Research findings led us to design the Virtual Design Lab for children who were at least five years of age and to not be fully immersive.

Futurism, Technology, and Inclusivity

Preparing Today's Learners for Tomorrow

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Let's begin with a cliché: "Children are the future." While it seems obvious, museums must make a conscious effort to consider the future and its many possibilities when designing for younger audiences. Many children's galleries include activities of the present or even recent past – children driving cars to banks, using pneumatic deposit tubes, or dressing in costumes of traditional job roles. While The DoSeum certainly has these long-established elements, in recent years we have adapted our approach to exhibition development with a consideration for the future. Studies have shown that for children currently in kindergarten, the careers that they will ultimately have likely do not yet exist. At The DoSeum we ask ourselves: what skills will children need in the future? What tools, resources, and knowledge will be necessary? How can we provide equitable access to a positive future for all children?

As San Antonio's only museum dedicated to early learners – from birth through age 11 – The DoSeum's mission is to grow minds, connect families, and transform communities through joyful learning and discovery. With 70,000 square feet of indoor and outdoor exhibit space, the museum sees more than 400,000 guests annually at its campus. Fourteen percent of DoSeum guests qualify for and enter through significantly reduced admission via the Museums for All program, and we reach an additional 10,000 children each year through our outreach program, The GoSeum. Exhibits and programming are rooted in STEM, the arts, and literacy, with learner-centered, constructivist approaches at the heart of program design.

Accumulating data indicate that the return on investment in early childhood education is high, with one longitudinal study indicating

Fig. 1. The DoSeum's *Semmes Foundation Spy Academy* gallery is an immersive experience rooted in mathematics and role play.

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nine dollars of benefits for every dollar invested.[1] With this potential increasingly understood and realized, the importance of early childhood education is taking center stage: not only within the worlds of cognitive and emotional development but also economic development, community planning, and setting social policy. This forward-thinking, future-based approach is shaping the conversation of early childhood education.

We cannot predict the future. But what we can do is provide skill-building activities to develop future-proof skills. In our program development, The DoSeum team draws upon "21st-century skills" as interpreted by the Institute of Museum and Library Services (IMLS) for museums and libraries: critical thinking and problem solving; creativity and innovation; communication and collaboration; and cross-disciplinary thinking.[2] In 2018, we began working with futurist Peter Bishop of Teach the Future, a nonprofit that promotes "futures literacy" as a life skill for students and educators, to assist us in the development of a temporary exhibition entitled *Dream Tomorrow Today*. In the exhibition – created in celebration of San Antonio's tricentennial year – children imagined their desired future and began to develop the skills necessary to achieve that future. Work on this exhibition helped seat our exhibition development approach in the context of future thinking.

Following *Dream Tomorrow Today*, The DoSeum exhibit team now integrates future thinking and related skill building into all our exhibitions through conscientious experience design. In this article, we'll examine two exhibitions at the museum – *Semmes Foundation Spy Academy* and *Zachry Innovation Station* – to convey some of the strategies we've discovered through our research and practice. This future-focused approach can lead to many challenges, such as how to integrate safe and developmentally appropriate first and early uses of technology. The approach can also lead to innovative and unique experiences that our young learners will carry with them into their future.

Beyond the Wow Factor: Preparing Children for a Digital Future

As part of a five-year plan to revitalize The DoSeum's original 2015 galleries, in 2019 we began to renovate a portion of one of our most popular exhibitions, *Spy Academy*. This 2,000-square-foot immersive space includes fabricated environments that present mathematical challenges through a spy-themed, multi-level game in which children acquire a Spy Badge and complete missions to level-up as Spy Recruits (fig. 1). Ultimately, learners can become credentialed Master Spies, with their image and Spy Name memorialized on the Spy Hall of Fame in the gallery. In addition to basic concepts of addition and subtraction, the exhibition creatively introduces deductive reasoning and reading comprehension. The sequence of these missions is determined by the learner, a form of personalization that is aligned with the kind of free-choice learning that underlies The DoSeum's learner-centered approach. Because the learning is successfully embedded in the play-based narrative, many visitors do not realize they are using core math concepts and problem-solving frameworks as they focus on their missions. Rather, they employ key skills naturally, and without the trepidation that can accompany math-based curricula.

For the partial renovation, we focused on adding a layer of technology to the experience. Using our future-focused approach, we recognized that technology would serve to both introduce an important tool and topic to children but also alleviate the wasteful and high-maintenance paper and pencils that we had used in the gallery. Subject-matter experts, followed by local families, provided input and insight to the process. San Antonio is home to the largest concentration of military bases in the United States, so we were able to involve members of the National Security Agency (NSA), a military cyber-security agency (perfect for our subject matter), and local technologists and educators. We began with a one-and-a-half-day charrette in which teams of DoSeum

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Fig. 2. (top) DoSeum staff members present to community members in a one-and-a-half day rapid design charrette to renovate and add technology to *Spy Academy*.

Fig. 3. (bottom) A child receives their Spy Specialization (Surveillance Professional) in the new *Semmes Foundation Spy Academy*.

were communicated through hastily made drawings, referenced images, and prototypes.[3] The invited subject-matter experts provided feedback on each team's presentation, leading to an overall charge on what was most necessary for the exhibition.

Among many outcomes, this process led to conversations on the necessity of introducing digital citizenship and security with our young guests. How, for example, could we introduce the safe, effective, and respectful use of technology to our early learners, presenting topics related to information security and promoting positive interactions with fellow online users? This question posed a new challenge for The DoSeum: how to approach these relevant, serious technology concerns through our brand of joyful learning and exploration.

We also held two community conversations during our development process. For these, we invited our subject-matter experts and also families from throughout San Antonio, with whom we prototyped analog spy challenges and beta versions of the technology we were using. One of our key findings had to do with the characters developed for "spy specializations." At the introduction to the gallery, guests encounter a series of touchscreens where they can select three interests from a total of 18 – from writing and drawing to animals and costumes. Depending on the interests chosen, guests proceed as a specific agent type – or character – based on actual professions codeveloped with our subject-matter experts and the local community (fig. 3).

We initially debated whether or not children would want their character to look like themselves. So, before developing the characters, we asked children to choose a

staff members rapidly developed and designed a renovated *Spy Academy*, with subject-matter experts providing feedback (fig. 2). Meredith Doby, who led the charrette, modeled the process on her experience in University of the Arts' Museum Exhibition Planning and Design Master's program. She divided DoSeum staff into three groups from multiple departments (from Education and Exhibits to Facilities and Development), all stakeholders in the ultimate design and experience. Each team developed a mission, a big idea (a singular statement that tells what the exhibition is about), educational goals, exhibit elements, and floor plans that

desired avatar from an index of avatars with various skin tones and apparent genders. Interestingly, children did not select characters that looked like them; instead, they chose based on what tools or technology the avatars were using. When asked why they chose a particular avatar, one child referenced the combat agent's tool and stated, "Because I can fix things with it." Another child chose the Cyber Scientist character in response to that character's possession of a computer, saying, "Because I like to work on the computer." This experience led to us creating a set of diverse, non-binary, variously abled characters – all with *very cool* tools.

In spring 2020, we reopened *Spy Academy* as the *Semmes Foundation Spy Academy* – in recognition of the gallery's new sponsor – with new features that reflected our focus on digital citizenship and security. Digital modifications to enhance the guest experience included a new "Spy Watch" that children could scan to work through their missions, new selfie stations, and improved digital souvenirs optionally emailed to a guest's personal address (fig. 4). The watch replaced the previous clue-collecting method – the pencils and paper – that our junior spies had used in the space prior to the renovation. To model the safe use of technology, we included a "Digital Citizenship"

Fig. 5. In the *Zachry Innovation Station,* guests use both analog and digital tools to tinker and make. Here a child uses a saw, gloves, and safety goggles in the "Real Tools" section.

mission level. Challenges in this mission set include finding a toy with a recording device so that no one is unfairly recorded, as well as protecting information from enemy "spies" hacking into camera displays. We also created a level in which children must approach another child spy and request their code word, thus encouraging children to use technology as a means to also foster social and peer interactions. Designed to underscore the benefit of teamwork and the importance of acquiring information from multiple sources, for many children this is by far the most difficult challenge!

Because the exhibition opened one month before the COVID-19 pandemic shuttered museums, summative evaluation was limited. However, since opening in February 2020 – including the pandemic-induced closure from March to July 2020 – we have welcomed

35,000 Spy Academy recruits (completing four missions), with 1,600 guests achieving Master Spy status (completing 24 missions) and 1,200 guests achieving Ultra Master Spy status (completing 44 missions!). In our preliminary evaluation, the statement "My child used tools that they may use in the future" received an average rating of 4.5/5. The statement "My child learned how to be safe with technology" received an average rating of 3.9/5, and the statement "My child used technology to interact with another child, family member, or staff member" received an average rating of 4/5. Average dwell time in the renovated exhibition is an impressive 31 minutes. For most of our galleries we maintain a goal of 10 minutes.

By involving the community at the start of the process, we identified approaches to integrating technology that went beyond the "wow factor." Our content experts, for example, pushed us

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to approach digital citizenship and safety in the exhibition. We therefore approached and incorporated technology as a tool that children will continue to use in the future, far beyond their experience in the gallery. As DoSeum guests maneuver through their spy-based challenges, the newly layered technology serves as a context for – and gateway to – problem solving, critical thinking, numerical skills, reading comprehension, and collaboration. We see these skills as important progressions toward global competence in young learners.

Tools for the Future:
The Analog and the Digital

One floor above *Semmes Foundation Spy Academy* is The DoSeum's *Zachry Innovation Station*. This exhibition is rooted in maker-centered learning, with tool use, learner agency, and the Engineering Design Process – a defined series of steps used to solve a problem, emphasizing the testing and subsequent refinement of potential solutions – serving as the space's foundational skills and concepts. Similar to *Spy Academy*, in 2018 we set about renovating part of the gallery in an effort to use a futurist approach while also adjusting displays that featured a high volume of consumable and disposable supplies.

For this renovation, we also leveraged the power and promise of community insight – all rooted in futurism and aspirations for young learners. Once again, we began with a staff charrette judged by subject-matter experts. Given the exhibition's focus, this time we included local engineers, technologists, researchers, and educators. We also implemented an approach that we commonly use at The DoSeum: we develop the big idea for an exhibition from the first-person perspective of a child. For the renovated *Innovation Station*, the final big idea

was rooted in agency and self-efficacy: "I can tinker; I can make." The children are in control of their own skill development; we simply provide the opportunity.

Within this space, we considered what tools and resources children might need in their future. Central to this experience design was the definition of "tool." For this conversation, it was important to us to include both traditional hand tools and newer digital tools in close proximity, promoting them as necessary and complementary tools for the future, believing that both traditional and state-of-the-art techniques are equally relevant to a learner's toolbox.

We consciously placed the "Real Tools" exhibit – complete with hand drills, saws, screwdrivers, and sanders (fig. 5) – next to our Virtual Design Lab. In the lab, children can build a fictional landscape using Computer Aided Drafting (CAD), a program that offers a user-friendly exposure to digital tools. Upon completing their CAD creation, guests can upload it to a virtual world called DoLandia. Then, they can explore their creation using immersive media – in this instance virtual and augmented reality – with the option to continue to iterate on their design.

During development, we debated whether or not to offer guests a mouse for use with the CAD program. Subject-matter experts contested that while mice are commonly used today, they may not be in the future. By prototyping with DoSeum guests, we ultimately found that most children preferred the programs without the mouse. In fact, many children were conditioned for touchscreens and did not know how to even use a mouse.

Is Virtual Reality Safe for Early Learners?

With the introduction of virtual reality to our young learners, a question quickly arose: how does virtual reality (VR) differ from other media, and does its use have any effect on neurological development in children? In other words, is it *safe* for our core audience of early learners? Many commercial manufacturers of VR technology recommend that users be no younger than 12 or 13, but this language is likely in response to the Children's Online Privacy Protection Rule, which is focused on the protection of a child's personal information, and not a firm neuropsychological understanding of any health impacts.[4] Preliminary research suggests, though, that immersive media like VR may have negative impacts on children.[5] In addition to motion sickness and eye strain, some children have issues distinguishing between what is a real experience versus a VR experience, a phenomenon known as *reality blurring*.[6] Some early research has shown that virtual experiences can potentially elicit false memories in children.[7]

While VR technology is too young to yet permit longitudinal studies, it is overwhelmingly clear that more research is needed. Recognizing the infancy of VR and its use, The DoSeum team chose to take a conservative path that prioritized the safety of our guests. To help children understand that they are in control of an artificial, virtual experience, our headsets are handheld versus worn. This approach makes the experience less immersive (it also means the user can end it quickly if they experience motion sickness). In addition, to help ensure that the experience is differentiated from reality – and remembered as virtual versus real – the

virtual environment's aesthetic is cartoonish by design, rather than photorealistic (fig. 6). By age five, most children can distinguish between fantasy and reality, and can rationally judge that cartoons are not real.[8] Furthermore, at age five, children no longer perceive virtual characters as real beings with human needs and emotions.[9]

With this research at hand, The DoSeum's VR interactive is recommended for ages five and up. The design of the exhibit encourages this: the headsets hover at a height that accommodates the average five-year-old and older, while floor graphics and onscreen instructional text reinforce the recommended age (intro image). The experience also times out after one minute and 30 seconds. These design decisions, based on existing research, thus prioritize a positive and safe guest experience.

Prior to renovation, Innovation Station received a Net Promoter Score (NTS) of 67. Post-renovation it has received an NTS of 75.[10] The statement "My child used tools that they may use in the future" was rated on average 4.1/5. The statement "My child worked independently tinkering or making" received an average rating of 4.4/5, while the statement "My child developed skills they will use in the future" was rated on average 4.1/5.

Looking Forward...

Key findings from the renovation of *Semmes Foundation Spy Academy* and *Zachry Innovation Station* will inform future projects at The DoSeum. First, community engagement is essential. Conversations with families throughout our region shaped the direction and
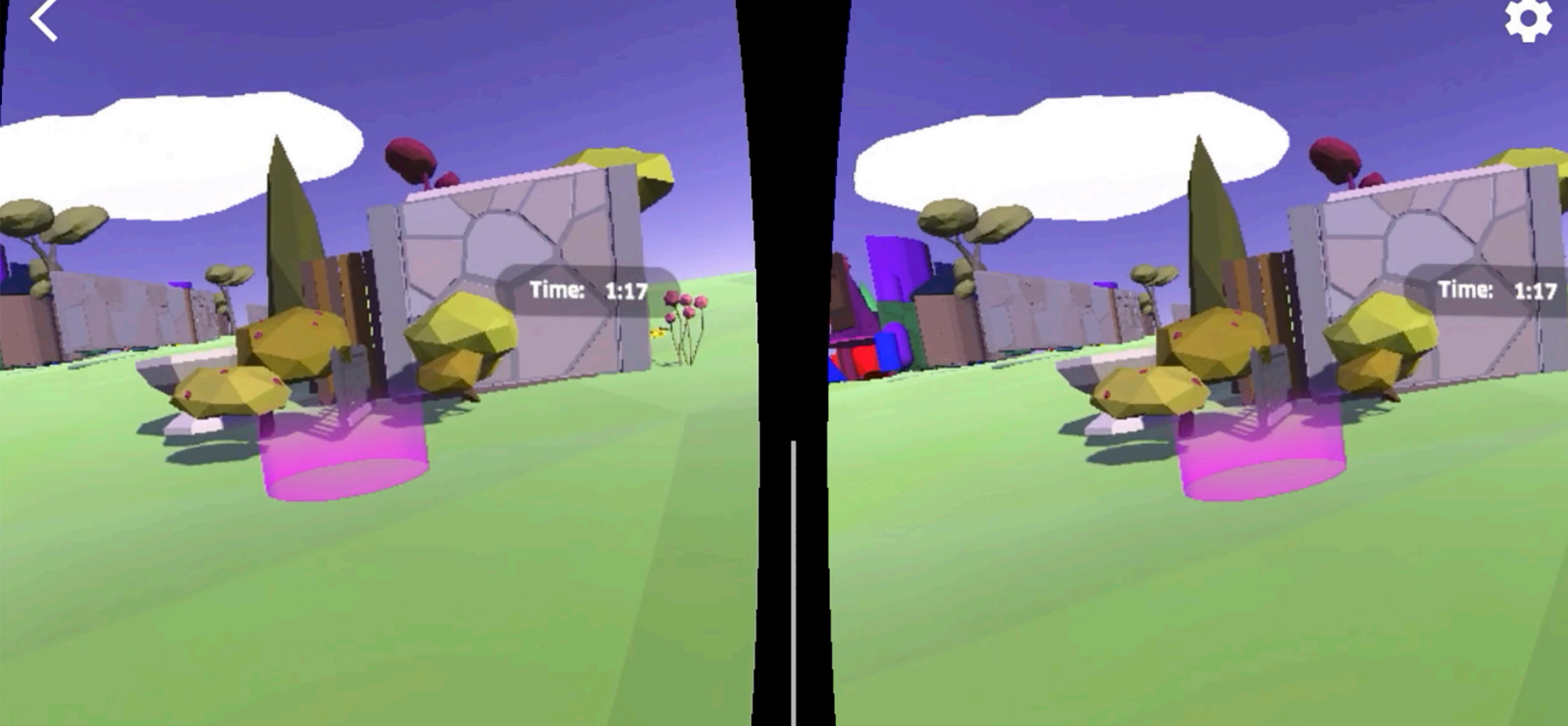
design of the final installations in very positive ways. Secondly, it is critical that we understand our internal limitations and boundaries. While The DoSeum's Education and Exhibits departments collectively represent decades of experience in both formal and informal learning contexts, looking to available research when necessary and reaching out to those in the field with expertise was fundamental to the success of the renovated spaces. Bolstered by our early successes, as we move forward we plan to continue to create conscientious design experiences with a learner-first approach – all through the lens of futurism, inclusivity, and safety. Children are the future and we as museums can help prepare them. ▮

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