International Journal *of* Designs for Learning
2020 | Volume 11, Issue 3 | Pages 36-46

# DESIGNING A FUTURE CLASSROOM LABORATORY FOR EXPLORING THE SCIENCE OF TEACHING AND LEARNING

Sarah Colton, Chad E. Smith, & Ludovic A. Sourdot, *Texas Woman's University*

The Texas Woman's University Future Classroom Laboratory (TWUFCL) is a unique learning space designed for use by university faculty, future teachers, and local PreK-12 teachers and students. Part of the European Schoolnet's Network of Future Classroom Labs, the TWUFCL offers users the chance to explore the science of teaching and learning in a technology-rich environment containing a multitude of individual approaches and applications that are available to teachers throughout the U.S. Centered around the Four C's of 21st Century Learning: communication, collaboration, critical thinking, and creativity. This unique learning space allows future teachers to explore technology and applications available in schools prior to student teaching. The space allows faculty to incorporate practical, interactive teaching experiences into coursework. Local K-12 teachers and students can use the innovative environment to explore ideas and applications they can take back to their own classrooms and use with students across the curriculum. The collaborative design approach to this evolving educational laboratory for training teachers and students included stakeholders from throughout the university and community in its state-of-the-art design described within.

**Sarah Colton** is a graduate student in Communication Sciences who works in the TWUFCL. She is studying to become a teacher of students who are deaf/hard of hearing.

**Chad E. Smith**, Ph.D., is an Associate Professor and faculty within the Education of the Deaf Program at Texas Woman's University. He is co-founder of the TWU Future Classroom Lab. His research interests include teacher methodology, 21st Century Learning, and technology applications in education.

**Ludovic A. Sourdot**, Ph.D., is an Associate Professor in Teacher Education, and co-founder of the TWU Future Classroom Lab. His research interests include popular culture and education and educational technology.

## INTRODUCTION

Next-generation learning and 21st Century Learning are becoming key elements in education today. Following the approach used by the Makerspace movement along with the integration of a variety of technology-rich educational applications, the Texas Woman's University Future Classroom Lab (TWUFCL) offers users the chance to grow and explore their knowledge of 21st-century learning and how to best apply those skills in the classroom. Prompted in part by groups like P21.org and adopted by schools like the New Tech Network, teachers and students are being confronted with the Four C's of 21st Century Learning: creativity, critical thinking, collaboration, and communication within the framework of the digital age. Because technology applications are no longer perceived as a luxury, but as key components of today's learning environments, future teachers are obligated to be able to use those technology applications and approaches prior to entering the classroom. However, a lack of exposure to educational technology in many teacher training programs often leaves teachers without the skills necessary to implement technology into their classrooms in a meaningful way (Kumar & Vigil, 2011). Because technology is such an integral part of everyday life, students will always be inundated with opportunities to connect with it at home, work, and play. As such, the designers of the TWUFCL wanted the space to be a place for both in-service and pre-service teachers to learn how to implement 21st century learning skills in the classroom as well as gain experience with a variety of educational technologies.



https://doi.org/10.14434/ijdl.v11i3.25860

## BACKGROUND INFORMATION

In this section, we highlight the research base for the designers' perspective. Learning 21st Century skills is critical for students for them to be adequately prepared for work and life in today's society (Partnership for 21st Century Skills, 2007). The TWUFCL aims to provide pre-service teachers with the tools they need to effectively teach those skills. Using an experiential learning theory or learning by doing, the TWUFCL encourages teachers, students, and faculty to come and explore technology and learning opportunities in a safe, non-threatening environment (Bohon et al., 2017). Pre-service and in-service teachers can experience meaningful 21st Century Learning applications they can take back to their own environments to use in ways that are applicable to their worlds.

As a part of teacher preparation, it was important for faculty and students to find ways of integrating 21st Century Learning and informal makerspace opportunities into the curriculum (Dousay, 2017). Love and Strimel (2016) recommend developing STEM curricula with technology and computer science elements to create meaningful connections between STEM and computer science education. Clark and Ernst (2008) believed that integrating computer science elements into the K-12 curriculum played a role in improving education on state and national levels. They also firmly believed that adding computer science to the curriculum would assist with the development of 21st-century learning (Ernst & Clark, 2007; Clark & Ernst 2009; Love & Strimel, 2016).

Media literacy is another critical skill for pre-service teachers to develop because it allows them to better relate to today's students (Kumar & Vigil, 2011; Aufderheide, 1993). In today's world, teachers must promote digital citizenship of their students (Kumar & Vigil, 2011; Ribble, 2012). The National Educational Technology Standards for Students (NETSS) directs teachers to provide examples of digital citizenship through designing and developing digital-age learning experiences and opportunities for assessment (Kumar & Vigil, 2011; Niederhauser et al., 2007). Moving beyond lectures with pen and paper activities that have been the focus of teacher training, a change in curriculum is necessary to incorporate and assess digital literacy in the classroom (Istance & Kools, 2013).

Further research is necessary on pre-service teachers' informal and professional technology use and how they utilize those skills within an educational context, as well as how instructors can leverage pre-service teachers' understanding of technology in their teacher preparation programs (Kumar & Vigil, 2011). Even though current pre-service teachers use technology in their everyday lives and expect it to be a part of their education, very few teacher preparation programs include connections between personal and professional use of technology (Kumar & Vigil, 2011; Albion, 2008). The lack of these connections has led to a significant disconnect between pre-service teachers' use of technology for informal vs. educational purposes (Kumar & Vigil, 2011; Buckingham, 2007; Smith et al., 2009). Many pre-service teachers have a positive attitude toward using technology in the classroom, but very few of them have the experience necessary to confidently implement it (Kumar & Vigil, 2011; Lei, 2009; Thornthwaite, 2009). It is often assumed that by simply being a member of a tech-savvy generation, pre-service teachers will automatically be able to successfully apply technology in an educational context (Kumar & Vigil, 2011; Caruso & Kvakik, 2005); however, this is rarely the case.

The relevance of the applications and technologies is significant to teacher preparation in the 21st century. Simply having a learning space equipped with the latest gadgets and technology without any PreK-12 application would not be practical. The TWUFCL is utilized with teacher preparation to activate learning within a realistic PreK-12 experience. Having access to the space allows students to explore and prepare innovative practice-based lessons for practicum or student teaching. One of the goals of the learning environment follows previous makerspace examples: to attract and recruit faculty members and their students to use the space for practicing instructional methodologies and experiment with available equipment for use with pre-service teachers in lesson and activity planning (Dousay, 2017).

Makerspace environments often offer professional development opportunities for local K12 teachers and their students (Dousay, 2017). Because TWU's Educator of the Deaf Preparation Program works closely with the local teachers of the deaf and their students, designing a classroom layout and format that provides in-service teachers realistic opportunities for educational technology experiences that could be replicated in their own classrooms was an essential aspect considered during the development of the lab (Dousay, 2017). Another significant design element was that the focus of the learning environment was not specific technologies, but how they could be applied in a variety of situations in K-12 classrooms. Once the learning environment opened on campus, the authors developed a Facebook page for the TWUFCL. In the same way other makerspaces have generated social media accounts such as Pinterest boards, content from the TWUFCL Facebook page includes videos and lesson plan concepts both pre-service and in-service teachers can consider for future lessons (Dousay, 2017).

## CONTEXT AND RATIONALE

Just like other makerspace approaches that allow users to pursue a variety of 'maker-tasks,'- technology-rich environments can also offer future teachers opportunities to make and explore. Within the TWUFCL, writing opportunities, artwork, and technology exploration are all made available to future school personnel (Abram, 2015).

Makerspaces can be creative areas on university campuses where the space is integrated within teacher preparation areas so that it encourages pre-service educators to explore innovative lessons and activities prior to student teaching (Dousay, 2017). Design that promotes faculty opportunities, student learning experiences and easy accessibility for users will help faculty integrate the learning space into their teaching (Dousay, 2017). Even in-service teachers visiting the creative learning environments find value in the exposure to doing and robotics applications not available at their school (Dousay, 2017). Programming or coding no longer requires the purchase of complex software or technology. Web-based resources such as *Scratch* and Code.org offer students, teachers, and future teachers a wealth of opportunities for coding in the classroom (Lye & Koh, 2014).

Another positive aspect of the TWUFCL and other makerspaces is that they give women the opportunity to participate in STEM activities that they might not otherwise be exposed to (Abram, 2015). Texas Woman's University is the leading public university in the U.S that is primarily for women. One goal of the TWUFCL is to give women who previously were uninterested or unsure about technology and engineering subjects the opportunity to gain experience and skills that will allow them to give other women/girls the ability to participate and excel in science, technology, engineering, arts, and mathematics (STEAM) content, in which women are typically underrepresented.

## GOALS AND OBJECTIVES

The goals and objectives of the Lab are designed to target three groups. Those groups include pre-service teachers, university teacher training faculty, and PreK-12 school populations. The third group consists of both preK-12 students and teachers. In order to create change in the ways pre-service teachers think about learning and teaching, the authors sought to bring a variety of populations to campus to interact with the learning space and demonstrate authentic class experiences.

Some of the goals and objectives for pre-service teachers include providing pre-service PreK-12 teachers with tools to plan, design, and produce their own media elements (multimedia production and presentation). Another goal for the TWU FCL is to bring local preK-12 students into the Lab for meaningful learning experiences with pre-service teachers in a way that allows pre-service teachers to plan and execute live 21st Century Learning experiences while also providing local school children the opportunity to participate in such activities.

The goals and objectives for university teacher training faculty include developing, demonstrating, and evaluating specific instructional approaches that incorporate various student-centered learning opportunities for diverse student populations, including those who are Deaf/Hard of Hearing (DHH). They should also integrate collaborative technology applications into teaching content methodologies of pre-service PreK-12 teachers as well as provide research-based instructional opportunities in a technology-equipped classroom environment for a PreK-12 classroom of diverse students. Another goal for university teacher training faculty is to apply 21st Century teaching tools for pre-service teachers allowing them to keep pace with educational trends in society, classrooms, and technology.

The goals and objectives for PreK-12 school populations include creating 21st Century Learning professional development opportunities for local teachers that can be replicated in local PreK-12 classrooms.

## DESIGN CONSIDERATIONS

The design for the FCL room layout and availability of resources is based on breaking away from the traditional learning environment that was designed in the late 19th century and has failed to keep up with progress in business and technology (Partnership for 21st Century Skills, 2007). Lye and Koh (2014) provide suggestions that lend themselves to creating a Future Classroom Lab for pre-service teachers. They advocate 1) promoting K-12 classroom-based interactions to promote critical thinking as well as computational thinking; 2) incorporating think-aloud experiences to construct coding elements, and 3) designing constructionism-based coding environments to promote critical thinking. Ryan (2016) indicated that the implementation of a new learning space should take place in phases rather than trying to do everything at once. The question the designers of the space had to address frequently is which classroom design, technology integration, and applications would have the most lasting impact on pre-service teachers and faculty (Dousay, 2017).

The TWUFCL is in Stoddard Hall, one of the oldest buildings on campus. Built in 1936, it originally served as a student dormitory and now houses classrooms, meeting rooms, and offices for faculty in the College of Professional Education (COPE). The TWUFCL was funded by the Teaching and Research Grant for Equipment and Technology (TARGET) Program, created by the provost, Dr. Robert Neely. It was during the design phase of the project that the authors found the Future Classroom Lab (http://fcl.eun.org/) in Brussels, Belgium. The Belgian learning space is the lead lab in the European Schoolnet's Network of Future Classroom Labs, of which the TWUFCL is the only US-member. The initial concept of the room was to try to incorporate as much of the design of the original FCL in Brussels, Belgium (see Figure 1) as possible. To accomplish this, the second author recruited the assistance of Stephanie Andrus-Jackson, the university's Assistant Director of Design Services, who created four original designs to transform a typical teaching


**FIGURE 1.** Floorplan of European Schoolnet Future Classroom Lab in Brussels, Belgium. Copyright 2015 European Schoolnet Future Classroom Lab.


**FIGURE 2.** Floorplan of Texas Woman's University Future Classroom Lab in Brussels, Belgium. Copyright 2016 Wilson Office Interiors.

classroom into the TWUFCL. The designs were created for two possible classrooms, both of which mimicked the total space and layout of the Belgian model and were able to include all of the learning zones. These designs were then transformed into architectural models incorporating *Allsteel* furniture by Wilsonoi.com. Once the grant application was received, however, the two rooms that were originally offered were determined to have an over-abundance of semester credit hours offered within, therefore prohibiting the spaces from being taken offline and transformed into a non-traditional classroom laboratory. The administration provided four alternative classrooms located in three buildings. Two of the options were in Stoddard Hall, the building that houses COPE, and the other options were at the far end of campus in buildings that house the Department of Music and the Department of Visual Arts. The authors selected the classroom located in Stoddard Hall due to the ease of access to the space for both faculty and students, especially those in COPE, since the goal of the TWUFCL is to provide future school personnel with the skills they need to successfully incorporate technology and other 21st century skills into classroom instruction. The authors believed that selecting a location that was easy for both faculty and students to access would promote involvement in the space. Once the classroom was selected, new plans were developed to attempt to recreate the unique learning environment in approximately half the square footage of the original designs. After choosing the location for the learning space, the authors encountered several significant issues when designing the TWUFCL. One of the key elements for the learning space was that students and faculty must have easy access to the room so that it would not be a chore to get to. Because one of the authors trains future teachers of the deaf and planned on having DHH individuals the TWUFCL, line of sight would be important, in that obstructions to line of sight make communication in sign language difficult and cumbersome. The previous room designation for the TWUFCL was a split classroom design with two columns in the center of the room and student tables on either side of the columns. With some creative work by Stephanie Andrus-Jackson, and the Coordinator for Classroom Technology, a successful collaborative plan was developed to include all the planned elements of the TWUFCL. After the room was re-deployed, the two columns in the center of the room that once provided an awkward set of visual barriers to communicating with the instructor, served as natural divisions of the learning zones for the space (see Figures 2 and 3).

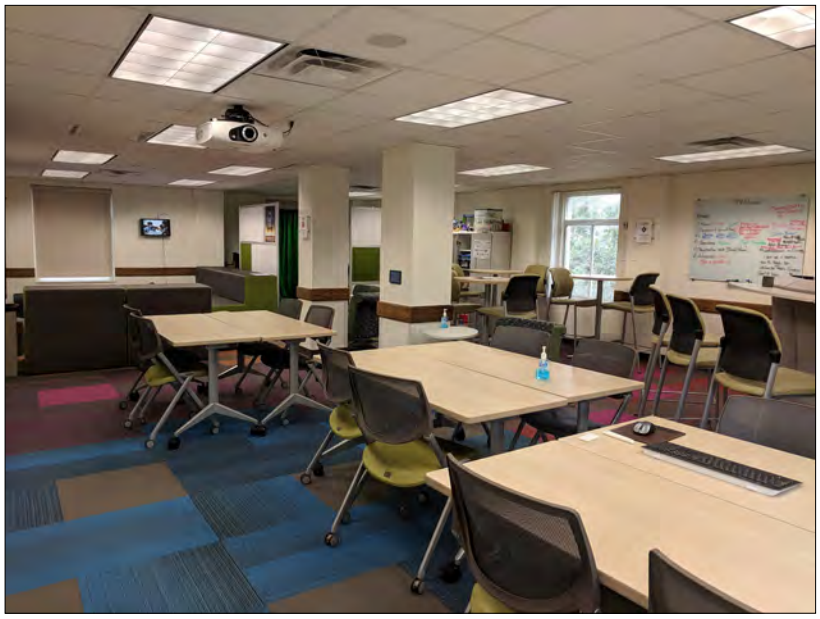

**FIGURE 3.** Corner View of the TWUFCL.

**FIGURE 4.** The Exchange Zone.

As a lab, the TWUFCL learning space is an evolving, growing experience as its users explore the science of teaching and learning. Many of the 31 FCL's in the European Schoolnet's Network of Future Classroom Labs have a total of six learning zones in which teachers and students are able to tackle a variety of learning ideas depending on the elements included within a given zone. The layout of the TWUFCL follows, in large part, the design of the lab in Brussels, going so far as

to replicate the color-coding of specific areas of the room as designated on a digital image found on the European website (see Figure 1).

## LEARNING ZONES

While the European model is designed for a K-12 experience, the purpose of the university space is to help future teachers investigate learning applications throughout their training. Examples of learning applications include self-exploration, incorporating 21st Century Learning into coursework, and opportunities to 'think outside the box' regarding instructional opportunities. Each learning zone in the TWUFCL is named based on the types of interactions that occur in that area.

### The Exchange Zone

The focus of the Exchange Zone (blue) is collaboration and communication. Here students can use the Nureva and Solstice systems to work together to brainstorm new ideas or work on group projects (see Figure 4). The *Nureva Span*™ system is a collaborative learning space that allows users from different locations to communicate and interact via independent devices all within a single canvas. Students and teachers can develop working plans and ideas on campus via the interactive projected wall, and from afar with smartphones, tablets, and personal computers. The *Solstice* system allows pre-service teachers to gain experience in a bring your own device (BYOD) environment that allows users to connect multiple personal devices to a single projector screen and share desktop images.

### The Develop Zone

The Develop Zone (red) serves as a quiet place for Pre-service teachers to practice working with a student one-on-one. This zone also features the "Hedge" from the *Allsteel* furniture company, a moveable wall with a small desk on one side, which allows the pre-service teacher to be observed without interrupting what they are working on with a student (see Figure 5).

### The Investigate Zone

The Investigate Zone (purple) is where students use the robots, circuits, and other technology in the lab (see Figure 6). This exploratory area allows students to use a variety of resources readily available to classroom teachers through department stores or online venues such as Amazon. Bluetooth technology applications such as *Sphero*, *Ollie*, and *Bluebot* are available, as well as construction applications such as *LEGO WeDo 2.0, K'Nex, Arduinos,* and *Little Bits STEAM kits* to encourage students to create and construct in ways they might not have otherwise experienced. Students are also able to explore virtual reality applications, such as Google Cardboard and Viewmaster viewers, with their own smartphone technology. A multitude of free Google Cardboard videos are available on YouTube™ that teachers can learn to use and take back to their own classrooms.

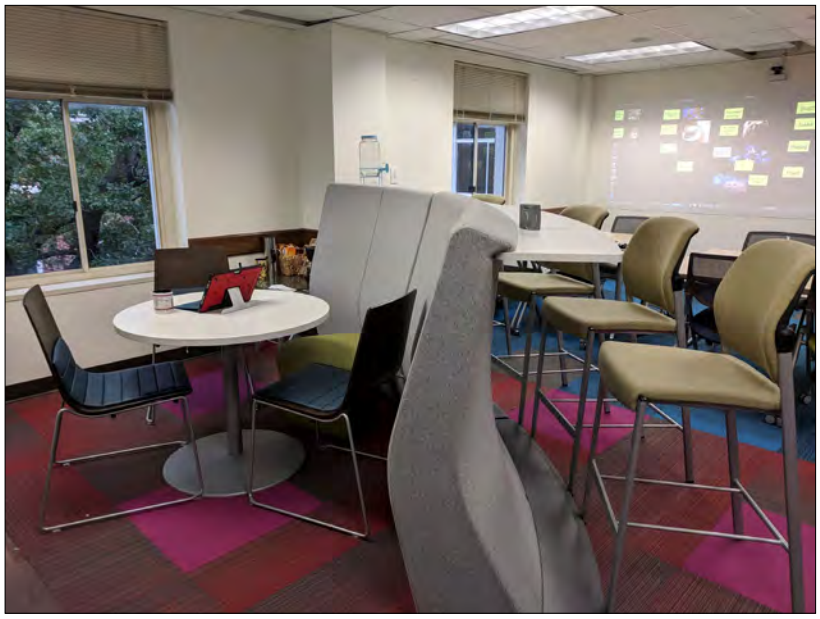

**FIGURE 5.** The Develop Zone.

**FIGURE 6.** The Investigate Zone.

Introductory tools for coding such as *Code-a-pillar, Ozobots*, and *Matatalab* are also available for those just beginning their coding experience. Even critical thinking games, such as *Circuit-Maze* and *Lazer-Maze* encourage students and adults to think critically in ways many are not accustomed to. While all the technology components are important, keeping non-technology household elements for experiences is equally significant. Readily available items such as vinegar, baking soda, Play-Doh, etc., all can play key roles in developing a variety of experiences for participants in the TWUFCL.

### The Create Zone

The Create Zone (green) is used for the creation and editing of videos. In this zone, students can use a Sony HXR-NX100 video camera, reflectors, a green screen, and a Mac computer equipped with Final Cut Pro 10 (a video editing software) to produce and edit videos (see Figure 7). Chroma-Key technology (green screen) is available in both the Google Play Store and the App Store, participants in TWUFCL activities are encouraged to explore with personal web-enabled devices such as smartphones and tablets so the experiences can be easily replicated back in their own classrooms.

**FIGURE 7.** The Create Zone.

### The Interact Zone

The Interact Zone (pink) previously featured security cameras that could be used to observe individuals using the lab from a different location, but the service used to maintain the cameras became too expensive, so they have since been removed, and the authors are currently looking for an alternative service.

**FIGURE 8.** The Present Zone.

### The Present Zone

The Present Zone (orange) features a large touch screen monitor and stadium seating that can be used for lectures or presentations, or group work. Also located in this zone is a *Cisco* video conferencing camera that allows students and teachers to create opportunities for video conferencing with other classrooms and groups (see Figure 8).

## INFRASTRUCUTRE AND FURNITURE

In addition to furniture selected specifically for the TWUFCL, there is also room equipment such as movable walls, seating, and desk/table arrangements to allow for a variety of classroom interactions. Student learning opportunities include items for the learning centers such as tablet technology, video technology, lab station devices such as robotics, *Arduinos*, and maker space activities like *Legos* and *K'nex*. *Allsteel* was chosen as the furniture supplier for the learning space. Known for its functionality, flexibility, and style, the furniture allowed the authors to create an adjustable learning environment while maintaining the key behavioral objectives. The furniture in the Exchange Zone consists of six five-foot tables with wheels, which allows them to be easily moved around the space. The Develop Zone is surrounded by the "Hedge", which is a 48.5-inch-tall moveable wall with a

small desk 43 inches up on one side. The Investigation Zone has several tall tables and chairs for the students to sit in while they work in that area. The Create Zone is surrounded by a moveable wall and has a green screen as well as a video camera and tripod, reflectors, and a Mac computer that is used for editing videos. Initially, the Interact Zone contained several security cameras, but they have since been removed. The Present Zone features two different seating options from the *Allsteel* company: the "Rise," moveable stadium seating, and "Scooches," small stool-like seats that can be easily moved around the room, as well as a ViewSonic touchscreen monitor.

## EQUIPMENT

The equipment within the TWUFCL provides shared-use opportunities to enhance teaching and learning experiences for pre-service teachers and education professionals seeking additional training both on-campus and via distance education endeavors (Table 1). The purpose of the learning space is not simply the inclusion of specific technology; it is giving both in-service and pre-service teachers the tools they need to incorporate 21st century learning into their classrooms. The focus of the environment is the exploration of teaching opportunities and applications. The space is designed specifically to give faculty and students the opportunity to explore 21st Century Learning within the content areas being pursued by faculty and future teachers.

## INSTRUCTIONAL TECHNOLOGY

Technology for the classroom can be divided into three groups: 1) presentation technology used by students and teachers, such as the ViewSonic located in the Present Zone (see Figure 8); 2) supervision technology which allows university supervisors to monitor classroom interactions and future teachers to self-reflect on their performances; and 3) collaborative-use technology which allows preK-12 students and teachers to interact internally and externally with each other and university personnel, such as the *Nureva Span*™ system located in the Exchange Zone (see Figure 4).

The types of personal use technology used in the TWUFCL include robotics technology (*Sphero*, *Ozobots*, *Makeblock*,

| LEARNING ZONE | BEHAVIORAL OBJECTIVES | TECHNOLOGY USED |
|---|---|---|
| Present | • Share<br>• Communicate<br>• Deliver<br>• Evaluate | *ViewSonic* |
| Create | • Make<br>• Edit<br>• Enhance<br>• Present | *Sony* HXR-NX100 Video Camera<br>Reflectors (lighting)<br>*Mac* Computer |
| Investigate | • Analyze<br>• Problem-Solve<br>• Organize<br>• Program | Classroom robots (*Makeblock, Matatalab*)<br>Building activities (*K'nex, Legos*, etc)<br>Circuit activities (*Arduinos, Makey Makey, Little Bits*, etc.) |
| Develop | • Assess<br>• Individualize<br>• Motivate<br>• Adapt | |
| Exchange | • Partner<br>• Collaborate<br>• Communicate<br>• Brainstorm | *Microsoft* Surfaces<br>*Nureva* Span<br>*Solstice* |
| Interact | • Motivate<br>• Supervise<br>• Guide<br>• Prompt | Camera System |

**TABLE 1.** Behavioral learning objectives and technology elements by section of the TWUFCL.

*Matatalab, Lego Boost*, etc.), circuit technology (*Little Bits*, *Arduino*, *Makey-Makey*, etc.) and building materials (*Legos*, *K'nex*, etc.). One of the goals of the Future Classroom Lab is to get both in-service and pre-service teachers to use the different technologies in the lab and take what they learn and apply it to the integration of technology and 21st century skills into their classrooms.

## SUSTAINABILITY

Due to the flexible layout of the TWUFCL, as well as the addition of new technologies, the space has undergone several changes since it first opened. One notable change to the design of the room is the addition of the carpet that is color-coded to match up with the main color of the different learning zones. New learning toys/tools are always being added to the investigate area, the most recent being the *Matatalab*, a robot that teaches children ages four to nine the basics of coding (Matatalab Co., n.d.), and Makeblock, a company that has a variety of robotics and coding opportunities for preschool to high school-aged students (Makeblock Co., n.d.). Texas Instruments donated a TI *Innovator Rover* and TI *Nspire* calculator. The *Rover* is a robotic vehicle that is programmable using the graphing calculator. A new addition to the Exchange Zone has been the Nureva, which is a visual collaboration tool which allows individuals in different places to work simultaneously on a project via the internet (Nureva Inc., n.d.). In addition to all the new technologies, some trial-and-error has also been a part of the layout of the lab. *Double Robotics* were also a feature of the TWUFCL, but they did not perform in the way that was anticipated, so they are not typically used outside the TWUFCL anymore.

## TEACHER EDUCATION INTEGRATION

Middle and elementary school students from the local Regional Day School Program for the Deaf (RDSPD) have visited the TWUFCL on several occasions. During these visits, the students participate in several activities that focus on a piece of technology as well as a 21st Century Learning skill. The visits are beneficial for pre-service teachers in that they get hands-on experience working with DHH students as well as incorporating different technologies into their lesson plans while in a more relaxed environment than a typical student-teaching situation. These visits benefit the middle and elementary-school students in that they gain experience with new technologies as well as working on the development of 21st-century skills. The pre-service and in-service teachers that accompany the middle and elementary-school students also benefit from these visits in that they are given examples of using technology to teach subjects in a way that would not usually be considered (i.e., using a Sphero to create an art project).

The TWUFCL provides a multitude of opportunities for pre-service teachers to gain experience with 21st-century learning skills and technology. Throughout the school year, the elementary and middle school classes from the Regional Day School Program for the Deaf take field trips to the TWUFCL. During the summer, the TWUFCL hosts Camp Computing in Deaf Education (Camp CoDE), a week-long camp for students in elementary and middle school. Students come to the lab and participate in a variety of 21st-century learning activities such as practicing coding skills, building and programming robots, creating stop-motion movies, and developing digital art.

In addition to field trips for elementary and middle school classes, the TWUFCL has hosted several events for in-service teachers, including working with 4-H to present a Lego Robotics workshop to a group of teachers of the deaf. The authors also organized Camp CoDE for Teachers, which serves as a "crash course" in incorporating a variety of technology applications into activities across different subjects.

Both the TWUFCL and the European Schoolnet FCL have several online resources available for both in-service and pre-service teachers. These resources have been used in a 100% online educational technology course, thus benefitting students who are unable to travel to the lab on campus.

## COLLABORATING ACROSS CAMPUS

The TWUFCL started as a collaboration in that the partners who set it up are from two different programs in two different colleges. The authors also collaborated with the interior designer for the university to set up the space in a way that matched up with the FCL in Europe, but in a way that could be utilized by college students. Matthew Moore, the Learning Environments Architect was responsible for designing the technology plan specific to the lab.

## DESIGN REFLECTIONS

Because the TWUFCL is a living and evolving space, components are constantly changing in response to different situations or applications, such as adding new robots or updating the focus of an area. For example, some of the technology in the Create Zone, like the Sony HXR-NX100 video camera, has become obsolete due to the increased quality of cameras and video-editing software available on smartphones. The authors are also currently working on figuring out a way to provide opportunities for early childhood students in the TWUFCL. Because so many of the activities in the lab are for DHH students and their teachers, environmental acoustics is always an issue. After renovation on the room began, the authors discovered one of the HVAC units for the building is located over one of the walls of the room, introducing significant ambient noise to the space. The authors are currently

looking for solutions to dampen environmental sound issues for the learning space.

## SHARING THE STORY

The authors have had the good fortune to be able to share the details of the learning environment and the diverse learning experiences occurring in the TWUFCL. In addition to annually sharing information with European School Network Lab partners, the authors continue to look for ways to communicate the continuing story of the space with the community. TWU alumni tour the space annually, and visitors are often invited to participate in TWUFCL events. The Denton County 4-H has also been a consistent partner in the TWUFCL by providing instructional opportunities for robotics for the TWUFCL faculty and the local regional day school program for the deaf. Because of that involvement, the local regional day school program for the deaf is developing a plan for providing regular robotic activities for its students in conjunction with 4-H.

## PLANNING NEXT STEPS

In addition to continuing to pursue opportunities for the integration of learning applications for the room, the authors will also pursue collaborative efforts with educational, technology, and community entities. The development of an advisory board will help promote the activities of the TWUFCL, serve as a guide for future next steps, provide operational and financial support to continue activities with future teachers and PreK-12 students, and generate feedback from diverse stakeholders within various TWU communities.

## CONCLUSION

The TWU Future Classroom Lab continues to grow and develop. The learning space provides users and visitors alike opportunities to explore the science of teaching and learning, as well as develop unique learning experiences for local PreK-12 students and teachers. As part of the European Schoolnet's Network of Future Classroom Labs, the authors continue to promote the development of teaching approaches that include the elements of the Four C's of 21st Century Learning as a makerspace and an ever-evolving technology-rich learning laboratory.

## ACKNOWLEDGEMENTS

The authors would like to thank Dr. Robert Neely, Stephanie Andrus-Jackson, and Matthew Moore for their significant contributions to the development and design of the Future Classroom Lab. The authors would also like to thank Tommaso Dalla Vecchia and Bart Verswijvel of the European Schoolnet's Future Classroom Lab in Brussels, Belgium, for their inclusion of the TWUFCL in the Network of Future Classroom Labs.

## REFERENCES

Abram, S. (2015). Real makerspaces in school libraries. *Internet@ Schools, 22*(1), 10-11.

Aufderheide, P. (Ed.). (1993). *Media literacy: A report of the national leadership conference.* The Aspen Institute. https://files.eric.ed.gov/fulltext/ED365294.pdf

Albion, P. R. (2008). Web 2.0 in teacher education: Two imperatives for action. *Computers in the Schools*, *25*(3-4), 181-198. https://doi.org/10.1080/07380560802368173

Bohon, L. L., McKelvey, S., Rhodes, J. A., & Robnolt, V. J. (2017). Training for content teachers of English Language Learners: Using experiential learning to improve instruction. *Teacher Development, 21*(5), 609-634. https://doi.org/10.1080/13664530.2016.1277256

Buckingham, D. (2007). Media education goes digital: An introduction. *Learning, Media and Technology*, *32*(2), 111-119. https://doi.org/10.1080/17439880701343006

Clark, A. C., & Ernst, J. V. (2009). Gaming in technology education. *The Technology Teacher*, *68*(5), 21-27.

Clark, A. C., & Ernst, J. V. (2008). STEM-based computational modeling for technology education. *Journal of Technology Studies*, *34*(1), 20-27. https://files.eric.ed.gov/fulltext/EJ861288.pdf

Dousay, T. A. (2017). An evolving makerspace for teacher education. *International Journal of Designs for Learning, 8*(1), 69-81. https://doi.org/10.14434/ijdl.v8i1.22672

Ernst, J. V., & Clark, A. C. (2007). Scientific and technical visualization in technology education. *The Technology Teacher*, *66*(8), 16-21.

Istance, D., & Kools, M. (2013). OECD work on technology and education: Innovative learning environments as an integrating framework. *European Journal of Education, 48*(1), 43-57. https://doi.org/10.1111/ejed.12017

Kumar, S., & Vigil, K. (2011). The net generation as pre-service teachers: Transferring familiarity with new technologies to educational environments. *Journal of Digital Learning in Teacher Education, 27*(4), 144-153. https://doi.org/10.1080/21532974.2011.10784671

Caruso, J.B., & Kvavik, R.B. (2005). *ECAR study of students and technology 2005: Convenience, connection, control, and learning.* Educause Center for Applied Research. https://library.educause.edu/-/media/files/library/2005/10/ers0506w-pdf.pdf

Lei, J. (2009). Digital natives as pre-service teachers: What technology preparation is needed?. *Journal of Computing in Teacher Education*, *25*(3), 87-97. https://www.tandfonline.com/doi/abs/10.1080/10402454.2009.10784615

Love, T. S., & Strimel, G. J. (2016). Computer science and technology and engineering education: A content analysis of standards and curricular resources. *Journal of Technology Studies, 42*(2), 76-89. www.jstor.org/stable/90018741

Lye, S. Y., & Koh, J. H. L. (2014). Review on teaching and learning of computational thinking through programming: What is next for K-12?. *Computers in Human Behavior, 41*, 51-61. https://doi.org/10.1016/j.chb.2014.09.012

Niederhauser, D. S., Lindstrom, D. L., & Strobel, J. (2007). Addressing the NETS* S in K-12 classrooms: Implications for teacher education.

*Journal of Technology and Teacher Education*, *15*(4), 483-512. https://www.learntechlib.org/primary/p/21705/

Nureva Inc. (n.d.). *Span™ Workspace.* https://www.nureva.com/visual-collaboration

Makeblock Co. (n.d.). *Makeblock Education*. https://education.makeblock.com/

Matatalab Co. (n.d.). *Meet Matatalab hands-on coding robots.* https://www.matatalab.com/

Partnership for 21st Century Skills. (2007). The intellectual and policy foundations of the 21st century skills framework. https://www.battelleforkids.org/networks/p21

Ribble, M. (2012). Digital citizenship for educational change. *Kappa Delta Pi Record*, *48*(4), 148-151.

Ryan, K. (2016). Creating collaborative learning spaces. *Technology & Learning*, *36*(7), 30-31.

Smith, S.D., Salaway, G., & Caruso, J.B. (2009). *The ECAR study of undergraduate students and information technology, 2009.* Educause Center for Applied Research. https://library.educause.edu/-/media/files/library/2009/10/ers0906w-pdf.pdf

Thornthwaite, C. (2009). Lessons learned from incorporating web 2.0 technologies into three levels of university coursework. In I. Gibson, R. Weber, K. McFerrin, R. Carlsen, & D. Willis (Eds.), *Proceedings of SITE – Society for Information Technology & Teacher Education International Conference* (pp.3513-3520). Waynesville, NC: Association for the Advancement of Computing in Education (AACE).