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Virtual Exchange Embedded in a STEM Summer Camp Improved United States High School Students' Awareness of Filipino Culture

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Introduction

Santa Fe College (SF), a regional college and part of the Florida State College System, and the University of Florida (UF), Florida's public flagship land-grant research university, in the United States partnered with Urdaneta City University (UCU) in the Philippines to develop, deliver, and assess a Virtual Exchange (VE) experience within STEMTank 2023, a high school summer program sponsored by the U.S. Department of Education. SF and UF have jointly offered the award-winning STEMTank program for four consecutive summers, providing pre-college access experiences for high school students from North-Central Florida's under-resourced communities. The program's hallmark is giving participants a taste of an engineering college experience through unique, open-ended design / build / test projects grounded in contemporary real-world engineering problems that include 1) analytical modeling to guide the design process, 2) prototype performance measurement with redesign / retest opportunities to improve performance, and 3) presentation of results by student participants to panels of subject matter experts who give critical feedback. To offer the program at no cost to participants, STEMTank is delivered in a hybrid format with two in-person interactions at the SF and UF campuses, respectively but with most instruction and interaction occurring online.

A 2021 university-wide survey-based study of the intercultural competency and global awareness of the UF undergraduate population revealed that engineering students, followed closely by mathematics and computer science students, rate lowest among majors at the university in skills and experience relevant to internationalism [1]. This relative lack of intercultural competency among STEM majors is mirrored broadly across U.S. universities, and there is a need for more experiences that embed multicultural and international elements in STEM curricula [2-6]. Moreover, Kulturel-Konak found engagement in extra-curricular activities correlated with increased interest in global awareness, which motivates students to pursue international experiences that positively relate to improved skills for international careers [7]. They, therefore, recommend embedding international experience into STEM curricula.

Since STEMTank is a summer pre-college access extra-curricular activity for its participating high school students, its 2023 organizers were motivated by the above studies to add an international component since STEM careers increasingly require global awareness and international competence. Thus, the Summer 2023 STEMTank program added an international element to its online component by partnering with UCU in a VE focused on an engineering challenge shared by Florida and the Philippines. Bordered by oceans and located at sub-tropical latitudes, both regions are at risk for destructive tropical cyclones (hurricanes in Florida and typhoons in the Philippines). So, the STEMTank 2023 VE challenged its high school participants to design, create, test, and analyze structures capable of surviving the catastrophic impacts of tropical cyclones and reducing risks to inhabitants and their property. To evaluate the cultural competency impact of the VE on American STEMTank participants, a pre/post survey was administered to high school camp attendees with 14 questions embedded to gauge the effects of international competence on these participants. This paper reports on the camp activities, describes the survey results as well as anecdotal observations, and analyzes outcomes from the survey and the overall program.

Background

STEMTank was inspired by the Shark Tank television show. The camp, curriculum, genesis, and goals are described in detail elsewhere [8]. In summary, STEMTank challenges participants to design, build, and test an engineered prototype that addresses or solves an open-ended, real-world (often community-based) technical problem. College student mentors from SF and UF support high school participants, evoking the feel of a college class through lectures and office hours with the instructional staff. As the experience's culminating event, participants present their prototype and preliminary testing results to a panel of "Sharks", subject matter experts drawn from academia, industry, and government that provide participants with commentary and critique of their project designs.

To instill students with broad self-efficiency foundations, STEM-focused college access programs must invoke a triad of positive student responses: 1) Attitude, "I like STEM"; 2) Self-Confidence, "I am good at STEM"; and 3) Resilience, "I can overcome STEM challenges" [9]. In early STEMTank iterations, the mentors and instructional staff fully supported participants in every activity to ensure none failed at any task or fell behind. To everyone's surprise, pre- and post-participant surveys revealed the program's positive self-efficacy influence on attitude and self-confidence, but there was no improvement in resilience. Overcoddled STEMTank students did not experience or normalize failure, a critical element of the student response triad for STEM program success. Authentic experiences of failure had to be added to induce growth of resilience. Still, this incorporation had to be strategic: it could not discourage participants or drive them to quit the program, as that outcome would negate any benefits or gains.

Thus, a hallmark of more recent STEMTank camps is the implementation of the Low-stakes Intentional Failure Technique (LIFT). In LIFT, relevant activities with a high likelihood of inducing failure are incorporated into projects but are strategically selected not to block achieving the primary end goal. Participants are intentionally not well-supported by the staff through these non-critical activities and are allowed to fail if unable to succeed on their own. This is deliberate. It provides and normalizes the experience of failure without blocking the participant's path to achieving the overall project goal. While participants can fail in non-essential project goals, the program is scaffolded to fully support participants' success with essential goals leading to the final desired outcome. Program facilitators do not let students fail when the outcome matters. Details of LIFT's impact on the self-efficacy outcomes of the Summer 2023 STEMTank participant cohort are given in a complimentary paper [10].

A challenge for STEMTank 2023 planners was to incorporate a VE with UCU into the pre-existing complex STEMTank structure, a project that emphasizes the LIFT strategy and engages high school students in an open-ended college-level engineering project. This integration built upon the scholarly literature that provides guidance on successful approaches to facilitate VE integration into STEM programs for high school cohorts. Ownes & Hite studied Project Based Learning (PBL) in the context of global collaboration through virtual interactions in a K-12 setting. Their 3-week PBL intervention engaged U.S., French, and Chinese fifth graders on an air pollution and water cycle project utilizing the Canvas Learning Management System (LMS). PBL developed students' abilities to share and understand ideas, use multiple representations to present them, and be more receptive to perspectives different from their own [11]. The guidance for STEMTank was to develop a project allowing international student partners to work together rather than in parallel to develop intercultural communication, international experience, and creative competencies in STEM. Thus, a STEMTank project was developed that cast Filipino student participants as customers for U.S. student designers and vice versa. Participants were asked to design structures that provided protection and safety against tropical cyclones in the counterpart country. This interaction forced participants to articulate design requirements and critique design ideas for their counterparts. Each group served as subject matter experts and envoys for their own culture, architecture, and norms. This mutually reciprocal approach, U.S. students designing for the Philippines and Filipino students designing for the U.S., cast all participants as equals, decreasing the potential for inequitable exchanges and interpretations [12].

Another guiding literature example is Johnon et al. who documented a collaborative VE between Bolivian and American classrooms, emphasizing the challenges and successes encountered in its inaugural year. The initiative incorporated joint projects, paper outlines, and group analyses, and culminated in faculty interviews to assess the program's effectiveness. Challenges included initial lack of bonding and disparities in student engagement and motivation [13]. The authors recommended 1) an equitable shared academic experience and 2) an introductory intercultural class before the VE. Both these features were implemented in STEMTank 2023. As a further benefit, VE provides an excellent foundation for international teams of scholars to organize and promote research and teaching collaborations [14]. This paper represents an initial cooperative pedagogical research product generated collaboratively by faculty from both countries.

Methods: Programmatic

STEMTank 2023 took place on June 5 - 23. During the three-week program, high school participants attended daily virtual synchronous lectures facilitated via Zoom by the SF and UF staff and college mentors. These sessions offered various opportunities for engagement allowing participants to answer questions posed by the lead and secondary facilitators. Participants were then required to attend office hours led by college student mentors to creatively collaborate in small groups. During this time, participants 1) asked specific questions about their designs, 2) carried out creative / engineering design processes and 3) received one-on-one feedback to assist in progress toward the larger project.

Four VE sessions were scheduled with UCU to formalize and facilitate international conversations and exchanges, allowing each cohort to learn more about their counterparts' community challenges and natural disaster preparation. This information exchange allowed U.S. participants to shift perspectives, viewing problems through a lens outside their own lived experience, deepening their understanding of themselves and the world around them. To prepare U.S. STEMTank participants for these international interactions, an asynchronous Canvas LMS module on cultural competency was made available before the VE started to encourage and enrich virtual interactions.

Both U.S.- and Philippines-based STEMTank participants were challenged to complete the same open-ended engineering design and build process by 1) imagining a structure that would withstand a tropical cyclone, 2) performing engineering calculations to settle on the size and shape of the structure to provide natural disaster protection in their cultural counterpart's county, 3) performing detailed design for a problem solution using Autodesk Fusion 360 CAD software, 4) working with college student mentors to refine the design, 5) 3D printing prototypes for testing, and 6) communicating results to the community.

Participant-designed creations were fabricated on Prusa i3 MK3S+ 3D printers at UF, as shown in Figure 1. Full-scale designs were constrained in size by the Prusa print volume (25 cm × 21 cm × 21 cm), and participants were allowed two full print volumes, if needed, to make a model. U.S. participants completed two design iterations. The first round was a quarter scale mock-up for testing in a 20 cm x 20 cm suction-style wind tunnel fabricated from cardboard by STEMTank staff, shown in Figure 2. Using feedback from the tests at quarter scale, participants redesigned and printed full-scale models for testing at UF’s 120’ x 20’ Boundary Layer Wind Tunnel at the Powell Family Structures & Materials Laboratory.

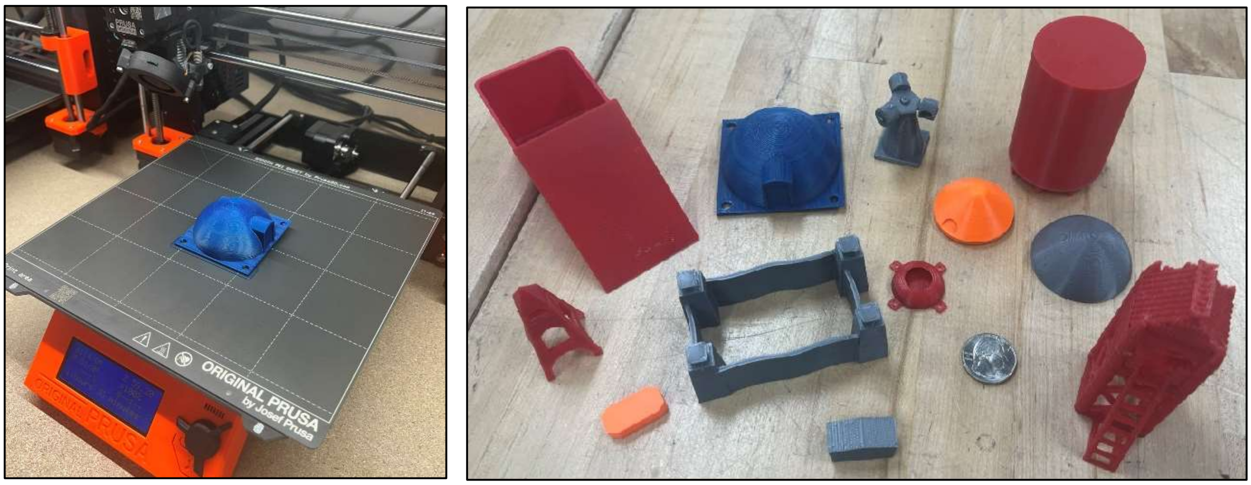

Fig. 1: Participant designs were first 3D printed at 1/4 of the intended scale.

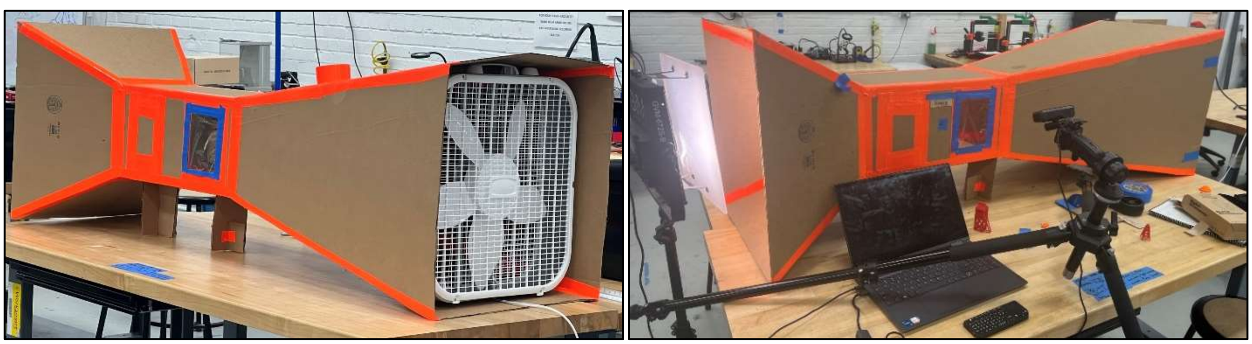

Fig. 2: A tabletop fan-driven suction wind tunnel was constructed to video quarter-scale model slip/tip.

Two predominant failure types were identified representing the models succumbing to typhoon / hurricane force winds: slipping and tipping. Participants performed calculations to determine which failure mode they expected for their design with a goal of predicting at what tunnel wind speed the slip or tip would occur. Slipping referred to the horizontal drag force on the model exceeding the static friction adhering it to the ground, causing it to slide. Tipping referred to the horizontal drag on the model causing it to rotate around its base and fall over. Geometry and weight were key considerations in these calculations. Drag force as a function of tunnel velocity was estimated using external flow drag coefficient tables for shapes similar to those created for the project. Model weight was initially estimated from Prusa Slicer during 3D printing preproduction. Once models were 3D printed, students weighed their creations on a digital balance, Figure 3, and further refined their engineering models. Their goals were to predict 1) whether slip or tip would be the predominant failure mode and 2) at what wind speed that event would occur. Wind tunnel velocity profiles as a function of height were estimated using profile data previously published for this Boundary Layer Wind Tunnel [15].

Fig. 3: Quarter- & full-scale 3D printed models were weighed for slip / tip calculations.

A schematic of UF's Boundary Layer Wind Tunnel is shown in Figure 4. The test section is 3 m tall by 6 m wide, and in fact the entire tunnel cross section is 3 m x 6 m. Flow is driven by a 6 m x 3 m bank of eight 1.5 m Aerovent vaneaxial fans. The fans are run at an operator controlled constant rpm (same rpm for each fan). The calibration of fan speed to wind speed at the test section is 100 rpm = ~3.5 mph mean wind speed (measured at 1.5 meters off the floor at the test section center). This relationship is linear over the operable fan range, so 1200 rpm (upper limit for this testing) creates ~42 mph mean wind at 1.5 meters off the floor at the test section center. This calibration was conducted and repeated many times since commissioning the wind tunnel using Turbulent Flow Instrumentation Cobra Probes that measure three components of velocity up to 2000 Hz. This is an open circuit wind tunnel, however, the rpm to speed calibration has been confirmed to remain accurate under normal operating environmental conditions (no rain, no high winds).

During model testing for STEMTank, the fan operator was instructed to increase the fan bank rpm in increments of 100 rpm and hold steady until given a signal by the companion operator on the wind tunnel floor observing the testing and model failures. In this manner, the fan rpm at which a given model failed was known and recorded. The failure rpm was converted to speed at 1.5 meters height using the above calibration, and then converted down to the height of the object using a supplied boundary layer velocity profile. The roughness elements used to produce mechanical turbulence and shape the boundary layer were flush with the floor (smooth terrain). STEMTank participants were given access to measurements of the boundary layer as measured in the UF wind tunnel prior to testing to work on the conversion details.

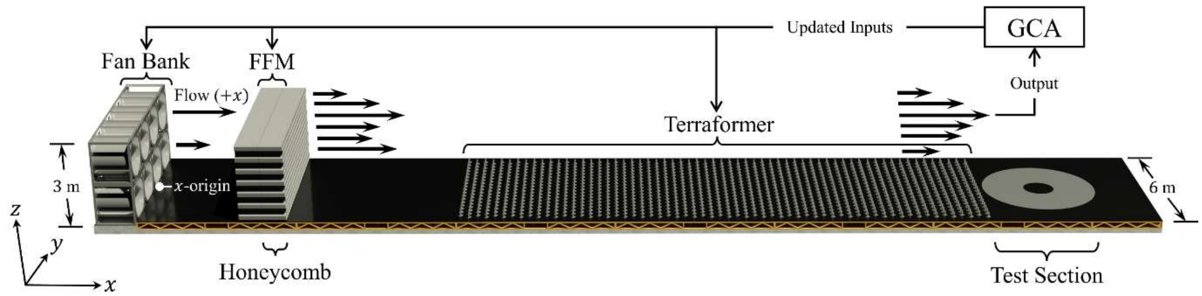

Fig. 4: Schematic of UF's Boundary Layer Wind Tunnel used for STEMTank 2023 model testing.

Both U.S.- and Philippines-based participants navigated the same curricular program and had opportunities for wind tunnel testing. The U.S. students tested in person. Filipino designs were 3D printed at UF and the tests were videoed and shared. Videos involved a wind tunnel controller slowly increasing the tunnel speed from zero to maximum while periodically calling out measured wind velocity. The wind speed at which the models were seen to visually slip or tip was considered the maximum speed the model could endure before failure. Analysis of wind tunnel results was compared to participant predictions of slip / tip wind speed as one metric to be shared with the panel of Sharks in the final presentations.

Methods: Pedagogical

U.S. STEMTank participants were high school students 14-18 years old. All students were current, active members of the TRIO federally funded college access program during the time of participation. STEMTank 2023 enrolled 12 participants: 33% (4) were female, and 66% (8) were male; 66% (8) of the participants were low-income and/or potential first-generation college students. Fifty percent (6) of the participants identified as an underrepresented minority.

The participants completed a 24-question baseline survey administered through Canvas to assess their academic persistence, self-efficacy, self-confidence, and cultural competence prior to the engineering programming. The instrument used a 5-point Likert scale (5 = Strongly Agree, 1 = Strongly Disagree). The source of the self-efficacy portion of the survey instrument is the New General Self-Efficacy Scale by Chen et al. [16]. In addition to the core self-efficacy questions, 14 cultural competence questions were embedded in the survey using the same 5-point Likert scale. These cultural competence questions are referenced in this paper's appendix.

An identical exit survey was administered via Canvas at the conclusion of the project. Of the 12 U.S. participants, N = 10 completed both surveys, which enabled application of two-tailed Wilcoxon Signed Rank Tests to evaluate participant self-reported cultural competence changes induced by STEMTank VE participation.

Results: Programmatic

Participants synthesized information from synchronous online lectures on CAD, 3D printing, and design of wind resistant structures. Through VE interactions with Filipino instructors and student participants from UCU, all U.S. STEMTank 2023 participants produced a unique custom quarter-scale model of a typhoon resistant structure for the Philippines using the Fusion 360 CAD package. These designs were 3D printed and tested in the tabletop wind tunnel for slip or tip. Generating a quarter scale model for preliminary small wind tunnel testing was tagged by the instructional staff as a LIFT critical deliverable, and students were mentored and supported by the staff to ensure all achieved this milestone. After viewing performance videos of their models in the 20 cm x 20 cm tabletop wind tunnel, participants were invited to make modifications to enhance model performance.

Some students were content with their designs and simply scaled them up for full-scale wind tunnel testing. Other students elected to change their designs to improve performance. For example, one U.S. participant explored modifying the base of his typhoon survival shelter once he observed its flat 3D printed surface was too smooth and caused the shelter to slip below the desired wind speed. He 3D printed several different roughness patterns and developed a mechanism to interchange them on the full-scale model (see Figure 3 - right). Another student realized her design was too light and tipped over at a velocity that would not enable it to survive a typhoon. After calculation, she deduced even printing the structure with 100% infill would not make it heavy enough. The student noted the density of solid 3D-printed PLA is 1.25 g/cm^3 while wet sand's density is 1.92 g/cm^3, about 53% higher. In response, she modified her design so at full scale it was hollow with a hole on top and could be filled with wet sand to increase weight, enabling survival without tipping up to the desired wind velocity threshold (see Figure 8 – left).

In parallel, the Filipino STEMTank participants designed Florida compliant protective structures to provide reprieve from hurricanes. 15 Filipino students started the project, 9 finished on-paper designs, and 2 of these designs were transmitted to UF for 3D printing in time to access the large wind tunnel for testing. One example is shown in Figure 5.

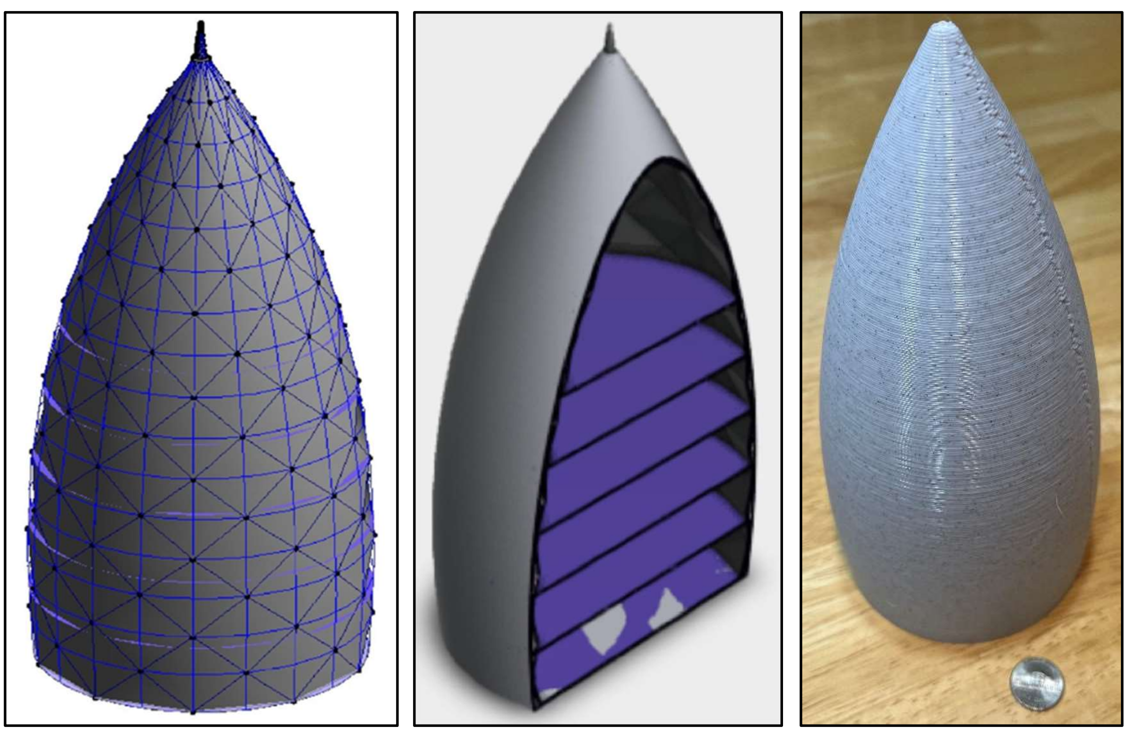

Fig. 5: A hurricane evacuation center designed by a Filipino STEMTank participant to provide shelter is shown (left) in rendered in CAD, (middle) sectioned to reveal interior detail, and (right) 3D printed for wind tunnel testing at UF. The coin for scale in the foreground is a U.S. nickel.

Ironically, Typhoon Guchol, a Category 2 tropical cyclone, struck the Philippines the week of June 5, coinciding with the start of STEMTank. Internet connectivity in country was knocked out by the storm, and many Filipino STEMTank participants had to tend to their family's safety and wellbeing. As a result of the storm, program completion rate was lower than desired. Nonetheless, those students who could continue to participate performed exceptional design work. One example, which reached the 3D printing and testing phase was the hurricane evacuation center, shown in Figure 5. The intent of this structure was to provide a safe place for people displaced by a hurricane to stay for prolonged periods in relative safety and with access to needed supplies. The design included multiple internal levels to provide ample space for a triage health care center, a greenhouse for food production, active water filtration for drinking and cooking, private bedrooms with toilets and bathtubs, and space to board pets. Solar cells on the outside would provide non-grid-connected reliable electricity. The structure's aerodynamic design could survive high winds that would topple other buildings, and the evacuation center would remain intact and open to harbor people displaced by the storm.

Instructional staff tagged 3D printing a full-scale design as a critical milestone for LIFT. STEMTank staff worked with U.S. participants to ensure all had a completed full-scale model to test in the large wind tunnel. In some cases, Design for 3D Printing methodology had to be applied to ensure each design could be fabricated. Many of the designs were typhoon shelters to protect people, livestock, and/or property. They were hollow on the inside and contained a sloping wall to present an aerodynamic silhouette to oncoming wind. 3D printers can print sloping walls but typically not at angles exceeding 45 degrees unless internal supports are utilized. So, most full-scale model redesigns involved either changing the wall angle to a less severe angle, creating internal supports (while leaving most of the space hollow), or breaking the print into parts in creative ways to enable 3D printing of a desired steep wall slope without internal supports.

All U.S. participant designs, and two Filipino designs, were 3D printed at UF and taken to the 120' x 20' Boundary Layer Wind Tunnel at the Powell Family Structures & Materials Laboratory for testing. As shown in Figure 6, models expected to slip based on student engineering calculations were placed atop a plywood board. Slipping was identified if the model was pushed by wind off the board. Models expected to tip were placed in front of the board's leading lip, which provided a trip for models to rotate around when wind speed reached a critical velocity.

Fig. 6: Full-scale 3D printed models set up for slip (right) and for tip (left) are evaluated in the large wind tunnel.

Results: Pedagogical

To evaluate the cultural exchange efficacy, familiarity, and growth induced in U.S. STEMTank participants through this experience, a pre/post survey containing 14 cultural competence questions, represented in Figure 7, was administered. Of the 12 U.S. participants, N = 10 completed both surveys, which enabled application of two-tailed Wilcoxon Signed Rank Tests to evaluate participant self-reported cultural competence changes. For studies with larger populations, $P < 0.05$ is the standard threshold for statistical significance. However, owing to the small sample size and short VE exposure time, results of this study were considered significant at $P < 0.15$: an 85% chance that the observed effect was not random. Of 14 cultural competence questions asked, 7 did not achieve adequate pre/post differentiation to meet the hypothesis testing threshold. Of the remaining 7 questions, no statistical change was observed on 4 questions, but 3 questions did meet the established statistical significance threshold. These questions centered on students' self-perceived learning about different cultures, cross culture etiquette, and the benefit of thought diversity in groups:

Q6. I have access to first-hand opportunities to learn about a culture different than my own. [null hypothesis rejection – positive signal: $P < 0.0833$]

Q8. I know some of the etiquette and rules around verbal and/or nonverbal communication in the Philippines. [null hypothesis rejection – positive signal: $P < 0.1397$]

Q14. Groups usually produce better results when they are made up of people who all see things the same way. [null hypothesis rejection – negative signal $P < 0.1404$]

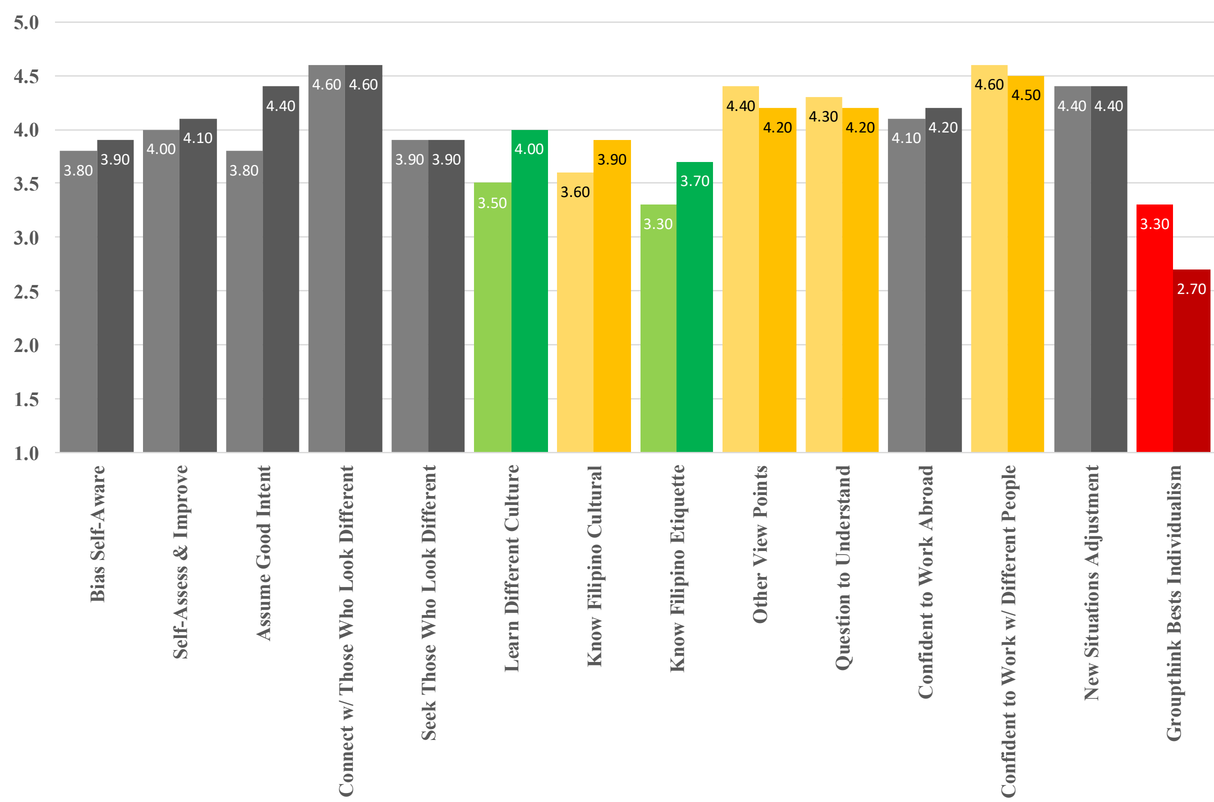

Fig. 7: A bar chart visualization of pre/post intervention data. This figure does not convey significance but shows the average magnitude of differential pre/post responses to illustrate significance threshold achievement for Wilcoxon Signed Rank Test application.

Figure 7 gives a non-statistical visualization of the survey data set. Student Likert scale survey pre-intervention and post-intervention responses were averaged to provide a visual comparison. Importantly, the magnitudes in Figure 7 do not illustrate statistical significance and so uncertainty bars are not given; it is intended only as a visual guide to the participants' question responses. Although not strictly quantitative, the Figure 7 bar chart acts as a kind of 'heat map' for the questions that elicited the strongest pre/post differential responses and therefore passed the significance threshold for application of the Wilcoxon Signed Rank Test. Questions that did not reach the $P < 0.15$ threshold of statistical significance for analysis are denoted in gray. Questions that did achieve the $P < 0.15$ threshold but did not reject the null hypothesis are denoted in yellow. Questions that achieved significance and for which the null threshold was rejected are given in green for a positive signal and red for a negative signal.

Discussion

To apply Wilcoxon Signed Rank Test to matched pairs of pre-post data, the data must first demonstrate statistical significance by crossing a threshold where a critical number of surveyed participants report change. If this threshold is not reached, no conclusion can be drawn. A rough analogy for this phenomenon is a data stream where noise is so high that any signal within it cannot be discerned. Of 14 questions asked, 7 did not achieve adequate pre/post differentiation to meet the hypothesis testing threshold, which means no conclusions could be drawn about the impact of VE in STEMTank on student responses to those questions. This result is very common for statistical analyses attempted on relatively small populations; so it is not surprising to observe it here with a sample size of $N = 10$. Of the remaining 7 questions that did satisfy the testing threshold, no statistically significant change at the $P < 0.15$ level was detected in the following 4 questions:

Q7. I know some of the cultural traditions of the Philippines.

Q9. When talking to people from another country I try to see things from their point of view.

Q10. I like to ask people questions to better understand how they think and what they value.

Q12. I can work productively with people whose cultural background is different from mine.

STEMTank did not have a significant impact on participant differential responses to these four questions. However, Figure 7 reveals the pre-STEMTank average for Questions 9, 10, and 12 was above 4, "Agree" on the 5-point Likert scale. So, a likely reason STEMTank participation did not illicit a change across cultural competencies embodied by these questions is that students entered the program already feeling capable in these areas, and there was not much room to grow.

As stated in the Results section, Questions 6 and 8 met the statistical testing threshold and rejected the null hypothesis with a positive signal significant to $P < 0.0833$ and $P < 0.1397$, respectively. So STEMTank and its embedded VE did have a statistically significant influence on participants' cultural competency in these areas. Looking at Figure 7, Q6 and Q8 are the lowest entry values on the survey, both below 3.5. Not surprisingly, both these questions relate to student experiences interacting with counterparts from other cultures. Recall from the literature review that students strong in STEM tend to be weakest in global experience. Moreover, these U.S. students hail from under-resourced communities and perhaps have never had an opportunity to travel internationally or work with students from other parts of the world. Thus, a possible reason for the strong positive signal associated with these two questions is that STEMTank represents the first time many U.S.

participants worked closely with international collaborators. STEMTank may have supplied their first tangible opportunities to learn about a different culture through VE interactions with Filipino UCU faculty and students. Moreover, it provided a first opportunity to explore etiquette and rules around verbal and/or nonverbal communication with Filipinos.

During analysis, the authors noted that Question 14 was an anomaly. The question was asked in an unusual way, eliciting a negative response as the desired trend got stronger. This question met the statistical testing threshold and rejected the null hypothesis with a negative signal significant to $P < 0.1404$. Students were asked if groups produce better results when their members all see things the same way. As the result of exposure to an open-ended engineering design process (where creativity and divergent thinking are valued) with embedded VE designed to expose participants to a different culture's ideas, it is hoped students would feel less strongly about the statement in Q14 than before exposure. This outcome is precisely what was observed. This result can, therefore, be interpreted as STEMTank generating in participants a stronger belief in the value of varied viewpoints, perspectives, and ideas.

In addition to the positive benefits of STEMTank participation illuminated quantitatively and statistically by the pre/post survey results, much anecdotal evidence exists to show participants had beneficial experiences. As shown in Figure 8, high school students worked hands-on with college faculty and mentors to carry out a unique, memorable, and engaging experience that provided a sense of what it feels like to be a college engineering major.

Fig. 8: Participants work with college faculty (right) and STEMTank college student mentors (left) at the large wind tunnel to prepare full-scale models for testing.

For some of STEMTank's low-income and/or potential first-generation college students, STEMTank might be the only pre-college access to higher education they experience before deciding to apply and attend a higher education institution. The STEMTank connections participants made were valuable, transcended the program, and paid dividends for the future. For example, STEMTank's UF lead instructor has written scholarship and college admission recommendation letters for STEMTank participants, and STEMTank alumni students who matriculated into UF have joined his laboratory as undergraduate research students. Mentors maintain their connections with mentees beyond the program's conclusion, providing valuable insight on the college application and selection process from the vantage point of someone who recently navigated the process. STEMTank has even formed a LinkedIn community for alumni, mentors, instructors, and Sharks. UCU faculty have also joined this community, which provides professional networking opportunities that transcend the STEMTank experience itself.

Finally, STEMTank 2023 participants had the opportunity to visit a unique facility: UF's 120' x 20' Boundary Layer Wind Tunnel at the Powell Family Structures & Materials Laboratory. As shown in Figure 9, participants were allowed to stand in the tunnel as it was ramped up to full wind speed to experience for themselves what hurricane-force winds feel like on the body. This memorable experience instills in them excitement and curiosity for STEM and will hopefully elicit some to consider engineering majors and careers when they might not otherwise have made this choice.

Fig. 9: Participants stand in the large wind tunnel experiencing the feel of high-speed wind.

Conclusions

Santa Fe College (USA), the University of Florida (USA), and Urdaneta City University (Philippines) collaborated to deliver for participants a VE component in STEMTank 2023, a pre-college access summer program for high school students from under-resourced communities. STEMTank incorporated LIFT pedagogy to instill resilience in participants, but it is recognized that STEM students lack intercultural competency. This critical experience gap was closed by challenging U.S. and Filipino high school students to collaboratively design structures resilient to tropical cyclones that affect both regions. The program fostered a reciprocal exchange of cultural insights.

The programmatic methods employed; including daily virtual lectures, asynchronous cultural competency modules, visits to host colleges for hands-on experiences, and structured synchronous VE sessions; facilitated effective communication and collaboration among participants from different countries and cultural backgrounds. Pedagogically, the results of a participant pre/post survey indicated a positive impact on participants' cultural competency in specific areas. While not all cultural competence questions showed significant changes, the statistically significant improvements in U.S. participants' understanding of different cultures, knowledge of communication etiquette in the Philippines, and recognition of the value of diverse perspectives are noteworthy given the program's short time (3 weeks) and small population (N = 10) for which data are available. While students who entered the program with higher baseline levels of cultural competency did not show significant changes, students with lower cultural competency did experience growth. This observation suggests that the international component of STEMTank may have been particularly beneficial for students with limited prior exposure to global experiences.

In conclusion, the STEMTank 2023 program, enriched by incorporation of a VE with UCU, successfully addressed the need for more multicultural and international elements in STEM pre-college access programs. The program provides a valuable model for future engineering VE initiatives involving high school participants. The positive outcomes observed suggest that such initiatives can contribute significantly to preparing the next generation of STEM professionals for global challenges and international collaborative opportunities.

Acknowledgements

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Appendix: Cultural Competence Pre/Post Survey Questions

1. I am aware of my own biases and how they affect my thinking.
2. I assess my strengths and weaknesses in the area of diversity and try to improve myself.
3. I assume good intent and ask for clarification when I do not understand what was said or implied.
4. I connect easily with people who look different from me and am able to communicate easily with them.
5. I actively seek opportunities to connect with people who are different from me and seek to build rapport with them.
6. I have access to first-hand opportunities to learn about a culture different than my own.
7. I know some of the cultural traditions of the Philippines.
8. I know some of the etiquette and rules around verbal and/or nonverbal communication in the Philippines.

9. When talking to people from another country I try to see things from their point of view.
10. I like to ask people questions to better understand how they think and what they value.
11. I am confident that I can produce work with people from other places around the globe.
12. I can work productively with people whose cultural background is different from mine.
13. I am able to adjust to new people, places, and situations.
14. Groups usually produce better results when they are made up of people who all see things the same way.

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