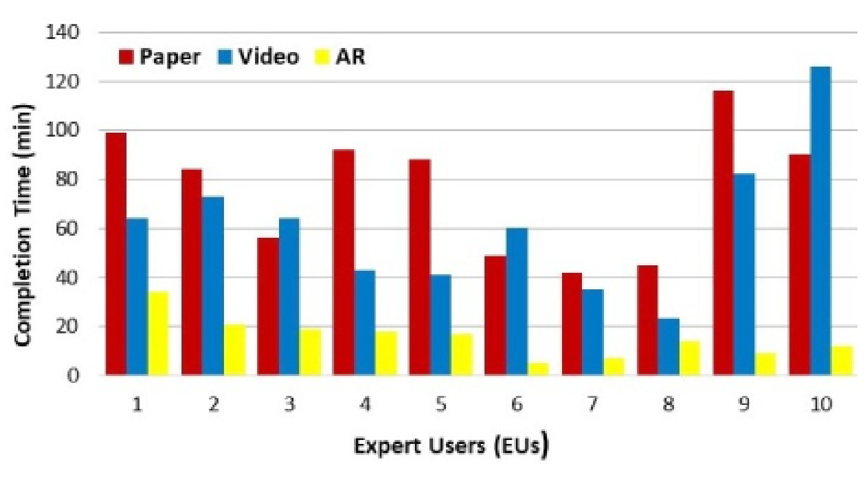


**Figure 4: Authoring time to create various modes of instructions.**

**User Study 2:** The purpose of study 2 was to validate the usability of the instructions what were created in Study 1. To validate the usability of the created instructions, we invited 16 Novice Users (NUs) to be part of a second study. The objective for the NUs was to follow the instruction set given to them and to complete the task. Every NU performed all three tasks but utilized three different modes of instructions to complete the tasks. To prevent the NUs from learning aspects of the tasks, we used the three different modes of instructions for the three different tasks. We monitored the NUs and recorded successes/failures of each task and sub-task.

## 3.3 Observations and results

The results from the user studies provide evidence for the benefits that in-situ AR authoring can provide. The timing data for content creation provides clear evidence that, in all cases, the amount of time that the experts required for authoring instructions was reduced compared to the other alternatives (refer fig. 4). The ratio of reduction depends on the complexity of the task. The novice success percentages from study 2 corroborate the fact that all instructions created by the experts are indeed usable. The data did not reveal any significant difference in the ability to complete the task among the three modalities. All modes have a success rate higher than 85% (mean= 96.55, SD= 5.57), see the supplementary material. This high success rate is seen as evidence that all generated instructions can be considered to be usable. Additional observations of the NUs for sub-tasks specific to tool manipulation, such as the use of a hex key and combination wrenches, demonstrated that no mistakes were made when using the AR instructions. One of the NUs made the following comment: “I think AR was very cool. It even showed me where to put that thing [the hex key] and even how to turn it”. Comparatively, there were at least two recorded cases of errors in tool usage with the paper instructions. We see this as evidence that AR instructions created within AR (an in-situ system) can directly have an impact in terms of error reduction. This can be corroborated if more complicated spatial tasks with a larger user group were to be conducted.

Overall we received positive feedback for ProcessAR. The average SUS score for ProcessAR was 73.25 (table 1), which implies that the system is definitely usable, but that there is room for improvement. One of the EUs commented during the post-study survey regarding his preference for video over AR: “I would [have] liked to have used a video at the end to assemble the brake wire back into the housing. It is very precise and I wish I could have just capture[d] while I was doing it instead of showing [it] using the virtual model. I would have been able to feel it, instead of being shaky”. Although it is more work intensive and tedious to create videos, they are capable of capturing the finer details, also in motions. Thus we believe that combining the strengths of an in-situ motion capturing AR systems, as our baseline system, and the ability of embedding videos could be a powerful combination, encouraging us to think in terms of adding multi-media AR support.

Also, we observed that some NUs were not looking at the region of interest where the AR instructions were rendered, at least at the beginning of a check point. This led us to explore two additional features that could guide the user to a point of view of interest and integrate such a feature into our current baseline system, namely adaptive point of view trigger and navigation around the work space (section 4.5.4).

Based on the outcomes of our work, coupled with the outcomes from the formative interviews, and results from the literature, we set the following design goals and started development of ProcessAR with the preliminary AR system as a starting point.

## 3.4 Design Goals

- **D1. Spatial Movement and Spatial Awareness** The importance of spatial movement and awareness is evident from the results of our preliminary design study, the literature, and expert interviews. We define spatial movement as the ability to understand how to interact with tools and objects within the work space, as well as how these tools and objects should interact with each other for successful completion of the task. For example, during an assembly task such as an engine block assembly, the sequence of parts to be assembled have to be strictly adhered to. Failing to follow this sequence will lead to failure of task completion. It is also important to address how the novice user themselves navigate within the work space. As the instructional medium of AR is rendered close to the area of interest, the instructions are rendered at different location within the work space. It is important that the system is aware of the next target location of instructional delivery and indicates it to the user.
- **D2. Multimedia Support** From the comments made by the EUs, we realized the importance of supporting a 2D-based medium, such as embedding 2D videos within the AR space to capture the advantages of both AR and Video. Thus, a system capable of supporting multiple media was explored. The importance of multimedia instruction is often disregarded in favour of focusing only on one type of medium, thus wasting the opportunity of providing multiple valuable options to content creators. For example, multimedia instructions would also enable SMEs to create 2D instructions when clear 3D animations cannot easily be recorded (e.g., in the case of animating flexible materials–wires and cables).
- **D3. Perspective Awareness** As observed in the preliminary study, NUs had trouble identifying the location of the next instruction within the workspace (e.g., if an instruction first takes place at the 12 o'clock position, while the next step has to take place at the 8 o'clock position). This led to users rewinding the instructions multiple times before they were able to catch up with the spatially distributed nature of the tasks. We address this problem in the next iteration of the baseline system (i.e., in ProcessAR).
- **D4. Asynchronous System** From the formative expert interviews and the literature, one of the major limitations of the current reliable instruction transfer system (i.e., one-on-one instruction) was identified to be the synchronicity of this process. As in the aforementioned case, a constant presence of the SME is required for a successful skill-transfer. Although asynchronous media, such as video and paper instructions, already exist, the immersive nature of spatial tasks is limited with these media and lacks spatial awareness. As such, AR is a useful medium to deliver such information, due to its immersion and its ability for object tracking and superposition of content. Synchronous AR systems for learning spatial tasks in remote interactions have be been explored (e.g., by Loki [67] and Oda et al. [46]) within controlled setups. Generalizing such approaches, we fill the research gap of asynchronous AR instruction with ProcessAR. The greatest difficulty with synchronous systems are the cost and scalability in training a larger group of novice users. Both of these problems are avoided with an asynchronous system.

# 4 PROCESSAR OVERVIEW

ProcessAR is an AR authoring system designed to improve the tutorial creation process of spatio-temporal tasks through leveraging the advantages of the combination of a system that recognizes important parts of the environment together with virtual object rendering. The system is operated first by an expert author that composes the tutorial and then later by a novice user that consumes it. We implemented a prototype to support this process which incorporates three phases: 1) visually scanning the surrounding physical tools once to locate them and later render the corresponding virtual models, 2) recording/editing expert motions with the virtual tools for the procedural task together with their vocal instructions, and 3) a novice consuming the tutorial in the form of 3D animations or embedded 2D videos and the expert's voice instructions.

## 4.1 Architecture

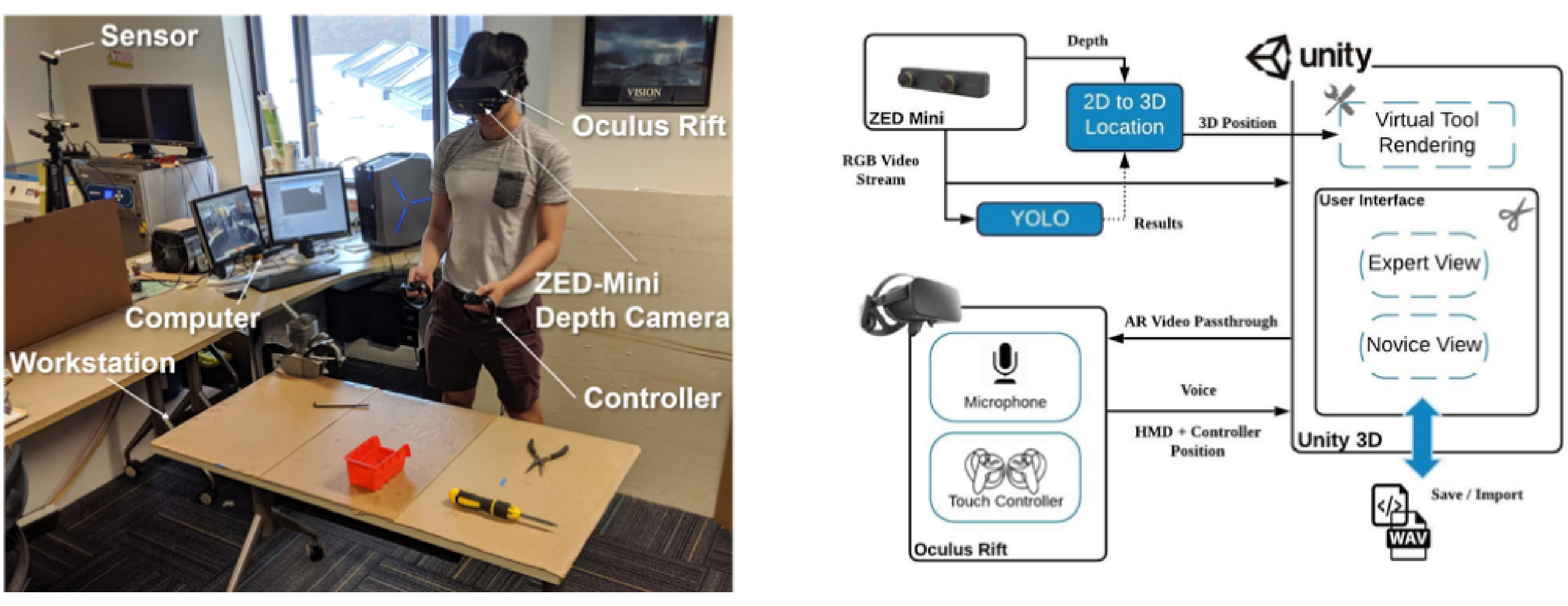


**Figure 5: (left) Hardware setup for implementation. The modified Oculus Rift VR head-mounted display supports video pass-through with a ZED mini depth camera to work in AR mode. Oculus touch controllers are tracked using external sensors. (right) System Architecture: The workspace is observed by the ZED mini depth camera, from which a 2D video feed is sent into Unity 3D to render an AR environment.**

ProcessAR was deployed using an Oculus Rift HMD with a ZED Mini camera for AR pass-through attached, yet we also point out that ProcessAR is also capable of running on more modern headsets such as the Rift S and the Quest with a PC VR-compatible Oculus link. The AR system is powered by a gaming desktop computer with a Nvidia GeForce GTX 2080 Ti GPU and an Intel i7-9700K CPU. Our tracking setup consists of three Oculus tracking sensors in the environment as depicted in figure 5 (left). To minimize headset and controller occlusion in AR, two sensors were mounted on tripods, 2m above the floor, facing down and one sensor on the floor facing up. We developed the system with Unity3D, which runs AR video passthrough and object detection in real time. The egocentric AR view rendering is implemented via the ZED-Unity plugin [63], where camera frames and depth data are relayed from the ZED-Mini to a Unity3D program and displayed through the HMD at 60 frames per second (FPS). We used the OpenCV for Unity plugin [61] to deploy YOLO and perform computer vision computations all within Unity3D.

At runtime, a copy of each camera frame is pre-processed and fed to YOLO for real time object detection in Unity. Once an object is detected, its 2D vector positions are combined with depth-data from the ZED Mini to compute the corresponding 3D position, similar to the concept of a pinhole camera, which is then used to overlay virtual objects on top of the actual ones.

To allow interaction with virtual replicas of detected objects, we used the virtual hand representations that were bound to the Oculus controllers via the Unity Oculus SDK [45]. Using Unity, we also deployed a virtual control panel to allow users to monitor and edit their spatial task authoring process as well as the activation of object detection. A virtual laser pointer served as the main means to interact with the panel by tapping on a controller button.

## 4.2 Object Recognition

Real-time object recognition is essential to create responsive interactions between the user and the virtual replicas of objects in the environment. For this reason, we chose YOLO v3 [55] for object detection, also due to its speed and robustness. To perform object detection, we created our own image data set to train the model [1], today a standard method for machine learning.

To avoid the labour-intensive task of training objects, we relied on past research in this space. For each object, we collected approximately 2000 images using the method mentioned in LabelAR [35]. Specifically, we placed virtual 3D bounding boxes around the objects in AR and recorded the images from the ZED stereo camera. The 3D bounding boxes are projected onto images as 2D labels. The labeled data set were then trained, simplifying the workload.

During runtime, when the targeted objects come into the ZED Mini's FOV, ProcessAR recognizes the objects and provides detection information, which are the object's class and 2D bounding box. The results are processed in the background and the exact 3D location is generated based on a simple pinhole camera model. Once the 3D position is computed, ProcessAR renders a prefabricated computer-aided design (CAD) model corresponding to the detected tool object pulled from a repository within Unity for the user to manipulate.

Like YOLO, many other objection detection models visualize results by continuously drawing labeled bounding boxes. This may be suitable for video streams, but can be problematic in 3D space. Not only do bounding boxes lack spatial information, but it can be very computationally taxing to render a new virtual object based on the position detected by YOLO for every frame. To handle this issue, we implemented two methods: a virtual placeholder and training object substitution.

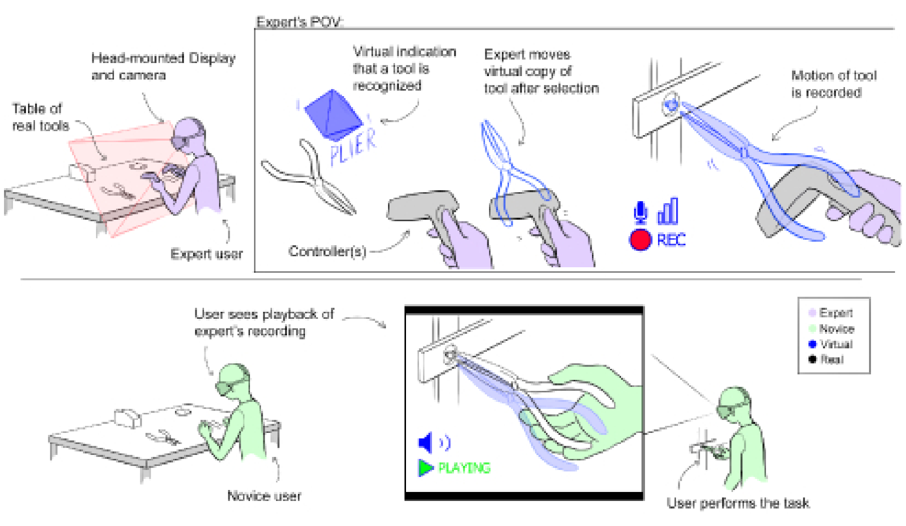


**Figure 6: First, Expert Users visually scan the set of tools available within their work space once. Upon recognition, virtual models of the tools and objects are rendered from the repository and can then be controlled with the aid of the controller. This enables the experts to record instructions along with voice instructions, which can then both be replayed for novice users later.**

## 4.3 Virtual Repository

As mentioned above, upon detection of an real object, a virtual model is rendered into the scene as an means for authors to create the instructions. However, this feature relies on existence of a pre-made virtual model repository to use of ProcessAR.

We used large CAD repositories, such as GrabCAD and TraceParts, to find pre-existing virtual models for our application. Also, it is standard practice today for stock part manufacturers (McMaster Carr) to release CAD models of their catalog. Hence, our reliance on pre-made models for standard parts is not unreasonable, especially in manufacturing, the main target application domain for ProcessAR. Custom parts can be created with additional effort through 3D scanning tools such as Qlone [50], Cognex [12] and display.land [15]. To support these needs, authors are provided with the ability to add their own repository and trained object detection data sets inside ProcessAR.

## 4.4 Visualization

Our approach of using a virtual placeholder leverages virtual object rendering. Instead of directly superimposing the CAD model on the physical tool upon detection, we generate a virtual marker with a tool label (orange diamond; figure 1 fig B) that is only replaced by the actual CAD model upon contact with the user's controller. The virtual marker has a preconfigured lifetime, which self-destructs after a certain amount of time if left untouched, thus prompting the system to re-detect the object until the user selects the correct targeted virtual tool. Once the user has made a tool selection, the system replaces the placeholder with a CAD model by searching an internal CAD database for a match corresponding to the tool's label. This approach addresses situations where temporarily inaccurate detection causes confusion with mismatched overlays of the (wrong) virtual model on a physical object.

To compensate for the difficulty of recognizing small objects, we physically grouped such objects of identical class into plastic containers, which are easier to recognize and train, and substituted the training data with the container images while keeping the same label. For example, a small screw is an object that tends to have a low training accuracy, so we grouped multiple screws in a bin and trained the bin instead. This approach reduced the difficulty of model training without posing additional distractions to the user, because small component objects placed in containers are (very) common in the context of the task. We are aware that some procedural tasks demand multiple instances of expendable objects, such as a bins of screws or two shelf brackets and multiple wood screws for installing a shelf on a wall. However, rendering all instances at once could cause confusion and generate visual clutter in the virtual space. We overcome this problem by allowing these specific virtual objects to self-duplicate at their initially rendered position after being grabbed by the user's controller. Meanwhile, reusable tools such as screwdrivers and drills were configured to only render once.

## 4.5 Authoring

*4.5.1 3D Animation. Virtual Object Recording:* Once a required tool or object is correctly identified, located, and initialized, the authoring user can interact with the virtual tool and demonstrate the "intended action" they wish to perform with the tool. This demonstration can be recorded according to the needs of the spatial task by grabbing virtual objects using the Oculus controller. (refer figure 6) The recording is achieved with a script to store the three translational coordinates for the position, four quaternion coordinates for the orientation, and corresponding time stamps. The amount of data and the difference in time between each data point varies based on frame rate of the system. The recording process is initiated with a button trigger only when the user's virtual hands are manipulating the virtual tool. This constraint was added to prevent unintended recording of multiple objects. The motion of the tool is still recorded as long as the user remains within the recording mode, which in turn enables the user to adjust and reposition the virtual tool if needed. Each recording is a self-contained unit called a checkpoint. Each checkpoint contains one 3D animation corresponding to a virtual tool. To clarify the authoring workflow, the author of the AR instruction has to interact with the virtual tool and demonstrate the action to be recorded. Then they have to pick up the real tool and perform the real action before moving to the next step.

*Voice Recording:* Aside from the instructional motion capture, ProcessAR also enables the user to perform voice recordings for the purpose of clarifying tasks or to explain possible error cases. This feature allows users to use voice-over during instruction capture, both for object manipulation and video creation. After each recording, an audio file is saved (in WAV format) for later use when deploying the instructions to a novice. Finally, time stamps are used to ensure motion and vocal recordings are in sync upon deployment to the novice.

*4.5.2 2D Video Embedding. Video Recording:* ProcessAR also supports video recording as an alternative to 3D instructions. This allows users to mix-and-match 3D animation and 2D video demonstrations, whichever they believe to be more appropriate for the current task step. The user signals the beginning and end of the video recording through a button press. During recording, instead of using controllers, the user only has to directly demonstrate the task with their physical hands. Meanwhile in the background, ProcessAR captures the real-time stereo video stream viewed by the user through the Oculus headset and stores the video clip using H.264 compression for later overlay into 3D space. Users are also allowed to import external video files if they choose not to use real-time recording.

Expert Mode - For expert users to author video instructions, ProcessAR features a novel interaction modality to overlay videos in AR. We created a radial UI panel that automatically loads the first color frame of each 2D video onto a designated panel button, associating each entry on the radial menu to a specific video. As mentioned previously, these videos can be sourced externally or recorded in-situ. The radial panel resembles a paint palette. As opposed to picking colors, the user can then freely navigate to each panel entry through the controller joystick, which prompts a virtual window to appear and enables the user to preview the clip. Once a video is chosen, the user can pull a video marker object out from the window to tag virtual replicas that are relevant to the video instruction. Similar to 3D animation recording, a set of replicas tagged by a video is considered a checkpoint. (refer figure 1 E & F and figure 7)

Novice Mode - In novice mode, novices can view videos previously overlaid by the expert users to complete the current procedural task in progress. When the novice proceeds to a video instruction, ProcessAR invokes a checklist of objects pending detection by YOLO. The list of objects are authored by the expert user as a means of asynchronous task guidance. This functionality ensures that the novice is aware of the required tools for a task prior to taking action. Once the checklist is fulfilled, a virtual screen featuring the corresponding task video is overlaid at the final detected object's 3D position. The video screen can be freely dragged around by the users in case it is blocking their view. To play or pause the video, the user just needs to simply gaze at or look away from the screen. To alleviate the trouble of manually reorienting the screen to face the user, we applied a look-at camera matrix such that the screen is always facing the front of the Oculus HMD. This feature was added to support the perspective awareness design goal (D3). The design rationale for this feature is based on the preliminary study, where, with video-based instructions, most of the novice users had a tendency to pause the video mid-way during task completion to avoid cognitive overload. Our functionality offers the same kind of feature in AR.

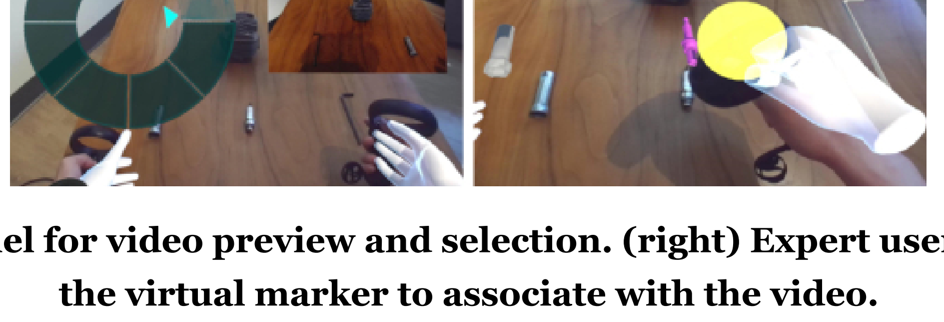

**Figure 7: (left) UI Panel for video preview and selection. (right) Expert user tagging objects with the virtual marker to associate with the video.**

*4.5.3 User Interface. Expert/Novice User Interface:* For monitoring instruction creation, ProcessAR includes a virtual control panel to help users keep track of and edit their procedure recordings (refer figure 8). The panel follows the user's field of view in AR and can be called upon and hidden through the trigger buttons of the Oculus Touch controllers. Virtual buttons on the panel provide preview and deletion mechanisms for both user motion and voice recordings, as well as display information about accumulated recordings. The activation of object detection and the display of the spatial mapping can also be controlled via virtual toggles. Through the panel, users are empowered to freely preview and manipulate recorded instructions analogous to common video editing software.

*4.5.4 Adaptive Point Of View Trigger & Navigation.*


**Figure 8: (left) Expert mode UI to preview, edit, delete created checkpoints. (right) UI in novice mode, allowing the user to keep track of their progress.**

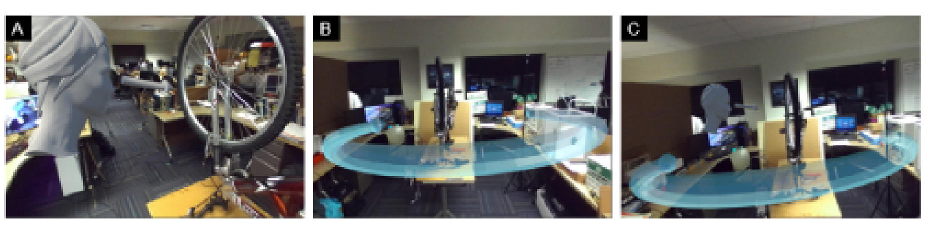

**Figure 9: (A) A Virtual head indicating direction and position of where the next instruction will begin; (B) a navigational arrow rendered on the AR work space, based on the authors' movement; (C) the adaptive POV trigger and navigational arrows can be used together.**

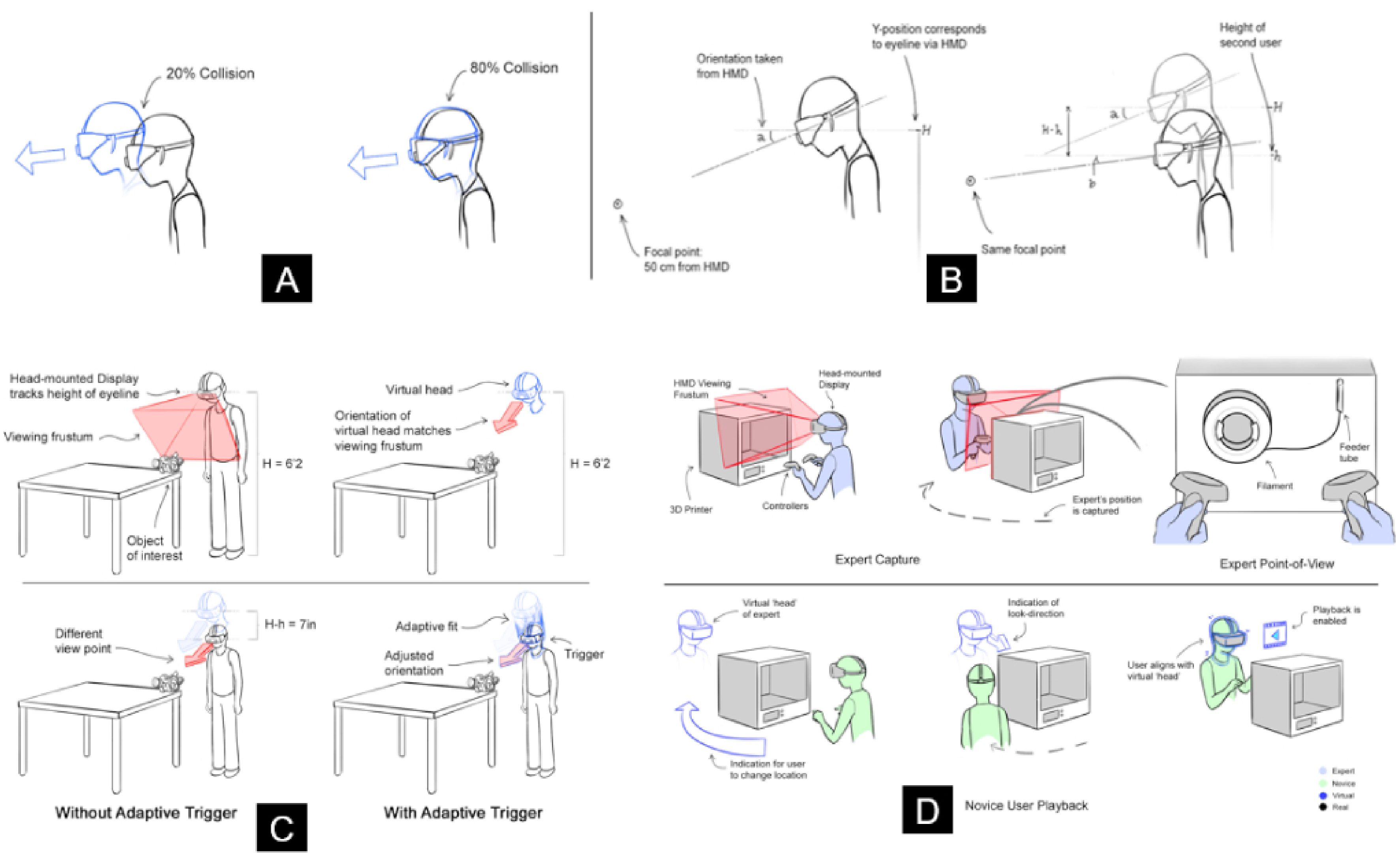


**Figure 10: (A) Sketch of a volumetric collision, where a user collides with a reference virtual head, created by the expert, used by ProcessAR system as a trigger. (B) Illustration of the method ProcessAR uses to adapt the virtual head to users with different heights. (C) A representation of the adaptive POV trigger mechanism, for users with varying heights. (D) (Top) Shows a workflow of an author navigating a work space, while the novice follows the path rendered by ProcessAR based on the authors movement (D) (Bottom).**

Due to the 3D nature of the instructions, well-authored 3D AR animated instructions are able to holistically capture tool operation, without needing recording from multiple perspectives. This contrasts with 2D video, where often the most appropriate perspective to view the instruction has to be pre-identified by the SME and then used to capture the content. As observed in our preliminary design study, novices sometimes missed the location where the motion of the virtual 3D content was starting from. To avoid that, we were inspired by results from the literature [64] and thus provide a virtual rendering of a head with an arrow pointing towards the most appropriate perspective in our system (see fig.10 C). This "best" perspective is based on observing the position and orientation information of the HMD at the time of authoring, which also obviates the need for an explicit action from the EU to set such a trigger. Once a viewer collides their head by more than 65% volumetric overlap (threshold identified by trial and error) with such a trigger, ProcessAR activates the corresponding instruction sequence (similar to fig.10 A). The position of the POV is obtained from the HMD pose of the user. Yet, first trials identified that a major obstacle for this method was when users of different heights use the system, which makes it challenging to match a head pose.

Thus, we decided to automatically adapt the rendering of the virtual head trigger to the current users' height, by adjusting the y-axis of the head model, based on an initial calibration of the users' eye level from the HMD when the system starts (refer fig.10 B). A focal point is set about 50 cm (average working distance between hand and eye) away along the directional normal of the gaze of the HMD, and using simple trigonometry we re-position the virtual trigger to suit the new users' height. With this method the system can automatically adapt for both tall and short users.

**Navigation:** Navigation enables the NU to navigate around the work space. To guide the NU to the location of the next trigger point, the system automatically renders the path for navigation by storing the position of the HMD worn by the author at the time of creation. A corresponding semi-circular arrow is then rendered by taking three points, the initial, middle, and final tracked positions as input. The semi-transparent arrow then indicates the location of the next task to the NU (refer figure 9).

# 5 FINAL USER EVALUATION

We invited 12 users (7 male and 5 female) to test and evaluate features of the ProcessAR system. Four users (all male) were chosen as Expert Users (EUs) due to their prior expertise in performing car maintenance (2 users) and bike repair operations (hobby cyclists, 2 users). The other 8 users were Novice Users (NUs). The study duration was 90 minutes, and all users were compensated with a $20 Amazon gift card. All Expert studies were conducted before the studies with the Novices. For later analysis, all studies were recorded from a first-person view via VR screen mirror capture and from a third-person point of view via an external camera.

Upon arrival all users were asked to fill out a standard pre-survey questionnaire asking for background information, such as gender, age, height, level of expertise with the task, and familiarity with AR or programming. The users had an age range between 19 and 28 years. None of the users had prior experience with AR, two users had played VR games before on HTC Vive headset. The EUs were between 5' 7" to 6' 1" tall, while the novices had a height range of 5' 2" to 6'0".

The EUs were asked to create two sets of instructions for the same task by using two variations of the AR authoring system. The features involved in both these systems are described in table 2. The "baseline" system can create both 3D and 2D instructions but lacks features such as object detection to load the virtual tools. Instead it relies on button presses to traverse through a library of virtual tools and loads them. Similarly, 2D videos can be recorded but attaching them to specific objects is not possible; instead, they are arbitrarily placed in the work space. Finally, the user's position is not tracked, and point of view triggers and navigational arrows for task guidance are not rendered. These specific features were disabled for the baseline system, as this represent reasonably closely current commercial AR authoring tools, such as by PTC [49] and Microsoft's system [39]. The other condition used by the EUs was our ProcessAR system with all features enabled.

**Table 2:** Two modes of AR authoring system and their features.

| Modes | 3D | 2D | 2D video embedding | Object | POV | Navigation |
|---|---|---|---|---|---|---|
| - | animate | record | (to objects) | Recognition | Trigger | |
| ProcessAR | yes | yes | yes | yes | yes | yes |
| Baseline | yes | yes | - | - | - | - |

One of the tasks to be authored was the same as in the design study (i.e., to create AR instructions for an engine assembly operation). The other task was similar to the bike repair operation described in the design study, which involved removing and reinstalling the front wheel of the bicycle. Yet, here we added the task of replacing the brake pad of the rear wheel, along with tightening the brake wire of the single pivot side-pull brake. The study was counterbalanced such that the order of the AR conditions alternated between users. That is, if one user experienced the baseline system first, the second user then used the ProcessAR system first. Following the EUs, the NUs were asked to complete the task using instructions generated by both systems (Baseline and ProcessAR), as created by the EUs, completing each task twice.

## 5.1 Measures

For the EUs we measured the time of completion for each instruction, while for the NUs we measured the task completion time. Both the EUs and NUs were asked to rate each system feature on a 5-point Likert scale questionnaire, followed by the SUS for evaluating the usability of the whole system, and a NASA TLX survey for perceived workload. For NUs we also investigated the number of rewind button hits, i.e., we measured how many times the Novices had to replay a particular instruction. Finally, we also collected post study feedback about the system from all users.

# 6 Results & Discussion

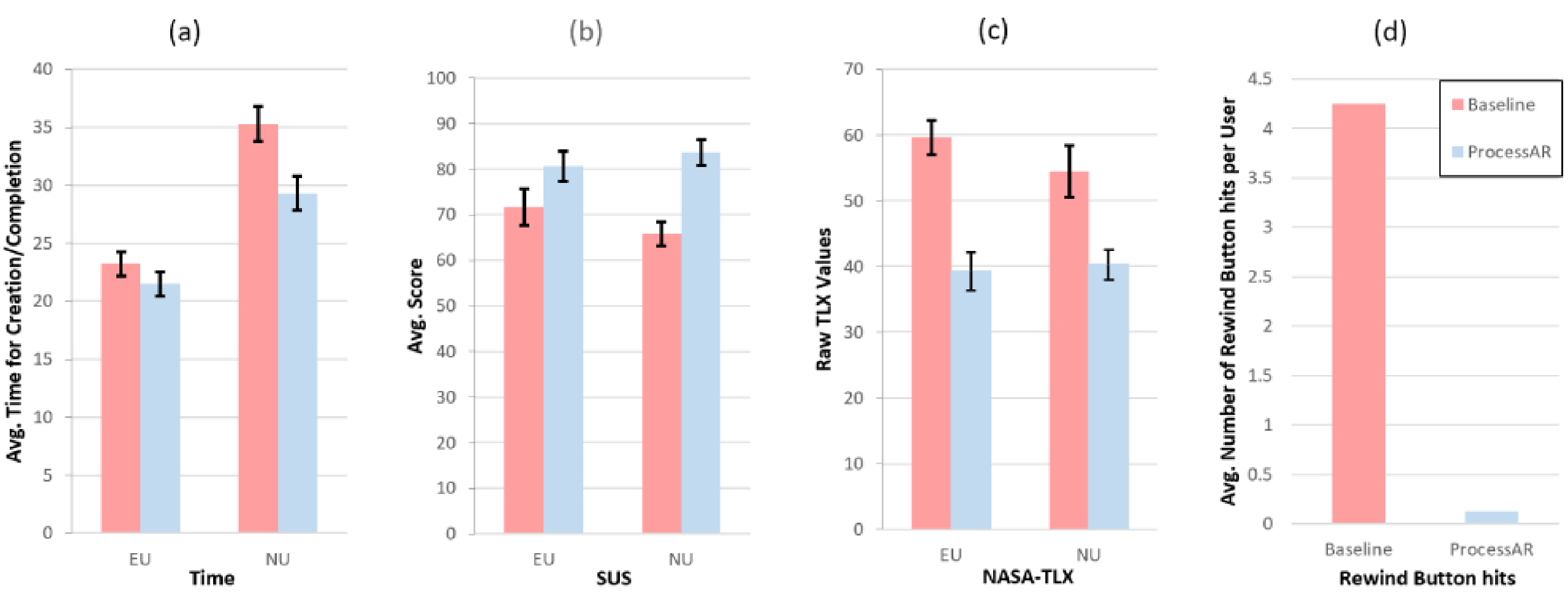


**Figure 11: (a) Time taken by EU to complete instructional creation, or NU task completion time for both modes; (b) SUS scores for the systems followed by NASA TXL scores (c); (d) average rewind button hits for each user in both modes. Error bars show standard error.**


**Figure 12: The Likert-scale statements used for evaluation along with an illustration of the responses for each statement.**

Compared to the baseline, the ProcessAR system shows promising results with differences in qualitative data, such as a cognitive load reduction, as identified through NASA TLX scores and 5-point Likert scale questions capturing users' perception of the system, for both Expert and Novice users. The quantitative measures provided a reliable reference for the usability of ProcessAR. Other metrics together with user feedback provide a basis for deeper discussions.

Task time: in terms of time for instruction creation by EUs, the ProcessAR condition (M=21.5, SD=2.93) is relatively close to the Baseline condition (M=23.2, SD=3.01). The sample t-test results with Fisher's exact test are: t(6) = 0.80,p = 0.44 > 0.05, with effect size r = 0.3. Thus, there was no statistically significant difference in overall task time between both conditions. Yet, post-study video analysis and observations shows that the Experts were slightly faster at selecting the desired virtual tool by simply looking at the tool, instead of traversing through the library via button presses. This information combined with the feedback for Q2 of the EU Likert-scale questionnaire yields a better perspective. Q2 queries EUs about their agreement to the following statement "*I was able to easily identify and interact with my virtual tools*". Here, 75% of the EUs strongly identified with the statement for ProcessAR, while for the baseline case 50% of EUs responded with slight disagreement. While the speed of NUs was also observed to be faster (figure 11 a), we attribute this to the fact that most NUs had to rewind instructions as they had missed the beginning of the instruction. This was unnecessary in the ProcessAR condition due to the adaptive point of view trigger. This observation is further substantiated through the data from the Likert questionnaire (Q6) (refer figure 12), data on rewind button hits, and post-study feedback from users. There was only one user who had to hit the rewind button to watch an instruction again under the ProcessAR condition, while all users had to rewind at least thrice in the baseline condition. Another interesting observation was that except for one instance NUs did not perceive a need to use the controller, as all instructions were rendered when and where required, due to the adaptive point of view trigger. This led to users effectively interacting directly with the tools, without the need to constantly switch between controllers and the physical tool. Q5 of the NU Likert scale questionnaire assessed NUs agreement to "*It was easy to switch between performing the task and navigating to the next instruction*". Overwhelmingly all NUs rated the ProcessAR condition as being easy, while 6 out of 8 NUs strongly disagreed with the statement for the baseline. This observation is best corroborated by the following comment of one of the NUs during the post-survey, where they stated: "*I would have been fine with using the controller to move to the next step, had I not known about the hands-free [controller-less] option. That was cool.*"

Usability and Cognitive Load: The scores from the SUS questionnaire indicate no statistically significant difference in terms of usability between ProcessAR and baseline for expert users (EUs). The scores for ProcessAR (M=80.6, SD=6.6) and the baseline condition (M=71.7, SD=8.2) do not differ significantly according to a t-test: t(6) = 1.60, p = 0.14 > 0.05, r = 0.54. Yet, the average SUS score of 80.6 for ProcessAR is encouraging, as an average score of 70 and above translates to "*excellent*" usability, as indicated by analysis of Bangor et al. [2]. However, for NUs there was a statistical difference in SUS scores between ProcessAR (M=83.7, SD=7.9) and the baseline condition (M=65.8, SD=7.4): t(14) = 4.67, p = 0.0004 < 0.05, r = 0.78. Pairing these results with the Likert-scale questionnaire and post-study feedback, we find evidence that the NUs found the system to be effective for training. Thus we can state that the usability of ProcessAR was enhanced through the added features, such as the adaptive POV triggers and hands-free interaction.

The perceived workload measure in the NASA TLX survey provided better results for the ProcessAR system by both EUs and NUs. The EUs raw NASA TLX scores were (M=39.25,SD=5.83) for ProcessAR and (M=59.62, SD=5.09) for the baseline condition. The sample t-test results identified a significant difference: t(6) = 5.19, p = 0.0020 < 0.05, r = 0.9. For NUs the raw NASA TLX scores were (M=40.25, SD=6.36) for ProcessAR and (M=54.5, SD=11.09) for the baseline condition. The sample t-test again identified a significant difference: t(14) = 3.15, p = 0.0071 < 0.05, r = 0.64. Both for Experts and Novice users the results demonstrate a statistically significant reduction in workload with ProcessAR.

Finally, we would like to mention two suggestions by users. Some experts users felt the reliance on controllers to be intrusive to a seamless interaction during authoring 3D instructions. That is, the EUs had to first demonstrate the interaction with the tool/object with the virtual model via a controller, then switch to using the physical tool/object to perform the action. This is best described by a user quote "*I wish I can just show what I have to do [with the physical tool] and the 3D instructions are generated, instead of switching back and forth with the controller and the tool.*". The other feedback was "*The graphics of me holding the wrench [tool/object] could be better, like right now my virtual hands go inside the wrench for me to grab it. It would be better if the graphics was more precise*". This user was referring to the fact that to interact with the virtual tool, the controller has to collide with the virtual model and the fact that dynamic tool interaction such as the movement of pliers when squeezing the handles or a wrench adjustment animation currently cannot be captured. Both these suggestions are acknowledged as limitations and will be pursued as part of future work.

# 7 LIMITATIONS AND FUTURE WORK

To improve reliability in tracking and issues due to occlusion, we avoided relying purely on computer vision and instead preferred the use of the Oculus touch controllers, which can be robustly tracked in real time (also due to their inertial measurement units, IMUs). Their reliability makes our system perform smoothly and enables the authors to create the 3D animation. Unfortunately, using the controllers occupies the users' hands and can be intrusive while performing the task. The expert is thus required to keep switching between the controllers and using their hands. If a different interaction device, such as a tracked glove [22, 70], would be employed, it might be possible to track the tool position without compromising the use of hands. Still, ProcessAR provides hands-free interaction for Novices, so this issue affected only the Expert users.

Some dynamic tools, such as measuring tapes or socket wrenches with changeable heads are hard to animate. Enabling the corresponding virtual tools to be dynamic and being able to record interactions with them automatically would enables even better tool operation tutorials to be produced in AR. Finally, a feature which could detect task completion or incorrect performance, similar to work such as Drill Sergeant [58], would also be beneficial.

Future work on ProcessAR could expand on the navigational feature, to create and enable use of more complex navigational maps. It is also theoretically possible to create AR content with ProcessAR and to then deploy the instructional content on any other AR-enabled device, such as a phone or a tablet. Such an implementation would expand the reach of AR to a wider audience while still ensuring ease of instructional content creation for the expert authors.

# 8 CONCLUSION

We presented ProcessAR, an AR authoring platform with a robust implementation for procedurally developing 3D and 2D AR instructions, especially for delivering spatio-temporal instructions. Currently, most industries still use the inefficient method of one-on-one training to train their employees for tasks such as machine operation and manufacturing. Unfortunately, due to the large number of retiring workers [13] there is an increased demand for newer and more flexible workers to meet the challenges of the future where many technical changes leave a skills gap [29]. Our system also extends current AR-based instruction systems, such as Microsoft Dynamics 365 Guide, by supporting custom animations of 3D models of tools. Our user evaluations with experts and novices corroborated that SMEs are easily able to use our system to author AR instructions with no experience in AR programming and only minimal training on the tool. Based on the outcomes of our work, we can conclusively state that ProcessAR allows experts to create task tutorials more quickly than other forms of instruction. Moreover, ProcessAR can be used to train workers on demand, which has the potential to speed up manufacturing workforce skill transfer, make it less expensive and enables more flexibility to re-allocate workers across workflows.

Until recent advances in commercially viable head mounted devices for AR systems, there was no technology sufficiently reliable to capture and deliver spatio-temporal aspects of human knowledge similar to what we demonstrated here. With the advent of AR this has been rectified but this technology comes with the price of instructional content being hard(er) to create. We believe systems such as ProcessAR enable and encourage more SMEs to create instructions and share their hands-on skills and knowledge, enabling them to encapsulate their experience for the benefit of a wider audience and thus also make training scalable across a variety of tasks and procedures.

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## FOOTNOTE

[1]Please refer to the Supplemental Material



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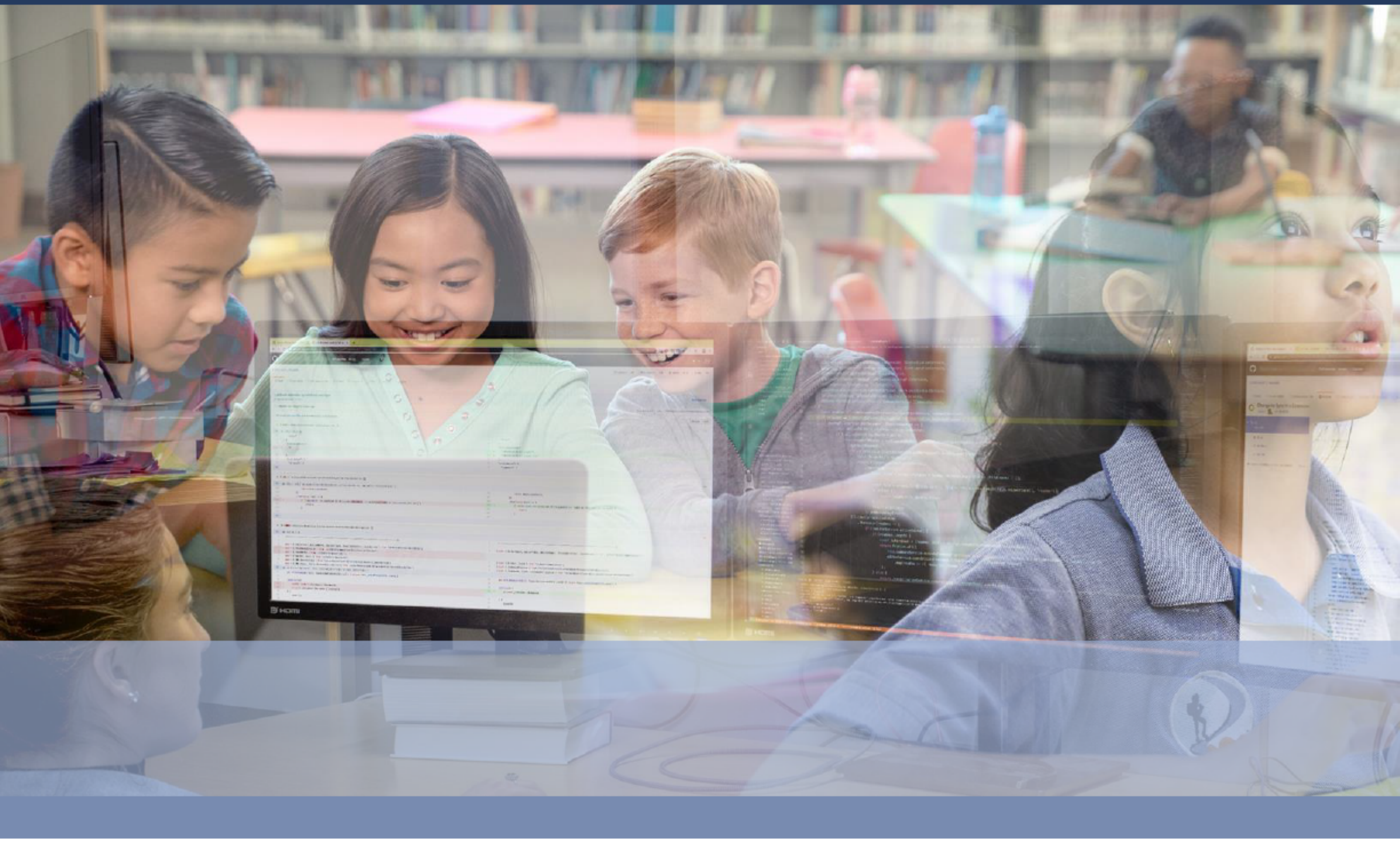
# Equitable education in a post-pandemic world:

## Effective learning for every student

JUNE 2021



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THE education WORLD FORUM

# About this white paper

As education systems around the globe move towards recovery from the Covid pandemic, a major challenge is how to ensure equitable and inclusive learning opportunities for every student. For the purposes of this paper, we will be looking at equity in education as the ability for every student to reach their potential at school, no matter what their background or constraints.

Remote learning posed significant challenges for disadvantaged students, and schools were faced with differing levels of learning during lockdown periods dependent on individual circumstances. Students needs and expectations have evolved along with those of their parents. Emerging approaches developed across the world can help to tackle learning gaps by focusing on fundamental issues like reading, improving social and emotional learning and creating more inclusive approaches to raise digital skills.

This white paper aims to explore challenges and potential solutions based on the input from a series of virtual fireside chats, interviews, and case studies from leading educators across the globe. We'll begin with an introduction from Gavin Dykes, Program Director at the Education World Forum, followed by perspectives from the World Bank on equity and the role of education technology in addressing equity challenges. The next section presents case studies of how education systems are focusing on resolving equity challenges. The final part summarizes steps that education systems can take to ensure more equitable approaches to education as we navigate the Covid pandemic and beyond.

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# Introduction

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Wherever you look, equity seems key to recovery and moving on from difficult times. Three such examples of this common theme in recent global research on education include calls to action to: "ensure equity and align resources with needs[1] to create a whole society approach that delivers equity in education"[2]; "ensure inclusive access to opportunities after this crisis we need to put equity in action in the recovery"[3]. Focusing on equity makes sense, not least because those who lose out most in crises are so often our poorest.

There is of course inequity of access to technology and access to learning, but also inequity in access to learning support; inequity in literacy and numeracy skills acquisition; and inequity reinforced by differing levels of access to technology and proficiency in its use. Inequity takes many forms and may arise and be amplified by a complex combination of causes. How can we reduce inequity? Some have identified the difference between good help and bad help, and the design decisions that can lead to success and failure when it comes to policy[4].

'Good help' starts with listening, laying aside presumed answers and ensuring we check for context and circumstance. It's just like improving learning or personalizing learning at scale. Thinking such personalization through is valuable and important, not least when applying algorithms and artificial intelligence to social and education issues. We should think hard and work carefully to 'bake in' equity if we are to use technology tools for the common good.

There are other tools that can help structure our listening to engage all stakeholders in assessment and review of progress which can lead to more widespread agency and improve and develop better collective intelligence[5]. A tool developed to help mature adoption of technology in schools was Naace's self-review framework[6] in the UK. The framework included a series of descriptions of what good adoption looked like in areas such as leadership, teaching and learning, and professional development of teachers. If used wisely, the Self

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[1] Effective and Equitable Educational Recovery – 10 Principles; Education International; OECD 2021

[2] Unwin, T., Naseem, A., Pawluczuk, A., Shareef, M., Spiesberger, P., West, P. and Yoo, C. (2020) Education for the Most Marginalised post-COVID-19: Guidance for Governments on the Use of Digital Technologies in Education. Act One: Executive Summary. London: EdTech Hub. DOI****; https://edtechhub.org/wp-content/uploads/2020/09/Education-for-the-most-marginalised-Report-Act-1-v8.pdf

[3] https://www.philadelphiafed.org/community-development/inclusive-growth/covid-19-equity-in-recovery

[4] https://www.nesta.org.uk/report/good-and-bad-help-how-purpose-and-confidence-transform-lives

[5] Syed, Matthew (2019) Rebel Ideas – The Power of Diverse Thinking

[6] https://www.naace.co.uk/si-srf.html

Review Framework encouraged stakeholder groups to discuss progress and to identify priorities for improvement. We might wonder if the principle of the self-review framework could be developed and applied to issues other than technology adoption—and perhaps to our current challenges of equity, recovery, and progress.

Teachers have done brilliant work in supporting students during the pandemic. Many have gone far beyond boundaries normally expected in their work. How much freedom have teachers had recognizing students who have reacted positively by taking charge of their learning in a personalized way? How many students have had found their own new positive learning pathways through last year's extraordinary circumstances? Some students have become key to keeping families and communities working; others have stepped up to take on additional responsibilities or yet more have gone beyond the boundaries of curriculum and learned new skills and knowledge in unanticipated subject areas. Should we all be recognizing such students and encouraging them in their efforts? Or should we simply gather data about performance against pre-existing curriculum? They say it's an ill wind that blows nobody any good—a saying first recorded in 1546[7]. It would be a shame to miss acknowledging and celebrating any of the hard work and good learning that has so recently emerged, by teachers and learners alike.

## Perspective on equity from the World Bank—and how education technology can help bridge the gap

"There is inequity everywhere, from the most developed to the least developed countries, and so this is now a global problem, and the world needs to turn its attention to inequity," said Alex Twinomugisha, Ed Tech Specialist at the World Bank.

Learning poverty is a huge challenge. Globally, the share of 10-year-olds that cannot read a simple paragraph prior to Covid was 53%, but since Covid this has risen to at least 63%, with some areas like Sub-Saharan Africa now reaching more than 90%.

Equity challenges are very diverse. Income is a major challenge for families, and so removing school fees globally is a key priority of the World Bank to enable access to basic education. The gender divide is another serious issue that the team is focusing on to help ensure students can go to and complete school. Special needs continues to be an ongoing challenge for education systems, as well as rural-urban divides where schools may simply not be accessible.

Equity issues can also be generated by the lack of appropriate support. This can take many forms, from a lack of teachers to teachers without appropriate training, insufficient access to books or other learning materials, and an unsupportive home environment.

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[7] https://www.phrases.org.uk/meanings/ill-wind.html

“First we have to get children back into school. One of the worries we have is that children are not going to come back—especially the most vulnerable,” said Twinomugisha.

In priority order, it is thus first necessary to get all children back to school. The second priority is to ensure all children at school are learning—including those with special needs—by providing an environment that enables effective learning. And finally, recognize that when children return to school post closures, there will be more significant learning differences than before—and ensure that these learning losses are compensated for.

“In some countries schools have been closed up to a year, they have lost enormous learning compared to where they should have been. That learning gap has to be filled,” Twinomugisha added.

To do that, systems need to focus on remediation and teaching students at the right level depending on their learning needs. Tutoring is an approach being used by some countries to help students catch up.

However to do that, “[i]t’s become glaringly clear that if you want to reach all children […] you have to close the digital divide,” says Twinomugisha. That means focusing on connectivity, the right device for learning and the right skills to use it for students. But it also means ensuring teachers are adequately trained, and Ministries of Education and schools have the capacity to deploy and manage technology effectively.

To bridge the gap, partnerships are essential, and governments have innovated during the pandemic by establishing partnerships with NGOs, the private sector, telecom companies to offer free data connections to educational content as well as in building nutrition programs.

“Many governments are partnering with Microsoft to give access to learning management systems,” said Twinomugisha.

From the World Bank perspective, they are working hard to offer both financial resources as well as policy advice and knowledge, based in evidence, for countries to come together and focus on equity and inclusion. They recommend scaling up the investment in technology, as it’s proven its importance and has promising solutions such as adaptive learning to focus on individual needs.

“We forget there is a school closure somewhere around the world on a weekly basis,” added Twinomugisha, and he highlighted the importance of school systems becoming more resilient and flexible.

Fundamentally, it’s crucial that students keep learning wherever they might be, and that to bridge the gap of learning losses, we need to enable wider access to learning opportunities both in and out of school.

# Equity Case Studies from Across the Globe

## Inclusive social and emotional learning in Western Australia

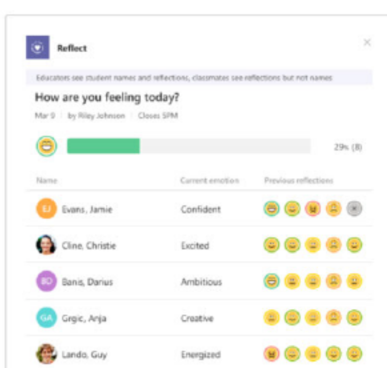
Catholic Education Western Australia is a state-wide education system, covering 168 schools and 70K students with a strong focus on student well-being. Their strategy involves promoting wellness for every single student, rather than focusing on preventing illness.

According to Shannon Steven, Well-Being Consultant at CEWA: "…the stats are quite scary. One in four 16–24-year-olds will experience a mental health disorder in a twelve-month period. And one in four children aged 6 to 14 will be assessed with a disorder." This really highlights the need for wellbeing in our schools. CEWA's vision for wellbeing is helping our young people to flourish and we define well-being as "feeling good, functioning well, and doing good for others."

> *"Positive education involves moving away from the deficit-based model to a strength-based approach—by understanding the root causes of success and learning how to get more of it."* **Shannon Steven, CEWA**

Positive education involves moving away from the deficit-based model to a strength-based approach—by understanding the root causes of success and learning how to get more of it. CEWA is using Microsoft's Reflect app, embedded into Microsoft Teams[8], to help students identify and navigate their emotions. It helps educators to complete a daily check-in with their students, and to measure improvements in student well-being.

It's important for students to recognize, name and respond to their own experiences. The Reflect app helps students to better identify what the emotions are that they are experiencing, and to be able to thus process and manage their feelings. It's important for students to recognize, name and respond to their own experiences.




[8] Reflect in Microsoft Teams for Education - Microsoft Educator Center

## Saudi Arabia creates a more equitable approach to teaching computer science using Minecraft: Education Edition

Since the onset of Covid-19, digital transformation has accelerated, and the number of new technology jobs in the market is expected to reach 150 million by 2025 according to Microsoft Data Scientists analyzing LinkedIn data[9]. It's thus more critical than ever to build deep digital skills among students, starting from the youngest age.

Traditionally, computer science appeals to a narrow group of students—mainly boys—and curriculum approaches reinforce this as called out by Microsoft in the recent white paper on Computer Science curriculum[10].

In the Kingdom of Saudi Arabia, right in the midst of the pandemic, the Edutainment Company worked closely with the Ministry of Education to revamp approaches to computer science education. Although the Edutainment Company had already been running many informal computer science events like the Hour of Code and Saudi Codes, this new initiative involved an education reform to introduce the topic into formal education.

The focus was to make computer science more appealing to a wide range of students, by bringing in game-based learning through Minecraft: Education Edition, and opportunities to learn practical coding skills with Hour of Code.

### Usage of Minecraft: Education Edition exploded since the initiation of the program

"We now have millions of participants joining the Hour of Code and the Minecraft competition. We have never been more excited for the future of game-based learning, and we are preparing the largest competition together with the Ministry of Education," said Ayman El-Attas, Program Director at the Edutainment Company and Minecraft mentor.

Embedded into every program brief as well as the Vision 2030 of Saudi Arabia[11], diversity and inclusion is a key part of Edutainment Company's strategy, as well as personalized learning approaches.

### Teacher training is crucial when introducing computer science and Minecraft: Education Edition

"Teachers are at the heart of any program success. We make sure teacher empowerment happens at three stages. Content creation, tailored to educators, which shows that game-

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[9]https://msit.powerbi.com/view?r=eyJrIjoiZWMyNjA0YzAtZGY4Zi00MTI1LTk4MjQtNWI1NTA5NDY1MzRjIiwidCI6IjcyZjk4OGJmLTg2ZjEtNDFhZi05MWFiLTJkN2NkMDExZGI0NyIsImMiOjV9

[10] https://edudownloads.azureedge.net/msdownloads/Microsoft-Computer-Science-Framework.pdf

[11] https://www.oecd.org/countries/saudiarabia/education-in-saudi-arabia-76df15a2-en.htm#:~:text=Saudi%20Arabia%20has%20embarked%20upon%20an%20unprecedented%20reform,puts%20education%20at%20the%20centre%20of%20Vision%202030.

based tools are powerful educational tools. Change management and empowerment continues in stage 2 with hands on training. And finally, the classroom support level, to ensure the quality and sustainability of the program. Virtual classrooms have proven to be effective using Microsoft Teams. It's key to listen to the system and keep experimenting with new approaches," said El-Attas.

Parents have been kept well informed and have given very positive feedback to teachers. They've reported new levels of enthusiasm among their children for instance in completing math homework as a result of introducing Minecraft: Education Edition.

The usage of Minecraft: Education Edition has also transformed the teacher-student relationship to student centered learning. As students are often highly proficient in using Minecraft, they are becoming "teacher assistants" when their teachers implement the tool in class. The most expert students are helping their peers, and enabling collaboration, communication, and effective team work to achieve a common goal.

With the new education reform driven by the MOE, as well as the support from Microsoft from a transformation perspective, a lot of change is now in process. The pandemic accelerated technology adoption, and so it's given a whole new momentum to computer science education and open-ness among schools to keep improving their education technology usage.

## Literacy for every student in Tacoma schools, USA

617 million children and adolescents across the world are affected by learning loss due to the pandemic, impacting on their ability to read according to UNESCO[12]. Even in the most developed countries, like the United States, school disruptions due to Covid are causing the most disadvantaged students to fall further behind in literacy[13]. Literacy is a fundamental skill, essential to progress in all other school subjects, but also to thrive in life and in society.

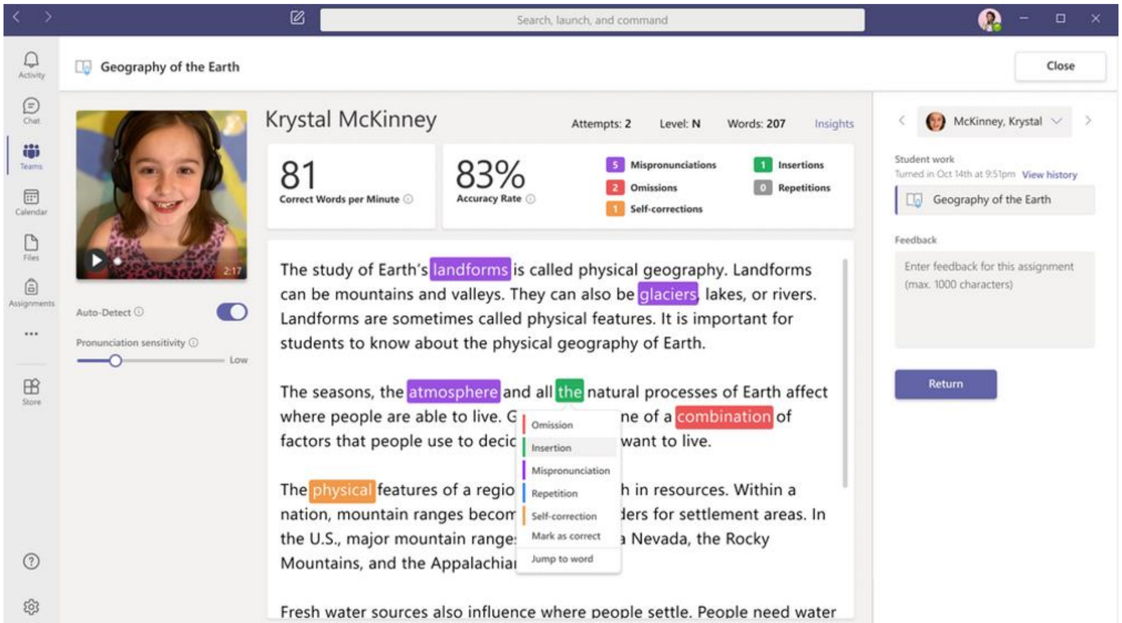
Schools in Tacoma in the Pacific Northwest of the United States have been among the first across the globe to adopt Reading Progress to offer personalized reading support for students. Reading Progress in Teams[14] helps students build fluency through independent reading practice, educator review, and educator insights. It enables independent practice, and helps teachers track progress. The app focuses on a positive, progression-based approach that helps students improve and build confidence.

[12] International Literacy day: background paper on 'youth and adult literacy in the time of COVID-19: impacts and revelations', 8 September 2020 - UNESCO Digital Library

[13] Changing Patterns of Growth in Oral Reading Fluency During the COVID-19 Pandemic | Policy Analysis for California Education (edpolicyinca.org)

[14] https://aka.ms/ReadingProgressPP

“Struggling readers, they avoid reading—and by avoiding reading, they struggle even more,” said Liliya Petrovskaya, a fourth-grade teacher at Manitou Park Elementary.




As the tool supports independent practice, teachers can give individual reading assignments to every single student at their reading level. As students work independently, it removes anxiety of having to read in front of the whole class. The analysis data generated helps teachers reduce the time to grade students, and to have more time freed up to support students in class time.

“I can spend my planning time to figure out how do I intentionally approach every student, as well as the whole class. […] Reading Progress motivated a lot of kids and really gave them ownership of their learning,” continued Petrovskaya.

Teachers report that as a result of implementing the app, students are reading more at home, are more excited to read in the classroom and are setting their own individual goals that they wish to exceed.

The data generated by the tool can help understand the learning trajectory not just of individual students but also the whole class—helping teachers and leaders better understand how to allocate teaching time and resources. But above all, the schools underlined that their goal with the tool, is to instill a passion for reading which will unlock the potential for every single student to achieve more throughout their lives.

## Building equity at scale in New York, USA

> *"Equity matters—more so than ever."* **Superintendent Prayor**

New York Brooklyn South District covers 27 high schools, 1700 teachers and 39,000 students with a diverse community. They have seen there have been huge impacts in terms of learning deficits due to lack of external academic support, or due to family problems.

The first challenge for the district was to address was to understand where issues were sharpest, to provide devices and connectivity to their students. Many students kept cameras off as they were embarrassed about their home environments, and educators needed to be flexible about being able to see students as a result. Educators also adjusted expectations of their students in terms of work completion—especially on timelines for submission of assignments as some students might be sharing their device with multiple siblings.

Partnerships with the private sector really helped to reach out and support those who needed it most. The district also initiated the HEEAT (Healthcare, Energy, Environment, Agriculture and Technology) program to help every single student to focus in on their passions, by enabling students to take classes with employers active in those areas, with the support of teachers engaging with the business community. It's enabling students to get closer to the world of work and develop their employability.

## Equitable hybrid learning in Guanajuato State, Mexico

The state is using a mix of approaches: broadcast media, workbooks and education technology including Microsoft Teams to stay in touch with students and ensure learning continuity despite school closures.

The Ministry of Education designed a series of digital books that summarized the most important content for teachers and students, and then offered a laptop and Wi-Fi for those students that needed them. They could then download the digital books, and the Ministry saw huge amounts of downloads. They also quickly moved to train teachers in Office 365 for education to support hybrid learning.

"We focused on Teams as the perfect tool for the teaching process and to enable interaction between the teachers and students. More than 1.2 million education accounts were delivered to all K12 students in public and private schools," said Jorge Enrique Hernandez, Minister of Education, Guanajuato State.

Students could thus keep in touch using email and share content with teachers via cloud storage. The massive training plan and clear vision for online learning led to exponential growth of the Teams platform for learning.

As the next stage, they are creating "Espacio Comun"—or common space, a virtual community in Teams for parents, teachers, students, and staff in one space. The aim is to help parents and teachers track student progress, as well as to provide all the information needed about education in the State. Education leaders will also be brought together in groups to work, plan, manage and report on progress. Teachers are also getting their own professional learning groups to ensure ongoing training.

Creative Universes is also a key part of the Espacio Comun—a new innovation for students to enable collaborative learning, networking and social responsibility. Creative Universes will provide a source of inspiration and entrepreneurship for students, where they can continue to develop skills needed for their future in a hybrid scenario even as they go back in the new school year.

Massive training continues, to upgrade all teacher skills to be able to use the Espacio Comun effectively in a few months' time. Guanajuato State has been a great example in moving quickly to drive transformation at large scale for all stakeholders in the system.

## The way forward: How can system leaders foster more equitable education systems as we move beyond the pandemic?

Based on the case studies and interviews, a set of key principles have emerged for system leaders to bear in mind.

- **Equity by design:** learning differences have increased dramatically as a result of the pandemic, with significant learning loss for the most disadvantaged students. Equity thus needs to be front and center of any new education program, and approach and needs to be a top priority in new investments.
- **Ensure every single student can get back to school:** within the constraints of health regulations, it's important to focus on getting students back to the classroom. Technology platforms can support ongoing learning while schools are still physically closed.
- **Ensure every single student has access to the technology needed for learning:** an appropriate device, connectivity, digital learning resources and trained teachers are essential for resilient teaching and learning. Education systems need to ensure appropriate access to infrastructure, learning platforms and trained staff to enable digital learning at scale.
- **Focus on fundamentals and build from there:** basic skills like literacy and numeracy should be addressed when trying to mitigate learning losses. These "gatekeeper" skills enable learning to continue in other areas. At the same time, thinking about how digital competence and employability can be ensured is also a priority to ensure equitable access to digital jobs and an inclusive digital society.
- **Plan for flexibility:** acknowledge that learning differences are more significant than ever and build in more flexible approaches at micro and macro level. This could include more open deadlines for class assignments, as well as adaptive, personalized learning at system level.
- **Help teachers get the training and support they need:** teachers have carried a heavy burden during Covid, rapidly adjusting their pedagogy and their digital pedagogy skills as well as embracing social and emotional learning to accommodate the challenges their students were facing. Ensuring they get ongoing training and recognition for their efforts should be a priority.
- **Leverage community to help:** Covid has brought together the wider community to support education: NGOs, the private sector, and the education system. Building on these new partnerships, to create long-term sustainable action for equity is essential for success.

## Actions

Watch the complete interview series that informed this white paper at http://aka.ms/VirtualETS

Visit the system leader hub at http://aka.ms/systemleaders

Plan your system transformation journey http://aka.ms/ejourney

Review a framework for whole systems transformation http://aka.ms/k12etf

Read the paper on *Education Reimagined by New Pedagogies for Deep Learning* http://aka.ms/hybridlearningpaper

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•**Review**•

# Multimodal teaching, learning and training in virtual reality: a review and case study

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**Abstract** It is becoming increasingly prevalent in digital learning research to encompass an array of different meanings, spaces, processes, and teaching strategies for discerning a global perspective on constructing the student learning experience. Multimodality is an emergent phenomenon that may influence how digital learning is designed, especially when employed in highly interactive and immersive learning environments such as Virtual Reality (VR). VR environments may aid students' efforts to be active learners through consciously attending to, and reflecting on, critique leveraging reflexivity and novel meaning-making most likely to lead to a conceptual change. This paper employs eleven industrial case-studies to highlight the application of multimodal VR-based teaching and training as a pedagogically rich strategy that may be designed, mapped and visualized through distinct VR-design elements and features. The outcomes of the use cases contribute to discern in-VR multimodal teaching as an emerging discourse that couples system design-based paradigms with embodied, situated and reflective praxis in spatial, emotional and temporal VR learning environments.

**Keywords** Virtual reality; Multimodality; Training; Teaching and learning; Semiotic resources

## 1 Introduction

Digital teaching and learning embrace active pedagogy and learner-centred approaches. The basic assumption is that learners are unique and therefore learning should be personalized. As argued by Reigeluth et al.[1], learner's centred activities value intrinsic motivation[2,3] as well as metacognition[4] for a more personalized and meaningful learning process. For achieving an active, situated and embodied learning experience, meta-cognitive knowledge seems to enhance learning[5]. In line with this assumption, one can consider specific pedagogical methods such as active learning, learning by doing, collaborative learning, problem-based learning and game-based learning. Prince indicates for instance that active learning has a positive but weak effect on students' academic achievement[6]. Vernon and Blakes meta-analysis indicates that problem-based learning may yield metacognitive learning over traditional methods[7]. This is also supported by Dochy et al. meta-analysis that concludes for robust positive effects on student's skills without studies reporting negative effects[8]. Those conclusions are also in line with Walker and Leary's meta-analysis[9]. Based on previous meta-analysis and systematic reviews[10–15], serious games[16] may also be efficient in various contexts, if combined with informed learning instructions.

In line with the idea of "Active pedagogy" and "Learner-centred approaches" the concept of "Multimodality", was developed in the early 2000s[17,18]. Multimodality refers to "multiple" modes of representation, with combined elements of print, visual images and design. This shift from paper-based education to multimodal education involves rethinking the way in which teaching, and learning are designed, approached and practiced. This promotes the way in which pedagogies, content and technology are designed and used to enable multimodality to take place in a variety of contexts and social relationships[19].

Whether digital tools are employed to scaffold new ways of learning or they are just reproducing traditional modes of teaching and learning is still an open research question[20]. Digital tools are at least as efficient as non-digital tools, when integrated into a consistent pedagogic strategy, with clearly defined training objectives and instructions. Therefore, the purpose is not to replace traditional methods by digital tools. Rather, one should consider digital tools for the actual value they can bring, for instance regarding the personalization of the content, in combination to non-digital tools and methods. Digital tools are part of the toolbox available for the trainers and they can contribute to the development of multimodal, active and learner-centred approach.

In this context, Virtual Reality (VR) was recently introduced to the consumer market[21] and deployed in digital educational interventions[22]. Education and training are pointed out as promising fields of VR implementation[23]. The advent of immersive and high-fidelity digital technologies such as virtual reality may supplement or enhance analogue learning spaces as modes of expression. For example, Öman and Hashemi suggested that technology may be used to increase students' communicative and collaborative skills instead of focusing on how to use the technology from a technical perspective[24]. VR is shown to offer self-regulated and multiple learning choices compared to other learning platforms which lead to high quality of experience and retention[25–29].

However, the use of VR in the context of multimodality for teaching and learning has not been investigated yet. As an example, a search using the terms VR and multimodality and teaching or learning for any peer reviewed article published between 2010 and 2020 on Science Direct (Elsevier) led to 0 hit. The IEEE database only retrieved 5 articles. The first one relates to the use of listening strategies by learners in Second Life VR environment[30]. A second one relates to multimodality in VR but without teaching and learning purpose[31]. The three other papers are totally unrelated to the topic of interest[32–34]. This shows that Virtual Reality and Multimodality are rarely tackled scientifically as a connected issue.

We propose that multimodality may be investigated as a teaching and learning process in terms of ways of enacting it within a VR's semiotic domain as a design space that affords constructivist and activity-based learning. Multimodality may be viewed as the vehicle for students to design and orchestrate their own modes of learning that are meaningful to them in the form of multimodal ensembles and semiotic resource[35]. Such multimodal ensembles may include images and language along with more static modalities resembling frozen actions[36] such as classroom objects and equipment incorporating desks, tables, displays, chairs, books and chalkboards. There is a plethora of evidence on how multimodality may be deployed in traditional learning environments[37−39], in blended learning spaces[40−42] and online learning spaces[43−45]. There are constellations of evidence on employing multimodality as means to experience teaching and learning in digital and analogue semiotic domains. Yet, there is infrequent substantiation on how meanings of words, images, communication processes, teaching strategies, roles and learning activities may be situated in a VR semiotic domain.

This paper attempts to illuminate the application of multimodal teaching and learning as a pedagogically rich strategy that blends, couples and combines constructivist-led practice. Such strategy constitutes distinct ways of thinking, acting and interacting. Essentially, it allows to experience teaching and learning in unique ways. In Section 2 hereafter, we present an overview of the literature supporting how VR may be used in learning and teaching as means to increase learning efficiency, based on recent developments in designing and representing learning content and activities through VR. In Section 3, we propose a methodology for integration of VR into multimodal learning path and we illustrate this methodology in Section 4 with eleven different VR case-studies resembling different design approaches to map multimodal learning with VR features and components. Finally, in Section 5, we evaluate this proposition considering the current situation of the pandemic and how VR and emerging XR (eXtended Reality) technologies can contribute to reshaping the learning and teaching fields while physical distancing tends to be normalized.

## 2 Transcending multimodal teaching to VR technology

Digital learning technologies aim to help learners increase their capacity for innovation, leadership, multi- and inter-disciplinary collaboration, emotional intelligence, critical skills, collective problem identification and solving skills, in a participatory environment[46]. Multimedia resources and tools in these environments include, e. g.: videos, interactive images, recorded presentations, online quizzes, discussion forums (synchronous and asynchronous), visual representations of learner data to describe progress (summative analysis) and what learners are doing to learn[47]. The increasing use of multimedia in education and training offers the possibility of presenting content in multiple representations (text, images, video, audio, ubiquitous media) to accommodate different teaching and training strategies, learning outcomes, assessment methods and feedback mechanisms. Key aspects are the use of a range of tools, resources and services in a pedagogical manner to enhance the students' experience.

The integration of multimedia learning into different modes of learning seems to encourage learners to develop a more flexible approach based on inquiry and information retrieval. Hazari[48] and Mayer et al.[49] argue that student learning is deeper and more meaningful when a range of interactive tools and resources are deployed rather than using text alone. Shah and Freedman[50] list the benefits of using visualizations in learning, such as (1) external representation of information, (2) deeper learning, (3) triggering learners' attention and concentration by making information more complete, thus simplifying ill-defined concepts and ideas.

These tools can be serious games, and virtual reality. These technologies allow us to go beyond standard forms of written and spoken language[17]. VR environments are being envisaged as a medium that aid learners' efforts to be active. Learners consciously attend to, and reflect on, critique leveraging reflexivity and novel meaning-making leading to a conceptual change. There is an enlightening research spectrum on measuring the instructional effectiveness of immersive virtual reality[51−53], understanding trainers' conceptions of teaching in VR[54,55], students' attitudes towards VR[56,57] and trainer professional development using VR[58−60]. There are also studies that investigate associations between specific pedagogies and theories with VR[61,62] embroiling constructivist models of learning with the premise to individually and collaboratively construct knowledge and experience through critical learning and thinking. In summary, these previous works indicate that learners respond to the environment with an interaction-reaction opposition: they build their own knowledge and social interactions are primordial to that building[63].

The advent of VR head-mounted displays has encouraged the development of an array of VR environments particularly used for augmenting the student learning experience[23]. In this context, VR may be broadly described as an experience in which students interact within a 3D dimensional world with body and gestural movement, experiencing interactive content such as images and sounds[64]. A distinctive characteristic of a VR system is that students can interact and manipulate objects by emulating how objects are manipulated in the real-life[65]. Commentators and researchers alike have attempted, through meta-analyses and systematic reviews, to discern the processes, strategies and methods that are most likely to be aligned with VR tools, elements and features (e.g. for Language Learning)[66]. There is consensus that VR may promote activity based and student-centred learning, as proliferated in the constructivist learning paradigm, whilst attaining student motivation, self-regulation and self-assessment. A key advantage of learning using VR is that students can view objects and content from multiple perspectives and thereby situating learning in line with subject contexts. For example, VR allows rich learning environments such as factories or real-life like working spaces, particle physics events and brain anatomy. It affords opportunities to learn through interacting with virtual objects leading to creating new cognitive schemata tied to situated learning instances. In conjunction to this, spatial perception and cognition such as acquiring navigation and localization skills within a VR environment may be codified and represented as third-person symbolic experiences increasingly supporting and amplifying a sense of social and self-presence[67,68]. Cooper and Thong highlights four distinctive elements of VR as an educational tool: (1) *Experiencing* as the ability of students to respond physically and emotionally to a range of stimuli, (2) *Engagement* as the multisensory experience that may enhance student's engagement, (3) *Equitability* as ways of responding to sameness and differences in schools and (4) *Everywhere* as offering exciting possibilities in relation to location, timeliness and how the learning process emerge[69].

Usual VR advantages listed in the literature are embodying, acting, repeating[70], and increasing motivation while learning compared to other media[26,71]. Yet, leaners' acceptance and learning instructions' creation are still restraining large adoption[65,72]. In education and training this can be explained by lack of on-campus experiments[73,74]. Globally, previous meta-analyses (2 studies), systematic reviews (1 study) and reviews (2 studies) documented VR efficiency for learning[26,70,71,75,76]. But, according to Lanier et al. experimental quality in VR is sometimes questionable due to the methodological challenges faced on the study design, data analysis reporting and disseminating the knowledge gained[77].

Within the issue of learning with VR in the context of a multimodal path, the ability to create efficient teaching and learning environments as well as strong experimental proofs depends on design principles that are applied.

## 3 Design principles for multimodal VR teaching, learning and training

Despite the considerable uptake of VR for learning and teaching, there is little, if any, evidence on design-focused studies that illuminate in-VR elements and features that focus on the affordances and constraints as well as the dynamics perpetuated to support multimodal teaching using VR.

An early study from Dickey[78] investigated the potential of a VR to support activity-based multimodal teaching and learning through an evaluative case study. VR elements that afforded an activity-based and multimodal approach to teaching included an in-VR *chat tool* as the primary means for presenting a concept for discussion. Responsive feedback and interaction with the students were the main learning affordances along with multimodal information presented as visual illustrations. Another affordance was granting unique names for students to establish *unique virtual identities* for maintaining control over the learning environment. Such virtual identities were inextricably connected with *avatar* representations[68]. Pre-selecting, modifying or creating new avatars helped students to distinguish their virtual appearance and learning about and coming to appreciate *design* in their efforts to apply design principles for creating their avatars by manipulating avatar objects, shapes, colours and attributes. Kinesthetics and point-of-view aspects for avatars to interact with objects, within the virtual learning space were directly linked with the provision of an 'avatar' mode for individual and collaborative activities. An integrated web-browser was also viewed as a feature that can instigate multimodal learning especially when connected to in-VR learning objects via sensors for allowing students to make relationships between the VR object and its underlying information found on the Web. This inter-connection between in-VR objects and information about them on the Web alludes to the employment of *distinct semiotic principle*[35]. Learning occurs through interrelations within and across multiple sign systems (symbols, objects, images, facts, information) as an inter-related and connected knowledge from different semiotic domains.

More recently, Doumanis et al. investigated the impact of a multimodal learning interaction of gamified tasks in a collaborative virtual world[79]. Multimodal interactions within the VR seemed to improve learning in comparison to the non-multimodal control group. Specifically, the multimodal interactions observed improved students' ability to generate ideas thus facilitated a sense of presence and immersion with the VR condition. Doumanis et al. triggered three types of immersion (e. g. spatial, emotional and temporal) aligned with VR features. Navigation in the VR world with speech control and virtual representation with an avatar along with access to information, user grouping, textual communication and dialogue log were central features for encouraging active, multimodal and critical, as opposed to passive and unimodal, learning. Principles of active learning were embedded in the use of the VR features creating certain dynamics and controlling essential features. For example, teachers should have full control of the VR classroom in terms of controlling student navigation or a "proxy option" to temporarily take control of a student's avatar as means to facilitate their effort to learn the system or grouping students for collaborative in-VR projects having students working in teams and taking on assigned roles. Therefore, VR allows more interaction opportunities for learners with peers, content (e. g. information) and objects (digital assets). Designing in-VR group dialogic learning experiences enables for distributed knowledge and collaborative problem-solving, encouraging perception of thinking and reasoning as inherently social processes. Designing VR elements creates learning situations for students to think with others by using and manipulating VR tools and places emphasis on the distributed knowledge product generated by a web of students working for resolving a common problem.

Innocenti et al. developed a virtual environment for learning how to play musical instruments[67]. Similarly, to Dickey[78] and Doumanis et al.[79], *navigation elements* is a key multimodal feature as means to provide spatial orientation cues for learning and usability aspects. For example, to mitigate VR sickness while students are interacting and manipulating 3D objects for designing a prototype or researching an object, *a virtual locomotion technique*[80] may be induced to offer natural, usable and efficient ways for multimodal driven activities to be navigated through and enacted in the VR environment.

Navigation elements need to be tied to in-VR collaborative scenarios for aiding students to perform tasks, set by the teachers or by peers, for practicing the intended learning outcomes. Collaborative scenarios may encompass pre-determined designs of the VP-space such as scaffold for helping the students to move within the VR environment, progressively learning how to interact with objects, making the in-VR goals clear and distinguishable and encouraging exploration, inquiry and observation of how the different modes reveal intended meanings. VR is a semiotic domain that triggers students to learn in different ways, applying an array of developmental skills and competencies as they move from one VR scenario to the next. The role of the teacher and the student within the VR space are changing depending on the scenario, as the general premise is that there is no single master of knowledge. Rather each member takes roles with associated skills to master such as being the researcher, developer, designer or project manager in different settings. In that way, people with varied skillsets and dexterities have the possibility to exchange their roles and learn from each other. As opposed to designing unimodal online learning environments (e.g. creating a moodle page for students to download content, developed by the teacher), VR scenarios may be designed in a way that afford both a *change in practice* but also a *change in identity*[81]. This can be done by distributing and re-distributing students into diverse VR groups, switching different roles interchangeably and sharing knowledge mastered from participating in previous VR groups through employing reciprocal problem-based in-VR learning scenarios. The premise is that there is no 'master' of knowledge in the sense that knowledge construction and especially knowledge building is a collaborative process through a network of people that distributes pervasive multimodal information, roles and responsibilities.

Multimodality as a context-based and situated learning instantiation may be designed for and represented through collaborative VR, as part of XR. The most common collaborative VR features are: (1) focusing attention, (2) connecting learners to the learning materiel[82]. Collaborative VR[83] may encourage multiple perspectives on a given phenomenon through conversation and interaction and joint construction of knowledge[65] (it echoes the four pillars of learning[84]) by providing feedback to facilitate the adoption of learning reflexes[23] and monitoring of scenario development; allowing Distant learning[85]. Such collaborative practices in VR may encourage the formation of social identities and viewing knowledge as a social construct developed through a network of individuals having common goals and interests[86]. By employing Collaborative VR teachers may design virtual places that afford collaborative learning processes that take social interactions into account offering a more diverse and richer forms of dialogue that would be challenging to design or construct in other learning environments[87]. Individually or collaboratively, VR allows for learning instances to be embodied (to be represented by an avatar)[88]. Such embodiment gives a unique dimension illuminating a learning by doing orientation rather than only passively memorising and acquiring information[70]. This offers richer and more diverse forms of dialogue and interaction between students and contextualized learning objects for vicarious forms of learning[89]. Being immersed in VR creates a sense of presence, it allows learning from each other and adapting performance in response to meaningful pseudo-natural feedback[90] generated from interactions with 3D-objects. Reflecting on this pseudo-natural-occurring feedback may cause to transform a daunting learning experience to a harmonious learning situation[91] which can improve learning effectiveness compared to other modalities[92].

VR allows unique teaching and learning experiences which, by design, makes it interesting to implement in existing multimodal paths. Currently, the industry may not always seize the opportunity to apply such design principles, yet VR is starting to be introduced in multimodal paths across different subject areas and disciplines.

## 4 Use cases: employing VR for multimodal teaching, learning and training

The purpose of this section is to illustrate the variability of VR application into existing learning paths with examples coming from the field, schools, universities and companies in France and Singapore. Some were implemented in France, others in Singapore, or both and in other countries as well. Accordingly, the games are available in several languages, as illustrated in the following Figures 1 to 12. Each example, connected to a general purpose, is described according to certain in-VR teaching and learning goals: knowledge transmission, practicing, feedback, evaluation. For each goal, we identify the activity which can be implemented. We distinguish the paths according to the nature of the VR experience that is integrated: Serious games, Simulations, Collaborative VR (see Table 1). **(1) Serious Game**[93] **section:** we describe several use cases integrating a serious game in VR, single player, including feedback to the player. The user is facing a situation with a non-playing character, embodied with an avatar or only a voice. Feedback are provided immediately during the game as well as at the end of the game and help the user to improve. Such application is particularly relevant to train soft skills, such as how to behave with a client, a patient, a colleague. (**2) Simulation**[94] **section**: we describe several use cases integrating Simulation in VR, which purpose is to provide a relevant representation in VR of a target system to be learned (a machine, an organ, a network, etc.). Such a tool is relevant to train users to interact with said system and learn procedural sequences or gestures. **(3) Collaborative VR**[95] **section:** we describe several use cases integrating Collaborative VR, i. e. a virtual environment where participants can join and are embodied with a personalized photorealistic avatar. Participants can be distant or in the same room. They can share immersive content, such as interactive 3D models, 360° videos or role-playing game.

Such paths, embedding VR experiences along with other activity-oriented multimodal activities, could infer specific in-VR features, representations and visualizations mapped with intended learning outcomes. In addition, the association of multimodal activity-based teaching strategies would enable both individual and collaborative practices in the wider semiotic VR domain within which they occur. Such deployments are being evaluated through quality of experience in order to collect user's state with such apparatuses[96].

## 4.1 Serious games in VR

### #1 Social norms and behaviour changes relating to discriminations

The VR tool is proposed as a **Practicing** activity opening a seminar to foster equality behaviour by managers, regarding gender, disability and diversity. In gender awareness scenarios, the user can play whether a man or a woman. The game points discrimination and stereotypes through dialogue choices the learner must complete. It is part of a general company awareness policy regarding gender inequalities, aiming at understanding how many stereotypes about women drive once thoughts in the work environment, and how much these stereotypes influence our choices when it comes to promoting women. Other scenarios relate to physical and cognitive disabilities as well as sexual orientation. Figure 1 illustrates 2 situations and the 3 options that are offered to the player, following the last statement of the Non-Playing Character (NPC), in English, as deployed in Singaporian company.

In this example, we aim at generating empathy by playing the role of some else, a woman or a disabled person. Using the same approach, we propose another application, which will be integrated as part of a Medical and Dentistry and resulting from a French-Singapore partnership. The purpose is to play the role of a child in the medical environment to better understand his.her point of view and anticipate his.her fear and anxieties. This application will be used for **Practicing**. Figure 2 illustrates the point of view of the child as a patient in different situations: on the dentistry chair (left) and during a discussion with the doctor and a parent (right). Clues in the field of view support the role of the child, such as the view of the child body (Figure 2, left).

**Table 1 Summary of the use cases described to illustrate how VR can be integrated into learning paths, contributing to Knowledge transmission, Practicing, Feedback and Evaluation, in connection with other tools and activities**

| General purpose | Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|---|
| #1 Social norms and behaviour changes in a company | **Practicing** | **Feedback** | Knowledge transmission | Evaluation |
| | **Role-playing** | | Lecture | Implementation of knowledge in real-life situation and measurement of behaviour changes |
| | **Individual activity** | | Collective activity | |
| | **Asynchronous** | | Synchronous | |
| | **VR Serious Game** | | Classroom | |
| #2 Shop organization at school | **Practicing** | Feedback | Knowledge transmission | Evaluation |
| | **Role-playing** | Debrief with teacher | Lecture | Paper & pen |
| | **Individual activity** | Collective activity | Collective activity | Individual |
| | **Asynchronous** | Synchronous | Synchronous | Synchronous |
| | **VR Serious Game** | Classroom | Classroom | Classroom |
| #3 Sales management in a company | Knowledge transmission | **Practicing** | Practicing | Knowledge transmission |
| | Lecture | **Role-playing** | Other digital and non-digital activities | Lecture |
| | Collective activity | **Individual activity** | | Collective activity |
| | Synchronous | **Asynchronous** | | Synchronous |
| | Classroom | **VR Serious Game** | | Classroom |
| #4 Customer relationship in a company | Knowledge transmission | **Practicing** | Feedback | Evaluation |
| | Lecture | **Role-playing** | 1-to-1 meeting | Flashcards, quiz |
| | Collective activity | **Individual activity** | Individual | Individual |
| | Synchronous | **Asynchronous** | Synchronous | Asynchronous |
| | Classroom | **VR Serious Game** | Online | Tablet |
| #5 Cybersecurity in a company | Knowledge transmission | **Practicing** | **Feedback** | **Evaluation** |
| | Lecture | **Role-playing** | | |
| | Collective activity | **Individual activity** | | |
| | Synchronous | **Asynchronous** | | |
| | Classroom | **VR Serious Game** | | |
| #6 Machine assembly in a company | Knowledge transmission | Practicing | Knowledge transmission | **Practicing** |
| | Lecture | Other digital and non-digital activities | Lecture | **Simulation** |
| | Collective activity | | Collective activity | **Individual activity** |
| | Synchronous | | Synchronous | **Asynchronous** |
| | Classroom | | Classroom | **VR Simulation** |
| #7 Driving trains in a company | Knowledge transmission | **Practicing** | Feedback | Knowledge transmission |
| | Lecture | **Simulation** | Debrief with supervisor | Lecture |
| | Collective activity | **Collective activity** | Collective activity | Collective activity |
| | Synchronous | **Synchronous** | Synchronous | Synchronous |
| | Classroom | **VR Simulation** | Online | Classroom |

(*To be continued on the next page*)

***(Continued)***

| General purpose | Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|---|
| #8 Brain anatomy at school | Knowledge transmission | **Knowledge transmission** | **Practicing** | **Evaluation** |
| | Lecture | **Simulation** | | |
| | Collective activity | **Collective activity** | | **Individual activity** |
| | Synchronous | **Synchronous** | | **Asynchronous** |
| | Classroom | **VR Simulation** | | |
| #9 Process engineering at school | Knowledge transmission | **Knowledge transmission** | Practicing | Evaluation |
| | Lecture | **Lecture** | Group assignment | Paper and pen |
| | Collective activity | **Collective activity** | Collective activity | Individual |
| | Synchronous | **Synchronous** | Synchronous | Synchronous |
| | Classroom | **Collaborative VR** | N/A | Classroom |
| #10 Particle physics at school | Knowledge transmission | Practicing | **Knowledge transmission** | Feedback |
| | Lecture | Group assignment | **Lecture** | Lecture |
| | Collective activity | Collective activity | **Collective activity** | Collective activity |
| | Synchronous | Synchronous | **Synchronous** | Synchronous |
| | Classroom | Computer | **Collaborative VR** | Classroom |
| #11 Leadership skills in a company | **Knowledge transmission** | Practicing | **Practicing** | **Feedback** |
| | **Lecture** | Group assignment | **Group assignment** | **Lecture** |
| | **Collective activity** | Collective activity | **Collective activity** | **Collective activity** |
| | **Synchronous** | Synchronous | **Synchronous** | **Synchronous** |
| | **Collaborative VR** | N/A | **Collaborative VR** | **Collaborative VR** |

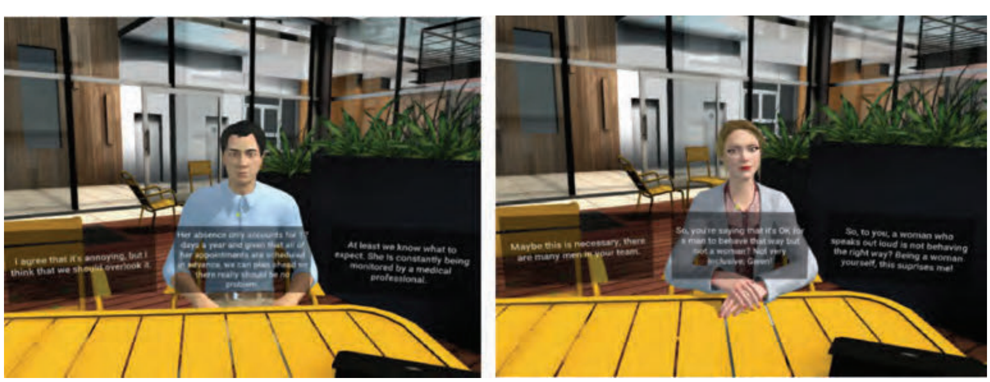

**Figure 1 Single user serious game in VR for social norms and behaviour changes relating to discriminations.**

## #2 Shop organization

The VR tool is proposed as a **Practicing** activity opening a course in a business school to train students to customer relationship management in a shop. The VR game, including an individual feedback, is played in the classroom and followed by a general discussion with the teacher. Then evaluation takes place using traditional paper and pen methods, in the classroom. This program organization is very close to the previous one, although it takes place at school. Figure 3 illustrates the overall view of the shop (right

**Figure 2 Single user serious game in VR for management of child in the medical and dentistry environment for medical students in France and Singapore.**


**Figure 3 Single user serious game in VR to learn non-conformity in a shop.**

picture) and a zoom on a particular shop area, juice machine, where actions are required from the player (left).

**#3 Sales management and shop organization**

The VR tool is proposed as a **Practicing** exercise on top of other applied exercises of a one-week training program for future shop managers. Learners play one half of a day a serious game training them to the management of costumers' satisfaction. The purpose is to be able to answer questions for the best customer service experience possible. The game allows learners to memorize typical issues customers can encounter in respect with companies wording and policy. Figure 4 illustrates the shop where the game takes place (left) and the client NPC the player is interacting with during the game (right). The red dot represents the player gaze direction allowing the interaction with the environment, such as the selection of answers.


**Figure 4 Shop management and selling skills use case.**

### #4 Customer relationship management in hospitality industry

The VR tool is proposed as a **Practicing** exercise embedded in a path for developing skills for front desk employees in the hospitality industry. The overall program also includes several individual debriefing sessions with a trainer, who can be distant from the trainee, flashcards to contribute to the retention. The entire path is validated through an assessment quiz certifying learning (retention). Figure 5 illustrates several situations of the game: with 2 client NPCs and 4 possible answers from which the player has to select (left, in English) and a single client NPC (right, in French). A "pause" button is shown as well as the score, showing the player progression in the game. This score contributes to immediate feedback to the player, indicating whether the selected answers are good or not regarding the quality of the customer relationship management.

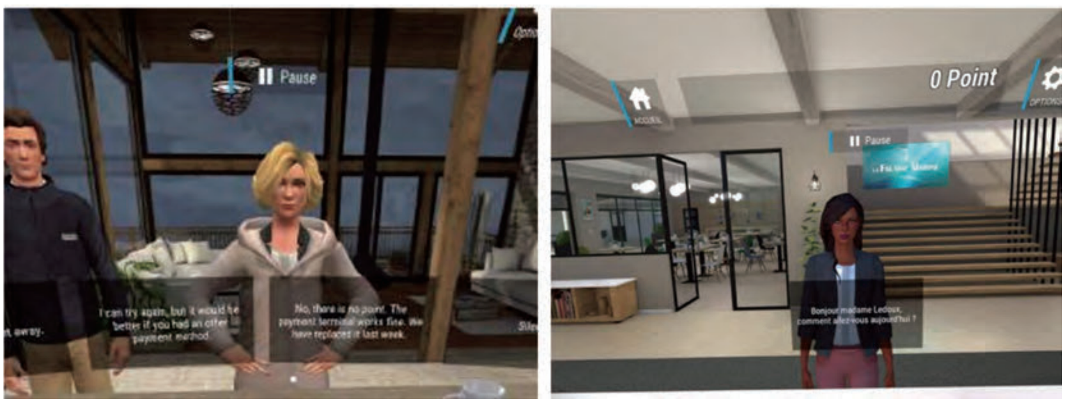


**Figure 5　Hospitality industry customers management use case.**

### #5 Cybersecurity rules

The VR tool is proposed as a **Practicing** and **Evaluating** activity, used as a closing applied exercise. The serious game consists in playing a thief trying to steal sensitive and confidential information from PCs, USB memory device but also paper notes. The purpose, as a player, is to steal as many information as possible during a short period of time. Learners' identify sensitive information unprotection behaviours. The game also provides feedback and an evaluation of the player. In this context, the VR game is added to a face-to-face (physical) training program for any worker in companies for them to learn cybersecurity rules. Figure 6 illustrates some objects the player can interact with to determine those that can present a risk regarding cybersecurity, these objects are identified with yellow circles. This learning scenario is implemented in France, in Singapore and other countries.

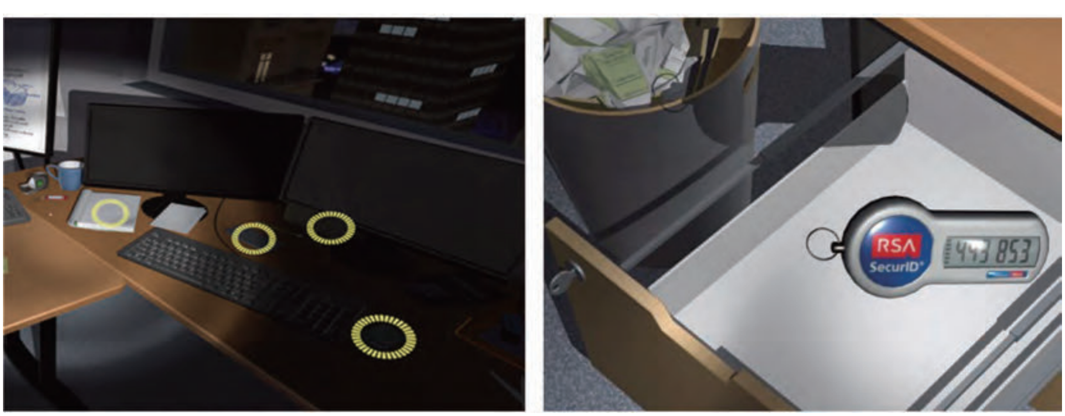


**Figure 6　Playing a thief trying to access sensitive data (e.g. passwords and strategic documents), cybersecurity use case.**

## 4.2 Simulation in VR

### #6 Machine assembly in the pharmaceutical industry

The VR tool is provided as a **Practicing** and **Evaluating** activity among multiple applied exercises in a training program for operators on production line in pharmaceutical industry. The VR consists in a simulation of a true machine with the actual procedure for performing assembly task. Each step is written and an agent (a voice) is guiding the player step by step through the process. The purpose is to allow learners to get confronted with the actual machine and pieces before doing it in real life. Several modes allow progressive learning: a guided and a semi-guided mode for **Practicing** and non-assisted mode for **Evaluation**. The training program also includes several activities, collective and individual. Figure 7 shows game interface elements: the different steps of the game are presented on the left picture, showing the player is currently playing step 1, instructions are presented to guide the player (here "take the grease tube and grease the joints"), the objects required for the action are highlighted with blue halo (here the joints and the grease tube), on the right picture the player can see his/her hand manipulating the spanner.

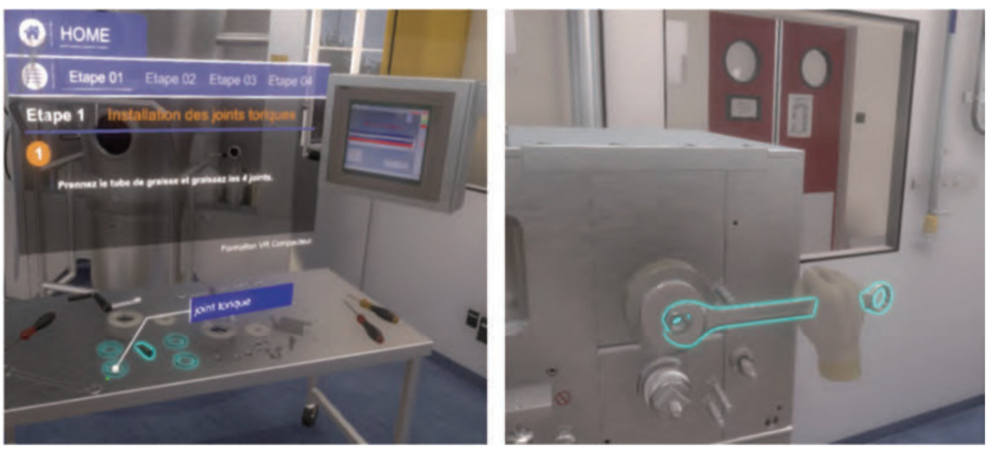


**Figure 7 Machine assembly in the pharmaceutical industry use case.**

### #7 Distant multimodal serious game for train driving

The VR tool is proposed as a **Practicing** exercise for two players integrated into a training program for developing skills communication skills along an inter-job process. In two different VR environments, one learner is driving the train while the other learner is communicating at distance from the Control place to give indications to the driver. During that time, the trainer is supervising the simulation without intervene. The trainer is annotating the scenario so he can do a debriefing of specific points with learners after the simulation. The purpose is to make learners memorize procedures while communicating and driving a train. Figure 8 illustrates the game environment.

### #8 Brain anatomy using on neuro-imaging reconstruction

The VR tool is provided as a **Practicing** tool, which can be used by neurosurgeon students to get used to brain anatomy and 3D manipulation. VR is added to help student to improve their 3D navigation skills, it consists in merged neuroimaging from patients' brain, with addition of artefact mimicking tumours. Students have to identify their precise localization and size. A collaborative mode allows teachers and students to use the application collectively. Such application contributes to downing and replacing part of real brain tumour surgery training. Figure 9 shows the user interface with a measurement tool (left) and the control panel to set the various display parameters (right). The controllers are represented in the virtual environment to facilitate the manipulation and interactions.

**Figure 8  Procedure and distant communication for train driving, view of driver (left), view of operator (right).**

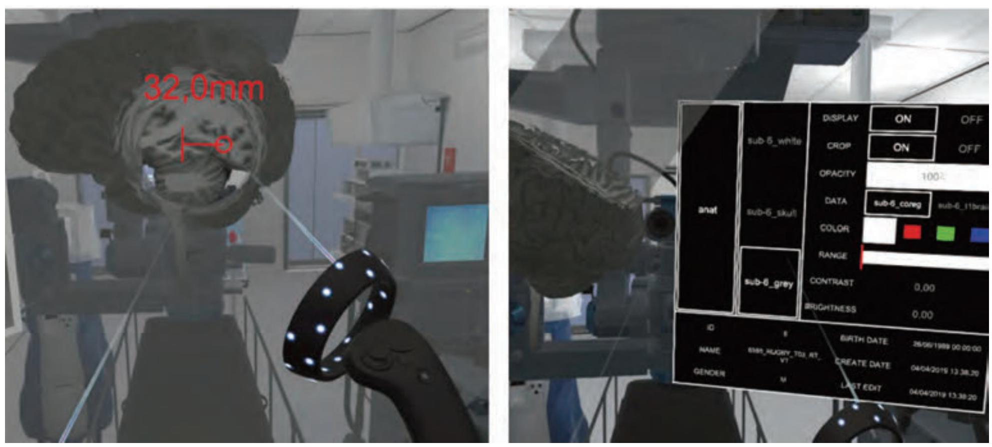


**Figure 9  Brain tumour detection and measurement for surgery preparation based on neuro-imaging data.**

### 4.3  Collaborative VR

#### #9 Process engineering in biology

The collaborative VR tool is provided for **Knowledge transmission** as an innovative medium to share contents relating to process engineering in a common virtual environment, with students and teacher located in the same classroom. The course takes place in an engineering school. The VR is added as a new mode of the pedagogical multimodal path, integrated with traditional lecture, group assignment, and pen and paper evaluation. Figure 10 shows the setup of the students in the classroom (left) and the setup in the virtual classroom (right).

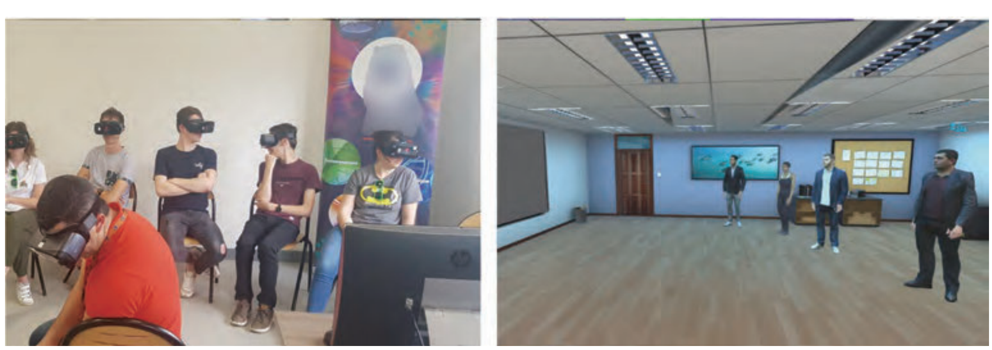

**Figure 10  Collaborative VR for a lecture on process engineering in pharmaceutical industry.**

#### #10 Bases of particle physics

The collaborative tool is provided for **Knowledge transmission** as a new mode of the pedagogical multimodal path, allowing to share immersive content (3D interactive models and 360° videos and pictures). The purpose of using VR is to allow students to better understand the actual dimensions of equipment used in particle physics (i.e. colliders) and have a more realistic representation of the experimentation site, without physically visiting Switzerland. During a regular session, high-school students follow introductory courses to particle physics in the morning, then individually sit in front of a computer to identify and sort real particle-collision events. They finish by sharing and piling up their results (together and with other classes around the world), to reach and experience the statistical methods and thresholds of particle discovery. VR is used to lecture students about the real size and lay-out of the gigantic apparatus that allow particle discoveries: an interactive 3D sketch of the CMS (Compact Muon Solenoid) detector (the lecturer and students are teleported to scale on the CMS detector) with particle collision events and then 360° images and video to show the "real" images. The main advantage is to show an environment that cannot be illustrated in a regular classroom, because of its size and inaccessibility. Figure 11 shows the setup of the students in the classroom (left) and the setup in the virtual classroom (right). A view of the virtual environment is shown on the screen in the physical classroom for non-VR participants. The 3D model is shown at real scale, so that the students can better measure it.

**Figure 11 Collaborative VR lecture about particle collision and representation of collider.**

#### #11 Management techniques and behaviour in a multinational company

The Collaborative VR tool is added at different time points for **Knowledge transmission**, **Practicing** and providing **Feedback** as a communication tool in a multimodal path. The general purpose of the training program is to promote learners' leadership skills. It is implemented in an international company with managers from several countries. The use of VR allows participants to connect more easily and regularly without needs for traveling. The trainer can control participants' audio, allowing everyone to hear each other or isolating tables from each other for specific activities. This program has notably been implemented with an international company with 34 managers from 13 countries in Asia-Pacific area, including Singapore. Figure 12 illustrates the view of the virtual environment from the desktop interface of the trainer. It shows the participant list and allows the management of the participants groups (the "tables").

## 5 Conclusion and perspectives

### 5.1 Recent technical progresses and impact on design of future VR experiences

In this paper, we highlight the connection between VR learning and multimodality and the instruction concepts related to it. This paper concentrates on VR but new hardware allow varying degree of "virtuality"[97].


**Figure 12 Collaborative VR for training distant managers.**

New generations of VR HMDs also offer AR modules with a "see-through" capability for rapid switch from computer generated environment to real environment and any mixture thereof. These features rely on external cameras able to capture the surrounding environment (e.g. HTC Vive Cosmos XR HMD and Vive Sync application; Varjo XR-1 HMD[98] and Varjo Worspace environment, Lynx-R1 HMD[99]). Simultaneously, new kinds of interactions are being integrated into consumer HMDs, this includes eye tracking, hand tracking, voice tracking and body tracking. Haptics and brain computing are also fields undergoing rapid progress and will be launched soon. All these technologies enable Natural User Interface[100]. This comes along with deployment of 5G networks and possibility for streaming and cloud-based application architectures. This is already used for gaming, this will soon benefit to VR. Shadow, a cloud gaming platform, is launching what it calls a "VR Exploration Program", i.e. a closed beta test for VR streaming[101]. These new generations of HMDs combined with opportunities of beyond-5G networks will allow the development of genuine Mixed Reality experiences with fully natural interactions. Changing the habits may take time, said Alvin Graylin, CEO of HTC China, but for the benefit of users. Hardware companies' strategies thus strongly impact the design of learning and teaching solutions that can be developed in France, in Singapore and globally.

## 5.2 Could physical distancing be a catalyst in VR/XR adoption?

This paper concentrates on learning and teaching but in the COVID-19 crises context, other uses of XR are wildly discussed. Prior to that crisis, VR was still emerging in some sectors. Several factors are limiting the adoption, including the cost of equipment and complexity of implementation. From a business point of view, these limitations to adoption may be observed both in France and in Singapore. In contrast, adoption of mobile technologies is much more significant, in line with the smartphone mobile equipment rate. While the future of VR was highly associated with entertainment and gaming in some recent market studies[102], one may expect that these trends will be impacted by the current context of physical distancing and climate issues. Therefore, it could be assumed that the evolution of the VR and XR technologies will support the development of new experiences for remote working, authentic and content rich mediated learning and healthcare contexts. Limiting people travels is a key aspect of the strategy to control pandemics, such as COVID-19 that emerged in Asia at the end of 2019 and spread in all continents in 2020. It impacted a wealth of events globally, such as the Mobile World Congress and Vivatech in Europe, the Game Developers Conference and Facebook F8 Developer conference in the USA, the International Conference on Learning Representations in Africa and CES Asia in Asia. Some events have decided to take the context constraints as an opportunity and proposed a virtual version of the event. It has been the case of the $V^2EC$ 2020, the Virtual VIVE Ecosystem Conference that was planned by HTC in China in March[103] and Laval Virtual planned in France in April[104]. These are in line with preliminary attempts such as the IDC conference hold in the Netherlands in September 2019, with the IBC 360 Live system initiated by Tiledmedia and Intel to live stream the five-day IBC 2019 conference globally in 8K, 360° virtual reality[105]. Of note, the use of VR for remote interaction, as described in use case #11 allows to significantly reduce traveling costs. As a consequence, the initial investment for individual equipment can be rapidly amortized.

The impact of sanitary constraints has been significant, and it may last for 18 to 24 months more from now at a certain level. This will induce deep changes in habits notably with the support of technologies precluding a return to what the world was before COVID. Some describe a fully digital world, where XR technology will be the must-have, that's the position of Alvin Graylin, HTC China CEO. At least for the coming years, an adoption phase will be characterised by coexistence in hybrid systems, for instance with organisation of physical events with virtual version, increased use of home office and flex office, blended learning with on-campus and remote learning, etc.

More than 70% of the world's students' population have been impacted by the pandemic and the closures of schools, estimates UNESCO[106]. The next school year may also be significantly impacted. This situation has revealed strong inequalities among Teaching systems regarding their digital maturity and their capacity to ensure pedagogical continuity. Although digital tools can bring significant advantages, for remote learning context as well as with the personalisation of education that undoubtedly bring support to students in difficulties, a strong private-public partnership will be essential to design and transform the Education system, says Marie-Christine Levet, CEO of Educapital, the first European Edtech VC fund[107]. This transformation will require support and training of the teachers and parallel adaptation of the technologies to their specific needs and requirements. Additionally, to hold the promise of a digital society, for learning, working and any other activities, XR technologies must be fully inclusive, and ensure accessibility to everyone, despite disabilities, would they be cognitive or physical. In this context, experimentation is the key to evaluate how technologies can be integrated into the teaching practice, especially in a multimodal perspective.

### 5.3 Conclusions and agenda for future research

This paper stipulated a review on designing and using VR for multimodal teaching, learning and training. VR and XR are highly versatile tools, which can be used for collaborative or individual activities, with distant or physically related participants at any step of the learning process: knowledge transmission, practicing, feedback and evaluation. We have described three main types of tools based on VR: Serious games, mostly for soft skills training, Simulation, mostly for procedural learning and Collaborative VR for immersion with innovative content and to facilitate interactions between distant participants. These are only a few examples and the advent of technologies will allow to combine them more easily (e. g. collaborative Serious Game and Simulation). The concept of Adaptive learning and Deep learning are also progressing along which will allow to create even more personalized and interactive learning experience as well as to provide indicators of individual progression to the trainer. However, we also identify a lack of robust evaluation framework to evaluate how these tools can be used in an optimized way and generate relevant synergies with existing tools, for the benefit of users: trainers and trainees. Our purpose is therefore to increase researchers' attention in terms of designing VR experimentations that could be inspired by the use cases we have described. Moreover, insights from this paper motivate us to list a certain number of research issues that need to be tackle. They are particularly aiming to apply scientific findings to the filed by pushing specific matters:

-How to design learning in VR based on a multimodal strategy?

-How to collect and analyse user data obtained in VR to discern a multimodal path?

-How to determine whether a VR system should replace or complement an existing multimodal teaching and learning intervention enacted in the classroom?

-What learning taxonomies may be mapped as means to enable in-VR multimodal teaching and learning for hybrid or purely online and distance forms of teaching and learning?

A gap seems to be prevalent between scientific knowledge and industrial practices when VR is deployed in multimodal learning paths. Communicating about use cases and choices that have been made might help to create a framework facilitating the process of mapping multimodality to in-VR features and components.

**Declaration of Competing Interest** The authors declare no competing financial interest.

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RESEARCH ARTICLE

# Using Immersive Virtual Reality in an Online Biology Course

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## Abstract

Interest in virtual reality (VR) for teaching and learning in higher education is growing, given its many potential applications. VR offers a socially interactive environment with novel ways to engage students with materials, objects, and activities and provide students with experiences such as "field trips" that would be otherwise very difficult. Preliminary work indicates overall positive gains in student learning across disciplines compared to other technology and traditional techniques, although more studies are needed to better our understanding of this tool. We employed an "immersive" VR (with a head-mounted display) in an online course which provided students with the opportunity to interact with peers and engage in activities. We asked about perceptions of the learning experience with the technology and how using VR impacts students' performance. We also noted the benefits and challenges of VR in an online course. Students perceived VR as a helpful component of the course, although performance on the cardiovascular unit assessment did not differ compared to the previous semester without VR.

**Keywords** VR · HBCU · Remote learning · Oculus headset · Undergraduate · Non-major

## Introduction

Virtual reality (VR) technology is increasingly being considered by educators to be a pedagogical tool that can be adopted for improved student learning (Fowler, 2015; Kwun et al., 2019; Matovu et al., 2022). Although it is still primarily considered for entertainment (e.g., gaming), VR has long been recognized as a teaching tool in the military for flight simulations and scenario exercises (Hawkins, 1995). VR can provide an interactive and engaging experience for students via a desktop computer,

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tablet, or smartphone, or the use of a head-mounted display, such as Meta's (formerly Facebook) Oculus Quest 2 (https://www.oculus.com) (Wohlgenannt et al., 2020). With the head-mounted display, students can only see the virtual environment with a 360° view and sound, which gives the users a strong sense of presence and is referred to as "immersive" VR (Wohlgenannt et al., 2020). Furthermore, headset-delivered VR allows students to interact with peers, manipulate and build new objects, and virtually "touch" objects that they might not have access to in their classroom due to various limiting factors. For instance, students can travel through parts of the human body or visit sites across the globe. Without VR, providing similar learning experiences to students would be challenging in real life (Dalgarno & Lee, 2010).

In higher education, VR has been most widely employed in engineering courses to enhance procedural-practical knowledge (i.e., knowing how to perform a task) (Radianti et al., 2020), as well as in medical fields for teaching anatomy and skill training (e.g., surgical performance) (Portelli et al., 2020). Yet, examination of the effectiveness of VR (via desktop and headset) in enhancing student outcomes in higher education shows mixed results (Coban et al., 2022; Matovu et al., 2022; Wu et al., 2020). A meta-analysis examining studies focused on medical student gains in anatomy knowledge with VR showed a moderate improvement in test scores compared to students who used textbooks, 2D images, or 3D models (Zhao et al., 2020). On the other hand, meta-analyses of student learning across various disciplines showed no difference in the use of VR versus traditional training methods (Kaplan et al., 2021). It is important to note that the number of studies remains low, and conclusions about the effectiveness of the technology are premature. Furthermore, the study design and learning goals vary considerably from gaining a procedural skill to content knowledge (Coban et al., 2022), making general conclusions about VR in higher education difficult.

Interestingly, the use of VR in education has shown the greatest learning gains in the architecture, engineering, and geometry fields, where the use and practice of spatial abilities are important (Coban et al., 2022). Thus, VR might be particularly beneficial for learning about 3D objects that are oversimplified in textbooks and graphical depictions used for teaching (e.g., the human heart). Many of the misconceptions that persist through professional studies about the cardiovascular system might stem from oversimplification of 2D visual aids (Ahopelto et al., 2011; Kaufman et al., 2013; Södervik et al., 2019). Indeed, spatial relationships of anatomical structures in complex 3D objects, such as the heart, are challenging to learn (Nakai et al., 2022). Given that VR provides 3D visual displays which can be manipulated and observed from various angles, using this technology for teaching and learning anatomy and physiology might hold advantages compared to traditional 2D interfaces (Maresky et al., 2019; Shelton & Hedley, 2004). In addition, using VR with 3D representations might assist in the development of spatial thinking (Carbonell Carrera & Bermejo Asensio, 2017), which is considered a critical skill for students in STEM (Uttal et al., 2013). Considering these benefits, exploring the potential benefits of immersive VR in learning about complex structures is imperative.

Effective integration of a new technology in a course necessitates student buy-in. For example, when computers and the Web first made their way to the classroom, student attitudes towards the technology in respect to learning predicted their adoptions (Halpin & Myers, 2002; Huang & Liaw, 2005). In relation to immersive VR as a novel educational tool, previous studies indicate that positive attitudes and perceptions towards it (Domingo & Bradley, 2018; Kavanagh et al., 2017) can in turn positively impact student gains and performance (Georgiou et al., 2021; Tsivitanidou et al., 2021). Yet, using new tools which are highly demanding for students to learn to use and navigate, as may occur with using headsets with controls for immersive VR, is likely to be met with tepid enthusiasm. Given that immersive VR is known to cause cybersickness, or nausea and dizziness, for some users (Nesbitt et al., 2017), student perceptions of the technology are likely mixed. Despite the negative sensations learners can experience, recent work suggests that students perceive immersive VR in online courses positively (Duncan Vaidya & Stevenson, 2021). Thus, assessing student perceptions of immersive VR when integrated into learning experiences, particularly in novel environments such as remote courses, warrants assessment and further exploration.

A new and considerably less common application of VR is in online courses (Atkins et al., 2020). With the increased use of the online environment for teaching since the onset of the COVID-19 pandemic, yet dwindling enthusiasm for the use of video conferencing, "Zoom fatigue" (Nadler, 2020), and challenges associated with distractions and focus (Peper et al., 2021), solutions for engaging students online are needed. Given the possibility of immersive VR to provide a socially interactive environment, the technology might therefore offer a solution for increasing student engagement in online courses (Fromm et al., 2021) and provide much-needed social interactions in a remote setting. Furthermore, immersive VR is expected to have positive impact on student learning of complex 3D structures, yet such effects remain largely unexplored in online classrooms.

The research questions (RQs) guiding this work are:

RQ1: What are student perceptions of immersive VR in an introductory non-major biology course delivered *online*?
RQ2: Is there evidence that VR positively impacts student performance in an introductory non-major biology course delivered *online*?

We gauged student perceptions of VR technology using short surveys consisting of closed-ended, Likert scale responses. We examined whether a lesson in VR on the cardiovascular system resulted in better student performance on an assessment compared to the previous semester which was delivered online but did not include VR sessions. Finally, we identified unique ways and opportunities in which VR can be utilized, as well as the drawbacks and challenges of an online biology course.

## Methods

### Participants

We incorporated VR activities in our first-year non-major biology course with 20 undergraduate students, most of whom were first-year and transfer students. All students were males enrolled in Men's Health (Majewska et al., 2022), a course at Morehouse College, Atlanta, GA, USA, a historically black college.

## Procedures

We launched the immersive VR activities in Spring 2021. As with all other course activities, we used a backward course design to develop the lesson plans based on student learning outcomes for the VR sessions (see examples in supplementary information). The course was taught online due to restrictions associated with COVID-19. Students registered for the courses without the prior knowledge that the course would include activities facilitated in VR and none had used VR headsets for educational purposes prior to the course. The Institutional Review Board approval (IRB—570,002,057) was obtained from Morehouse College for this study.

Students and instructors used the Oculus Quest 2 headset and associated handheld controllers, powered by the Qualcomm Snapdragon XR2 Platform. The headsets were shipped directly to each student. The objects, digital Morehouse campus, and other VR environments (e.g., wet lab; Fig. 1A) used in the course were created

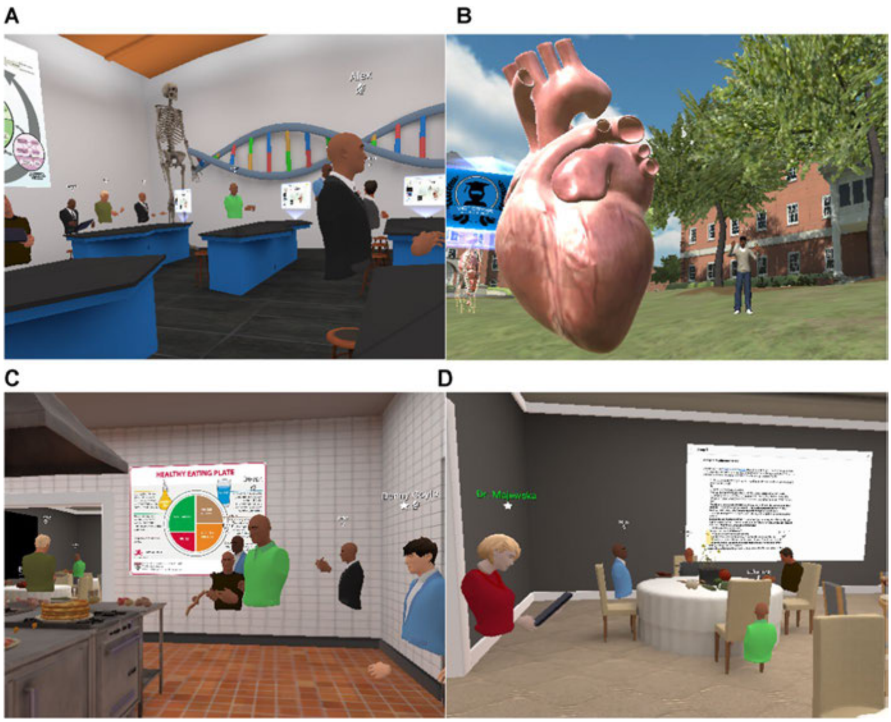


**Fig. 1** Examples of VR environments and objects. **A** Students seated in a "wet lab" classroom. **B** Examining the human heart on the virtual Morehouse campus quad. **C–D** Healthy diets lab activity in the industrial kitchen and adjacent dining room. Note that the avatars consist of torsos and hands; only the main host has an avatar with a full body (image **B**)

by content provider VictoryXR Inc (https://www.victoryxr.com/), hosted on the ENGAGE platform (https://engagevr.io/). VictoryXR staff facilitated training sessions with the instructors both as a group and independently to focus on specific aspects of each activity. Training sessions were necessary for instructors to develop facilitator skills via the handheld controllers and classroom management tools (teleporting, summoning, 3D audio). Additional online training by VictoryXR was available on YouTube for independent learning. We launched a “soft” start of the VR environments with VictoryXR staff prior to instruction with students, which allowed us to gain additional comfort with VR classroom management and object manipulation. VictoryXR assisted with the onboarding of students and “sat in” on initial sessions to offer students additional support and provide technical assistance.

We announced the upcoming VR sessions during class meetings on the online learning management system (Blackboard), and via email ahead of class time. Most of the VR sessions took place during the 2-h lab section of the course, which provided us sufficient time for any potential issues that could arise and for additional time to increase VR stamina given that initial use of VR can result in dizziness and motion sickness (Park & Lee, 2020). For each VR session, we first met on Zoom, provided an overview of VR activities, and transitioned to the headsets. We referenced the presence in VR environments as being on the digital Morehouse campus. The platform we used required an instructor-created link to join the VR session. For the first VR session, students were joined by VictoryXR staff on the VR Morehouse campus quad (a VR environment) and were given instructions and practice time on how to use the handheld controllers to move around the VR environment and add, resize, and manage VR objects.

We used VR to deliver several activities, including lessons on HeLa cells, cancer, the cardiovascular system, healthy foods and nutrition, the scientific method, and group project presentations (Fig. 1; for example lesson plans; see supplementary information). Each session was between 15 and 30 min and started with the students in a VR environment of the instructor’s choice (e.g., industrial kitchen, Fig. 1). Besides utilizing VR environments, we incorporated a “field trip” to the ocean in which students were asked to identify dependent and independent variables of a MythBusters (television program) experiment. This activity was part of our overarching aim for students to understand the scientific method. As part of the activity, students were able to virtually experience swimming with sharks in the “MythBusters: Underwater Shark Experiment. Are sharks repelled by the essence of dead sharks?” which can be viewed in the headset as a 360° video (https://www.youtube.com/watch?v=g_WZncx-Baw). The video was embedded into the VR environment, and viewing was controlled by the instructor, such that the video could be paused and the instructor verbally asked the students questions. Following the class time with a VR session, instructors reflected on the activity and recorded notes on the benefits and challenges encountered.

For the cardiovascular system unit of the course, we held a session in VR examining the anatomy of the heart. We began the session with students on the VR campus lawn where an enlarged transparent human body with a visible pulmonary and cardiovascular system was displayed. We also included a standalone enlarged human heart (Fig. 1B). We first provided a brief verbal description of the function of the cardiovascular system and explained the flow of oxygenated and deoxygenated blood through the system using the transparent human body as a visual aid. Next, we invited students to “walk” inside the enlarged heart while we pointed out the main anatomical features (e.g., atriums, ventricles, valves) and explained blood flow through the heart. Students were then asked to explore the exterior and interior heart anatomy.

## Data Collection and Analysis

### RQ1: What Are Student Perceptions of VR in an Introductory Non-major Biology Course Delivered Online?

We gauged student perceptions of VR in this course with short in-class surveys and an end-of-semester evaluation consisting of closed-ended Likert scale responses (Table 1). Participation in the surveys was voluntary. For in-class surveys, in the last 5–10 min, students were asked to answer questions (administered in VR) to gauge student perceptions of three sessions (weeks 4 to 6; Table 1). Survey questions asked during VR sessions were not validated. We did not administer surveys during each VR session in order to not overwhelm the students. To assess whether survey scores for each question differed between the three weeks, we used a simple linear regression with the score as a response and the week of the session as an explanatory variable.

During our last VR session, we administered an additional six-question survey to ask students about their perceptions of the previous VR sessions (Table 1). We also used the end-of-semester course evaluations which were administered to in part assess student perception of the overall VR experience (Table 1). The course evaluation questionnaire is based on the IDEA Student Ratings of Instruction and is validated (Benton & Li, 2017). The evaluations were distributed via Blackboard prior to the last class session.

### RQ2: Is There Evidence that VR Positively Impacts Student Performance in an Introductory Non-major Biology Course Delivered Online?

To assess student learning of the cardiovascular system, 3 days following the cardiovascular lesson in VR, students completed a quiz (eight questions administered on Blackboard). The same quiz was completed by students in the previous semester, who received a lecture on the cardiovascular system delivered via PowerPoint presentation on Zoom. We compared two semester scores students earned using a Wilcoxon test since the scores were not normally distributed as revealed by the Shapiro–Wilk normality test (semester 1: $W = 0.84$, $p = 0.006$, semester 2: $W = 0.73$, $p < 0.001$). All statistical analyses were performed using R programming (R Core Team, 2022).

**Table 1** Closed-ended survey questions and evaluation prompts administered to students to gauge their perceptions of VR experiences

| a. Questions (on weeks 4–6) | Likert scale |
|---|---|
| Q1: How smooth was the process to get onto the digital Morehouse campus? | 1 to 4: 1 hardest to 4 easiest |
| Q2: How much problem did you have with nausea while in the headset? | 1 to 4: 1 no problem to 4 very bad |
| Q3: How was the use of virtual reality in conveying the concepts of the class? | 1 to 4: 1 not-useful to 4 very-useful |
| b. Questions (on last VR session) | Likert scale |
| How was the use of virtual reality in conveying the concepts of HeLa cells (guest lecturer) (S1)? | 1 to 4: 1 not-useful to 4 very-useful |
| How was the use of virtual reality in conveying the concepts of cancer (S2)? | |
| How was the use of virtual reality in conveying the concepts of cardiovascular system (heart lab) (S3)? | |
| How was the use of virtual reality in conveying the concepts of healthy food and nutrition (diet lab) (S4)? | |
| How was the use of virtual reality in conveying the concepts of scientific method (scientific method lab) (S5)? | |
| How would you rate your overall experience with VR in this course? | 1 to 4: 1 terrible to 4 awesome |
| c. Prompts (end-of-semester evaluations) | Likert scale |
| Rate the effectiveness of using VR environments in facilitating your learning | not at all effective, slightly effective, moderately effective, very effective, extremely effective, and not applicable |
| Rate the effectiveness of using VR field trips in facilitating your learning | |
| Rate the effectiveness of using VR to create and manipulate objects in facilitating your learning | |
| Rate the effectiveness of using VR for group activities and presentations in facilitating your learning | |
| Rate the effectiveness of using VR, the overall experience, in facilitating your learning | |

## Results

### RQ1: What Are Student Perceptions of VR in an Introductory Non-major Biology Course Delivered Online?

The in-class surveys which we administered at the end of a VR session in the headsets received eleven to twenty student responses. Results suggest that students did not find the transition to headsets to be difficult (Q1; Fig. 2A). Also, students scored nausea as a moderate problem (Q2), with scores significantly decreasing by week 6

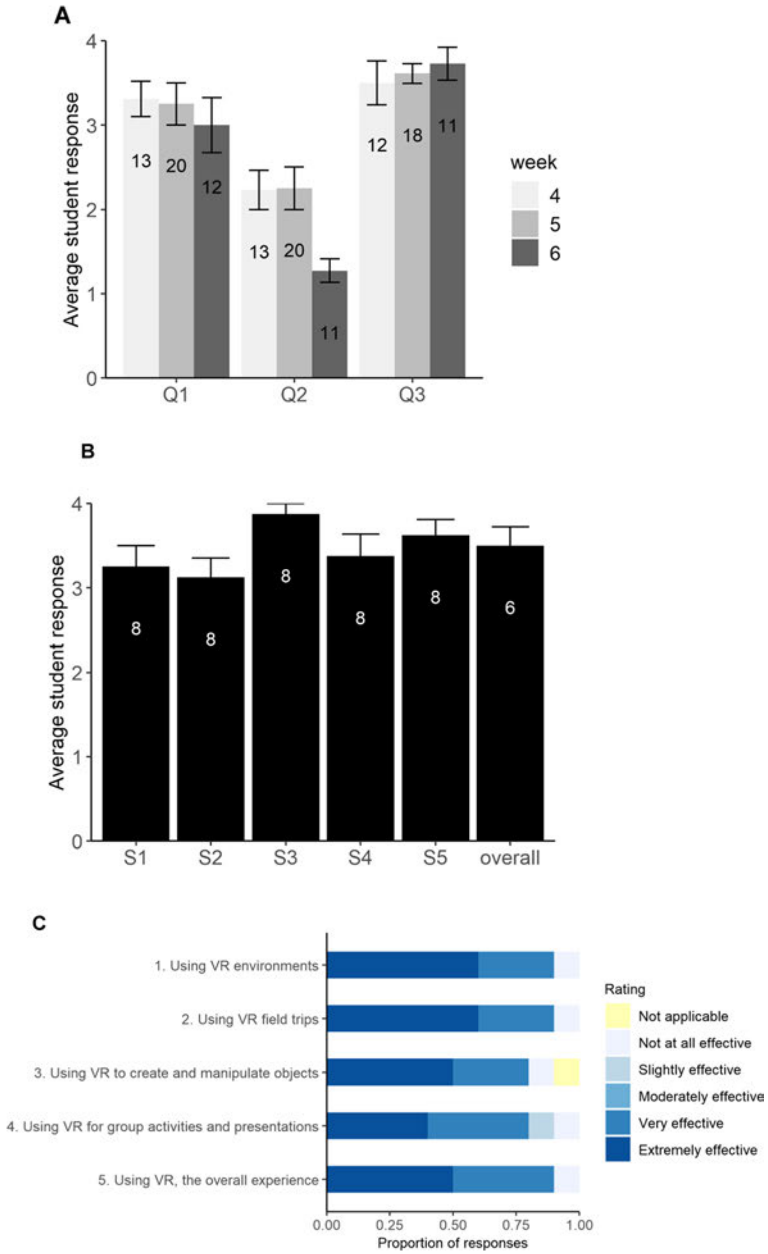


**Fig. 2** Average student responses to survey questions administered during virtual reality sessions on **A** weeks 4 to 6 and on the **B** last virtual reality session of the semester. Numbers inside the bar represent the number of student respondents. Error bars represent ± standard error. **C** Results of end-of-semester evaluations (administered on Blackboard) on the perceptions of the immersive virtual reality class experience. Survey and evaluation questions are provided in Table 1. Ten students completed the end-of-semester course evaluations

($t = -2.56$, df $= 41$, $p = 0.01$; Fig. 2A). Finally, student indicated VR was useful in conveying class concepts for the given week (Q3; Fig. 2A). Average scores did not differ between sessions for Q1 and Q3 ($p > 0.05$). The in-class survey administered during the last VR session received six to eight student responses and showed that the respondents found VR generally useful for the course (Fig. 2B).

Ten of the twenty students enrolled in the course completed end-of-semester evaluations. Results suggested that respondents found the different components of the VR session to be effective in their learning (Fig. 2C). Overall, respondents indicated VR was a helpful component of the course.

### RQ2: Is There Evidence That VR Positively Impacts Student Performance in an Introductory Non-major Biology Course Delivered Online?

The average score on a cardiovascular assessment for students in a course with VR was 8.50 points ($n = 14$ students; SD $= 1.61$) and without VR was 7.44 points ($n = 18$ students; SD $= 2.18$) out of 10 maximum points. The difference in average points earned was not statistically significant ($W = 95$, $p = 0.22$).

### Instructors' Notes on Benefits and Challenges

We encountered various challenges as well as unique opportunities in which VR can be applied in an online biology course (for summary see Table 2). We identified several features of immersive VR as improvements to our instruction in a remote environment. Specifically, VR facilitated novel and unique learning experiences, such as a "field trip" to the ocean to observe a shark experiment and explore the inside of a human heart, which are not readily feasible in a traditional or online course. In addition to VR's benefit of experiential learning in an online course, compared to using a video conferencing platform (e.g., Zoom), we noted that social interactions and collaborative work were more "realistic" in immersive VR. For instance, VR did not require the separation of students into break-out rooms for group work.

We also noted the challenges of using VR in an online course. Learning how to use the technology, navigate the VR environment, and manipulate objects was time-consuming. Time was also lost during transitions into the VR headsets due to multiple steps required for registration and logins to the app; however, we note that this challenge might be specific to the platform we used. Also, internet availability, reliability, and sufficient speed (about 25Mbit/s) were all essential for participation in VR activities. Thus, any problems with the internet caused disturbances to VR sessions for students.

## Discussion

### RQ1: Student Perceptions of VR

We implemented a pilot study with immersive VR activities in an online biology non-major course for undergraduate students to ask students about their perceptions of the new technology. We found that students rated it as a useful and

**Table 2** Benefits and opportunities as well as challenges and limitations we identified with delivering immersive VR activities online

| *Benefits and opportunities* | *Challenges and limitations* |
|---|---|
| • Student enthusiasm and curiosity to use new technology in a course | • Monetary cost associated with headsets and shipments to students |
| • More authentic interactions while online (e.g., all participants can speak at the same time but only those who are 'close' are audible) | • Requirement of reliable internet and minimum speeds of about 25Mbit/s |
| • Designing novel classroom environments and objects (e.g., a wet lab with various anatomical structures) | • Time-consuming onboarding to learn how to use the headset, controllers, and the hosting platform as well as to build and manipulate environments and objects |
| • Freedom to explore and manipulate objects by scaling, resizing, and walking through the objects | • *Some physical discomfort in the form of dizziness as avatar moves |
| • Visiting VR environments (pre-existing or built by other instructors) that represent other parts of the world (e.g., ancient Egyptian tomb) | • Creating VR environments and novel or complex objects may require a developer |
| • Viewing 360 videos (e.g., shark experiment) as field trips | • *Multiple steps are needed for student transition from Zoom to headsets: registration online using a computer, login to the platform, and selection of the correct session |
| • Sessions can be recorded, posted, and viewed later while retaining the ability to move around the space, interact with the environment and other viewers | • *Limited number of participants that can be recorded in a session |
| • Students can be quickly summoned, restricted to their seating area, and muted | • *Limited note-taking. For typing, handheld controllers are used for clicking and selecting one letter at a time |

star symbol (*) indicates a matter that we encountered with the platform we used

effective tool in their learning, despite some students experiencing the negative effects of cybersickness. We note that the survey questions asked during VR sessions were not validated and should be interpreted cautiously. Yet, given the positive responses noted in evaluations, which were validated, it suggests the students conveyed overall positive perceptions of VR activities in the online course. In agreement, previous work indicates students find VR engaging and express positive attitudes and perceptions towards the use of technology in a course (Cheng & Tsai, 2020; Georgiou et al., 2021; McCaw et al., 2021), including online environments (Duncan Vaidya & Stevenson, 2021). It is important to note that the novelty effect, the increased attention, and the effort associated with using new media (Clark, 1983), might have played a role in our students' reporting of positive perceptions of immersive VR. Nonetheless, given that attitude and motivation are important in learning, using VR might be particularly beneficial for student with low self-efficacy for learning science (Cheng & Tsai, 2020) or interest in STEM, as one might expect for non-majors examined in this study. Our findings demonstrating overall positive perceptions of immersive VR in an *online course* are particularly timely given the increased use of online environments for learning in higher education and interest in VR as a teaching tool. Finally, given that attitudes towards technology are critical in their effective implementation and adoption into education (Halpin & Myers, 2002; Huang & Liaw, 2005), our work suggests immersive VR in online courses for non-majors is a promising opportunity for educators and education researchers.

### RQ2: VR Impact on Student Performance

Besides student perceptions, we also asked whether VR positively impacted student performance. Specifically, we examined whether assessment outcomes on the cardiovascular unit differed between semesters with and without a lesson in VR. We observed a small yet non-significant increase in student performance with the use of immersive VR lesson on the heart. We interpret this finding cautiously as the number of student participants in the study was small and we did not measure additional variables, such as prior knowledge, that may have influenced our students' outcomes. However, recent work suggests there may be cognitive benefits to learning in VR (Di Natale et al., 2020; Makransky & Petersen, 2021) and that the positive perceptions of the technology we found can positively influence students' conceptual learning gains (Georgiou et al., 2021). By providing students with a sense of presence or agency, VR can increase interest and motivation, all of which can enhance learning (Makransky & Petersen, 2021). The theory also suggests that the realism of visuals is important for teaching abstract concepts, and more realistic visual representations can improve student performance (Skulmowski et al., 2022). Indeed, generating a 3D mental image of an object from a 2D image, even with details and added realism of colors and shading, can be challenging for students (Skulmowski et al., 2022). With the sense of presence and ability to explore the 3D object, VR might enhance spatial knowledge of a given object and domain (Dalgarno & Lee, 2010; Maresky et al., 2019). Additionally, the construction of a 3D mental image from a 3D object might require less mental capacity, although the effect may depend on the students' spatial ability (Huk, 2006). Because the human heart is anatomically complex, using a structurally realistic model in VR that can be observed from various angles and better represents the anatomy compared to a simple line drawing likely enhances learning. The use of immersive VR to learn about architecture, where students explored the exterior and interior of a virtual building, showed significant gains in architectural knowledge (Chan et al., 2022), suggesting the ability to see realistic objects in 3D aids student learning. Given the difficulty students have with the cardiovascular system all the way through medical school (Ahopelto et al., 2011; Kaufman et al., 2013; Södervik et al., 2019), experimental work is needed to better understand the benefits of different media, such as simple drawings, animations, and realistic 3D visuals on desktop and VR, in anatomy education.

### Instructors' Notes on Benefits and Challenges

Finally, we documented instructor-perceived benefits and challenges. As recognized by others (Fromm et al., 2021; Nakai et al., 2022), we found that VR can afford various opportunities, such as "field trips," in experiential learning. Furthermore, in agreement with previous work examining VR in online learning (Jeong et al., 2022), we found that immersive VR mimicked in-person interactions well, which was particularly noticeable for small group discussions. Instructors were able to move around the "room" and check in with different groups, as occurs in an in-person classroom setting. As Nakai et al. (2022), we found that VR benefitted our online course compared to Zoom alone. VR sessions allowed us to interact with all students in a more authentic way. We suspect that these social interactions in VR as well as the novelty of the technology influenced the overall positive perception students reported (see below). Future work should further examine how social interactions in VR contribute to the perceptions of the overall experience.

The benefits of teaching an online course in VR were also met with challenges and limitations, including nausea and internet issues, as has been noted by other studies (McCaw et al., 2021; Nakai et al., 2022). When internet speeds were less than the required speed (about 25Mbit/s), students experienced problems logging in and participating in the sessions, all of which suggest scalability problems with using VR in large online classrooms (> 50 students). Also, the implementation of immersive VR in an online course can highlight digital divide issues for urban vs. rural students and socioeconomic challenges when students might not be able to purchase or access the internet speed required to support the technology optimally.

## Future Directions

A study of VR technology in undergraduate science instruction is gaining momentum. Currently, most VR studies examine the use of VR in face-to-face classrooms, and more work is needed to explore the feasibility of the technology in a remote setting given the unique challenges encountered in online courses. We suspect that for many students taking online classes, the embodiment and the ability to have social interactions with peers and the instructor in VR provide motivation to participate and learn (Krämer, 2017), which could be directly assessed in future work with existing surveys on motivation. In addition to motivation, gauging student attitudes with open-ended questions about the VR technology over the course of the semester would elucidate other potential impacts on engagement and how it might impact performance. Finally, a comparison of how VR might influence attitudes and motivation towards science learning for non-major and major STEM students is needed to better understand the impacts the technology might have on recruitment and retention.

## Study Limitations

This pilot study offers insights into the feasibility and benefits of using VR in an online course; however, there are several limitations to the study. One limitation is that the data were collected from a single course at one institution, which might not be representative of student perceptions at research-intensive institutions or community colleges. Furthermore, we used closed-ended survey and evaluation prompts which limited gauging the breadth of perceptions students might have had about the VR experiences. Also, the students in the course were not science majors, which might influence their interest in the material presented in VR activities and thereby their ratings of the VR experiences. Lastly, given the continual advancement of VR, the challenges we identified might only capture the current state of the VR technology in online classrooms.

### Recommendations for Instructors

Ensuring internet speed is reliable and sufficiently high (greater than 25Mbit/s) is the first necessary step prior to considering the implementation of immersive VR activities in an online course. The choice of the hosting platform and content provider (or developer) should be weighed based on features available, customizability of avatars, environments, and objects as well as ease of use for an online course. Dedicating time to building up VR stamina to avoid dizziness is crucial, especially for those with no or minimal prior immersive VR experience. The time in the headset and in the VR environment, whether independent or as part of the class, is necessary to become physically and mentally more comfortable with the technology. If immersive VR is going to be a considerable part of an online course, we recommend encouraging the students to play games, watch 360° YouTube videos, or engage in “free-play” within VR to help students assimilate to the headset and controls prior to course activities. We also recommend the development of an Understanding and Agreement form for students to sign with a link to VR Oculus Health and Safety Warnings, to encourage students’ safe use of the technology indoors only and return of the equipment upon course completion.

## Conclusions

This study provides practical insights into the application of immersive VR activities (via head-mounted display) in an *online* course in higher education. Our work, in agreement with others, suggests VR has potential benefits for enhancing student learning and training, yet the research in the area is still new, and getting started poses many unknowns for educators. We encourage educators examining VR to share similar brief reports and provide conference presentations about their experiences with VR, platforms, and equipment used, in order for others to better gauge the benefits and feasibility of this tool. Time commitment and challenges associated with using immersive VR in an online classroom can appear discouraging, yet given the added benefit of social interactions and report of overall positive experience by students, educators should consider and weigh all of the costs and benefits.

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**Author Contribution** EV conceptualized the project, designed VR course activities, and collected the data. AAM assisted in designing VR activities, analyzed and visualized the data, and wrote the first draft and revisions of the manuscript; EV provided supervision of the project as well as edited and improved the manuscript.

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**Data Availability** Data associated with the results are available on Figshare (10.6084/m9.figshare.22562335).

## Declarations

**Competing Interests** The authors declare no competing interests.



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# ACADEMICS

lobaki

Mississippi

# Table Of Contents



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Aligned to curriculum standards for Mississippi

## 9th-12th Grade (cont.)



## Additional Content Offerings

# 3rd Grade

## Mathematics

### Geometry

**3.G.1 | Rhombus Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Pentagon Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Octagon Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Obtuse Isosceles Triangle Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Narrow Rhombus Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Hexagon Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Equilateral Triangle Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Acute Isosceles Triangle Tile**
Simple geometry manipulatives can be used to teach about shapes and angles or create tessellations. (unlimited) E

**3.G.1 | Wide Rhombus Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Trapezoid Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**3.G.1 | Square Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

## Science

### Earth & Space Science

**E.3.7B | Earth Cutaway**
A model of Earth with a section cut away to expose its layers. (unlimited) E

**E.3.7B | Earth Cutaway Info**
An Infographic model of Earth with a section cut away to expose its layers. (unlimited) E

**E.3.7B.3 | Grand Canyon**
Explore the Grand Canyon from different observation decks around the natural wonder. (unlimited) E

**E.3.9 | Cloud Climb**
Explore how clouds, atmosphere, and weather all come together to create different aspects of the Earth's sky. (unlimited) E

### Life Science

**L.3.2 | Glow Worm Caves of New Zealand**
Deep below ground, you will learn about strange carnivorous worms. (2 min)

**L.3.4 | How Animals See the World**
Experience how different animals see the world. Includes a human, cat, dog, fly, rat, and snake's point of view. (4 min)

**L.3.4.5 | Attenborough and the Giant Dinosaur**
Learn all about the Titanosaur with David Attenborough. (4 min)

**L.3.4.5 | Giraffatitan Dinosaur: Back to Life in 360 VR**
Encounter the Jurassic giant Giraffatitan, one of the tallest dinosaurs that ever lived, and learn all about how it lived and who its descendants are. (4 min)

**L.3.4.5 | Rhomaleosaurus Sea Dragon: Back to Life in 360 VR**
Encounter the prehistoric sea dragon Rhomaleosaurus, as it roams the gallery over 180 million years after it died. (4 min)

**L.3.4.5 | VR Jurassic Dinosaur**
Explore what life was like during the age of the dinosaur. (3 min)

### Physical Science

**P.3.5 | Gas in Tank**
Gas particles that move randomly inside a tank. (unlimited) E

**P.3.5 | Liquid Particles in Tank**
Liquid particles that move randomly inside a tank. (unlimited) E

**P.3.5 | Solid Particle Arrangement**
Rotating cube of crystalline atomic structure. (unlimited) E

**P.3.5 | Elementary Particle Swarm**
Protons, neutrons, and electrons move around randomly. (unlimited) E

**P.3.6 | Magnet-Like Poles**
Animated visualization of two bar magnets with like poles repelling each other. (unlimited) E

**P.3.6 | Magnet: Opposite Poles**
Animated visualization of two bar magnets attracting each other. (unlimited) E

E Accessible via the Engage app in the Library

**P.3.6 | Magnet: Single Bar**

Animated visualization of the electromagnetic field surrounding a single bar magnet. (unlimited) E

**P.3.6 | Magnet: Two Bars**

Animated visualization of the electromagnetic field surrounding two bar magnets. (unlimited) E

**P.3.6 | Magnet: Horseshoe**

Animated visualization of the electromagnetic field surrounding a horseshoe magnet. (unlimited) E

# Social Studies

## Civil Rights

**CR.3.2 | Civil Rights Museum**

Five Civil Rights leaders - Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

**CR.3.3 | Independence Hall**

Join George Washington, John Adams, Thomas Jefferson, Benjamin Franklin, and John Hancock as they come to life to tell you their stories about the founding of the United States. (unlimited) E

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## Economics

**E.3.3 | 360 Farm Tour: It Starts with a Seed**

Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 1 (6 min)

**E.3.3 | 360 Farm Tour: As the Corn Grows**

Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 2 (4 min)

**E.3.3 | 360 Farm Tour: Harvesting the Corn**

Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 3 (4 min)

**E.3.3 | 360 Farm Tour: Protecting the Corn**

Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 4 (4 min)

**E.3.3 | Story of Oats**

In this 360 video tour, you'll get to see how oats are transformed from a plant in the field to the food on your table. (6 min)

**E.3.3 | Weaving Around the World**

Follow the process of weaving that has been developed across cultures for thousands of years. From Venice to Addis Ababa, and the West Bank to the Navajo Nation Reservation. (4 min)

## Geography

**G.3.1 | Climbing the Redwoods: Fight for the Forests**

Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

**G.3.1 | Protecting Ocean Anchor Species: Racing Extinction**

Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

**G.3.1 | Rescuing Rhinos: Racing Extinction**

Join a conservation biologist on an interactive mission to learn how animals critical to the world's ecosystem thrive and survive in the wild. (5 min)

**G.3.1 | The Fight to Save Threatened Species**

Get closer than ever before to the most extraordinary creatures on the planet. Whale sharks, rhinos, elephants, manta rays, and lions are all threatened with extinction. (2 min)

**G.3.2 | Volcano**

Experience an erupting volcano. (unlimited) E

**G.3.2 | After the Floods: Rebuilding Ellicott City**

Take an immersive journey through the flooding, aftermath, and reconstruction of Ellicott City, Maryland to give a new perspective on the damage done by flooding. (6 min)

**G.3.2 | Chennai Floods Aftermath**

Take an immersive journey through the impact, rescue, and reason for the floods that occurred in Chennai, India, in December 2015. (6 min)

**G.3.2 | Kamchatka Volcano Eruption**

National Geographic VR takes you to the rim of a spectacular erupting volcano: Klyuchevskoy, one of the tallest and most active volcanoes on the planet. (2 min)

**G.3.2 | Life in Haiti: After a Devastating Natural Disaster**

Join filmmaker Dylan Roberts on a journey to the Haitian city of Jérémie, and the small village of Manish, to witness the aftermath of a colossal storm. (5 min)

**G.3.2 | Category 3 Hurricane Landfall Simulation**

Experience a category 3 hurricane through a simulation with guided popups. (1 min)

**G.3.2 | Earthquake VR Experience**

Be exposed to a virtual earthquake that provides a life-like training experience, without an actual earthquake. (2 min)

E Accessible via the Engage app in the Library

**G.3.2 | Expedition to the Heart of Active Volcano**

Join a group of climbers as they embark on a scientific exploration into an active volcano. (5 min)

**G.3.2 | Close-Range Tornado**

Get up close and personal with a tornado near Wray, CO from May 7th, 2016. (8 min)

**G.3.2 | Boston Snowstorm from Bunker Hill Monument**

Watch a major winter storm move through the city of Boston in this time-lapse from the top of Bunker Hill Monument. (3 min)

**G.3.2 | Inside Hurricane Maria**

Watch Hurricane Maria change from a category 1 to a category 5 in about 24 hours. (5 min)

**G.3.3 | Nuclear Power Plant**

Recreation of a nuclear power plant that students can explore. The interactive map allows students to tour the entire facility while illustrating how the different components are connected in the process of nuclear power generation. (unlimited) E

**G.3.3 | Nuclear Control Room**

Replica of the nuclear control room found at Three Mile Island. (unlimited) E

## History

**H.3.3 | Civil Rights Museum**

Five Civil Rights leaders - Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

# 4th Grade

## Mathematics

### Geometry

**4.G.1, 4.G.2, 4.G.3 | Rhombus Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Pentagon Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Octagon Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Obtuse Isosceles Triangle Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Narrow Rhombus Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Hexagon Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Equilateral Triangle Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Acute Isosceles Triangle Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3, 4.MD.5, 4.MD.6, 4.MD.7 | Wide Rhombus Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Trapezoid Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Square Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.G.1, 4.G.2, 4.G.3 | Protractor**
At-scale measuring tool for measuring angles. Designed to be used with geometric tiles, or as a general teaching/training tool. (unlimited) E

### Measurement & Data

**4.MD.1, 4.MD.2| Fraction Pizzeria**
Students can learn about fractions by taking customers' orders, building pizzas, running the register, and experimenting with slopes. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Rhombus Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Pentagon Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Octagon Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Obtuse Isosceles Triangle Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Narrow Rhombus Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Hexagon Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Equilateral Triangle Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Acute Isosceles Triangle Tile**
Simple geometry manipulatives that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Wide Rhombus Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Trapezoid Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Square Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or create tessellations. (unlimited) E

**4.MD.5, 4.MD.6, 4.MD.7 | Protractor**
At-scale measuring tool for measuring angles. Designed to be used with geometric tiles, or as a general teaching/training tool. (unlimited) E

E Accessible via the Engage app in the Library

## Number & Operations

**4.NF.1, 4.NF.2, 4.NF.5, 4.NF.6, 4.NF.7 | Fraction Pizzeria**

Students can learn about fractions by taking customers' orders, building pizzas, running the register, and experimenting with slopes. (unlimited) E

# Science

## Earth & Space Science

**E.4.9A, E.4.9B | Cloud Climb**

Explore how clouds, atmosphere, and weather all come together to create different aspects of the Earth's sky. (unlimited) E

**E.4.9C.5 | Category 3 Hurricane Landfall Simulation**

Experience a category 3 hurricane through a simulation with guided popups. (1 min)

**E.4.9C.5 | Close-Range Tornado**

Get up close and personal with a tornado near Wray, CO from May 7th, 2016. (8 min)

## Life Science

**L.4.1, L.4.1.3 | Anatomy Lab**

Highly interactive anatomy classroom that allows students to assemble the human body piece by piece with over 90 separate body parts to learn about. (unlimited) E

**L.4.1 | Brain**

Realistic model of a human brain. (unlimited) E

**L.4.1 | Heart**

Realistic model of a human heart. (unlimited) E

**L.4.1 | Liver**

Realistic model of a human liver. (unlimited) E

**L.4.1 | Lungs**

Realistic model of human lungs. (unlimited) E

**L.4.1 | What Happens Inside Your Body?**

The human body is an amazing and unique machine that triggers thousands of processes every second, learn about them on this adventure. (8 min)

**L.4.1.2 | Human Digestive System in VR**

Take an amazing journey through the body and find out what happens to your food as it travels through the digestive system. (3 min)

**L.4.2 | Bears of Kamchatka, Kambalnaya River**

Follow along as you experience the Bears of Kamchatka and learn about their habitat, daily life, and mating season. (5 min)

**L.4.2 | Chengdu Panda Base, China**

Get an in-depth look at the pandas that call Chengdu Panda Base their home and learn about their habitat, diet, and daily life. (11 min)

**L.4.2.2 | Explore the Coral Restoration**

Learn about the ecology of coral reefs, natural and human threats to corals, and the science of coral restoration. (4 min)

**L.4.2.2 | Reef 2**

Swim along an active thriving reef. (1 min)

**L.4.2.2 | Reef 3**

Swim along an active thriving reef. (1 min)

**L.4.2.2 | Reef 4**

Swim along an active thriving reef. (1 min)

## Physical Science

**P.4.6B | Light Lab**

This highly interactive classroom teaches students about the electromagnetic spectrum including activities like the double slit experiment, shining lights through a prism, building waves, stacking light, and playing with lenses. (unlimited) E

**P.4.6B | Speed of Light**

Visualization of the speed of light showing a glowing orb that revolves around the earth 7 times in one second. (unlimited) E

**P.4.6C | Music Playground**

Be immersed in a concert hall with intractable musical instruments that can be used collaboratively to play, teach, or learn about music and sound waves. (unlimited) E

**P.4.6C | Music Note: A**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: A Sharp**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: B**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: C**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: C Sharp**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: D**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: D Sharp**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: E**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: F**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

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**P.4.6C | Music Note: F Sharp**
Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: G**
Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**P.4.6C | Music Note: G Sharp**
Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

# Social Studies

## Civics

**CI.4.3.2 | Supreme Court**
Recreation of the front bench of the United States Supreme Court Chamber. (unlimited) E

## Civil Rights

**CR.4.1 | Medgar Evers House**
Explore a recreation of the Medgar Evers House and National Monument. Made in collaboration with the Evers family. (unlimited) E

**CR.4.1 | Civil Rights Museum**
Civil Rights leaders: Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers, come to life to tell you their stories on interactive stages. (unlimited) E

## Geography

**G.4.2 | Weaving Around the World**
Follow the process of weaving that has been developed across cultures for thousands of years. From Venice to Addis Ababa, and the West Bank to the Navajo Nation Reservation. (4 min)

**G.4.2 | Chennai Floods Aftermath**
Take an immersive journey through the impact, rescue, and reason for the floods that occurred in Chennai, India, in December 2015. (6 min)

**G.4.2 | Himalayas: A Trek to School**
Follow two girls as they travel up to 6 hours a day to school in a remote Himalayan village. (8 min)

**G.4.2 | Life in Haiti: After a Devastating Natural Disaster**
Join filmmaker Dylan Roberts on a journey to the Haitian city of Jérémie, and the small village of Manish, to witness the aftermath of a colossal storm. (5 min)

**G.4.2 | Out of Syria: Back to School**
Step into the lives of two teenagers from war-torn Syria, Mustafa and Sarah. They both fled the fighting with their families. They left their homelands and their schools behind. (4 min)

**G.4.2 | Protecting Ocean Anchor Species: Racing Extinction**
Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

E Accessible via the Engage app in the Library

# 5th Grade

## Mathematics

### Number & Operations

**5.NF.3, 5.NF.4, 5.NF.5 | Fraction Pizzeria**
Students can learn about fractions by taking customers' orders, building pizzas, running the register, and experimenting with slopes. (unlimited) E

## Science

### Earth & Space Science

**E.5.8A, E.5.8A.1, E.5.8B | Solar System**
Be immersed in an interactive classroom that allows students to visit each planet, watch them orbit, and learn about each one. (Unlimited) E

**E.5.8A, E.5.8A.2, E.5.8B | Sun**
Rotating model of the Sun. (unlimited) E

**E.5.8A, E.5.8A.1, E.5.8B | Solar System Model**
Animated model of the solar system where rotation and revolution speeds are scaled accurately. (Unlimited) E

**E.5.8A, E.5.8A.1 | Swirling Galaxy**
Rotating spiral-shaped galaxy. (unlimited) E

**E.5.8A, E.5.8A.3 | The Aurora Borealis over Alaska's Chatanika River**
Explore a timelapse of the Aurora Borealis filmed during a geomagnetic storm by William Briscoe Photography. (5 min)

**E.5.8A, E.5.8A.3 | 360 Degree Video of the Milky Way**
Explore a timelapse of the moving night sky. (1 min)

**E.5.8A, E.5.8A.1 | Enter the Black hole**
Enter a black hole and explore the area around it. (5 min)

**E.5.8A, E.5.8A.1 | Explore the Solar System**
Take a virtual tour of our Solar System, with the help of Crash Course Astronomy host Phil Plait. (5 min)

**E.5.8A, E.5.8A.3 | Journey into the Orion Nebula**
Journey into the famous star-forming region of the Orion Nebula based on an image from the Hubble Space Telescope. (2 min)

**E.5.8A, E.5.8A.4 | Journey to the Edge of Space**
Experience what it's like to leave Earth, traveling to over 90,000 feet into the stratosphere. (5 min)

**E.5.8A, E.5.8A.1 | Mars: The Red Planet VR Documentary**
Explore the planet Mars and see its history of exploration. (12 min)

**E.5.8A, E.5.8A.3, E.5.8B | The Night Sky and Milky Way: Visualize Astronomy**
Enjoy a panoramic view of the night sky and the Milky Way. (1 min)

**E.5.8A, E.5.8A.2, E.5.8B | Solar Eclipse**
Watch a total solar eclipse that took place in Casper, Wyoming on August 21st, 2017. (5 min)

**E.5.8A.1 | VR Solar System Space Video**
This amazing 360 video will transport you through our galactic neighborhood, the solar system. (18 min)

**E.5.8B | Moon Phases**
Interactive display of the phases of Earth's Moon. (unlimited) E

**E.5.10 | Damming the Nile: Episode 1**
Journey from the sacred source of the Blue Nile, down waterfalls, and through canyons to see this giant dam being built. Travel on East Africa's first metro train, go for a traditional Ethiopian lunch, and hear the government's view on the political crisis the dam project has created. (13 min)

**E.5.10 | Damming the Nile: Episode 2**
Journey to the great farming projects of Sudan, fly to a festival on the banks of the Nile and explore the ancient Sudanese pyramid. Then launch in a balloon over Luxor to find out how much this river means to the land of the pharaohs. (16 min)

**E.5.10 | Climbing the Redwoods: Fight for the Forests**
Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

### Life Science

**L.5.3B | Bears of Kamchatka, Kambalnaya River**
Follow along as you experience the Bears of Kamchatka and learn about their habitat, daily life, and mating season. (5 min)

**L.5.3B | Chengdu Panda Base, China**
Get an in-depth look at the pandas that call Chengdu Panda Base their home and learn about their habitat, diet, and daily life. (11 min)

**L.5.3B | Diving Exploration of Kelp Forest Aquarium**
Explore the Kelp Forest at Monterey Bay Aquarium. (3 min)

**L.5.3B | Travel-Dream-Imagine: A VR Journey from the Desert Floor to the Sea**
Travel with us as we step into the Judea Desert, bathe in a waterfall, wet our feet in the red sea, dive among corals, and float in one of the wonders of the world - the dead sea. (2 min)

E Accessible via the Engage app in the Library

**L.5.3B.1 | Diving Under Icebergs with a Seal in Antarctica**

Take a 360 journey under an iceberg with a crabeater seal and gentoo penguins in Antarctica. (2 min)

**L.5.3B.1 | Diving with Great White Shark**

Experience a great white shark up close and personal while learning about the majestic creature. (2 min)

**L.5.3B.1 | Great Hammerhead Shark Encounter**

Dive into this 360° video and get face-to-face with a curious great hammerhead shark. (2 min)

**L.5.3B.1 | Protecting Ocean Anchor Species: Racing Extinction**

Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

**L.5.3B.1 | Tiger Shark Encounter in the Bahamas: SharkFest**

Get face-to-face with massive tiger sharks as you plunge into the crystal-clear waters of the Bahamas. (3 min)

**L.5.3B.1 | Whale Sharks: Giants of the Deep**

Encounter a group of Whale Sharks feeding as they migrate south. (2 min)

**L.5.3B.1 | Explore an Underwater Mountain from a Submarine**

Ride along in a submarine and explore the ocean floor. (4 min)

**L.5.3B.1 | Explore the Deep Ocean**

Follow along in a Submarine and see the ocean from a new view. (2 min)

**L.5.3B.1 | Kelp**

Swim through a kelp forest. (1 min)

**L.5.3B.1 | Reef 2**

Swim along an active thriving reef. (1 min)

**L.5.3B.1 | Reef 3**

Swim along an active thriving reef. (1 min)

**L.5.3B.1 | Reef 4**

Swim along an active thriving reef. (1 min)

**L.5.3B.1 | Explore the Blue Hawaiian Adventure**

Learn about the diversity of life found in the Hawaiian Islands, and explore the ecology of three different species, their importance to Native Hawaiian culture, and the conservation measures in place for their protection. (4 min)

**L.5.3B.1 | Explore the Coral Restoration**

Learn about the ecology of coral reefs, natural and human threats to corals, and the science of coral restoration. (4 min)

**L.5.3B.2 | Glow Worm Caves of New Zealand**

Deep below ground, you will learn about strange carnivorous worms. (2 min)

**L.5.3B.2 | Lion Whisperer: Racing Extinction**

Follow along with Kevin Richardson as he explains the complexities of his relationship to his pride, and summarizes his life's work of protecting these amazing animals from the game hunting trade. (4 min)

**L.5.3B.2 | Lions 360**

Join National Geographic Explorer, Martin Edström, and come face to face with Gibson and his mother, as they struggle with their pride's alpha male. (5 min)

**L.5.3B.2 | Red Kite Bird Feeding Frenzy**

Watch the once endangered Red Kite Bird feed while learning about them. (1 min)

**L.5.3B.2 | Hyena 1**

Watch a hyena feed on a fresh kill. (1 min)

**L.5.3B.2 | Hyena 2**

Watch a hyena approach cautiously for a snack. (1 min)

**L.5.3B.2 | Leopard**

Watch a leopard munch on a meal. (1 min)

**L.5.3B.2 | Lioness 1**

A curious Lioness sniffs at the camera. (1 min)

**L.5.3B.2 | Lioness 2**

Lioness sniffs at food. (1 min)

**L.5.3B.3 | Fox's Point of View at Night- Planet Earth II: Cities**

Through the eyes of an urban fox, can you find food, spot the hazards, and track down a mate in a bustling city at night? (4 min)

**L.5.3B.3 | Ocean to Plate: A Journey into the Seafood Supply Chain**

Learn how populations and appetites grow. Global fisheries are reaching their ecological capacity, yet at least a third of harvested fish and seafood is lost or wasted along the supply chain. (7 min)

**L.5.3B.3 | Shoaling in the Deep**

Dive down deep into the heart of a shoal of fish, follow a manta ray as it skims the ocean floor, and lock eyes with a moray eel lurking in an underwater cave. (3 min)

**L.5.3B.3 | Whale Sharks at Risks- Racing Extinction**

Experience a close encounter with a whale shark- the largest fish on the Planet. (4 min)

## Physical Science

**P.5.5A, E.5.5A.2 | Gas in Tank**

Gas particles that move randomly inside a tank. (unlimited) E

**P.5.5A, E.5.5A.2 | Liquid Particles in Tank**

Liquid particles that move randomly inside a tank. (unlimited) E

**P.5.5A, E.5.5A.2 | Solid Particle Arrangement**

Rotating cube of crystalline atomic structure. (unlimited) E

**P.5.5A, P.5.5A.1 | Elementary Particle Swarm**

Protons, neutrons, and electrons move around randomly. (unlimited) E

**P.5.5A, P.5.5A.4 | Fluid Densities**

Three colored liquids of different densities flow out of pipes and stack on top of each other in a tank. (unlimited) E

E Accessible via the Engage app in the Library

# Social Studies

## Civics

**CI.5.1 | Independence Hall**
Join George Washington, John Adams, Thomas Jefferson, Benjamin Franklin, and John Hancock as they come to life to tell you their stories about the founding of the United States. (unlimited) E

**CI.5.2 | Women's March in Chicago**
Witness a Women's Rights march in Chicago that was held on January 21, 2017. (1 min)

**CI.5.2 | March for Our Lives**
Be immersed in Pioneer Valley's March for Our Lives that was held on March 24, 2018. (1 min)

**CI.5.2 | Syrians "Have to Survive Having No Rights" in Lebanon**
Learn about Syrian refugees who are living in makeshift settlements under harsh conditions, with no legal rights in Lebanon's Bekaa Valley. (3 min)

## Civil Rights

**CR.5.1 | Civil Rights Museum**
Five Civil Rights leaders - Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

**CR.5.1 | Historic Jamestown**
Interactive experience where students will experience the reason for the English Colonization and the significance of the location regarding resources, defensibility, and economic development. (unlimited) E

**CR.5.1 | Out of Syria: Back to School**
Step into the lives of two teenagers from war-torn Syria, Mustafa and Sarah. They both fled the fighting with their families. They left their homelands and their schools behind. (4 min)

**CR.5.1 | Seeking Home: Life Inside the Calais Migrant Camp**
Become part of a camp in northern France where migrants and refugees hope to make it across the English channel to start a new life in the United Kingdom. (6 min)

**CR.5.1 | Women's March in Chicago**
Witness a Women's Rights march in Chicago that was held on January 21, 2017. (1 min)

**CR.5.1 | March for Our Lives**
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**CR.5.1 | Syrians "Have to Survive Having No Rights" in Lebanon**
Learn about Syrian refugees who are living in makeshift settlements under harsh conditions, with no legal rights in Lebanon's Bekaa Valley. (3 min)

**CR.5.1 | Traveling While Black**
This film offers a revealing view of the Green Book Era as told through Ben's Chili Bowl, a black-owned restaurant in Washington, to remind us of the hardships that African-Americans faced during that time period. (20 min)

**CR.5.2 | Discover the Taj Mahal, India**
Join Asha Leo as she ventures around India and explores the Taj Mahal. (5 min)

**CR.5.2 | Hajj: Experience the Journey to Mecca**
Walk with Al Jazeera's, Basma Atassi, in Mecca to see the major landmarks that millions of Muslims visit during the period of Hajj, the annual Islamic Pilgrimage. (8 min)

**CR.5.2 | Japan: Where Tradition Meets the Future**
Explore Japanese tradition, modernity, and nature. (3 min)

**CR.5.2 | Taj Mahal 360 Degree (VR) Tour in India**
Explore one of the 7 Wonders of the World, the Taj Mahal in India. (2 min)

**CR.5.2| Walking Tours of Japan: Kiyomizudera Temple in Kyoto**
Experience a walking tour of Kiyomizudera Temple in Kyoto, Japan. (17 min)

## Economics

**E.5.1 | AeroFarms: The Future of Farming**
See how AeroFarms in Newark, NJ grows over 2 million pounds of greens a year without sunlight, soil, or pesticides, making it the world's largest indoor vertical farm. (2 min)

## Geography

**G.5.2 | Antarctica: Part II**
View Antarctica from aboard a ship as it sails around for you to see the different wildlife. (6 min)

**G.5.2 | Back to Nature: Rainforest**
Escape to the lush temperate rainforest of Southern Australia. (4 min)

**G.5.2 | Chennai Floods Aftermath**
Take an immersive journey through the impact, rescue, and reason for the floods that occurred in Chennai, India, in December 2015. (6 min)

**G.5.2 | Iceland**
Soar over Iceland and take in the different views that it has to offer. (3 min)

**G.5.2 | Life in Haiti: After a Devastating Natural Disaster**
Join filmmaker Dylan Roberts on a journey to the Haitian city of Jérémie, and the small village of Manish, to witness the aftermath of a colossal storm. (5 min)

E Accessible via the Engage app in the Library

**G.5.2 | Climbing the Redwoods: Fight for the Forests**

Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

**G.5.2 | Category 3 Hurricane Landfall Simulation**

Experience a category 3 hurricane through a simulation with guided popups. (1 min)

## History

**H.5.2, H.5.3, H.5.4, H.5.5 | Historic Jamestown**

Interactive experience where students will grasp the reason for the English Colonization and the significance of the location regarding resources, defensibility, and economic development. (unlimited) E

**H.5.4 | Independence Hall**

Join George Washington, John Adams, Thomas Jefferson, Benjamin Franklin, and John Hancock as they come to life to tell you their stories about the founding of the United States. (unlimited) E

**H.5.4, H.5.5 | Battle Road: The American Revolution**

Be surrounded by scores of professional reenactors, organizers, onlookers, and photographers as they gather at Lexington, Concord, and Minute Man National Historical Park to honor the memory of this critical turning point in American history. (5 min)

**H.5.7 | Liberty Bell**

Realistic recreation of the Liberty Bell in Philadelphia, PA. Touch the bell to hear it ring, just as it would have sounded before it cracked. (unlimited) E

# 6th Grade

## Science

### Earth and the Universe

**E.6.8 | Solar System**
Interactive classroom that allows students to visit each planet, watch them orbit, and learn about each one. (Unlimited) E

**E.6.8 | Sun**
Rotating model of the Sun. (unlimited) E

**E.6.8 | Solar System Model**
Animated model of the solar system. Rotation and revolution speeds are scaled accurately. (Unlimited) E

**E.6.8 | Moon Phases**
Interactive display of the phases of Earth's Moon. (Unlimited) E

**E.6.8 | 1. Cool VR Walk on the Moon/ 2. Yosemite**
EXP.1 Walk on the Moon from the Project Apollo Archive. EXP.2 Experience a guided tour of some of Yosemite's majestic spots. (2 min/4 min)

**E.6.8 | The Aurora Borealis over Alaska's Chatanika River**
Explore a timelapse of the Aurora Borealis filmed during a geomagnetic storm by William Briscoe Photography. (5 min)

**E.6.8 | 360 Degree Video of the Milky Way**
Explore a timelapse of the moving night sky. (1 min)

**E.6.8 | Enter the Black hole**
Enter a black hole and explore the area around it. (5 min)

**E.6.8 | First-Ever 360 VR Filmed in Space: One Strange Rock**
Fly side-by-side with astronauts and experience weightlessness, the speed of traveling at 17 thousand miles per hour, and take in a stunning view of Earth. (5 min)

**E.6.8 | Explore the Solar System**
Take a virtual tour of our Solar System, with the help of Crash Course Astronomy host Phil Plait. (5 min)

**E.6.8 | Journey into the Orion Nebula**
Journey into the famous star-forming region of the Orion Nebula based on an image from the Hubble Space Telescope. (2 min)

**E.6.8 | Journey to the Edge of Space**
Experience what it's like to leave Earth, traveling to over 90,000 feet into the stratosphere. (5 min)

**E.6.8 | Mars: The Red Planet VR Documentary**
Explore the planet Mars and see its history of exploration. (12 min)

**E.6.8 | NASA's Curiosity Mars Rover at Namib Dune**
View the Namib Dune and portions of Mount Sharp through the eyes of the Mars Rover. (2 min)

**E.6.8 | The Night Sky and Milky Way: Visualize Astronomy**
Enjoy a panoramic video of the night sky and Milky Way. (1 min)

**E.6.8 | Solar Eclipse**
Watch a total solar eclipse that took place in Casper, Wyoming on August 21st, 2017. (5 min)

**E.6.8 | Space Experience**
View Earth from Space below the International Space Station but beware… meteorites have been forecast. (1 min)

**E.6.8 | Take a VR Tour of 6 Real Exoplanets**
Team up with astrophysicists to experience a scientifically accurate, VR tour of 6 exoplanets. (11 min)

**E.6.8 | VR Solar System Space Video**
This amazing 360 virtual reality video will transport you through our galactic neighborhood, the solar system. (18 min)

**E.6.8 | First ever 3D VR filmed in Space**
See life from the view of Astronauts in the International Space Station. (5 min)

**E.6.8 | Curiosity Mars Rover's**
View the Glen Torridon area of Mars from the eyes of the Mars Rover. (2 min)

**E.6.8 | Sample Asteroid Bennu**
Follow along on NASA's first asteroid sample return mission as they make a daring attempt to collect samples from an asteroid. (4 min)

### Life Science

**L.6.1 | Cell Classroom**
Interactive classroom located inside an animal cell. Infographics help students learn about the parts of a cell, alongside animations of the protein synthesis process. (unlimited) E

**L.6.1 | Plant Cell**
Interactive classroom located inside a plant cell. Explore the different organelles and components of the cell and explore the photosynthesis process. (unlimited) E

### Physical Science

**P.6.6.4 | Electromagnet: Small Solenoid**
Animated visualization of an electromagnetic solenoid with 15 coils. (unlimited) E

**P.6.6.4 | Electromagnet: Large Solenoid**
Animated visualization of an electromagnetic solenoid with 26 coils. (unlimited) E

**P.6.6.4 | Magnet: Like Poles**
Animated visualization of two bar magnets with like poles repelling each other. (unlimited) E

**P.6.6.4 | Magnet: Opposite Poles**
Animated visualization of two bar magnets attracting each other. (unlimited) E

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**P.6.6.4 | Magnet – Single Bar**
Animated visualization of the electromagnetic field surrounding a single bar magnet. (unlimited) E

**P.6.6.4 | Magnet – Two Bars**
Animated visualization of the electromagnetic field surrounding two bar magnets. (unlimited) E

**P.6.6.4 | Magnet – Horseshoe**
Animated visualization of the electromagnetic field surrounding a horseshoe magnet. (unlimited) E

# Social Studies

## Civics

**CI.6.1 | A London City Guided Tour**
Take a guided tour to view some of London's most iconic landmarks. (5 min)

**CI.6.1 | Amazing Morocco**
Join Louis as he adventures around Morocco. (8 min)

**CI.6.1 | Discover the Taj Mahal, India**
Join Asha Leo as she ventures around India and explores the Taj Mahal. (5 min)

**CI.6.1 | Hajj: Experience the Journey to Mecca**
Walk with Al Jazeera's Basma Atassi in Mecca and see the major landmarks that millions of Muslims visit during the period of Hajj, the annual Islamic Pilgrimage. (8 min)

**CI.6.1 | Himalayas: A Trek to School**
Follow two girls as they travel up to 6 hours a day to school in a remote Himalayan village. (8 min)

**CI.6.1 | Japan: Where Tradition Meets the Future**
Explore Japanese tradition, modernity, and nature. (3 min)

**CI.6.1 | North Korea**
Tour throughout the Northeastern parts of North Korea including Rason, Namyang, Hoeryong, Chongjin, Kyongson, and Chilbo. (19 min)

**CI.6.1 | The Fight for Falluja**
Experience firsthand the battles Iraqi forces endured to retake the important strategic city of Fallujah from ISIS. (11 min)

**CI.6.1, CI.6.2 | Syrians "Have to Survive Having No Rights" in Lebanon**
Learn about Syrian refugees who are living in makeshift settlements under harsh conditions, with no legal rights in Lebanon's Bekaa Valley. (3 min)

**CI.6.2 | Beyond the Map | A Day in a Favela**
Step inside this 360 experience of a day in a Favela and meet some truly inspiring people. (3 min)

**CI.6.2 | Women's March in Chicago**
Witness a Women's Rights march in Chicago that was held on January 21, 2017. (1 min)

**CI.6.2 | March for our Lives**
Be immersed in Pioneer Valley's March for Our Lives that was held on March 24, 2018. (1 min)

## Economics

**E.6.1 | Back to Nature- Rainforest**
Escape to the lush temperate rainforest of Southern Australia. (4 min)

**E.6.1 | Damming the Nile: Episode 1**
Journey from the sacred source of the Blue Nile, down waterfalls, and through canyons to see this giant dam being built. Travel on East Africa's first metro train, go for a traditional Ethiopian lunch and hear the government's view on the political crisis the dam project has created. (13 min)

**E.6.1 | Damming the Nile: Episode 2**
Journey to the great farming projects of Sudan, fly to a festival on the banks of the Nile, and explore the ancient Sudanese pyramid. Then launch in a balloon over Luxor to find out how much this river means to the land of the pharaohs. (16 min)

**E.6.1 | Climbing the Redwoods- Fight for the Forests**
Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

**E.6.1 | Pond**
Explore a freshwater pond and the plants that surround it. (1 min)

**E.6.1 | Forest**
View a tranquil forest and the plant life throughout it. (1 min)

**E.6.1 | Waterfall 1**
View a waterfall and the surrounding plant life. (1 min)

**E.6.1 | Waterfall 2**
View a waterfall and the surrounding plant life. (1 min)

**E.6.1 | Waterfall 3**
View a waterfall and the surrounding plant life. (1 min)

## Geography

**G.6.2 | A London City Guided Tour**
Take a guided tour to view some of London's most iconic landmarks. (5 min)

**G.6.2 | Amazing Morocco**
Join Louis as he adventures around Morocco. (8 min)

**G.6.2 | Athens, Parthenon, Parthenonas, Acropolis- VR Walk**
Go on a journey through Athens and see its main attractions from Ancient Greece. (5 min)

**G.6.2 | Discover the Taj Mahal, India**
Join Asha Leo as she ventures around India and explores the Taj Mahal. (5 min)

E Accessible via the Engage app in the Library

**G.6.2 | Hajj: Experience the Journey to Mecca**
Walk with Al Jazeera's Basma Atassi in Mecca and see the major landmarks that millions of Muslims visit during the period of Hajj, the annual Islamic Pilgrimage. (8 min)

**G.6.2 | Taj Mahal 360 Degree (VR) Tour in India**
Explore one of the 7 Wonders of the World, the Taj Mahal in India. (2 min)

**G.6.2 | Walking Tours of Japan- Kiyomizudera Temple in Kyoto**
Experience a walking tour of Kiyomizudera Temple in Kyoto, Japan. (17 min)

**G.6.2 | Immerse Yourself in a Tour Around the Forbidden City of China**
With red walls and yellow tiles, the resplendent and magnificent Forbidden City is a treasure of China's ancient palace architecture. (5 min)

**G.6.2 | Leshan Giant Buddha- Leshan, China**
Go on a tour of the Entire Leshan scenic area, including the famous stone Buddha statue. (9 min)

**G.6.3 | Grand Canyon**
Explore the Grand Canyon from different observation decks around the natural wonder. (unlimited) E

**G.6.3 | Volcano**
Experience an erupting volcano. (unlimited) E

**G.6.3 | Earth Cutaway**
A model of Earth with a section cut away to expose its layers. (unlimited) E

**G.6.3 | Earth Cutaway info**
An Infographic model of Earth with a section cut away to expose its layers. (unlimited) E

## History

**H.6.1 | Weaving Around the World**
Follow the process of weaving that has been developed across cultures for thousands of years. From Venice to Addis Ababa, and the West Bank to the Navajo Nation Reservation. (4 min)

**H.6.1 | The Nutcracker: The Royal Ballet**
Immerse yourself in the extraordinary world of The Royal Ballet as you follow young dancer Julia Roscoe as she prepares for her debut as a snowflake in the Nutcracker. (7 min)

**H.6.1 | Carnegie Hall feat. The Philadelphia Orchestra**
The Philadelphia Orchestra performs Grieg's "In the Hall of the Mountain King" from Peer Gynt Suite No. 1 under the direction of Music Director Yannick Nézet-Séguin in Carnegie Hall's Stern Auditorium's Perelman Stage on October 13, 2015. (3 min)

**H.6.1 | Orchestra VR**
Join the Los Angeles Philharmonic as they perform the iconic opening of Beethoven's timeless Fifth Symphony at Walt Disney Concert Hall. (4 min)

**H.6.1 | Bruegel: A Fall With the Rebel Angels**
In partnership with the Royal Museums of Fine Arts of Belgium, the Google Cultural Institute has designed an immersive experience that lets you explore The Fall of the Rebel Angels (1562) like never before. (4 min)

**H.6.1 | Dreams of Dali**
Go inside and beyond Dali's painting Archaeological Reminiscence of Millet's Angelus and explore the world of the surrealist master like never before in this mesmerizing 360° video. (5 min)

E Accessible via the Engage app in the Library

# 7th Grade

## Mathematics

### Geometry

**7.G.2 | Rhombus Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Pentagon Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Octagon Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Obtuse Isosceles Triangle Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Narrow Rhombus Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Hexagon Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Equilateral Triangle Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Acute Isosceles Triangle Tile**
Simple geometry manipulable that can be used to teach about shapes and angles or build tessellations. (unlimited) E

**7.G.2 | Wide Rhombus Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Trapezoid Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Square Tile**
Simple geometry manipulable that can be used to teach about shapes and angles, or build tessellations. (unlimited) E

**7.G.2 | Protractor**
At-scale measuring tool for measuring angles. Designed to be used with geometric tiles, or as a general teaching/training tool. (unlimited) E

## Science

### Earth & Space Science

**E.7.9A | Cloud Climb**
Explore how clouds, atmosphere, and weather all come together to create different aspects of the Earth's sky. (unlimited) E

**E.7.9A | Moon Phases**
Interactive display of the phases of Earth's Moon. (unlimited) E

**E.7.9A | Antarctica: Unexpected Snow**
See how a Penguin and Seal colony as a winter storm moves in. (2 min)

**E.7.9A | Category 3 Hurricane Landfall Simulation**
Experience a category 3 hurricane through a simulation with guided popups. (1 min)

**E.7.9A | Close-Range Tornado**
Get up close and personal with a tornado near Wray, CO from May 7th, 2016. (8 min)

**E.7.9A | Boston Snowstorm from Bunker Hill Monument**
Watch a major winter storm move through the city of Boston in this time-lapse from the top of Bunker Hill Monument. (3 min)

**E.7.9A | Inside Hurricane Maria**
Watch Hurricane Maria change from a category 1 to a category 5 in about 24 hours. (5 min)

**E.7.9B | Ace Center @ Hermitage Greenhouse**
Join students from Hermitage High School as they explain how a greenhouse works and the different features within it. (3 min)

**E.7.9B | After the Floods: Rebuilding Ellicott City**
Take an immersive journey through the flooding, aftermath, and reconstruction of Ellicott City, Maryland to give a new perspective on the damage done by flooding. (6 min)

**E.7.9B | Back to Nature: Rainforest**
Escape to the lush temperate rainforest of Southern Australia. (4 min)

**E.7.9B | Chennai Floods Aftermath**
Take an immersive journey through the impact, rescue, and reason for the floods that occurred in Chennai, India, in December 2015. (6 min)

**E.7.9B | Damming the Nile: Episode 1**
Journey from the sacred source of the Blue Nile, down waterfalls, and through canyons to see this giant dam being built. Travel on East Africa's first metro train, go for a traditional Ethiopian lunch, and hear the government's view on the political crisis the dam project has created. (13 min)

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Journey to the great farming projects of Sudan, fly to a festival on the banks of the Nile and explore the ancient Sudanese pyramid. Then launch in a balloon over Luxor to find out how much this river means to the land of the pharaohs. (16 min)

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**E.7.9B | Life in Haiti: After a Devastating Natural Disaster**
Join filmmaker Dylan Roberts on a journey to the Haitian city of Jérémie, and the small village of Manish, to witness the aftermath of a colossal storm. (5 min)

**E.7.9B | Climbing the Redwoods: Fight for the Forests**
Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

**E.7.9B | Earthquake VR Experience**
Be exposed to a virtual earthquake that provides a life-like training experience, without an actual earthquake. (2 min)

**E.7.9B | Expedition to the Heart of Active Volcano**
Join a group of climbers as they embark on a scientific exploration into an active volcano. (5 min)

**E.7.9C | Sun**
Rotating model of the Sun. (unlimited) E

**E.7.9C | Solar System**
Animated model of the solar system. Rotation and revolution speeds are scaled accurately. (Unlimited) E

**E.7.9C | Solar Eclipse**
Watch a total solar eclipse that took place in Casper, Wyoming on August 21st, 2017. (5 min)

## Life Science

**L.7.3.2 | Cell Classroom**
Interactive classroom located inside an animal cell. Infographics help students learn about the parts of a cell, alongside animations of the protein synthesis process. (unlimited) E

**L.7.3.2 | Plant Cell**
Interactive classroom located inside a plant cell. Explore the different organelles and components of the cell and explore the photosynthesis process. (unlimited) E

## Physical Science

**P.7.5B | Bunsen Burner and Beaker**
Interactive model of a Bunsen burner, beaker, and ring stand. Toggling the valve turns on the burner flame and starts a chemical reaction in the beaker. (unlimited) E

**P.7.5C | Periodic Table**
Interactive classroom that teaches students about the periodic table of elements, their chemical and physical properties, and their atomic structures. (unlimited) E

**P.7.5C | Hydrogen and Helium Formation**
Protons, neutrons, and electrons move around randomly and then collide to form hydrogen and helium atoms. (unlimited) E

**P.7.5D | Cell Classroom**
Interactive classroom located inside an animal cell. Infographics help students learn about the parts of a cell, alongside animations of the protein synthesis process. (unlimited) E

**P.7.5D | Covalent Bonding- H2**
Simple visualization of the covalent bond between two hydrogen atoms. (unlimited) E

**P.7.5D | Covalent Bonding – Glucose Hybridized**
Visualization of a covalently bonded glucose molecule with hybridized orbitals. (unlimited) E

**P.7.5D | Covalent Bonding – O2 Hybridized**
Visualization of two covalently bonded oxygen atoms with hybridized orbitals. (unlimited) E

**P.7.5D | Covalent Bonding – H2O Hybridized**
Visualization of a covalently bonded water molecule with hybridized orbitals. (unlimited) E

**P.7.5D | Ionic Bonding – NaCl**
Animated visualization of the ionic bond between a sodium atom and a chlorine atom. (unlimited) E

**P.7.5D | Ionic Bonding: NaOH**
Animated visualization of the ionic bond between a sodium atom and a hydroxide anion. (unlimited) E

**P.7.5D | Ionic Bonding: NaF**
Animated visualization of the ionic bond between a sodium atom and a fluorine atom. (unlimited) E

**P.7.5D | Ionic Bonding: MgSO4**
Animated visualization of the ionic bond between a magnesium atom and a sulfate anion. (unlimited) E

# Social Studies

## Early World History

**7.1 | Ancient Egypt: Hall of Pharaohs**
Visit the Hall of Pharaohs and interact and learn from 5 of Egypt's most well-known pharaohs of all time: Ramesses the Great, Nefertiti, King Tut, Alexander the Great, and Cleopatra. (unlimited) E

**7.1 | Ancient Egypt: The Great Pyramids**
Explore the hidden passageways of the Great Pyramid of Giza as you learn about the famous structure and its significance to Ancient Egyptian culture and tradition. (unlimited) E

**7.1 | Crawl Inside a 3,500-Year-Old Egyptian Tomb**
Descend 7 meters under the sandy hills of southern Egypt to become one of the first modern humans to explore a newly discovered ancient Egyptian tomb. (3 min)

**7.1 | The Dream of Egypt's Tuthmosis IV**
A tour around the statue of the Sphinx temple and the pyramids of Giza. (4 min)

**7.2 | Immerse Yourself in a Tour Around the Forbidden City of China**
With red walls and yellow tiles, the resplendent and magnificent Forbidden City is a treasure of China's ancient palace architecture. (5 min)

E Accessible via the Engage app in the Library

**7.2 | Leshan Giant Buddha- Leshan, China**
Go on a tour of the Entire Leshan scenic area, including the famous stone Buddha statue. (9 min)

**7.3 | Dholavira: Archaeological Site That Contains Ruins of the Ancient Indus Valley Civilization**
Dholavira is an archaeological site that contains one of the five largest Harappan sites and most prominent archaeological sites in India belonging to the Indus Valley Civilization. (2 min)

**7.4 | Athens, Parthenon, Parthenonas, Acropolis: VR Walk**
Go on a journey through Athens and its main attractions from Ancient Greece. (5 min)

**7.5 | Pompeii Amazing Tour in VR- Italy**
Explore the site of Pompeii, an ancient Roman town-city near modern Naples, that was mostly destroyed and buried under 4 to 6 m (13 to 20 ft) of volcanic ash and pumice in the eruption of Mount Vesuvius in 79 AD. (15 min)

**7.6 | Witness the Mysterious World of West African Voodoo**
Journey to Togo, a tiny nation in West Africa, that contains the region's largest Voodoo market- 'Marche des Fetches' and learn about the rich history that surrounds this religion. (5 min)

**7.7 | World Religions**
See the different major religions of the world and how they are dispersed across the world. (9 min)

**7.9 | Bruegel: The Fall of the Rebel Angels**
In partnership with the Royal Museum of Fine Arts of Belgium, the Google Cultural Institute has designed an immersive experience that lets you explore The Fall of the Rebel Angels (1562) like never before. (4 min)

## US History

**7C.14 | Civil War: A Letter from the Trenches**
Get transported back to the 1860s to "experience" what life was like for a young cadet in the Confederate army, trekking through the mud and dodging enemy fire as you journey through the trenches. (5 min)

**7C.6, 7C.6.5 | Historic Jamestown**
Interactive experience where students will experience the reason for the English Colonization and the significance of the location regarding resources, defensibility, and economic development. (unlimited) E

**7C.7, 7C.8 | Independence Hall**
Join George Washington, John Adams, Thomas Jefferson, Benjamin Franklin, and John Hancock
as they come to life to tell you their stories about the founding of the United States. (unlimited) E

**7C.7 | Battle Road: The American Revolution**
Be surrounded by scores of professional reenactors, organizers, onlookers, and photographers as they gather at Lexington, Concord, and Minute Man National Historical Park to honor the memory of this critical turning point in American history. (5 min)

**7C.8 | Liberty Bell**
Realistic recreation of the Liberty Bell in Philadelphia, PA. Touch the bell to hear it ring, just as it would have sounded before it cracked. (unlimited) E

E Accessible via the Engage app in the Library

# 8th Grade

## Science

### Earth & Space Science

**E.8.9A | Earth Cutaway**
A model of Earth with a section cut away to expose its layers. (unlimited) E

**E.8.9A | Earth Magnetic Field**
Animated visualization of the electromagnetic field surrounding Planet Earth. (unlimited) E

**E.8.9A | Earthquake VR Experience**
Be exposed to a virtual earthquake that provides a life-like training experience, without an actual earthquake. (2 min)

**E.8.9A | Expedition to the Heart of Active Volcano**
Join a group of climbers as they embark on a scientific exploration into an active volcano. (5 min)

**E.8.9A | Volcano**
Experience a model of an Erupting Volcano. (unlimited) E

**E.8.9B | After the Floods: Rebuilding Ellicott City**
Take an immersive journey through the flooding, aftermath, and reconstruction of Ellicott City, Maryland to give a new perspective on the damage done by flooding. (6 min)

**E.8.9B | Chennai Floods Aftermath**
Take an immersive journey through the impact, rescue, and reason for the floods that occurred in Chennai, India, in December 2015. (6 min)

**E.8.9B | Kamchatka Volcano Eruption**
National Geographic VR takes you to the rim of a spectacular erupting volcano: Klyuchevskoy, one of the tallest and most active volcanoes on the planet. (2 min)

**E.8.9B | Life in Haiti: After a Devastating Natural Disaster**
Join filmmaker Dylan Roberts on a journey to the Haitian city of Jérémie, and the small village of Manish, to witness the aftermath of a colossal storm. (5 min)

**E.8.9B | Category 3 Hurricane Landfall Simulation**
Experience a category 3 hurricane through a simulation with guided popups. (1 min)

**E.8.9B | Expedition to the Heart of Active Volcano**
Join a group of climbers as they embark on a scientific exploration into an active volcano. (5 min)

**E.8.9B | Close-Range Tornado**
Get up close and personal with a tornado near Wray, CO from May 7th, 2016. (8 min)

**E.8.9B | Boston Snowstorm from Bunker Hill Monument**
Watch a major winter storm move through the city of Boston in this time-lapse from the top of Bunker Hill Monument. (3 min)

**E.8.9B | Inside Hurricane Maria**
Watch Hurricane Maria change from a category 1 to a category 5 in about 24 hours. (5 min)

### Life Science

**L.8.2B | Glow Worm Caves of New Zealand**
Deep below ground, you will learn about strange carnivorous worms. (2 min)

**L.8.2B | Great Hammerhead Shark Encounter**
Dive into this 360° video and go face-to-face with a curious great hammerhead shark. (2 min)

**L.8.2B | How Animals See the World**
Experience how different animals see the world. Includes a human, cat, dog, fly, rat, and snake's point of view. (4 min)

**L.8.4B | Attenborough and the Giant Dinosaur**
Learn all about the Titanosaur with David Attenborough. (4 min)

**L.8.4B | Giraffatitan Dinosaur: Back to Life in 360 VR**
Encounter the Jurassic giant Giraffatitan, one of the tallest dinosaurs that ever lived, and learn all about how it lived and who its descendants are. (4 min)

**L.8.4B | Rhomaleosaurus Sea Dragon: Back to Life in 360 VR**
Encounter the prehistoric sea dragon Rhomaleosaurus, as it roams the gallery over 180 million years after it died. (4 min)

### Physical Science

**P.8.6.8 | Light Lab**
This highly interactive classroom teaches students about the electromagnetic spectrum including activities like the Double Slit Experiment, shining lights through a prism, building their own waves, stacking light, and playing with lenses. (unlimited) E

## Social Studies

### Mississippi Studies

**MS.8 | Medgar Evers House**
Explore a recreation of the Medgar Evers House and National Monument. Made in collaboration with the Evers family. (unlimited) E

E Accessible via the Engage app in the Library

**MS.8 | Civil Rights Museum**

Five Civil Rights leaders - Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

## US History

**8.1 | Castillo Cannon Drill**

Stand aboard the Castillo's gun deck and see what firing a cannon would be like in the 1740s. (6 min)

**8.1 | Historic Jamestown**

Interactive experience where students will witness the English Colonization and the significance of the location regarding resources, defensibility, and economic development. (unlimited) E

**8.2 | Independence Hall**

Join George Washington, John Adams, Thomas Jefferson, Benjamin Franklin, and John Hancock as they tell you stories about the founding of the United States. (unlimited) E

**8.2 | Battle Road: The American Revolution**

Be surrounded by scores of professional reenactors, organizers, onlookers, and photographers as they gather at Lexington, Concord, and Minute Man National Historical Park to honor the memory of this critical turning point in American history. (5 min)

**8.8, 8.9 | Civil War: A Letter from the Trenches**

Get transported back to the 1860s to "experience" what life was like for a young cadet in the Confederate army, trekking through the mud and dodging enemy fire as you journey through the trenches. (5 min)

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# 9th-12th Grade

## Mathematics

### Calculus

**CAL 1-4, CAL 6-11, CAL 13-18, CAL 21-30 | CalcVR**
Interactive app that allows students to explore the geometric meaning of three-dimensional objects, concepts and notions prevalent to multivariable Calculus.

## Science

### Biology

**BIO.1A.3 | Anatomy Lab**
Highly interactive anatomy classroom that allows Students assemble the human body piece by piece with over 90 separate body parts to learn about. (unlimited) E

**BIO.1A.3 | Brain**
Realistic model of the Human Brain. (unlimited) E

**BIO.1A.3 | Heart**
Realistic model of a Human Heart. (unlimited) E

**BIO.1A.3 | Liver**
Realistic model of a Human Liver. (unlimited) E

**BIO.1A.3 | Lungs**
Realistic model of the Human Lungs. (unlimited) E

**BIO.1B.1, BIO.1C, BIO.1D | Cell Classroom**
Interactive classroom located inside an animal cell. Infographics help students learn about the parts of a cell, alongside animations of the protein synthesis process. (unlimited) E

**BIO.1B.1, BIO.1C, BIO.1D | Plant Cell**
Interactive classroom located inside a plant cell. Explore the different organelles and components of the cell and explore the photosynthesis process. (unlimited) E

**BIO.4 | Back to Nature- Rainforest**
Escape to the lush temperate rainforest of Southern Australia. (4 min)

**BIO.4 | Diving Exploration of Kelp Forest Aquarium**
Explore the Kelp Forest at Monterey Bay Aquarium. (3 min)

**BIO.4 | Diving Under Icebergs with a Seal in Antarctica**
Take a 360 journey under an iceberg with a crabeater seal and Gentoo Penguins in Antarctica. (2 min)

**BIO.4 | Elephant Seals and King Penguin Chicks**
These King Penguin chicks get our (elephant) seal of approval. (2 min)

**BIO.4 | In the Presence of Animals**
Experience a dangerous world with some of the planet's most at-risk species: an endangered jaguar, a rainforest sloth, a massive bison, fluttering monarchs, and a mother olive ridley turtle. (5 min)

**BIO.4, BIO.5 | Protecting Ocean Anchor Species- Racing Extinction**
Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

**BIO.4 | Underwater National Park**
Plunge into a Caribbean gem with National Geographic photographer Brian Skerry to explore the Buck Island Reef – America's first protected marine monument. (6 min)

**BIO.5 | Bears of Kamchatka, Kambalnaya River**
Follow along as you experience the Bears of Kamchatka and learn about their habitat, daily life, and mating season. (5 min)

**BIO.5 | Chengdu Panda Base, China**
Get an in-depth look at the pandas that call Chengdu Panda Base their home and learn about their habitat, diet, and daily life. (11 min)

**BIO.5 | Gorillas in the Congo: A Jump VR Video**
Experience gorillas in their natural habitat of the Congo Jungle. (2 min)

**BIO.5 | Great Hammerhead Shark Encounter**
Dive into this 360° video and go face to face with a curious great hammerhead shark. (2 min)

**BIO.5 | Red Kite Bird Feeding Frenzy**
Watch the once endangered Red Kite Bird feeding while learning about them. (1 min)

### Botany

**BOT.1, BOT.4 | 360 Farm Tour : It starts with a Seed**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 1 (6 min)

**BOT.1, BOT.4 | 360 Farm Tour: As the Corn Grows**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 2 (4 min)

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**BOT.1, BOT.4 | 360 Farm Tour: Harvesting the Corn**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 3 (4 min)

**BOT.1, BOT.4 | 360 Farm Tour: Protecting the Corn**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 4 (4 min)

**BOT1., BOT.4 | Back to Nature- Rainforest**
Escape to the lush temperate rainforest of Southern Australia. (4 min)

**BOT.1, BOT.4 | Climbing the Redwoods- Fight for the Forests**
Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

**BOT.1 | Diving Exploration of Kelp Forest Aquarium**
Explore the Kelp Forest at Monterey Bay Aquarium. (3 min)

**BOT.1 | Forest**
View a tranquil forest and the plant life throughout it. (1 min)

**BOT.1 | Kelp**
Swim through a kelp forest. (1 min)

## Chemistry

**CHE.3 | Periodic Table**
Interactive classroom that teaches students about the periodic table of elements, their chemical and physical properties, and their atomic structures. (unlimited) E

**CHE.4 | Covalent Bonding- H2**
Simple visualization of the covalent bond between two hydrogen atoms. (unlimited) E

**CHE.4 | Covalent Bonding – Glucose Hybridized**
Visualization of a covalently bonded glucose molecule with hybridized orbitals. (unlimited) E

**CHE.4 | Covalent Bonding – O2 Hybridized**
Visualization of two covalently bonded oxygen atoms with hybridized orbitals. (unlimited) E

**CHE.4 | Covalent Bonding – H2O Hybridized**
Visualization of a covalently bonded water molecule with hybridized orbitals. (unlimited) E

**CHE.4 | Ionic Bonding – NaCl**
Animated visualization of the ionic bond between a sodium atom and a chlorine atom. (unlimited) E

**CHE.4 | Ionic Bonding – NaOH**
Animated visualization of the ionic bond between a sodium atom and a hydroxide anion. (unlimited) E

**CHE.4 | Ionic Bonding- NaF**
Animated visualization of the ionic bond between a sodium atom and a fluorine atom. (unlimited) E

**CHE.4 | Ionic Bonding – MgSO4**
Animated visualization of the ionic bond between a magnesium atom and a sulfate anion. (unlimited) E

## Earth & Space Science

**ESS.1.A | Big Bang Explosion**
Explosion particle effect with fire, smoke, and plasma. (unlimited) E

**ESS.1.A | Big Bang Sound**
Sound effect of what scientists estimate the big bang would have sounded like. (unlimited) E

**ESS.1.A, ESS.1.B | 360 Degree Video of the Milky Way**
Interactive time-lapse of the moving night sky. (1 min)

**ESS.1.A, ESS.1.B | Enter the Black hole**
Enter a black hole and explore the area around it. (5 min)

**ESS.1.A, ESS.1.B | Explore the Solar System**
Take a virtual tour of our Solar System, with the help of Crash Course Astronomy host Phil Plait. (5 min)

**ESS.1.A | First-Ever 360 VR filmed in Space: One Strange Rock**
Fly side-by-side with astronauts and experience weightlessness, the speed of traveling at 17 thousand miles per hour, and take in a stunning view of Earth. (5 min)

**ESS.1.A | Journey into the Orion Nebula**
Journey into the famous star-forming region of the Orion Nebula based on an image from the Hubble Space Telescope. (2 min)

**ESS.1.A | Journey to the Edge of Space**
Experience what it's like to leave Earth, traveling to over 90,000 feet into the stratosphere. (5 min)

**ESS.1.A | Mars- The Red Planet VR Documentary**
Explore the planet Mars and see its history of exploration. (12 min)

**ESS.1.A | NASA's Curiosity Mars Rover at Namib Dune**
View the Namib Dune and portions of Mount Sharp through the eyes of the Mars Rover. (2 min)

**ESS.1.A, ESS.1.B | The Night Sky and Milky Way: Visualize Astronomy**
Enjoy a panoramic video of the night sky and Milky Way. (1 min)

**ESS.1.A, ESS.1.B | Solar System 360 Degree Tour**
Take a 360-degree virtual tour of our Solar system with Crash Course host Phil Plait. (5 min)

**ESS.1.A, ESS.1.B | Space Experience**
View Earth from Space below the International Space Station, but beware... meteorites have been forecast. (1 min)

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**ESS.1.A | Take a VR Tour of 6 Real Exoplanets**

Team up with astrophysicists to experience a scientifically accurate, VR tour of 6 exoplanets. (11 min)

**ESS.1.A, ESS.1.B | VR Solar System Space Video**

This amazing 360 video will transport you through our galactic neighborhood, the solar system. (18 min)

**ESS.1.A, ESS.1.B | Sample Asteroid Bennu**

Follow along on NASA's first asteroid sample return mission as they make a daring attempt to collect samples from an asteroid. (4 min)

**ESS.1.B | Solar System**

Be immersed in an interactive classroom that allows students to visit each planet, watch them orbit, and learn about each one. (Unlimited) E

**ESS.1.B | Solar System Model**

Animated model of the solar system where rotation and revolution speeds are scaled accurately. (Unlimited) E

**ESS.1.B | Star Visualization- Exponential**

Visualization of the number of stars in the universe using color-coded exponential groups. (unlimited) E

**ESS.1.B | 1. Cool VR Walk on the Moon/ 2. Yosemite**

EXP.1 Walk on the Moon from the Project Apollo Archive. EXP.2 Experience a guided tour of some of Yosemite's majestic spots. (2 min/4 min)

**ESS.1.B | The Aurora Borealis over Alaska's Chatanika River**

Explore a timelapse of the Aurora Borealis filmed during a geomagnetic storm by William Briscoe Photography. (5 min)

**ESS.1.B | Solar Eclipse**

Watch a total solar eclipse that took place in Casper, Wyoming on August 21st, 2017. (5 min)

**ESS.2.A | Earth Cutaway**

A model of Earth with a section cut away to expose its layers. (unlimited) E

**ESS.2.A | Earth Cutaway info**

An Infographic model of Earth with a section cut away to expose its layers. (unlimited) E

**ESS.3 | Earth Magnetic Field**

Animated visualization of the electromagnetic field surrounding Planet Earth. (unlimited) E

**ESS.3 | Cloud Climb**

Explore how clouds, atmosphere, and weather all come together to create different aspects of the Earth's sky. (unlimited) E

**ESS.4 | Damming the Nile : Episode 1**

Journey from the sacred source of the Blue Nile, down waterfalls, and through canyons to see this giant dam being built. Travel on East Africa's first metro train, go for a traditional Ethiopian lunch, and hear the government's view on the political crisis the dam project has created. (13 min)

**ESS.4 | Damming the Nile: Episode 2**

Journey to the great farming projects of Sudan, fly to a festival on the banks of the Nile, and explore the ancient Sudanese pyramid. Then launch in a balloon over Luxor to find out how much this river means to the land of the pharaohs. (16 min)

**ESS.4 | Climbing the Redwoods- Fight for the Forests**

Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

**ESS.4 | Lion Whisperer- Racing Extinction**

Kevin Richardson, also known as the "lion whisperer", explains the complexities of his relationship to his pride, and summarizes his life's work of protecting these amazing animals from the game hunting trade. (4 min)

**ESS.4 | Protecting Ocean Anchor Species- Racing Extinction**

Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

**ESS.4 | Rescuing Rhinos: Racing Extinction**

Join a conservation biologist on an interactive mission to learn how animals critical to the world's ecosystem thrive and survive in the wild. (5 min)

## Environmental Science

**ENV.1, ENV.3 | Antarctica- Part II**

View Antarctica from aboard a ship as it sails around for you to see the different wildlife. (6 min)

**ENV.1 | The Hidden World of National Park**

Follow rangers on a journey to places most people never go. Experience the sights, sounds, and adventures of Kenai Fjords, Hawai'i Volcanoes, Carlsbad Caverns, Bryce Canyon, and Dry Tortugas. (5 min)

**ENV.1 | Diving Exploration of Kelp Forest Aquarium**

Explore the Kelp Forest at Monterey Bay Aquarium. (3 min)

**ENV.1 | Diving Under Icebergs with a Seal in Antarctica**

Take a 360 journey under an iceberg with a crabeater seal and Gentoo Penguins in Antarctica. (2 min)

**ENV.1 | Elephant Seals and King Penguin Chick**

These king penguin chicks get our (elephant) seal of approval. (2 min)

**ENV.1 | Fox's Point of View at Night- Planet Earth II: Cities**

Through the eyes of an urban fox, can you find food, spot the hazards, and track down a mate in a bustling city at night? (4 min)

**ENV.1 | Travel-Dream-Imagine- A VR Journey from the desert floor to the Sea**

Travel with us as we step into the Judea desert, bathe in a waterfall in a hidden oasis, wet our feet in the red sea, dive among corals, and finally float in one of the wonders of the world - the dead sea. (2 min)

E Accessible via the Engage app in the Library

**ENV.2 | Lion Whisperer- Racing Extinction**
Kevin Richardson, also known as the "lion whisperer", explains the complexities of his relationship to his pride, and summarizes his life's work of protecting these amazing animals from the game hunting trade. (4 min)

**ENV.2 | Lions 360**
National Geographic Explorer Martin Edström, you will come face to face with Gibson and his mother, as they struggle with their pride's alpha male. (5 min)

**ENV.2 | Manatee: Crystal River National Wildlife Refuge**
Underwater cinematographer and VR filmmaker Adam Ravetch takes us on an adventure on Florida's Crystal River as he captures the river's wild manatees in their natural habitat at the Crystal River National Wildlife Refuge. (3 min)

**ENV.2 | Protecting Ocean Anchor Species- Racing Extinction**
Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

**ENV.2 | Rescuing Rhinos- Racing Extinction**
Join a conservation biologist on an interactive mission to learn how animals critical to the world's ecosystem thrive and survive in the wild. (5 min)

**ENV.2 | Surrounded by Lemurs- Perth Zoo- Australia**
Take a private tour of Lemur Island and encounter these critically endangered species. (4 min)

**ENV.2 | The Fight to save Threatened Species**
Get closer than ever before to the most extraordinary creatures on the planet. Whale sharks, rhinos, elephants, manta rays, and lions are all threatened with extinction. (2 min)

**ENV.2 | Whale Sharks at Risks- Racing Extinction**
Experience a close encounter with a Whale Shark, the largest fish on the Planet. (4 min)

**ENV.3 | Back to Nature- Rainforest**
Escape to the lush temperate rainforest of Southern Australia. (4 min)

**ENV.3 | Climbing the Redwoods- Fight for the Forests**
Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

## Foundation of Biology

**FB.1.2 | Microscope**
Highly interactive science lab microscope with 4 different, insertable slides that they can view at 3 different zoom levels. (unlimited) E

**FB.4 | Glow Worm Caves of New Zealand**
Deep below ground, you will learn about strange carnivorous worms. (2 min)

**FB.4 | Giraffe 1**
See a giraffe interacting with its natural habitat. (1 min)

**FB.4 | Giraffe 2**
See a giraffe interacting with its natural habitat. (1 min)

**FB.5.2 | Attenborough and the Giant Dinosaur**
Learn all about the Titanosaur with David Attenborough. (4 min)

**FB.5.2 | Giraffatitan Dinosaur: Back to Life in 360 VR**
Encounter the Jurassic giant Giraffatitan, one of the tallest dinosaurs that ever lived, and learn all about how it lived and who its descendants are. (4 min)

**FB.5.2 | Rhomaleosaurus Sea Dragon: Back to Life in 360 VR**
Encounter the prehistoric sea dragon Rhomaleosaurus, as it roams the gallery over 180 million years after it died. (4 min)

**FB.5.2 | VR Jurassic Dinosaur**
Explore what life was like during the age of the dinosaur. (3 min)

## Foundations of Science Literacy

**FSL.1 | Explore the Blue Shipwreck Alley**
Tied to the virtual dive on the wreck of D.M Wilson, students research the historical, ecological, and economic importance of Thunder Bay National Marine Sanctuary. Students create a digital infographic that communicates the importance of preserving a shipwreck. (3 min)

**FSL.1, FSL.2 | NASA Astronaut Training: Space Walk**
The stunning NASA VR/360 video, produced by Harmonic, offers a variety of perspectives - in the pool and out - as astronauts complete space-walk training for future missions to the International Space Station. (3 min)

**FSL.1, FSL.2 | Curiosity Mars Rover**
View the Glen Torridon area of Mars from the eyes of the Mars Rover. (2 min)

**FSL.1, FSL.2 | Wind Tunnel Test of NASA's Most Powerful Rocket**
Follow NASA as they test their most powerful rocket in a wind tunnel test. (3 min)

**FSL.1, FSL.2 | Space Engine in Immersive 360 Video**
Experience a Space engine as it flies and looks at different interesting locations in Space. (5 min)

**FSL.1, FSL.2 | Rocket Launch: DeltaIV NROL-45**
Experience one of the most powerful activities in spaceflight- Launch. (4 min)

**FSL.1 | 1. Cool VR Walk on the Moon/ 2. Yosemite**
EXP.1 Walk on the Moon from the Project Apollo Archive. EXP.2 Experience a guided tour of some of Yosemite's majestic spots. (2 min/4 min)

E Accessible via the Engage app in the Library

**FSL.1, FSL.2 | NASA's Curiosity Mars Rover at Namib Dune**
View the Namib Dune and portions of Mount Sharp through the eyes of the Mars Rover. (2 min)

**FSL.1.2 | Microscope**
Highly interactive science lab microscope with 4 different, insertable slides that they can view at 3 different zoom levels. (unlimited) E

**FSL.2 | Category 3 Hurricane Landfall Simulation**
Experience a category 3 hurricane through a simulation with guided popups. (1 min)

**FSL.2 | Mars- The Red Planet VR Documentary**
Explore the planet Mars and see its history of exploration. (12 min)

**FSL.2 | Explore an underwater mountain from a submarine**
Ride along as you dive in a submarine and explore the ocean floor. (4 min)

**FSL.2 | Explore the Deep Ocean**
Follow along in a Submarine and see the ocean from a new view. (2 min)

**FSL.2 | Explore Lake Ontario Schooner: St. Peter**
Explore the wreck of the Schooner St. Peter, which lies in Lake Ontario National Marine Sanctuary. Students research the technologies used by maritime archaeologists to locate and image shipwrecks and participate in simulations of the use of two of these technologies, sonar, and photogrammetry. (4 min)

## Genetics

**GEN.2B | Giraffe 1**
See a giraffe interacting with its natural habitat. (1 min)

**GEN.2B | Giraffe 2**
See a giraffe interacting with its natural habitat. (1 min)

**GEN.2B | Glow Worm Caves of New Zealand**
Deep below ground, you will learn about strange carnivorous worms. (2 min)

**GEN.2B | Great Hammerhead Shark Encounter**
Dive into this 360° video and go face to face with a curious great hammerhead shark. (2 min)

## Human Anatomy & Physiology

**HAP.1, HAP.13 | Human Digestive System in VR**
Take an amazing journey through the body and find out what happens to your food as it travels through the digestive system. (3 min)

**HAP.1 | What Happens Inside Your Body?**
The human body is an amazing and unique machine that triggers thousands of processes every second, learn about them on this adventure. (8 min)

**HAP.4, HAP. 5, HAP.6, HAP.10, HAP.12, HAP.13, HAP.14 | Anatomy Lab**
Highly interactive anatomy classroom that allows students to assemble the human body piece by piece with over 90 separate body parts to learn about. (unlimited) E

**HAP.4 | VR Bone Resorption**
Watch bone resorption at the cellular level in action. (1 min)

**HAP.6 | Brain**
Realistic model of the Human Brain. (unlimited) E

**HAP.6 | A Walk-Through Dementia- At Home**
A unique experience designed to put you in the shoes of someone living with dementia. (3 min)

**HAP.6 | A Walk-Through Dementia- Walking Home**
A unique experience designed to put you in the shoes of someone living with dementia. (4 min)

**HAP.6 | Autism Virtual Reality**
Become a student with autism in the daily fight for survival. (7 min)

**HAP.6 | VR Surgery – Brain Aneurysm**
Immerse the general public, patients, medical students, and allied healthcare professionals into what a real brain operation is like. (6 min)

**HAP.6 | Inside Anxiety**
Anxiety can make you feel on edge, unable to concentrate, fearful, irritable, and like you have lost control. Step inside the mind of someone who experiences anxiety and see the world from their point of view. (9 min)

**HAP.6.1, HAP 6.7 | Anatomy of Hearing**
Take a deep dive into the different parts that make up the Human Ear, and see how we use our sense of hearing. (unlimited)

**HAP.8 | Miracle of Life**
Experience the epic moment we are all conceived in. Our DNA is passed on from our parents, our first cells grow and we begin the miraculous journey of life. (5 min)

**HAP.10 | Heart**
Realistic model of the Human Heart. (unlimited) E

**HAP.10 | 360 Video of a Heart Valve Operation the Heart Center Leipzig**
Experience exclusive insights into surgery in full 360 degree video. Head of Cardiac Surgery Prof. Michael Borger explains what happens during a mitral valve Operation. (4 min)

**HAP.10 | Cardiac Arrest (Code Blue) Advanced Life Support**
This 360-degree training video demonstrates how to manage a cardiac arrest (code blue) using an automated defibrillator. (7 min)

E Accessible via the Engage app in the Library

**HAP.10 | Patient Point of View in Advanced Life Support (Code Blue)**

This 360-degree video is filmed from a patient's point of view and demonstrates what happens if you have a cardiac arrest in the hospital. (7 min)

**HAP.10, HAP.12 | Choking and Cardiac Arrest (Code Blue) Advanced Life Support**

This 360-degree training video demonstrates how to manage a cardiac arrest (code blue) due to choking. (3 min)

**HAP.10 | Experience a Heart Transplant in 360**

Filmed recently at William P. Clements Jr. University Hospital, the video details the process of a heart transplant and all its intricacies, with narration from our Transplant team, including Drs. Matthias Peltz, Pietro Bajona, and John Murala. (5 min)

**HAP.12 | Lungs**

Realistic model of the Human Lungs. (unlimited) E

**HAP.12 | Resuscitation of a Covid-19 Patient w/ Respiratory Failure Best Practices Demonstration**

This immersive 360-degree video takes you inside a hospital emergency department and shows the best practices learned by medical staff in New York City and Philadelphia for treating critically ill COVID-19 patients with respiratory failure. (11 min)

**HAP.13 | Liver**

Realistic model of the Human Liver. (unlimited) E

**HAP.13 | Oesophageal Cancer Operation Filmed**

The operation to remove a tumor from Janet Jenkins, 65, at Southampton General Hospital was carried out by Professor Tim Underwood who is currently undertaking the research. The surgery lasted eight hours. (2 min)

## Marine & Aquatic Science

**MAQ.2, MAQ.4 | Pond**

Explore a freshwater pond and the plants that surround it. (1 min)

**MAQ.2, MAQ.4 | Reef 2**

Swim along an active thriving reef. (1 min)

**MAQ.2, MAQ.4 | Reef 3**

Swim along an active thriving reef. (1 min)

**MAQ.2, MAQ.4 | Reef 4**

Swim along an active thriving reef. (1 min)

**MAQ.2 | Waterfall 1**

View a waterfall and the surrounding plant life. (1 min)

**MAQ.2 | Waterfall 2**

View a waterfall and the surrounding plant life. (1 min)

**MAQ.2 | Waterfall 3**

View a waterfall and the surrounding plant life. (1 min)

**MAQ.2, MAQ.4 | Explore the Blue Hawaiian Adventure**

Learn about the diversity of life found in the Hawaiian Islands, and explore the ecology of three different species, their importance to Native Hawaiian culture, and the conservation measures in place for their protection. (4 min)

**MAQ.2 | Explore the Mallows Ghost Fleet**

Learn about the  Mallows Bay-Potomac River National Marine Sanctuary and the "Ghost Fleet." and explore how human actions affect the environment by interpreting data and evidence about the impact of turbidity on submerged aquatic vegetation. (4 min)

**MAQ.3, MAQ.5 | Explore an Underwater Mountains in a Submarine**

Ride along as you dive in a submarine and explore the ocean floor. (4 min)

**MAQ.3 | Explore the Deep Ocean**

Follow along in a Submarine and see the ocean from a new view. (2 min)

**MAQ.4, MAQ.5 | Underwater National Park**

Plunge into a Caribbean gem with National Geographic photographer Brian Skerry to explore the Buck Island Reef – America's first protected marine monument. (6 min)

**MAQ.4 | Explore the Coral Restoration**

Learn about the ecology of coral reefs, natural and human threats to corals, and the science of coral restoration. (4 min)

**MAQ.5 | Diving Exploration of Kelp Forest Aquarium**

Explore the Kelp Forest at Monterey Bay Aquarium. (3 min)

**MAQ.5, MAQ.7 | Diving Under Icebergs with a Seal in Antarctica**

Take a 360 journey under an iceberg with a crabeater seal and Gentoo Penguins in Antarctica. (2 min)

**MAQ.5 | Elephant Seals and King Penguin Chicks**

These King Penguin chicks get our (elephant) seal of approval. (2 min)

**MAQ.5, MAQ.7 | Great White Sharks**

Get up close with Great White Sharks on an actual dive while learning more about them. (2 min)

**MAQ.5, MAQ.7 | Isle of Jaws**

Suit up and join the team on the search for the mysterious "Isle of Jaws" in Discovery's first-ever full virtual reality act. (7 min)

**MAQ.5, MAQ.7 | Manatee: Crystal River National Wildlife Refuge**

Underwater cinematographer and VR filmmaker Adam Ravetch takes us on an adventure on Florida's Crystal River as he captures the river's wild manatees in their natural habitat at the Crystal River National Wildlife Refuge. (3 min)

**MAQ.5 | Ocean to Plate: A Journey into the Seafood Supply Chain**

As populations and appetites grow, global fisheries are reaching their ecological capacity, yet at least a third of harvested fish and seafood is lost or wasted along the supply chain. (7 min)

E Accessible via the Engage app in the Library

**MAQ.5, MAQ.7 | Protecting Ocean Anchor Species- Racing Extinction**
Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

**MAQ.5, MAQ.7 | Shoaling in the Deep**
Dive down deep into the heart of a shoal of fish, follow a manta ray as it skims the ocean floor, and lock eyes with a moray eel lurking in an underwater cave. (3 min)

**MAQ.5, MAQ.7 | Swimming with Giants 360**
Earth's oceans have been home to giant animals for hundreds of millions of years. Have you ever wondered what it would be like to swim with some of these giants? (5 min)

**MAQ.5 | Kelp**
Swim through a kelp forest. (1 min)

**MAQ.5 | Scuba in the Maldives**
Dive into the waters o Maldives and experience the aquatic life and environment. (2 min)

**MAQ.7 | Arctic Orca**
Orca Foraging in a school fish with free divers. (1 min)

**MAQ.7 | Diving with Great White Shark**
Experience a Great white shark up close and personal while learning about the majestic creatures. (2 min)

**MAQ.7 | Great Hammerhead Shark Encounter**
Dive into this 360° video and go face to face with a curious great hammerhead shark. (2 min)

**MAQ.7 | Mythbusters: Shark Shipwreck**
Explore the sunken wreckage of the Ray of Hope with the MythBusters. (4 min)

**MAQ.7 | Mythbusters: Sharks Everywhere!**
MythBuster Adam Savage takes you underwater and face-to-face with a shiver of sharks. (5 min)

**MAQ.7 | The Blu: Whale Encounter**
Go deep under the ocean, onto the deck of a sunken ship, and face to face with the largest species on Earth. (2 min)

**MAQ.7 | Tiger Shark Encounter in the Bahamas- SharkFest**
Come face to face with massive tiger sharks as you plunge into the crystal clear waters of the Bahamas. (3 min)

**MAQ.7 | Whale Sharks at Risk- Racing Extinction**
Experience a close encounter with a Whale Shark- the largest fish on the Planet. (4 min)

**MAQ.7 | Whale Sharks: Giants of the Deep**
Encounter a group of Whale Sharks feeding as they migrate south. (2 min)

**MAQ.7 | Wild Dolphins VR**
Over 6 years ago, our production team filmed unique footage of wild dolphins in the Sataya Reef in Egypt's Red Sea. (2 min)

**MAQ.7 | Sharks**
Explore an aquarium of sharks. (1 min)

## Physical Science

**PHS.1 | Gas in Tank**
Three colored liquids of different densities flow out of pipes and stack on top of each other in a tank. (unlimited) E

**PHS.1 | Liquid Particles in Tank**
Liquid particles that move randomly inside a tank. (unlimited) E

**PHS.1 | Solid Particle Arrangement**
Rotating cube of crystalline atomic structure. (unlimited) E

**PHS.3 | Periodic Table**
Interactive classroom that teaches students about the periodic table of elements, their chemical and physical properties, and their atomic structures. (unlimited) E

**PHS.3 | Hydrogen and Helium Formation**
Protons, neutrons, and electrons move around randomly and then collide to form hydrogen and helium atoms. (unlimited) E

**PHS.5, PHS.9 | Electromagnet- Small Solenoid**
Animated visualization of an electromagnetic solenoid with 15 coils. (unlimited) E

**PHS.5, PHS.9 | Electromagnet – Large Solenoid**
Animated visualization of an electromagnetic solenoid with 26 coils. (unlimited) E

**PHS.5, PHS.9 | Magnet- Like Poles**
Animated visualization of two bar magnets with like poles repelling each other. (unlimited) E

**PHS.5, PHS.9 | Magnet – Opposite Poles**
Animated visualization of two bar magnets attracting each other. (unlimited) E

**PHS.5, PHS.9 | Magnet – Single Bar**
Animated visualization of the electromagnetic field surrounding a single bar magnet. (unlimited) E

**PHS.5, PHS.9 | Magnet – Two Bars**
Animated visualization of the electromagnetic field surrounding two bar magnets. (unlimited) E

**PHS.5, PHS.9 | Magnet – Horseshoe**
Animated visualization of the electromagnetic field surrounding a horseshoe magnet. (unlimited) E

**PHS.6, PHS.6.5 | Music Playground**
Concert hall with interactive musical instruments that can be used to collaboratively play, teach, or learn about music and soundwaves. (unlimited) E

**PHS.6, PHS.6.6 | Light Lab**
This highly interactive classroom teaches students about the electromagnetic spectrum including activities like the Double Slit Experiment, shining lights through a prism, building their own waves, stacking light, and playing with lenses. (unlimited) E

**PHS.6 | Music Note- A**
Interactive music note spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- A Sharp**
Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

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**PHS.6 | Music Note- B**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- C**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- C Sharp**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- D**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- D Sharp**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- E**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- F**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- F Sharp**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- G**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6 | Music Note- G Sharp**

Interactive music notes spanning 4 octaves and using 10 different instrument sounds. (unlimited) E

**PHS.6.5 | Anatomy of Hearing**

Take a deep dive into the different parts that make up the Human Ear, and see how we use our sense of hearing. (unlimited) E

**PHS.7 | Bunsen Burner and Beaker**

Interactive model of a Bunsen burner, beaker, and ring stand. Toggling the valve turns on the burner flame and starts a chemical reaction in the beaker. (unlimited) E

## Physics

**PHY.1, PHY.2 | Bridge Builder**

An interactive module that allows for the building of bridges to scale using architectural applications. (unlimited) E

## Zoology

**ZOO.1, ZOO.9 | Attenborough and the Giant Dinosaur**

Learn all about the Titanosaur with David Attenborough. (4 min)

**ZOO.1 | Rhomaleosaurus Sea Dragon: Back to Life in 360 VR**

Encounter the prehistoric sea dragon Rhomaleosaurus, as it roams the gallery over 180 million years after it died. (4 min)

**ZOO.7 | Diving with Great White Shark**

Experience a Great white shark up close and personal while learning about the majestic creatures. (2 min)

**ZOO.7, ZOO.9 | Elephant Seals and King Penguin Chicks**

These King Penguin chicks get our (elephant) seal of approval. (2 min)

**ZOO.7 | Great Hammerhead Shark Encounter**

Dive into this 360° video and go face to face with a curious great hammerhead shark. (2 min)

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Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

**ZOO.7 | Shoaling in the Deep**

Dive down deep into the heart of a shoal of fish, follow a manta ray as it skims the ocean floor, and lock eyes with a moray eel lurking in an underwater cave. (3 min)

**ZOO.7 | Swimming with Giants 360**

Earth’s oceans have been home to giant animals for hundreds of millions of years. Have you ever wondered what it would be like to swim with some of these giants? (5 min)

**ZOO.7 | The Blu: Whale Encounter**

Go deep under the ocean, onto the deck of a sunken ship, and face to face with the largest species on Earth. (2 min)

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**ZOO.7 | Tiger Shark Encounter in the Bahamas- SharkFest**
Come face to face with massive tiger sharks as you plunge into the crystal clear waters of the Bahamas. (3 min)

**ZOO.7 | Whale Sharks at Risks- Racing Extinction**
Experience a close encounter with a Whale Shark- the largest fish on the Planet. (4 min)

**ZOO.7 | Whale Sharks: Giants of the Deep**
Encounter a group of Whale Sharks feeding as they migrate south. (2 min)

**ZOO.7 | Sharks**
Explore an aquarium of sharks. (1 min)

**ZOO.8 | Reptile Room- Discovery Nature and Animal**
Take a virtual tour inside a reptile room at a zoo. (1 min)

**ZOO.9 | Red Kite Bird Feeding Frenzy**
Watch the once endangered Red Kite Bird feeding while learning about them. (1 min)

**ZOO.9 | VR Jurassic Dinosaur**
Explore what life was like during the age of the dinosaur. (3 min)

**ZOO.10 | 360 Orangutan School**
Go inside the International Animal Rescue Sanctuary in the forests of Borneo to see what it takes to teach a baby orangutan… to be an orangutan. (9 min)

**ZOO.10 | Arctic Orca**
Orca Foraging in a school fish with free divers. (1 min)

**ZOO.10 | Bears of Kamchatka, Kambalnaya River**
Follow along as you experience the Bears of Kamchatka and learn about their habitat, daily life, and mating season. (5 min)

**ZOO.10 | Caring for Rhinos**
A herd of nine rhinos graze in the South African bush while we hear Chris Sussons, game reserve manager, give some cool facts about rhinos and why they need to protect them from poachers. (2 min)

**ZOO.10 | Chengdu Panda Base, China**
Get an in-depth look at the pandas that call Chengdu Panda Base their home and learn about their habitat, diet, and daily life. (11 min)

**ZOO.10 | Diving Under Icebergs with a Seal in Antarctica**
Take a 360 journey under an iceberg with a crabeater seal and Gentoo Penguins in Antarctica. (2 min)

**ZOO.10 | Elephants on the Brink**
A herd of African elephants curiously investigates its surroundings in South Africa and happens to notice cameras filming their behavior. (3 min)

**ZOO.10 | Getting Licked by a Cow in Ireland**
Get up close and personal with cows. Now you'll know what it's like to be licked and sniffed by them. (1 min)

**ZOO.10 | Gorillas in the Congo: A Jump VR Video**
Experience gorillas in their natural habitat of the Congo Jungle. (2 min)

**ZOO.10 | Lion Whisperer- Racing Extinction**
Kevin Richardson, also known as the "lion whisperer", explains the complexities of his relationship to his pride, and summarizes his life's work of protecting these amazing animals from the game hunting trade. (4 min)

**ZOO.10 | Lions 360**
National Geographic Explorer Martin Edström, you will come face to face with Gibson and his mother, as they struggle with their pride's alpha male. (5 min)

**ZOO.10 | Play with Meerkats: Animals with Cameras**
Get up close and personal with Meerkats as they investigate the camera. (1 min)

**ZOO.10 | Playful Elephants Swim**
A family of elephants decide to take a break from the hot South Africa sun and swim in the local watering hole as Vicky Brooker, elephant curator, tells about the animals. (2 min)

**ZOO.10 | Rescuing Rhinos- Racing Extinction**
Join a conservation biologist on an interactive mission to learn how animals critical to the world's ecosystem thrive and survive in the wild. (5 min)

**ZOO.10 | Surrounded by Lemurs- Perth Zoo- Australia**
Take a private tour of Lemur Island and encounter these critically endangered species. (10 min)

**ZOO.10 | Surrounded by White Lions**
Experience White lions at a preserve. (4 min)

**ZOO.10 | Surrounded by Wild Elephants**
Come face to face with the largest land animal on the planet, the African elephant. Follow along as this herd of giants take a detour to investigate a stranger in their midst. (3 min)

**ZOO.10 | The Eye of the Tiger**
Look at the day in the life of a tiger at the Dierenpark Amersfoort Zoo. (2 min)

**ZOO.10 | What it's like to be Surrounded by Wild Dogs**
See how Wild dogs differ from domesticated ones and how they interact within a herd. (1 min)

**ZOO.10 | Wild Dolphins VR**
Over 6 years ago, our production team filmed unique footage of wild dolphins in the Sataya Reef in Egypt's Red Sea. (2 min)

**ZOO.10 | Baboon 1**
See how a group of Baboons interact. Part. 1 (1 min)

**ZOO.10 | Baboon 2**
See how a group of Baboons interact. Part. 2 (1 min)

**ZOO.10 | Baboon 3**
See how a group of Baboons interact. Part. 3 (1 min)

**ZOO.10 | Cows**
See a group of African Cows roam in search of food. (1 min)

**ZOO.10 | Deer**
See Antelope deer feeding on a plain. (1 min)

**ZOO.10 | Elephant 1**
See a herd of elephants graze about. Part 1 (1 min)
**ZOO.10 | Elephant 2**
See a herd of elephants graze about. Part 2 (1 min)
**ZOO.10 | Elephant 3**
See a herd of elephants graze about. Part 3 (1 min)
**ZOO.10 | Elephant 4**
See a herd of elephants graze about. Part 4 (1 min)
**ZOO.10 | Giraffe 1**
Get up close with a giraffe as it feeds. Part 1 (1 min)
**ZOO.10 | Giraffe 2**
Get close to a giraffe as it feeds. Part 1 (1 min)
**ZOO.10 | Hyena 1**
Watch a hyena feed on a fresh kill. (1 min)
**ZOO.10 | Hyena 2**
Watch a hyena approach cautiously for a snack. (1 min)
**ZOO.10 | Lemur 1**
Watch lemurs climb and play in a zoo. Part 1 (1 min)
**ZOO.10 | Lemur 2**
Watch lemurs climb and play in a zoo. Part 2 (1 min)
**ZOO.10 | Lemur 3**
Watch lemurs climb and play in a zoo. Part 3 (1 min)
**ZOO.10 | Leopard**
Watch a leopard munch on a meal. (1 min)
**ZOO.10 | Lioness 1**
A curious Lioness sniffs at the camera. (1 min)
**ZOO.10 | Lioness 2**
Lioness sniffs at food. (1 min)
**ZOO.10 | Monkey 1**
Monkeys steal a sweet treat. (1 min)
**ZOO.10 | Monkey 2**
Watch a monkey enjoy a fun treat. (1 min)
**ZOO.10 | Monkey Cage**
See two playful monkeys in a zoo. (1 min)
**ZOO.10 | Rhino 1**
Watch a Rhino wallow in a mud hole. (1 min)
**ZOO.10 | Rhino 2**
Watch a baby rhino enjoy a bottle. (1 min)
**ZOO.10 | Rhino 3**
Watch a baby rhino frolic around. (1 min)
**ZOO.10 | Zebra 1**
Watch a herd of zebras grazing. (1 min)
**ZOO.10 | Zebra 2**
Watch how zebras move as a herd. (1 min)

# Social Studies

## African American Studies

**AAS.5 | Traveling While Black**
This film offers a revealing view of the Green Book Era as told through Ben's Chili Bowl, a black-owned restaurant in Washington, to remind us of the hardships that African-Americans faced during that time period. (20 min)
**AAS.8, AAS.9 | Civil Rights Museum**
Five Civil Rights leaders - Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

## History of the Ancient Middle East

**HAME.1 | Ancient Egypt: Hall of Pharaohs**
Visit the Hall of Pharaohs and interact and learn from 5 of Egypt's most well-known pharaohs of all time: Ramesses the Great, Nefertiti, King Tut, Alexander the Great, and Cleopatra. (unlimited) E
**HAME.1 | Ancient Egypt- The Great Pyramid**
Explore the hidden passageways of the Great Pyramid of Giza as you learn about the famous structure and its significance to Ancient Egyptian culture and traditions. (unlimited) E
**HAME.1 | Crawl Inside a 3,500-Year-Old Egyptian Tomb**
Descend 7 meters under the sandy hills of southern Egypt to become one of the first modern humans to explore a newly discovered ancient Egyptian tomb. (3 min)
**HAME.1 | The Dream of Egypt's Tuthmosis IV**
A tour around the statue of the Sphinx temple and the pyramids of Giza. (4 min)
**HAME.1.2 | Athens, Parthenon, Parthenonas, Acropolis- VR Walk**
Go on a journey through Athens and its main attractions from Ancient Greece. (5 min)

## Humanities

**HUM.1 | Immerse yourself in a tour around the Forbidden City of China**
With red walls and yellow tiles, the resplendent and magnificent Forbidden City is a treasure of China's ancient palace architecture. (5 min)
**HUM.1 | Leshan Giant Buddha- Leshan, China**
Go on a tour of the Entire Leshan scenic area, including the famous stone Buddha statue. (9 min)
**HUM.1 | Dholavira: Archaeological Site That Contains Ruins of the Ancient Indus Valley Civilization**
Dholavira is an archaeological site that contains one of the five largest Harappan sites and most prominent archaeological sites in India belonging to the Indus Valley Civilization. (2 min)
**HUM.1 | Ancient Egypt- Hall of Pharaohs**
Visit the Hall of Pharaohs and interact and learn from 5 of Egypt's most well-known pharaohs of all time: Ramesses the Great, Nefertiti, King Tut, Alexander the Great, and Cleopatra. (unlimited) E

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A tour around the statue of the Sphinx temple and the pyramids of Giza. (4 min)

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Go on a journey through Athens and its main attractions from Ancient Greece. (5 min)

**HUM.5 | Bruegel: A Fall With The Rebel Angels**
In partnership with the Royal Museums of Fine Arts of Belgium, the Google Cultural Institute has designed an immersive experience that lets you explore The Fall of the Rebel Angels (1562) like never before. (4 min)

## Introduction to Geography

**ITG.2 | Grand Canyon**
Explore the Grand Canyon from different observation decks around the natural wonder. (unlimited) E

**ITG.2 | 1. VR Pearl Harbor Attack | 2. Explore South Dakota's Badlands**
EXP.1: The Japanese midget submarine, manned by Ensign Kazuo Sakamaki, failed in its mission to attack and destroy American warships. EXP.2:The Badlands is home to the largest mixed-grass prairie where bison and other wildlife graze freely. (6 min/2 min)

**ITG.2 |1. Cool VR Walk on the Moon/ 2. Yosemite**
EXP.1 Walk on the Moon from the Project Apollo Archive. EXP.2 Experience a guided tour of some of Yosemite's majestic spots. (2 min/4 min)

**ITG.2 | A London City Guided Tour**
Take a guided tour to view some of London's most iconic landmarks. (5 min)

**ITG.2, ITG.6 | Athens, Parthenon, Parthenonas, Acropolis: VR Walk**
Go on a journey through Athens and its main attractions from Ancient Greece. (5 min)

**ITG.2, ITG.6 | Discover the Taj Mahal, India**
Join Asha Leo as she ventures around India and explores the Taj Mahal. (5 min)

**ITG.2, ITG.6 | Hajj: Experience the Journey to Mecca**
Walk with Al Jazeera's Basma Atassi in Mecca and see the major landmarks that millions of Muslims visit during the period of Hajj, the annual Islamic Pilgrimage. (8 min)

**ITG.2 | Japan: Where Tradition Meets the Future**
Explore Japanese tradition, modernity, and nature. (3 min)

**ITG.2, ITG.6 | Taj Mahal 360 Degree (VR) Tour in India**
Explore one of the 7 Wonders of the World, the Taj Mahal in India. (2 min)

**ITG.2 | The Aurora Borealis over Alaska's Chatanika River**
Explore a timelapse of the Aurora Borealis filmed during a geomagnetic storm by William Briscoe Photography. (5 min)

**ITG.2, ITG.6 | Walking Tours of Japan: Kiyomizudera Temple in Kyoto**
Experience a walking tour of Kiyomizudera Temple in Kyoto, Japan. (17 min)

**ITG.2, ITG.6 | Immerse yourself in a tour around the Forbidden City of China**
With red walls and yellow tiles, the resplendent and magnificent Forbidden City is a treasure of China's ancient palace architecture. (5 min)

**ITG.2 | Leshan Giant Buddha: Leshan, China**
Go on a tour of the Entire Leshan scenic area, including the famous stone Buddha statue. (9 min)

**ITG.2, ITG.5 | World Religions**
See the different major religions of the world and how they are dispersed across the world. (9 min)

**ITG.2 | Canyon**
Peer down into a canyon from the top. (1 min)

**ITG.4 | Earth Cutaway**
A model of Earth with a section cut away to expose its layers. (unlimited) E

**ITG.4 | Earth Cutaway info**
An Infographic model of Earth with a section cut away to expose its layers. (unlimited) E

**ITG.5 | Syrians "Have to Survive Having No Rights" in Lebanon**
Learn about Syrian refugees who are living in makeshift settlements under harsh conditions, with no legal rights in Lebanon's Bekaa Valley. (3 min)

**ITG.6 | Amazing Morocco**
Join Louis as he adventures around Morocco. (8 min)

**ITG.6 | Let's go Rickshaw Ride around Japan 1**
Learn about traditional Japanese cuisine and take in sites. (3 min)

**ITG.6 | Let's go Rickshaw Ride around Japan 2**
See the bridge, Togetsu-Kyo which means "The moon crossing bridge," over the Katsura River which flows through the center of Arashiyama. (2 min)

**ITG.6 | Let's go Rickshaw Ride around Japan 3**
The path leading to Okochi Sanso garden from Nonomiya Shrine is about 400m long. (2 min)

E Accessible via the Engage app in the Library

**ITG.6 | Witness the Mysterious World of West African Voodoo**

Journey to Togo, a tiny nation in West Africa, that contains the region's largest Voodoo market- 'Marche des Fetches' and learn about the rich history that surrounds this religion. (5 min)

**ITG.6 | The Fight for Falluja**

Experience firsthand the battles Iraqi forces endured to retake the important strategic city of Fallujah from ISIS. (11 min)

**ITG.8 | Beyond the Map | A Day in a Favela**

In Rio, one out of every five residents lives in a favela, that's more than one and a half million people. (3 min)

**ITG.9 | Damming the Nile: Episode 1**

Journey from the sacred source of the Blue Nile, down waterfalls, and through canyons to see this giant dam being built. Travel on East Africa's first metro train, go for a traditional Ethiopian lunch, and hear the government's view on the political crisis the dam project has created. (13 min)

**ITG.9 | Damming the Nile: Episode 2**

Journey to the great farming projects of Sudan, fly to a festival on the banks of the Nile and explore the ancient Sudanese pyramid. Then launch in a balloon over Luxor to find out how much this river means to the land of the pharaohs. (16 min)

**ITG.9 | The Hidden World of National Parks**

Follow rangers on a journey to places most people never go. Experience the sights, sounds, and adventures of Kenai Fjords, Hawai'i Volcanoes, Carlsbad Caverns, Bryce Canyon, and Dry Tortugas. (5 min)

**ITG.9 | Climbing the Redwoods: Fight for the Forests**

Climb 200 feet up 'Grandfather,' the highest Redwood in a Northern California Grove while learning about the Redwood Forest and preservation efforts. (2 min)

**ITG.9 | Ocean to Plate: A Journey into the Seafood Supply Chain**

As populations and appetites grow, global fisheries are reaching their ecological capacity, yet at least a third of harvested fish and seafood is lost or wasted along the supply chain. (7 min)

**ITG.9 | Protecting Ocean Anchor Species: Racing Extinction**

Join marine biologist Luke Tipple as he swims alongside manta rays and whale sharks while sharing why they are vital to the survival of our oceans. (3 min)

## Minority Studies

**MIN.1 | Seeking Home: Life Inside the Calais Migrant Camp**

This documentary of a migrant camp in northern France follows the residents as the "Jungle", migrants have turned the rugged landscape into a makeshift town with churches, mosques, restaurants, and even a beauty salon while waiting on hoping to migrate across the English Channel. (6 min)

**MIN.1 | Witness the Mysterious World of West African Voodoo**

Journey to Togo, a tiny nation in West Africa, that contains the region's largest Voodoo market- 'Marche des Fetches' and learn about the rich history that surrounds this religion. (5 min)

**MIN.1 | Traveling While Black**

This film offers a revealing view of the Green Book Era as told through Ben's Chili Bowl, a black-owned restaurant in Washington, to remind us of the hardships that African-Americans faced during that time period. (20 min)

**MIN.7 | Chennai Floods Aftermath**

Take an immersive journey through the impact, rescue, and reason for the floods that occurred in Chennai, India, in December 2015. (6 min)

**MIN.7 | Himalayas: A Trek to School**

Follow two girls as they travel up to 6 hours a day to school in a remote Himalayan village. (8 min)

**MIN.7 | Life in Haiti: After a Devastating Natural Disaster**

Join filmmaker Dylan Roberts on a journey to the Haitian city of Jérémie, and the small village of Manish, to witness the aftermath of a colossal storm. (5 min)

**MIN.7 | Out of Syria- Back to School**

Step into the lives of two teenagers from war-torn Syria, Mustafa and Sarah. They both fled the fighting with their families. They left their homelands and their schools behind. (4 min)

**MIN.7 | The Fight for Falluja**

Experience firsthand the battles Iraqi forces endured to retake the important strategic city of Fallujah from ISIS. (11 min)

## Mississippi Studies

**MS.8 | Traveling While Black**

This film offers a revealing view of the Green Book Era as told through Ben's Chili Bowl, a black-owned restaurant in Washington, to remind us of the hardships that African-Americans faced during that time period. (20 min)

**MS.8 | Medgar Evers House**

Explore a recreation of the Medgar Evers House and National Monument. Made in collaboration with the Evers family. (unlimited) E

**MS.8 | Civil Rights Museum**

Five Civil Rights leaders -Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

E Accessible via the Engage app in the Library

## Problems in American Democracy

**PAD.1 | Independence Hall**
Join George Washington, John Adams, Thomas Jefferson, Benjamin Franklin, and John Hancock as they come to life to tell you their stories about the founding of the United States. (unlimited) E

**PAD.8 | Civil Rights Museum**
Five Civil Rights leaders - Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

## Psychology

**PSY.4, PSY.14 | Autism Virtual Reality**
Become a student with autism in the daily fight for survival. (7 min)

**PSY.4, PSY.8, PSY.14 | Inside Anxiety**
Anxiety can make you feel on edge, unable to concentrate, fearful, irritable, and like you have lost control. Step inside the mind of someone who experiences anxiety and see the world from their point of view. (9 min)

**PSY.7, PSY.14 | A Walk-Through Dementia- At Home**
A unique experience designed to put you in the shoes of someone living with dementia. (3 min)

**PSY.7, PSY.14 | A Walk-Through Dementia- Walking Home**
A unique experience designed to put you in the shoes of someone living with dementia. (4 min)

## US History

**US.3, US.11 | Civil Rights Museum**
Five Civil Rights leaders - Rosa Parks, John Lewis, Martin Luther King Jr., Thurgood Marshall, and Medgar Evers - come to life and teach you their stories on interactive stages. (unlimited) E

**US.4 | Explore a WWI Trench in VR**
Explore and discover how WWI soldiers lived in the trenches, view across No Man's Land, explore an officer's quarters, step inside the first aid field hospital and navigate the wet and muddy trench system. (2 min)

**US.7 | 1. VR Pearl Harbor Attack | 2. Explore South Dakota's Badlands**
EXP.1: The Japanese midget submarine, manned by Ensign Kazuo Sakamaki, failed in its mission to attack and destroy American warships. EXP.2:The Badlands is home to the largest mixed-grass prairie where bison and other wildlife graze freely. (6 min/2 min)

**US.7 | 1941 Battle Reenactment**
Watch the reenactment of this World War II battle from 1941. in this video, you'll see operating German vehicles, such as the Pz.Kpfw. III medium tank as well as the StuG III self-propelled gun. The tanks on the Soviet side are the T-34-76 and the BT-7. (3 min)

**US.7 | Honor Everywhere**
See the World War II Memorial, Arlington National Cemetery, US Marines Corps War Memorial, US Air Force Memorial, and the Korean Memorial. (9 min)

**US.7 | Remembering Pearl Harbor VR: Experience History**
Follow Lt. James Downing as he recounts his time as postmaster of the USS West Virginia. (2 min)

**US.8 | Nuclear Bunker**
Replica of an underground nuclear bunker to be used as a shelter from potential disasters. (unlimited) E

**US.9 | The JFK Assassination**
Follow along as you get an in-depth look into the assassination of JFK. (4 min)

**US.11 | Medgar Evers House**
Explore a recreation of the Medgar Evers House and National Monument. Made in collaboration with the Evers family. (unlimited) E

**US.11 | Traveling While Black**
This film offers a revealing view of the Green Book Era as told through Ben's Chili Bowl, a black-owned restaurant in Washington, to remind us of the hardships that African-Americans faced during that time period. (20 min)

**US.12 | The Fight for Falluja**
Experience firsthand the battles Iraqi forces endured to retake the important strategic city of Fallujah from ISIS. (11 min)

**US.12 | Women's March in Chicago**
Experience a women's rights march in Chicago on Jan 21, 2017. (1 min)

**US.12 | March for our Lives**
Pioneer Valley's March for our Lives on March 24, 2018. (1 min)

**US.12 | Protest Alt Left & Right at Berkley**
Experience a political division march from August 29, 2017. (1 min)

## US Government

**USG.5 | Traveling While Black**
This film offers a revealing view of the Green Book Era as told through Ben's Chili Bowl, a black-owned restaurant in Washington, to remind us of the hardships that African-Americans faced during that time period. (20 min)

**USG.5, USG.6 | Women's March in Chicago**
Experience a women's rights march in Chicago on Jan 21, 2017. (1 min)

**USG.6 | March for our Lives**
Pioneer Valley's March for our Lives on March 24, 2018. (1 min)

E Accessible via the Engage app in the Library

## World History

**WH.8 | Explore a WWI Trench in VR**

Explore and discover how WWI soldiers lived in the trenches, view across No Man's Land, explore an officer's quarters, step inside the first aid field hospital and navigate the wet and muddy trench system. (2 min)

**WH.10 | 1941 Battle Reenactment**

Watch the reenactment of this World War II battle from 1941. in this video, you'll see operating German vehicles, such as the Pz.Kpfw. III medium tank as well as the StuG III self-propelled gun. The tanks on the Soviet side are the T-34-76 and the BT-7. (3 min)

**WH.10 | Honor Everywhere**

See the World War II Memorial, Arlington National Cemetery, US Marines Corps War Memorial, US Air Force Memorial, and the Korean Memorial. (9 min)

**WH.10 | Remembering Pearl Harbor VR: Experience History**

Follow Lt. James Downing, as he recounts his time as postmaster of the USS West Virginia. (2 min)

**WH.10 | Virtually Inside the First Tank**

Join Richard "The Challenger" Cutland and Nicholas "Chieftain" Moran as they explore the oldest members of the collection at The Tank Museum at Bovington, UK, including the world's last surviving Mark I tank: the oldest surviving combat tank in the world. (7 min)

**WH.11 | Nuclear Bunker**

Replica of an underground nuclear bunker to be used as a shelter from potential disasters. (unlimited) E

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# ADDITIONAL OFFERINGS

## Other Content

**Museum of Science Fiction**
A VR Sci-Fiction Museum. (unlimited) E

**Accelerant Turbine**
Model of a steam turbine set in a warehouse location. (unlimited) E

**Trolley Barn**
Mockup of a proposed design for a trolley bar in Belmont, NC. (unlimited) E

**Picto Puzzle**
Multiplayer game where one participant designs a maze, one level at a time, and the other participants must race to solve it before the next level is created. (unlimited) E

**Bridge Builder**
An interactive module that allows for the building of bridges to scale using architectural applications. (unlimited) E

**EMU Multicultural Center**
Multi-use space featuring a community center, art gallery, and a café. (unlimited) E

**Sun Formation**
See lots of Particles colliding to form the Sun. (unlimited) E

**Star Visualization- Sand Pile 1**
Visualization of the number of stars in the universe as grains of sand on a map of the US. (unlimited) E

**Star Visualization- Sand Pile 2**
Visualization of the number of stars in the universe as grains of sand on a partial map of the US. (unlimited) E

**Particle collision with Sparks**
Two swarms of particles colliding with each other and forming sparks. (unlimited) E

**Bunsen Burner**
Interactive model of a Bunsen burner with toggleable flame. (unlimited) E

**Erlenmeyer Flask**
Flask/beaker with a chemical reaction taking place inside. (unlimited) E

**Hazardous Waste Disposal**
Interactive model of a fire extinguisher. (unlimited) E

**Fire Extinguisher**
Interactive model of a fire extinguisher. (unlimited) E

**Lab Safety Manual**
Interactive at-scale measuring tool. (unlimited) E

**Emergency Eye Wash**
Interactive model of an emergency eyewash and shower station as found in a science lab. (unlimited) E

**Tape Measure**
Interactive at-scale measuring tool. Users can extend the tape in 1-ft segments up to 10 feet. (unlimited) E

**Face Mask**
Photorealistic model of a blue disposable face mask. (unlimited) E

**Fume Hood**
Interactive science lab fume hood. (unlimited) E

**International Space Station**
Model of the exterior of the International Space Station. (unlimited) E

**Fire Extinguisher- Network**
Interactive model of a fire extinguisher that allows for the user to pull the pin, aim the handle, and squeeze the trigger to produce the foam. (unlimited) E

**Painting Tool**
Select the color you want to paint the other objects, then touch one painting tool to the other to change its color. (unlimited) E

**X- Ray Machine**
Interactive model of an x-ray machine. (unlimited) E

**Google Data Center Tour**
Take a Google data center tour and learn about the massive scale, the incredible attention to security and privacy, and the amazing efforts to make the data center extremely efficient and green. (9 min)

**Letter A - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter A. (2 min)

**Letter B - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter B. (2 min)

**Letter C - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter C. (2 min)

**Letter D - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter D. (2 min)

**Letter E - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter E. (2 min)

**Letter F - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter F. (2 min)

**Letter G - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter G. (2 min)

**Letter H - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter H. (2 min)

**Letter I - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter I. (3 min)

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**Letter J - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter J. (5 min)

**Letter K - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter K. (5 min)

**Letter L - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter L. (7 min)

**Letter M - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter M. (6 min)

**Letter N - 360 3D Animated VR Kids Video**
Try out our 360 degree video where you can turn all around to find the objects that begin with the Letter N. (4 min)

**Backstage with an Elite Ballerina**
Go behind the scenes with Sarah Lane, a soloist at the American Ballet Theatre, as she prepares to dance the title role in "The Sleeping Beauty" at Lincoln Center. (5 min)

**Explore the World in 4k**
Venture around the world and see different aspects of the natural world and various cities and wildlife. (3 min)

**GoPro VR: New York City Jump**
There's no better way to see New York City in 360 then through the eyes of a born and bred NY photographer. (3 min)

**Okinawa 360 - VR Sea Tour**
Explore the diverse aquatic life surrounding Okinawa. (5 min)

**Visit Hamilton Island Virtual Reality with Qantas**
Fly over Hamilton Island and explore the resort from a Qantas Jet. (8 min)

**How Babies See The World**
Follow along as you see through the eyes of a baby how their eyesight changes over the first year of life. (2 min)

**Wreck Diving Time Lapse**
Scuba dive one of the Caribbean's most iconic shipwrecks. (1 min)

**A Skateboard Ride to STEM Learning | 360° VR video**
University of Washington Professor Kristen Missall discusses her research partnership with Iowa Children's Museum and leads a tour of its "Notion of Motion" exhibit. (3 min)

**NYC 360 Time Warp**
Time lapse of a day in New York City. (1 min)

**All Skippers Invited**
Join a short selling trip on a sunny day. (1 min)

## Panoramic Experiences

**The Alamo**
Alamo 1
Alamo 2
Alamo 3
Alamo 4
Alamo 5
Alamo 6
Alamo Cenotaph Monument

**The Forbidden City**
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Forbidden City 3
Forbidden City 4
Forbidden City 5
Forbidden City 6
Forbidden City 7
Forbidden City 8

**The Louvre**
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Louvre Outside
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Louvre Rivoli

**The Vatican**
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Basilica di San Giovanni in Laterano
Basilica di San Giovanni in Laterano 2
Basilica Papale di Santa Maria Maggiore
Basilica Papale di Santa Maria Maggiore 2
Baths of Caracalla
Baths of Diocletian
Borghese Gallery and Museum
Borghese Gallery and Museum 2
Borghese Gallery and Museum 3
Borghese Gallery and Museum Entrance
Campidoglio
Capitoline Museums 1
Capitoline Museums 2
Capitoline Museums 3
Capitoline Museums 4
Capitoline Museums Exterior
Castel Sant'Angelo
Castel Sant'Angelo 2
Castel Sant'Angelo 3
Circus Maximus
Colosseum
Colosseum 2
Doria Pamphilj Gallery
Fiumi Fountain
Fontana di Trevi
Hadrian's Villa

**The Vatican (cont.)**

Largo di Torre Argentina
Largo Romolo e Remo
Ludus Magnus
National Roman Museum
Palatine Hill
Pantheon
Pantheon Entrance
Piazza del Popolo
Piazza Navona
Pyramid of Caius Cestius
Roman Forum
Roman Forum 2
Spanish Steps
St. Clemens Basilica
Temple of Asclepius
Trajan's Column
Trajan's Market
Villa d'Este 1
Villa d'Este 2

**Jerusalem**

Ben Yehuda St 1
Ben Yehuda St 2
Chords Bridge
Church of All Nations
Church of the Holy Sepulchre 1
Church of the Holy Sepulchre 2
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Damascus Gate
Davidka Square
Dome of the Rock 1
Dome of the Rock 2
Dome of the Rock Exterior
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Gethsemane
Hall of Names, Yad Vashem
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Model of Jerusalem in 2nd Temple Period 1
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Montefiore Windmill
Mount of Olives
Museum on the Seam
National Hall for Israel's Fallen
Pool of Siloam
Rockefeller Archaeological Museum
Sacher Park
The Garden Tomb Jerusalem 1
The Garden Tomb Jerusalem 2
The Israel Museum
The Israel Museum Exterior
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Tomb of the Prophets
Tomb of the Virgin
Tower of David
Warsaw Ghetto Monument
Western Wall
Wohl Rose Garden
Zedekiah's Cave
Zion Gate

**Mount Rushmore**

Lincoln Borglum Visitor Center 1
Lincoln Borglum Visitor Center 2
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**Yosemite National Park**

Bridalveil Falls View
Cathedral Beach
El Capitan Picnic Area
Glacier Point Trail
Glacier Point
Lost Arrow Spire
Lower Yosemite Falls Bridge
Lower Yosemite Falls Trailhead
Merced River 1
Merced River 2
Merced River 3
North Dome
Sentinel Beach
Tunnel View
Upper Yosemite Falls Trail
Upper Yosemite Falls
Washburn Point
Yosemite Falls
Yosemite Mountaintop
Yosemite Valley View

**London, England**

Barbican Centre
Big Ben
Borough Market 1
Borough Market 2
Buckingham Palace
Canary Wharf
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Kyoto Garden Holland Park
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Piccadilly Circus
Princess Diana Memorial Garden
Royal Albert Hall
Shaftesbury Memorial Fountain
St. James's Palace
St. Mary's Axe
St. Paul's Cathedral
Tate Modern

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**London, England (cont.)**

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The British Museum 1
The British Museum 2
The British Museum 3
The British Museum 4
The British Museum 5
The British Museum 6
The British Museum Exterior
Tower Bridge
Tower of London
Trafalgar Square

## Virtual Museums & Field Trips

**Smithsonian National Museum of Natural History**
Explore and learn from the many exhibits in the Smithsonian. (unlimited)

**The Vatican Museum**
Raphael's Rooms, Pio Clementino Museum, Niccoline Chapel, Room of Chiaroscuro. (unlimited)

**George Washington's Mount Vernon**
Explore George Washington's historic home. (unlimited)

**The Met 360 Project**
Great Hall (2 min), The Met Cloisters (2 min), The Temple of Dendur (2 min), The Met Breuer (2 min), The Charles Engelhard Court (3 min), Arms and Armor Galleries (3 min), Collection (6min)

**Kennicott Glacier**
Explore the Kennicott Glacier in the Wrangell-St. Elias National Park and Preserve in Alaska. (unlimited)

**Access Mars**
Explore the Planet of Mars from the Mars Rover. (unlimited)

**National Museum of the US Air Force**
Explore the Museum of the US Air Force and learn about its history. (unlimited)

**Antietam National Battlefield**
Explore this historic battlefield from the Civil War. (unlimited)

**Gettysburg National Battlefield**
Explore this historic Battlefield from the Civil War. (unlimited)

**Fredericksburg National Battlefield**
Explore this historic battlefield from the Civil War. (unlimited)

**Charleston and Fort Sumter**
Explore this historic battlefield from the American Revolution. (unlimited)

**Shiloh National Battlefield**
Explore this historic Battlefield from the Civil War. (unlimited)

**Chattanooga National Military Park**
Explore this historic Battlefield from the Civil War. (unlimited)

**Yorktown Battlefield**
Explore this historic Battlefield from the Revolutionary War. (unlimited)

**Vicksburg National Military Park**
Explore this historic Battlefield from the Civil War. (unlimited)

**Appomattox Courthouse**
Explore this historic Courthouse where the end of the Civil War happened. (unlimited)

**Chancellorsville Battlefield**
Explore this historic Battlefield from the Civil War. (unlimited)

**Guilford Courthouse**
Explore this historic site from the Revolutionary War. (unlimited)

**Eutaw Springs Battlefield**
Explore this historic Battlefield from the Revolutionary War. (unlimited)

**Mount Everest**
Explore the impressive heights of Mount Everest. (unlimited)

# CAREER & WORKFORCE DEVELOPMENT

lobaki™

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DISCLAIMER: Please be advised that some content is not suitable for all ages!

## Law, Public Safety, Corrections, & Security



## Manufacturing



## Marketing, Sales, & Service



## Science, Technology, Engineering, & Mathematics



## Transportation, Distribution, & Logistics



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# Agriculture, Food, and Natural Resources

## Natural Resources Systems

**Careers in Forestry: Research Assistant**
Follow along with Katrina Deinton to learn about being a Research Assistant in the forestry industry. (2 min)

**Careers in Forestry: Planning Manager**
Follow along with John Hair to learn about being a Planning Manager in the forestry industry. (2 min)

**Careers in Forestry: General Forester**
Follow along with Regional Ecologist, Jenny Mulgrew and Assistant Forest Manager, Jamie Adcock to learn about being a General Forester in the forestry industry. (2 min)

**Careers in Forestry: Design & Manufacture**
Follow along with Claire Coquet to learn about being a Design Engineer in the forestry industry. (2 min)

**Careers in Forestry: Harvester Operator**
Follow along with Scott MacFarlane to learn about being a Harvest Operator in the forestry industry. (2 min)

**Tree Farm**
Experience what it's like to work on a tree farm. (2 min)

**Logging**
Experience what harvesting trees on a farm is like. (2 min)

**Mill**
See what is done to trees to get them ready for the mill. (2 min)

**Driving a Loading Truck | Forestry**
Pick up harvested trees, referred to as logs, and load them onto trucks to be transported out of the forest. (4 min)

**Forestry Machinery**
Experience the machinery used in the forestry industry. (5 min)

**Log Truck | Forestry**
Experience a log truck as it gets loaded. (3 min)

**Timber Harvesting VR Experience | Fellerbuncher**
Follow along and learn what a Fellerbuncher does in Timber Harvesting. (2 min)

**Timber Harvesting VR Experience | Loader**
Follow along and learn how a Loader is used in Timber Harvesting. (2 min)

**Timber Harvesting VR Experience | Processor**
See how a Processor is used in Timber Harvesting. (2 min)

## Animal Systems

**A Day in the Life of a Rangeland Manager**
Billy Freeman (an honest-to-gosh cowboy) introduces us to the McKenzie Ranch at the Sierra Foothill Reserve in Clovis, California. (7 min)

**Tour of a Chicken Processing Plant**
Learn about the processing plant and how chickens are handled while getting ready to go to market. (4 min)

**Mink Farm Tour**
See inside a working Canadian mink farm and learn all about how minks are cared for and how Canadian mink farmers produce high-quality products for the industry. (7 min)

**Egg Grading and Processing Tour**
See inside a working Canadian egg processing facility and see for yourself what happens to an egg between the farm and your table. (7 min)

**Canadian Free-Run Egg Farm Tour**
In this 360° tour, you'll learn what makes eggs "Free Run", what the hens eat, how hens are cared for, as well as how solar power is generated to meet this farm's needs. (5 min)

**Canadian Pig Farm Tour**
See inside a working Canadian pig farm and learn all about how pigs are cared for, what they eat, where they live, and how Canadian pig farmers keep their animals entertained and healthy. (10 min)

**Getting Licked by a Cow in Ireland**
Get up close and personal with cows. Now you'll know what it's like to be licked and sniffed by them. (1 min)

**Farm Food Tour – Egg**
Welcome to Megan's egg farm in Southwestern Ontario, Canada. You'll learn about biosecurity, egg collection, how hens are cared for, and much more. (6 min)

**Farm Food Tour – Sheep**
Welcome to Peter and Elly's sheep farm. See how this Canadian family raises sheep on pasture, in the barn, and during transport. (7 min)

**Farm Life - Virginia Beef Cattle**
Follow along as Virginia farmers care for Beef Cattle. (1 min)

**Farm Life - Virginia Chicken House**
Take a look at how a Chicken house works and is run. (1 min)

**Farm Life - Virginia Dairy Cow Milking**
See up close how cows are milked and the process of milking. (2 min)

**New Foals at the UC Davis Horse Barn**
Follow Dr. Amy McLean as she gives an overview of the research herd that is a part of the UC Davis animal science horse barn and stallion internship program. (2 min)

**Organic Chicken Egg Farm Tour**
Learn what it takes for an egg to be considered organic. (1 min)

**Smithfield Sow Farm Tour**
Take a virtual tour of Smithfield's sow farm and learn about the care and work that goes into taking care of their hogs. (6 min)

E Indicates experiences accessible from the Engage app.

**Smithfield Wean-to-Finish Farm Tour**
Step inside one of Smithfield Farm's wean-to-finish farms, a combination of the nursery and finishing stages of hog production, where piglets live and grow until they reach market weight. (5 min)

**Take a Tour of a Chicken Farm**
Follow along with a farmer as he goes over how broiler chickens (meat chickens) are raised until they are big enough to be sold for meat. (5 min)

**USPOULTRY's Turkey Farm Virtual Tour**
Experience how young turkeys are raised and the care they are given by the farmer who is raising them. (6 min)

**Voluntary Milking System Dairy Farm**
This Canadian family dairy farm uses a Voluntary Milking System which enables their cows to decide when they would like to be milked. (6 min)

## Food Products & Processing Systems

**AeroFarms: The Future of Farming**
See how AeroFarms in Newark, NJ grows over 2 million pounds of greens a year without sunlight, soil, or pesticides, making it the world's largest indoor vertical farm. (2 min)

**USCC Compost Equipment Demo Day 2017**
Join the US Composting Council Equipment Demo Day in Los Angeles and see different machines that are used in the composting process. (6 min)

**Virtual Food Tour: Cheese Processing**
Find out how cheese is processed - from the time the milk leaves a Canadian family dairy farm to the time it reaches your table. (6 min)

**Virtual Food Tour: Milk Processing**
Learn how milk travels from a Canadian family dairy farm to a processing facility where it is made ready for your family's table. (6 min)

**Story of Oats**
In this 360 video tour, you'll get to see how oats are transformed from a plant in the field to the food on your table. (6 min)

**Custom Foods Plant Tour**
Tour the Custom Foods' manufacturing facility in De Soto, Kansas, and see how food is manufactured. (3 min)

**In the Mix with Furlani's Food Corporation**
Tour of Furlani's Food Corporation, a premier manufacturer of fresh and frozen bread. (3 min)

## Plant Systems

**Peanut harvest**
Heath Donner of Mississippi County takes us along for a 360 view of harvesting peanuts. (1 min)

**Wheat Harvest**
Ride along with a farmer through the various processes involved in harvesting wheat from a field. (3 min)

**Canadian Apple Orchard Tour**
In this 360 tour, you'll get to tour a working apple orchard and learn how apples are grown, cared for, and harvested. (6 min)

**Farming Part 1 - BIG BUD Tractors - Welker Farms Inc**
Follow along with an employee of Welker Farms, Inc as they go through the spraying season for their crops. (16 min)

**Farming Part 2 - BIG BRUTE - Welker Farms Inc**
Follow along with an employee of Welker Farms, Inc as they go through the spraying season for their crops. (19 min)

**Farming Part 3 - Harvest - Welker Farms Inc**
Follow along with an employee of Welker Farms, Inc as they go through Harvesting season for their crops. (15 min)

**Riverhill Farms Tour**
Welcome to Riverhill Farms, the home of one of our independent family farmers. Join Glenn Rodes, an eighth-generation farmer, as he shares what it means to be committed to raising turkeys the honest, simple way. (2 min)

**360 Farm Tour: It Starts with a Seed**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 1 (6 min)

**360 Farm Tour: As The Corn Grows**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 2 (6 min)

**360 Farm Tour: Harvesting the Corn**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 3 (6 min)

**360 Farm Tour: Protecting the Corn**
Follow a fifth-generation farmer and see the challenges farmers face, solutions that technology offers, and ultimately the fruits of labor that will transform into food, feed, and fuel. Part 4 (6 min)

**ACE Center @ Hermitage Greenhouse**
Join students from Hermitage High School as they explain how a greenhouse works. (3 min)

**Bayer Digital Farming**
Have you ever wondered what digitalization and farming have in common? Digital Farming can help farmers predict what is coming around the corner. Learn more here at Bayer's 360° tractor virtual experience. (2 min)

**Capture Scratch's Virtual Farm Tour**
This virtual reality tour invited visitors to the Toronto Garlic Festival to "witness" a real garlic harvest in the hot sun, bringing festival-goers closer to the garlic growing process. (4 min)

E Indicates experiences accessible from the Engage app.

**Cultivating - John Deere 4020**
Join Ryan as he cultivates a field with a John Deere 4020. (7 min)

**Degelman Dozer Blade**
Join a farmer as he works with a Degelman Dozer blade on his farm. (11 min)

**ExplOregon Agriculture - Blueberry Harvest**
Join ExplOregon Agriculture Foundation at Blue Raeven Farms as they harvest blueberries. (2 min)

**ExplOregon Agriculture - Broccoli Harvest**
Join ExplOregon Agriculture Foundation at Pearmine Farms as they harvest broccoli. (2 min)

**ExplOregon Agriculture - Cauliflower Planting**
Join ExplOregon Agriculture Foundation at Pearmine Farms as they plant Cauliflower. (2 min)

**ExplOregon Agriculture - Christmas Tree Harvest**
Join ExplOregon Agriculture Foundation at Stroda Brothers Farms as they harvest Christmas Trees. (2 min)

**ExplOregon Agriculture - Field Corn Harvest**
Join ExplOregon Agriculture Foundation at Meadowoods Farms as they harvest Field Corn. (2 min)

**ExplOregon Agriculture - Green Bean Harvest**
Join ExplOregon Agriculture Foundation at Cook Family Farms as they harvest Green Beans. (2 min)

**ExplOregon Agriculture - Mint Distillery**
Join ExplOregon Agriculture Foundation at Stroda Brothers Farms as they harvest and distill Mint. (2 min)

**ExplOregon Agriculture - Mint Harvest**
Join ExplOregon Agriculture Foundation at C & L Farms as they harvest Mint. (1 min)

**ExplOregon Agriculture - Radish Seed Harvest**
Join ExplOregon Agriculture Foundation at Ruddenklau Farms as they harvest radish seeds. (3 min)

**ExplOregon Agriculture - Sugar Beet Seed Harvest**
Join ExplOregon Agriculture Foundation at Cooks Family Farms as they harvest Sugar Beet Seed. (3 min)

**ExplOregon Agriculture - Sweet Corn Harvest**
Join ExplOregon Agriculture Foundation at Cooks Family Farms as they harvest Sweet Corn. (2 min)

**Farm Life - Virginia Tobacco**
Follow along as Farmers work to harvest Tobacco Leaves. (1 min)

**Farm Life - Virginia Peanut Digging and Harvest**
Follow along as Virginia farmers dig and harvest Peanuts. (4 min)

**Farm Life - Virginia Apple Orchard**
Follow along as farmers work to harvest apples from an orchard. (2 min)

**Farm Life - Virginia Corn Chopping**
Follow along as a farmer cuts and harvests corn. (2 min)

**Farm Life - Virginia Corn Planting**
Follow along as a farmer plants corn. (1 min)

**Farm Life - Virginia Cotton Harvest**
Join a farmer as he works to harvest cotton. (5 min)

**Farming Simulator: Tour Through Goldcrest Valley**
Visit Goldcrest Valley, the new environment in Farming Simulator 17, and see what farming life is like. (3 min)

**George the Farmer - Apples VR**
Join George the Farmer and his mates Simone and Ben as they investigate how apples are grown. (4 min)

**George the Farmer - Dairy VR**
Join George the Farmer and his mates Simone and Ben as they investigate where delicious dairy products like milk and yogurt really come from. (4 min)

**George the Farmer Chickpeas – VR**
Join George the Farmer and his mates Simone and Ben as they investigate chickpeas at harvest time. (4 min)

**George the Farmer Forestry – VR**
Join George the Farmer and his mates Simone and Ben as they investigate some of the products made from Pine Trees in sustainable pine plantations. (4 min)

**Harvest – An Immersive VR Experience**
Soar high above the fields of Perthshire as a fleet of combine harvesters and tractors harvest the year's oats, wheat, and barley. Jump inside the cabin of a high-tech combine and stand next to the tractor as it dumps grain in the silo. (4 min)

**Harvesting in VR**
Ride along with a farmer as he works on harvesting his field. (14 min)

**Harvesting Rice | Harvest 2018**
Come along on this virtual tractor ride and learn about harvesting rice. (36 min)

**Virtual Farm Tour | Organic Valley**
Take a virtual tour into how Dairy cows are raised to produce organic milk. (1 min)

**VR Harvest - Polish Grain Farm Chill Out**
Follow Polish Farmers as they work to harvest and chill out the grain. (2 min)

## Power, Structural, & Technical Systems

**Look Inside Brooklyn's Farming Revolution**
Visit a high-tech, hydroponic farm that is breaking away from the traditional, transport-heavy, industrial food system and blazing the trail for the future of super-efficient urban farming. (3 min)

**A Vertical Farm Grows In Newark**
AeroFarms is a farming company that grows produce indoors without sun, soil, or pesticides. Step inside one of their vertical farms, which grows kale, arugula, and other greens in Newark. (2 min)

**Gotham Greens' Urban Rooftop Farm**
Go behind the scenes at Gotham Greens in Brooklyn, New York, where all kinds of leafy greens are grown in their state-of-the-art urban rooftop greenhouse. (2 min)

# Architecture & Construction

## Construction

**Life on an Oil Rig**
Have you ever wondered what life is like on an oil rig in the North Sea? Well, in this immersive video, one worker takes you around the Shearwater platform. (3 min)

**Chevron's Jack/St. Malo Offshore Platform**
Travel by helicopter into the Gulf of Mexico, about 280 miles south of New Orleans, to Jack/St. Malo, Chevron's largest deepwater offshore platform. Tour the massive operation and meet some of the platform's employees. (2 Min)

**Riding the Truss at the Somerton High School Construction Project**
Ride on a truss getting flown and set into place at the Somerton High School project. (3 Min)

**Tour of a Construction Site Using Kryton Products**
See how Kryton products are used on a construction site. (2 Min)

**Sewer Tunnel Construction**
Metropolitan St. Louis Sewer District's construction site where crews are digging a 30-foot shaft in preparation for the arrival of a small Tunnel Boring Machine (TBM). (4 min)

**Elbphilharmonie construction site**
A virtual tour through the Elbphilharmonie construction site. (2 min)

**A Day in the Life of a Construction Craft Worker at LiUNA**
Learn about the pathway into the Construction Craft Worker career and what a typical day in this profession looks like. (5 min)

**Aurora Wind Farm Under Construction**
A tour that shows the construction process of our Aurora wind project in Williams and Mountrail counties in North Dakota. (3 min)

**Build your Future at Bird Construction**
Take a tour of the workplace of Bird Construction, a leading general contractor in Canada. (3 min)

**Cat Command Console for Excavators**
Experience a CAT Command Remote Solutions, including the onboard electronic systems and vision systems, that allow machines to be controlled without anyone in the cab. (3 min)

**Convocation Center Construction**
Take a look at the construction of a convocation center. (4 min)

**E. Bronson Ingram College - Construction Experience**
Take an overlook of the construction of the E. Bronson Ingram College at Vanderbilt University. (3 min)

**Staten Island: Empire Outlets Construction Site**
Explore the construction work at the Empire Outlets site in St. George, Staten Island. (1 min)

**The Box Construction Site - Autumn/Winter 2017**
Experience a construction site when digging and waterproofing works are taking place. (2 min)

**TheatreSquared Construction – Boom Crane Climb**
Experience a boom crane operator climb more than 300+ feet in the air in order to operate this piece of machinery. (6 min)

**Construction Video Experience**
Experience a construction site and see what goes into building a place. (1 min)

**Wind Farm Construction**
Watch as the wind plant takes shape and hear first-hand how the turbines are put together. (4 min)

**Working with Heavy Machinery.**
See what it's like to work with heavy machinery on a job site. (7 min)

**View of Safety**
View a recent McCarthy safety meeting and listen to important messages from the safety coordinator and project superintendent on site. (4 min)

**Safety in a Box: Caught In Between (English/Spanish)**
Experience the dangers of workplace accidents such as being caught in between objects in this safety video. (1 min)

**Safety in a Box: Construction 2 (English)**
Experience the dangers of workplace accidents and various scenarios that can occur on a construction site. (6 min)

**Safety in a Box: Construction 2 (Spanish)**
Experience the dangers of workplace accidents and various scenarios that can occur on a construction site. (7 min)

**Safety in a Box: Electrocution (English/Spanish)**
Experience the dangers of electrocution that can take place on a construction site. (1 min)

**Safety in a Box: Falling from Height (English/Spanish)**
Experience the dangers of a fall from a height in this scenario video on safety at a construction site. (1 min)

**Safety in a Box: Struck By (English/Spanish)**
Experience the dangers of being struck by a piece of equipment in this scenario on safety at a construction site. (1 min)

**Intro to Electrical**
See what it takes to set up a DC, and AC, and an AC as DC Connection in this beginner training module. (unlimited) E

**Carpentry Tool Identification**
Identification of various tools of Carpentry. (unlimited) E

**Intro to Carpentry**
Identify tools and board types in a building frame. (unlimited) E

**Entergy In Field Safety Training**
In-field safety training for power lines. (unlimited)

**First-Hand Excavator Training 101**
Ride along with Randy as he teaches you to operate a Komatsy PC-210 excavator with you in the driver seat. (10 min)

**Pouring Concrete**
Follow Joe on a construction site as he walks you thigh how concrete is poured. (6 min)

**Introduction to OSHA & Employee Rights of OSHA**
Meet Jim and learn about what OSHA is and the rights an employee has under OSHA. (2 min)

**OSHA Fall Safety Basics**
Follow Jim as he takes you through the basics of fall safety according to OSHA. (9 min)

**OSHA Fall Safety: Harness & Lanyard**
Follow Jim as he takes you through the basics of using a harness & lanyard according to OSHA guidelines. (11 min)

**OSHA Fall Safety: ABCD'S of Fall Protection**
Follow Jim as he takes you through OSHA's ABCDs of fall protection. (12 min)

**OSHA Fall Safety: Laddars**
Follow Jim as he takes you through the basics of using ladders according to OSHA safety guidelines. (14 min)

**OSHA Fall Safety: Scaffolding**
Follow Jim as he takes you through the basics of using scaffolding safety according to OSHA guidelines. (13 min)

**OSHA Fall Safety: Roofs**
Follow Jim as he takes you through the basics of roof safety according to OSHA guidelines. (10 min)

## Maintenance/Operations

**Underwater Inspection**
Join a scuba diver as they inspect a ship's propeller system and hull all from under the water. (2 min)

**Steelmaking at ArcelorMittal Dofasco**
Join Materials engineer Sagarika Paul and millwright Jesse Castelli for a tour of the steelmaking process at ArcelorMittal Dofasco. (2 min)

## Design/Pre-Construction

**The History of Hamburg's Rethe Bridge**
This video recounts the history of Hamburg's Rethe Bridge and its stunning architecture. (8 min)

**Underneath the Lincoln Memorial**
Get a rare look around the underground of the Lincoln Memorial and see the charcoal drawings left by construction workers who helped build the foundation over 100 years ago. (2 min)

**Construction project - 1st week of 2022**
Listen as a client, construction manager, and architect discuss beam conditions and repairs needed in a typical construction project meeting. (3 min)

**Bridge Builder**
An interactive module that allows for the building of bridges to scale using architectural applications. (unlimited)

# Arts, Audio/Video Technology, & Communications

## Printing Technology

**Where it's Made: The New York Times Newspaper**
The New York Times prints between 300,000 to 800,000 newspapers daily at its main facility in Queens. Take an immersive tour as the paper comes together. (2 min)

## Journalism & Broadcasting

**Wimbledon-Broadcasting Training**
Follow along with the team that is broadcasting from Wimbledon as they give a behind-the-scenes look at how the broadcast comes together. (4 min)

**Behind the Scenes of a Film Set.**
Follow Sarah, the assistant director, as she shows you around a working sound state and introduces you to how many people and jobs go into a production. (12 min)

## Visual Arts

**A Day in the Life of an Illustrator**
What is it like to be an illustrator? What does it take to break into the industry? Learn more from Subin Yang who is an illustrator based in Seoul/Portland who has worked with companies like NBC News, Naver, and artists like Khruangbin. (6 min)

E Indicates experiences accessible from the Engage app.

**A Day in the Life of a Fashion Designer**

What does it take to start your own fashion brand? How do you get other people to notice what you're doing? Meet Stijn Tolman and learn about his journey with Takno and what keeps him going and motivated. (9 min)

**School of Design & Media Facility Tour**

Join Deda and Mark as they take you on a tour through NYP's School of Design & Media to experience different possible careers like interactive design and woodworking. (10 min)

### Performing Arts

**A Day in the Life of a Conductor/Music Composer**

Take a brief look into the Early Childhood Education section of the Teaching Academy program at the Trumbull Career and Technical Center. (2 min)

**Behind the Scenes of a Film Set.**

Follow Sarah, the assistant director, as she shows you around a working sound state and introduces you to how many people and jobs go into a production. (12 min)

## Business Management & Administration

### Administrative Support

**Radial Fulfillment Operations**

Take a tour of the order fulfillment center and learn what happens when you place an order; from wave planning to picking, personalization, packing and loading for shipment. (4 min)

### Business Information Management

**Professions: IT Specialist**

For a global company like Bayer, IT is key in almost all business processes from infrastructure to R&D, which is why our IT landscape offers countless exciting entry and career opportunities for IT Talkents. (3 min)

## Education & Training

### Professional Support Services

**Preserving 97 Orchard**

Join Danielle Swanson, the Collections Manager at the Museum,  and learn more about the preservation work that has been going on at the Tenement Museum's 97 Orchard Street building. (2 min)

### Teaching/Training

**Failure to Communicate: An Immersive Experience about Learner Variability**

Experience about Learner Variability in which a teacher is encouraged to look at her class from one of her student's unique and engrossing perspectives. (11 min)

**Early Childhood Careers Lewis and Clark Virtual Tour**

Explore a career in Early Childhood at Lewis and Clark education lab. (1 min)

**Cambrian College Early Childhood Education Lab**

Tour Cambrian College's early childhood education lab and experience the teacher's view of the classroom. (1 min)

**Early Childhood Education**

Experience an Early childhood education program classroom from the view of a teacher. (1 min)

**Early Childhood Education Walk Through**

Take a brief look into the Early Childhood Education section of the Teaching Academy program at the Trumbull Career and Technical Center. (2 min)

## Finance

### Securities & Investments

**Explore the Future in Professional Services with Deloitte**

The Learning Partnership takes you behind the scenes of Deloitte LLP, which provides auditing, consulting, financial advisory, risk management, tax, and other related services to its many clients.. (3 min)

## Government & Public Administration

### National Security

**The Most Dangerous Job: Working the Flight Deck in the US Navy**

Working on a flight deck is among the most dangerous jobs in the United States Navy. In April 2016, eight sailors on board the USS Dwight Eisenhower were seriously injured and evacuated off the ship after an arresting wire snapped on the flight deck. The ship's sailors and top brass talk about life on the deck. (4 min)

E Indicates experiences accessible from the Engage app.

**Navy: Explore Life from Every Angle**
Get a unique perspective of life onboard HMAS Canberra, watching personnel work out, maintain systems, and complete drills. (3 min)

**Maritime Security Response Team**
Experience a mission with the Maritime Security Response Team (MSRT), which is part of the Coast Guard's Armed Deployed Specialized Forces. (3 min)

**Air Force Academy: Jacks Valley Basic Training**
Follow Cadets of the US Air Force Academy as they are pushed to their physical limits in Basic Cadet Training in Jacks Valley. (3 min)

# Health Science

## Biotechnology Research & Development

**IMCS: Careers in Biotechnology**
Take a tour inside the IMCS laboratory with co-founder and scientist Andrew Lee and learn about the biotechnology products that his company makes. (2 min)

**Cardiovascular Research**
At Bayer, cardiovascular research is one of the key pillars of the Pharmaceutical division- and the dedicated researchers at the state-of-the-art research campus in Wuppertal Aprath are provided everything they need to find the next life changing solution. (4 min)

## Diagnostic Services

**Job preview of Vet Tech at Midwest Birds & Exotic Animal Hospital**
Follow along with a worker from the Midwest Birds & Exotic Animals Hospital and learn what a typical day consists of. (3 min)

**A Day in the Life of a Vet Tech Student**
Explore the two-year Veterinary Technician program. Learn what it takes to work with animals and the skills needed to be an integral team player within veterinary practices, research facilities, or other animal-related industries. (3 min)

**Department of Health Science Lab Tour**
Join Parthajit as he takes you on a tour of Brock University's Undergraduate Teaching Lab, Immunology Lab, Human Hemodynamics Lab and Anatomy lab of the Department of Health Science (4 min)

**OCD Triggers**
8 Immersive experiences used to trigger an OCD moment: Self-Harm, Dirty Bathroom, Rave, Church, Road Rage, Existential Crisis, Pool Party, House Party, Traditional OCD-Misalignment. (unlimited)

**C3: Crash Course Coordination**
Interactive game that helps to improve hand-eye coordination. (unlimited)

**Imagining Academy**
David Anthony, COO of Medical Imaging Solutions (MIS) explains the Imaging Technician career field and getting started with the Imaging Academy. (2 min)

**VirtuLIVE: Operating Room**
Join Chris as he explores professions within the Advent Health Celebration Hospital's Operating Room. Learn about careers such as a Physician's Assistant, Nurse Practitioner (APRN), Neurosurgeon, Surgical Technologist, Operating Room Registered Nurse, Various Operating room representatives and vendors. (35 min)

## Health Informatics

**Lessons in Professionalism: Dental Receptionist**
Experience the importance of professionalism in the dental office and examples of what you shouldn't do as a receptionist. (2 min)

## Support Services

**Patient Point of View in Advanced Life Support (Code Blue)**
Training video demonstrates a cardiac arrest (code blue) as if the doctor is leading an arrest for the first time. (7 min)

**Pediatric Trauma Scenario: Patient Stabilization**
Experience an Emergency Room Staff work to get a patient stabilized while waiting for a life flight to arrive. (3 min)

**Pediatric Trauma Scenario: Emergency Room Prep**
Experience an emergency Room Staff preparing for the arrival of a pediatric patient. (2 min)

**Point of View Perspective of a Trauma Patient**
Experience the point of view of a trauma patient—on the scene, in an ambulance, and in the emergency department of a hospital. (4 min)

**Inside The Hospital Mortuary**
Find out what happens on the last leg of a patient's journey. (5 min)

**GC Nursing Pediatric Code Training**
Experience a pediatric cardiac arrest training video. (10 min)

**Going for an MRI Scan from a Patient's Perspective**
Experience going for an MRI Scan. (3 min)

**Advanced Life Support / Code Blue**
Learn how to lead a cardiac arrest /code blue using the advanced cardiac life support (ALS/ACLS) algorithms. (8 min)

**VR Patient Experience**
Experience what a Patient experience is like in a hospital-like setting. (7 min)denada

**EMT Vehicle Orientation**
Tour inside the Lexington County EMS ambulance with a paramedic, Lisa Dawkins. (3 min)

**Resuscitation of a Covid-19 Patient w/ Respiratory Failure Best Practices Demonstration**
This immersive 360-degree video takes you inside a hospital emergency department and shows the best practices learned by medical staff in New York City and Philadelphia for treating critically ill COVID-19 patients with respiratory failure. (11 min)

**Mississippi Valley Regional Blood Center**
Meet Elizabeth Hopkin, Director of Reference Laboratories at Mississippi Valley Regional Blood Center, and listen to her experience preparing for and having a career in the science and medical field. (3 min)

**TVAPL Endotracheal Intubation Simulation**
Learn the procedure to intubate an unconscious patient in this teaching simulation. (2 min)

## Therapeutic Services

**Careers in Cardiology**
Explore professions in healthcare! Professions explored: Cardiovascular Technologist (CVT), Registered Nurse (RN), Educator, Manager, and Echo-cardiogram Technician (ECHO). (42 min)

**EKG Concepts**
Interactive training course on 12-Lead EKG. (unlimited)

**Anatomy Lab**
Highly interactive anatomy classroom that allows students to assemble the human body piece by piece with over 90 separate body parts to learn about (unlimited) E

**A Visit to the Dentist**
A module that aims to facilitate the teaching of dental hygiene and ease anxiety faced by persons with disabilities during dental visits. (4 min)

**Medical Realities - Surgical Training**
Witness a surgery performed by Dr. Shafi Ahmed Consultant Surgeon at St Bartholomew's Hospital, London, 2015. (3 min)

**Surgical Training in Virtual Reality for Oculus Rift**
Follow a guided surgery performed by Dr. Shafi Ahmed Consultant Surgeon at St Bartholomew's Hospital, London, 2015. (4 min)

**Department of Health Science Lab Tour**
Join Parthajit as he takes you on a tour of Brock University's Undergraduate Teaching Lab, Immunology Lab, Human Hemodynamics Lab and Anatomy lab of the Department of Health Science. (4 min)

**Division of Occupational Science and Occupational Therapy**
Follow Occupational Therapy student Thomas Carr as he takes you on a tour of the Occupational Therapy Lab at UNC. (3 min)

**Nursing & Midwifery**
Join midwifery student Jess Cox and nursing student Jane Green as they take you on a tour of the mock hospital wards and the campus of Anglia Ruskins University. (2 min)

**Cervical Disc Replacement with Dr. Richard Guyer**
Join Parthajit as he takes you on a tour of Brock University's Undergraduate Teaching Lab, Immunology Lab, Human Hemodynamics Lab and Anatomy lab of the Department of Health Science (8 min)

**Lessons in Professionalism: Dentist**
Experience the importance of professionalism in the dentist office and see examples of what you shouldn't do in regards to HIPPA. (2 min)

**Lessons in Professionalism: Dental Assistant/X-Ray Tech**
Experience the importance of professionalism in the dentist office and see examples of what you shouldn't do as a dental assistant or x-ray tech. (2 min)

**TVAPL Endotracheal Intubation Simulation**
Learn the procedure to intubate an unconscious patient in this teaching simulation. (2 min)

**VirtuLIVE: Operating Room**
Join Chris as he explores professions within the Advent Health Celebration Hospital's Operating Room. Learn about careers such as a Physician's Assistant, Nurse Practitioner (APRN), Neurosurgeon, Surgical Technologist, Operating Room Registered Nurse, Various Operating room representatives and vendors. (35 min)

# Hospitality & Tourism

## Restaurants and Food/Beverage

**OCI Kitchen- Culinary Arts Tour**
Experience a cooking class at Oregon Culinary Institute and experience a culinary class. (2 min)

**Baking Lab Tour**
Experience a baking class in a culinary lab. (1 min)

**Culinary Lab Tour**
Follow along with a culinary class in this experience. (1 min)

**Explore NBCC's Culinary Lab**
Explore the NBCC Culinary Lab and see what the culinary program has to offer. (1 min)

**LBCC Culinary Arts Tour**
Take a tour of LBCC's Culinary arts program and see what the culinary program has to offer. (3 min)

**Leeward CC Culinary Arts Campus Tour**
Take a tour of Leeward CC 's Fundamentals and Contemporary Cuisine Kitchens, The Pearl fine dining restaurant, and our Bake Shop which are all managed by students. (5 min)

**The Executive Sous Chef**
Take a tour of LBCC's Culinary arts program and see what it takes to be an Executive Sous Chef. (2 min)

### Lodging

**Washing Windows in the Sky**
Watch an immersive video of window washers cleaning a skyscraper 900 feet above Midtown Manhattan. (2 min)

**Workplace Tours: Best Western Plus**
Get behind the scenes at Best Western Plus and learn more about careers within the hospitality industry. (4 min)

## Human & Community Services

### Family & Community Services

**Careers 360: Charity Jobs**
Wanna work in the charity field but not sure where to start? Join a round table discussion with the National Youth Agency, NSPCC, Charity Aids Foundation, O2 Think Big, and GoThinkBig to talk about getting started in the sector. (13 min)

**Social Work Hazard Assessment**
Follow a Social Worker as she takes you through how hazards are assessed in a child protection service visit. (4 min)

**Social Work Home Assessment**
Follow along with a Social Worker as she interacts with a family that she is assessing. (5 min)

**Hazard Hunt: Social Worker**
Take on the role of a Home Health Social Worker as you wander through the apartment to identify ten health and safety hazards and learn more about what makes them so hazardous. (unlimited)

## Information Technology

### Network Systems

**Professions: IT Specialist**
For a global company like Bayer, IT is key in almost all business processes from infrastructure to R&D, which is why our IT landscape offers countless exciting entry and career opportunities for IT Talkents. (3 min)

**IT Specialist for System Integration at Amazon**
Do you know what to do in case of computer problems? You like to tinker with computers? In your training as an IT Specialist with a focus on system integration, you will primarily dedicate yourself to computer hardware. (4 min)

### Programming & Software Development

**Robotic Software Development Engineers**
Meet the Software Development Engineers from Global Ops Robotics who are working together to deliver innovations that will shape the future of Amazon Operations. (3 min)

**Diversity in Coding**
Explore and learn about coding academies in Austin, TX and meet some of the students who are learning about coding. (2 min)

### Web & Digital Communications

**Web Developer**
Meet a junior Web Developer and experience a day in his life as part of the Ingenico Group. (2 min)

## Law, Public Safety Corrections & Security

### Emergency & Fire Management Services

**EMT Vehicle Orientation**
Tour inside the Lexington County EMS ambulance with a paramedic, Lisa Dawkins. (3 min)

**Ambulance: VR**
Immerse yourself in the world of the paramedics of the West Midlands Ambulance Service. Travel at high speed in the front seat of an ambulance and join the paramedics in people's homes as they respond to emergency calls. (6 min)

**Fire Rescue**
Experience what it's like to be a firefighter in a life and death emergency in this true story with dramatic reconstruction of two London firefighters who put their lives on the line to rescue six children from a blazing house fire. (6 min)

**9-1-1 Communications Center Career Exploration**
Tour inside the Lexington County 9-1-1 Communications Center with Lt. Julianna Hendrix and learn about the people who answer 9-1-1 calls. (3 min)

**Fire Station Career Exploration**
Take a tour inside the Lexington County Fire Service, Station #30 with Captain Sean O'Neal (7 min)

**Emergency Medical Training**
Dive into this training scenario for EMT and see how they handle it. (3 min)

**Firefighter Training Overview**
Experience different training scenarios that a firefighter goes through in this overview of training for firefighters. (2 min)

**Multi-Vehicle Crash & Rescue Response**
Experience what it takes for Rescue Response to remove a person from a bad wreck. (6 min)

**Slope Rescue**
Join a training team of Rescue Responders as they work to remove a person caught in a car on a slope. (4 min)

**Car in a House**
Follow a Rescue Response training class as they learn how to handle a car that has crashed into a house. (2 min)

**Car on Side**
Follow a Rescue Response Training class as they work to learn how to handle a car crash where the car is on its side. (3 min)

**Car on Roof**
Follow a Rescue Response Training class as they learn how to handle a crash where the car landed on its roof. (3 min)

**Cranfield University Accident Investigation Course- Crash Site Simulation**
Learn how to investigate a crash site and what goes into documenting and gathering evidence. (12 min)

**Step into the Shoes of a Firefighter**
See how firefighters respond when an alarm goes off at the station. (1 min)

## Law Enforcement Services

**You, Who Pass Without Seeing Me**
Experience safety for a road officer in this road safety scenario. (1 min)

**How to Become a Secret Service Agent**
Learn about five different training exercises recruits go through at this Secret Service training Facility in Maryland. (3 min)

**The Protectors, Walk in the Ranger's Shoes**
The Protectors chronicles a day in the life of a ranger in Garamba National Park. These rangers are often the last line of defense in a race against extinction at the hands of poachers slaughtering elephants for their ivory tusks. (10 min)

**A Day in the Life of a Police Officer**
Get to know the Haywood Police Department and learn what a day on the job is like. (5 min)

**Criminal Justice 360 View**
Experience a 360 view of the Tolles Criminal Justice Program as recruits work through a typical training session in the Criminal Justice Lab. (2 min)

## Security & Protective Services

**Security Check**
Experience this scenario that takes you through the night shift of two security guards on duty, when something strange happens. (3 min)

**Training for an Active Shooter Situation**
Experience a simulation of what it's like to deal with an active shooter in various situations. (3 min)

# Manufacturing

## Maintenance, Installation, & Repair

**FAUP | HVAC Chiller 1**
See some of the things an HVAC Tech works on such as an HVAC Chiller. (2 min)

**FAUP | HVAC Chiller 2**
See some of the things an HVAC Tech works on such as an HVAC Chiller. (2 min)

**FAUP | HVAC Room 1**
Experience the inside of an HVAC Room that an HVAC Tech would work on. (2 min)

**FAUP | HVAC Room 2**
Experience the inside of an HVAC Room that an HVAC Tech would work on. (2 min)

**FAUP | HVAC Room 3**
Experience the inside of an HVAC Room that an HVAC Tech would work on. (2 min)

**LG HVAC Installation site-Starfield HANAM Shopping Theme Park**
See the LG HVAC solutions that cover a shopping complex. (2 min)

**SCTCC HVAC/R Virtual Tour**
Check out the Heating, Air Conditioning, and Refrigeration labs on the SCTCC campus in this virtual tour. (2 min)

**Wind Farm Tour**
Experience a Wind Farm from the eyes of those that maintain it. (4 min)

**Rig Direct™**
Explore the full process of Rig Direct. (4 min)

**Industrial Mechanic**
Experience the daily workflow of an industrial machinery mechanic and see how they repair, maintain and adjust the systems and machines that are important to the manufacturing process. (2 min)

**Workplace Safety | Ladder Safety**
Watch as a maintenance worker learns about ladder safety in a workplace. (2 min)

**Workplace Safety | Forklift Inspection**
Follow Al as he shows you how to inspect a forklift to ensure it is ready for operations. (2 min)

**Workplace Safety | Forklift Operation**
Join Al as he takes you through the basis of how to operate a forklift. (2 min)

**Workplace Safety | Harness Safety**
Follow Al as he shows a new trainee the importance of harness safety. (4 min)

**Workplace Safety | Hot Work Safety**
Join Al as he explains what Hot Work is and the importance of maintaining it for safety. (3 min)

**Workplace Safety | Lock Out/Tag Out**
Follow Lawrence as he goes over how to identify a Lock Out/Tag Out situation and the importance of it to workplace safety. (3 min)

## Manufacturing Production Process Development

**Behind the Scenes at a Toy Factory with the Nokia Ozo**
Go inside the manufacturing plant at Green Toys, a company that makes eco-friendly toys from recycled milk bottles. (3 min)

**CSIR Advanced Design & Manufacturing Innovation Center**
Explore the Design and Manufacturing process in this virtual tour of one of 9 CSIR facilities. (4 min)

**Experience the Future of Additive Manufacturing with Stratasys**
Tour an aircraft interior and aircraft manufacturing facility to see all the ways additive manufacturing is impacting aircraft interiors. (7 min)

**High Tech Manufacturing Brainport Industry Campus**
Brainport Industries Campus is where the innovation and competitive strength of the high-tech manufacturing industry grow wings. (3 min)

**BASF Workplace Experience: Our Production Plants**
Have a look around and get an insight into working at the world's largest chemical company. (2 min)

**Design your Career at AV Gauge**
Tour the workplace of AV Gauge & Fixture Inc., a leading manufacturer, specializing in gauging and checking fixtures in various industries. (4 min)

**JST Manufacturing Facility**
View JST's Boise, Idaho manufacturing facility and see different aspects of the manufacturing process. (2 min)

## Production

**Breman Machinery VR**
Experience all the different aspects of Breman Machinery in this plant tour. (5 min)

**Factory Tour - Digga Australia**
Explore various production areas, from machining to lasering, welding & painting bays to assembly and dispatch. (2 min)

**Tour for GAF**
Experience a roofing manufacturing plant as it produces products. (4 min)

**Factory Experience**
Factory tour and see every process that goes into making your favorite linen. (2 min)

**Sneak Peek of Automated REIN4CED Unbreakable Frame Production Facility**
Sneak-peek into REIN4CED's automated bicycle frame production line that is currently being set up. (2 min)

**Virtual Reality Tour of Advanced Manufacturing Plant**
Tour a leading textile manufacturing company and see different aspects of the textile manufacturing process. (5 min)

**CSIR Additive Manufacturing Facilities**
Explore one of the nine CSIR manufacturing facilities and see how their manufacturing process works. (4 min)

**Explore a Plant in VR**
A virtual experience of IONIQ electric production process from molten metal to inspection.
(5 min)

**Inside Auto Manufacturer FCA Canada**
Take a trip down the highway with leading Canadian car manufacturer FCA Canada Inc. (5 min)

**Orrcon Steel - Salisbury Mill Tour**
Take a tour of our Salisbury Steel Manufacturing Operations Mill in Queensland. (6 min)

**See Where Tesla Makes its Cars**
Take a 360 tour of Tesla's manufacturing factory in Fremont, California, and see how the cars are made. (2 min)

**Siemens Transformer Factory Weiz**
Follow Siemens as they explore how products are made at their factory. (4 min)

**Toyota Factory Tour**
Watch how a forklift is built around you and experience for yourself every step of the production process. (3 min)

**Trayvax Virtual Reality Tour**
Take a tour of Trayvax headquarters and see how we manufacture our slim metal wallets and web belts. (2 min)

**Twinsburg Facility VR Tour**
See how engineering plays a part in the manufacturing process. (3 min)

**Tour of Manufacturing Facility of Vinodrai Engineers Pvt. Ltd.**
Tour a manufacturing plant and see the process of producing goods. (5 min)

**Visit Digital Metal Production**
Take a 360-degree look inside the Performance Manufacturing Center where they build the new generations of Acura. (5 min)

**2017 Acura NSX Performance Manufacturing Tour**
Experience a tour that covers the end-to-end process of manufacturing as well as the implementation of products. (3 min)

**Tour of a Commercial Manufacturing Facility**
Tour a commercial transportation manufacturing facility and see different aspects of the manufacturing process. (6 min)

**ATLAS Manufacturing Facility in VR**
Have a look around and get an insight into working at the world's largest chemical company. (3 min)

**CSIR Advanced Materials & Engineering**
Virtual tours of one of 9 CSIR facilities and see different aspects of the manufacturing process. (5 min)

**Discover Septodont: Tour of the Anesthetics Manufacturing Facility**
Tour an anesthetics manufacturing facility and see different aspects of the manufacturing process. (6 min)

**Experience Accuride's Gunite Facility and The Plex Manufacturing Cloud**
Take a tour of the Accuride Corporation – a leading supplier of wheels and wheel-end components to the North American commercial vehicle industry. (9 min)

**Inside NASA's Rocket Factory: Tour of SLS Manufacturing**
Tour of the Space Launch System Rocket being made at NASA's Chris A. Hadfield Rocket Factory (CAHRF). (4 min)

**Key Gas Components of Manufacturing**
Explore the Key Gas Components of manufacturing and see different aspects of their manufacturing process. (3 min)

**Making Medicines**
Explore the world's largest biotech manufacturing facility and see how medicines are made. (4 min)

**Manufacturing Plant Virtual Tour**
Explore all aspects of a manufacturing plant in India through this virtual tour. (11 min)

**Manufacturing the R11: Shenzhen Oppo Factory Tour**
See how your phone is manufactured in this virtual tour. (7 min)

**Neon Manufacturing in Los Angeles**
Take a look at the neon-manufacturing process used to create a neon sign. (2 min)

**SANHUA: Visit to Manufacturing Facilities**
Visit our manufacturing facilities and see different aspects of the manufacturing process. (5 min)

**MIG Welding**
Learn about MIG Welding equipment and safety in this tutorial experience. (7 min)

**Welding Workshop | Hugh Baird College**
Explore an immersive 360° video of the Welding workshop at Hugh Baird College. (1 min)

**Plymovent- Factory Visit**
This 360 degrees video shows various welding fume extraction solutions installed by Plymovent on the factory floor. (3 min)

**SONNY'S Factory Tour: Conveyor Welding**
Visit our growing conveyor welding cell, which produces over 6 miles of car wash conveyor equipment per year. (1 min)

**SONNY'S Factory Tour: Robotic Welding**
Get a bird's-eye view of our robotic aluminum and steel welding cell. (2 min)

**Woman Welder Video**
See a female welder in action. (1 min)

**SONNY'S Factory Tour: Milling Machine**
Follow along as Dan takes you back to the milling workstation. (2 min)

**SONNY'S Product Tour: Drying Material**
Dan introduces you to Frank, our robotic roller fabricator, and goes over what its purpose is. (5 min)

**SONNY'S Factory Tour: Aluminum Welding**
Visit our aluminum welding cell and see the process of Aluminum Welding. (3 min)

**Techmatik - Virtual Tour**
Explore modern high-performance machines and devices for manufacturing with Techmatik. (4 min)

**Logistics Tour at Würth Elektronik Factory**
Take a factory tour at Würth Elektronik eiCan and see the logistics process in action. (2 min)

**Welding Symbols Identification**
Identify different welding symbols. (unlimited) E

**Intro to Welding**
Identify the meaning of fabrication symbols, appropriate voltage for chosen rod, and proper welding position and angle. (unlimited) E

**Where it's Made: an Airbus Plane**
Take a tour of the factory in Mobile, Alabama, where Airbus produces its A320 family of aircrafts. (2 min)

**Nucor-Yamato Steel- Blytheville Tour**
The American Institute of Steel Construction and Nucor Corporation tour the Blytheville mill and see how structural steel is made. (6 min)

**Toyota Factory Tour**
Watch how a forklift is built around you and experience for yourself each step of the production process at the Toyota Manufacturing facility in France. (3 min)

**See Where Tesla Makes its Cars**
Take a 360 tour of Tesla's manufacturing factory in Fremont, California, and see how the cars are made. (2 min)

**CNC Operator | Career Exploration**
CNC Operators use software skills and computer aided drafting programs to design and execute tasks crucial to manufacturing processes. (2 min)

**Meta Fab**
Experience several aspects of the Manufacturing process from welding and assembly to powder coating and silk screen printing. (8 min)

**Welder 360**
Explore the career of a welder in manufacturing. As a fabricator-welder, you will work either in a shop or out in the field crafting quality metal components in all shapes and sizes. (2 min)

E Indicates experiences accessible from the Engage app.

# Marketing, Sales, & Services

## Marketing Management

**Product Marketing Manager**
Meet a Product Marketing Manager and experience a day in her life as part of the Ingenico Group. (2 min)

## Professional Sales

**Big Dealer Support - John Deere Construction Equipment**
Learn what it takes for John Deere construction equipment dealers to support production-class machines. (2 min)

**What it is Like to Work in the Retail Industry**
Meet Various people that work in the retail industry with ServiceIQ and hear why they love working in the industry. (3 min)

# Science, Technology, Engineering, & Mathematics

## Engineering & Technology

**ASU Schools of Engineering - Tooker House Virtual Reality Tour**
Check out the "dorm built for engineers" at Arizona State University. (4 min)

**A Day in the Life of a Civil Engineering Technician at The Engineering Consulting Group**
Learn about the pathway into the Civil Engineering Technician career and what a typical day in this profession looks like. (5 min)

**A Day in the Life of an Area Distribution Engineering Technician at Hydro One**
Learn about the pathway into the Area Distribution Engineering Technician career and what a typical day in this profession looks like. (5 min)

**Engineering and IT**
Come inside our engineering facilities and see some exciting innovative research. (6 min)

**Engineering at Anglia Ruskin University**
Meet Mechanical Engineering Ph.D. students Simon and Beng (Hons) and Civil Engineering student Ujjwal as they talk about what inspired them and show you around the engineering facilities. (2 min)

**Engineering Our Future™ | Rockwell Automation**
See why engineers are needed for the future. (4 min)

**Mechanical Engineering Lab Tour**
Take a tour of a mechanical engineering lab and learn what mechanical engineers do. (5 min)

**See Yourself Here | Engineering**
Take a look at the opportunities for research, collaboration, and learning at the Opus College of Engineering. (6 min)

**Step Inside the Large Hadron Collider**
Take a tour of CERN's Large Hadron Collider – the world's greatest physics experiment. (3 min)

**Warwick School of Engineering**
Take a tour of the Warwick School of Engineering and learn about the program. (4 min)

**Zachry Engineering Education Complex**
Opened in 2018, the renovated Zachry building is the home of Texas A&M's world-class College of Engineering. (2 min)

**SONNY'S Factory Tour: Robotic Roller Fab**
Dan introduces you to Frank, our robotic roller fabricator, and explains what it does. (2 min)

**Bridge Builder**
An interactive module that allows for the building of bridges to scale using architectural applications. (unlimited)

**Bristol Robotics Laboratory - Pepper Robot**
Research is being done at the Bristol Robotics Laboratory (BRL) to use Pepper as a motivational robot coach to remind patients undergoing therapy to complete their exercises. (2 min)

**Bristol Robotics Laboratory - Robotics Innovation Facility**
Tour through the Bristol Robotics Laboratory (BRL), the leading and largest academic center for multi-disciplinary robotics research in the UK. (4 min)

**Argonne: Robotics Lab**
Argonne's Young Soo Park and Marius Stan are exploring these complex capabilities of Artificial Intelligence in Argonne's Robotics lab. (3 min)

**CWU - Robotics Lab**
The lab is researching using all the elements integrated together as an Avatar for patients with disability, such as quadriplegia. (2 min)

**Developing a Robotic Arm for Object Manipulation**
University of Michigan researchers are building a robotic arm to aid in industries, homes, and emergencies by first training it to sort through beanbags. (2 min)

**Human Robotics Lab**
Robotic Lab develops robotic devices for physical interaction with humans and pursues their application in motion augmentation, rehabilitation, and as advanced tools to study movement neuromechanics. (1 min)

**Robotics iPrep North**
Watch students explore basic robotics and see what it takes to build one. (2 min)

**TRI Robotics Virtual Open House**
Explore TRI's cutting-edge robotics research for Toyota that could reshape our lives. (34 min)

**Cloud Climb**
Explore how clouds, the atmosphere, and weather all come together to create different aspects of the Earth's sky. (unlimited) E

**Twinsburg Facility VR Tour**
See how engineering plays a part in the manufacturing process. (3 min)

**IMCS: Careers in Biotechnology**
Take a tour inside the IMCS laboratory with co-founder and scientist Andrew Lee and learn about the biotechnology products that his company makes. (2 min)

**Aerospace Engineer Tiera Fletcher's Career**
Get an inside look into Tiera's career, her groundbreaking work, and how she is leading the "Mars Generation." (2 min)

**Entrepreneur Inna Braverman's Career**
Get a look into Inna's career and see firsthand how she harnesses the power of the ocean and converts waves into usable energy at the Eco Wave Power Station in Gibraltar. (6 min)

**Deep Sea Exploration**
Dive into the midwaters off the coast of California with bioengineer and National Geographic Explorer Dr. Kakani Katija. Learn how she conducts deep water research by developing technologies that can go deep below the surface to observe wildlife and collect data and specimens. (6 min)

**Analog Nuclear Control Room- Careers in Energy**
Explore an analog Nuclear Control Room and learn about technician's careers in the field. (1 min)

**Step Inside your STEM Career: Mining**
Come on down-way down- and explore the depths of North American Palladium's Lac Des Lle's Underground mine. (2 min)

**Nuclear 360: Fuel**
Have you ever wondered what the inside of a nuclear energy plant looks like? Look inside the containment building a the plant in Waynesboro, GA. (4 min)

**SAFER NRC Facility Tour**
Explore the SAFER Nuclear Response Facility and learn about it. (4 min)

**UW's Petroleum Engineering Lab**
Petroleum engineers are involved in all facets of oil exploration and development, from identifying and characterizing the reservoir through drilling and completion to production. They also find new ways to extract oil and gas from older wells. (2 min)

**Ladies in Engineering**
Join Senior Field Manager Krista Shaffer as she recounts her involvement in Exploration Mission 1, the Mobile Launcher, and why it is important for women to be in fields like engineering. (30 min)

**Careers in Forestry: Design & Manufacture**
Follow along with Claire Coquet to learn about being a Design Engineer in the forestry industry. (2 min)

**Bayer's Crop Science Division**
Learn about Bayer's Crop Science Division and see how engineers, data scientists and other tech professionals work to shape Agriculture through breakthrough innovation for the benefit of farmers, consumers, and our planet. (4 min)

**Discover Radio & Rigging**
Follow Chris, a radio and rigging engineer, as he shows you around a radio tower. (4 min)

**In the Engine Room | Careers at Sea & Beyond**
Follow Aimen, a Marine Engineer, on a tour of the ship's engine room and experience what a day in his life as he sails from Singapore to Shanghai. (4 min)

**Mechatronics Technicians at Amazon**
Learn of the tasks mechatronics engineers can take. At Amazon, for example, they manage many small and large robots and are responsible for everything that has to do with them. (5 min)

**A 360 View of Highland Lakes**
Join Executive Vice President John Hofmann as he leads you on a journey along the highland lakes while giving a history of LCRA's dam system and background on its responsibility to manage the Colorado River. (3 min)

## Science & Mathematics

**Periodic Table**
An interactive classroom that teaches students about the periodic table of elements, their chemical and physical properties, and their atomic structures. (unlimited) E

**Light Lab**
This highly interactive classroom teaches students about the electromagnetic spectrum including activities like the Double Slit Experiment, shining lights through a prism, building their own waves, stacking light, and playing with lenses. (unlimited) E

**Cloud Climb**
Explore how clouds, the atmosphere, and weather all come together to create different aspects of the Earth's sky. (unlimited) E

**IMCS Careers | Meet Andrew Lee**
Follow Andrew Lee as he takes you on a tour of Integrated Micro-Chromatography Systems (IMCS) and see how they create, manufacture, and distribute the next generation of biotechnology products to various organizations. (2 min)

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**Bayer's Crop Science Division**
Learn about Bayer's Crop Science Division and see how engineers, data scientists and other tech professionals work to shape Agriculture through breakthrough innovation for the benefit of farmers, consumers, and our planet. (4 min)

**Fossil Hunting with Dr. Jack Horner in Yellowstone**
Join Dr. Jack Horner on a short exploration of slough creek where he explains the makeup of the landscape while we hunt for some fossils. (4 min)

**Bayer's Crop Science Division**
Learn about Bayer's Crop Science Division and see how engineers, data scientists and other tech professionals work to shape Agriculture through breakthrough innovation for the benefit of farmers, consumers, and our planet. (4 min)

**A Day in the Life of a Rangeland Manager**
Billy Freeman (an honest-to-gosh cowboy) introduces us to the McKenzie Ranch at the Sierra Foothill Reserve in Clovis, California. (7 min)

**Forensic Science Excavation**
Follow forensic students as they dig to find bones during the course of their studies. (1 min)

# Transportation, Distribution, & Logistics

## Facility & Mobile Equipment Maintenance

**Auto Service Tech Class Lewis and Clark Virtual Tour**
Take a tour of an auto service tech class and the Auto Service lab. (2 min)

**A Day in the Life of a Collision Repair Technician at Fix Auto**
Follow a Collision Repair Technician on a typical day on the job. (3 min)

**Auto Body Lab**
Explore the Auto body Lab where students learn how to do everything from minor patches to frame straightening to repainting. (3 min)

**Automotive Shop (Whitby) - Durham College**
Experience an auto body shop and see what goes on in one. (1 min)

**Automotive Technologies**
Experience a 360 view of the Tolles Automotive Technologies program. (1 min)

**Intro to Automotive - Beginner Tools**
Cover what tools someone would need if they are beginning their career in the automotive industry as an Oil Change Specialist. (11 min)

**LBCC Automotive Repair**
Follow students at LBCC as they learn about Automotive repair. (3 min)

**Video Tour - HVAC, Automotive Collision Repair, Automotive Technology, Welding**
Take a quick video tour of our HVAC, Automotive Collision Repair, Automotive Technology, and Welding programs. (3 min)

**BCoT Auto: Spot the Hazards**
Watch Brad, our Automotive Technician, handle the equipment in the workshop. (2 min)

**Auto Body Tool Identification**
Interactive identification model of various autobody tools. (unlimited) E

**Auto Body Repair**
Identify damaged brake system components and choose which tools are used to repair said parts. (unlimited) E

**Auto Body Painting**
Tool identification and painting practice. (unlimited) E

**Ford History: Ford Performance History**
Experience the history and performance of Ford Motor Company like you've never seen before. Immerse yourself in the Le Mans 24 where Ford GT celebrated its GTE Pro Class win 50 years after their famous podium sweep in 1966. (6 min)

## Logistic Planning and Management

**DB Schenker - Experience Logistics**
Experience logistics as close as it gets. Transportation Operations. (7 min)

**Logistics Tour at Würth Elektronik Factory**
Discover how we use automated systems and robot technology to make our logistics efficient. (7 min)

**Optoro Warehouse Tour**
Visit Optoro Warehouse and learn about logistics. (5 min)

**P3 Logistic Parks**
Experience one of the largest logistics parks in Europe, P3 Horni Pocernice in Prague. (3 min)

**Planzer: Warehouse Logistics in Villmergen**
Take a look around our state-of-the-art logistics center in Villmergen. (3 min)

**Intro to CDL Training**
Experience a Pre-Trip Inspection and Air Brake Test. (unlimited)

**Diesel Tech**
See what it takes to become a Diesel Tech and get your hands dirty in this interactive module. (unlimited)

**SWISS Airbus A320 | Geneva – Zurich**
Watch the lineup, takeoff, approach, and landing from inside the cockpit of a SWISS Airbus A320 flying from Geneva (GVA) to Zurich (ZRH). (12 min)

E Indicates experiences accessible from the Engage app.

## Transportation Operations

**Experience the Life of a Student Pilot| Careers in Aviation**
Meet Vianka and follow along as she takes us through the process of becoming a pilot, the different types of pilot licenses, and key topics students need to learn to operate an aircraft. (3 min)

**Council Knife River Trucking**
Meet Bill Larson from Knife River Trucking who shares his experiences as a truck driver. (3 min)

**Step Inside your Career: Helicopter Pilot**
Let Great Lakes Helicopter take you for a ride and learn what it takes to become a helicopter pilot. (1 min)

**Fly with Me**
Follow along with Robbie as he takes you on an r44 helicopter flight and explains basic controls and how to fly. (12 min)

**Explore the FedEx World Hub in Memphis**
Explore the FedEx Express World Hub in Memphis, TN. Learn how the massive facility and its 10,000 Team Members connect people with the products and shipments they care about. (3 min)

**Deck Officer | Careers at Sea & Beyond**
Ever wondered about a day in the life of a deck officer? Follow Jasmine as she shows you a day in her life as a deck officer sailing from Singapore to Shanghai. (4 min)

**Flight Lessons in VR**
Join Torius Moore, as he takes you through a flight check and flight start up sequences for takeoff. (2 min)

**Pre-Flight Check**
Follow a flight instructor as they take you through a pre-flight check for a plane to make sure it's ready to fly. (4 min)

## Warehousing and Distribution Center

**Dell Supply Chain Factory Tour**
Get a glimpse of how your electronics are made, packaged, stored, and distributed. (2 min)

**Inside Copernicus Educational Products**
Take a behind-the-scenes look at Copernicus Educational Products, a manufacturer of classroom furniture for over 20 years. (3 min)

**UAW-GM PIV Safety**
Experience safety protocols while operating a UAW-GM PIV. (3 min)

**Safety in a Box: Manufacturing (English)**
Experience the dangers of workplace accidents within a manufacturing space in this training experience. (8 min)

**Safety in a Box: Manufacturing (Spanish)**
Experience the dangers of workplace accidents within a manufacturing space in this training experience. (10 min)