CPR for ALL

A Low Cost CPR Training & Feedback Device For Low Resource CPR Training Programs

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Figure 1

Motivation

Bystander CPR training primarily uses high quality mannequins in order to simulate anatomically-correct CPR procedures. However, these mannequins can be expensive, making it difficult for some organizations to afford them [1]. As a part of our INFO 6940 Participatory Design & Making course at Cornell Tech, we partnered with 4 Weill Cornell Medicine emergency physicians to develop a low cost version of a CPR training model that can be used by the Pakistan Life Saver's Program (PLSP), a low-resource CPR training program in Pakistan responsible for providing CPR training to school children nationwide [2] (Figure 1).

Background

We were challenged to build a low cost version of a CPR model that correctly simulates chest compression necessary to train the public in high quality CPR. The PLSP is a non-profit organization that improves access to CPR training in Pakistan and is now responsible in part for conducting these training programs in schools with 6th-12th grade students [2]. PLSP has limited high quality CPR mannequins and has pillows available for each trainee to serve as CPR training devices. Our goal was to build an affordable, easy to reproduce, and scalable CPR training model to replace these pillows for the new CPR school curriculum.

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Methods

We conducted user interviews, empathy mapping, rapid prototyping and iterative usability testing to refine the scope and design of our digitally-fabricated CPR training model.

User Interviews & Empathy Mapping

We interviewed 4 Weill Cornell Medicine emergency physicians to learn more about their experiences learning CPR, training medical students in CPR, what types of mannequins or other technologies they used in their training sessions, and how to deliver high quality CPR. Next, we completed an empathy mapping activity to consider how a 6-12th grade student would think, feel, communicate, and do when receiving CPR training in a school environment. We concluded that our final CPR training model should aid in building student's confidence in administering CPR, increase their engagement with the CPR model, and help them monitor their own CPR compression depth and rate.

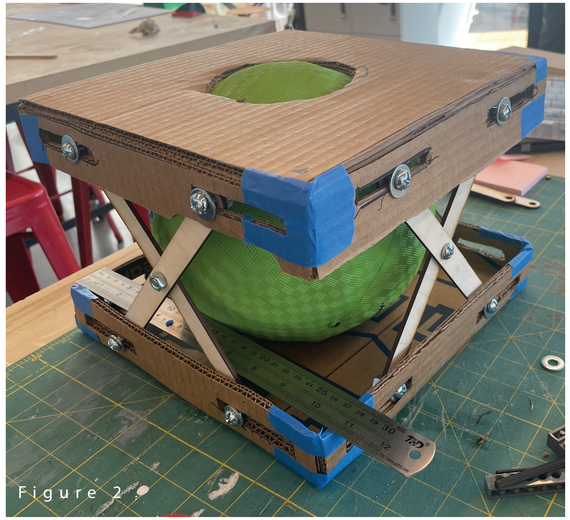
Figure 2

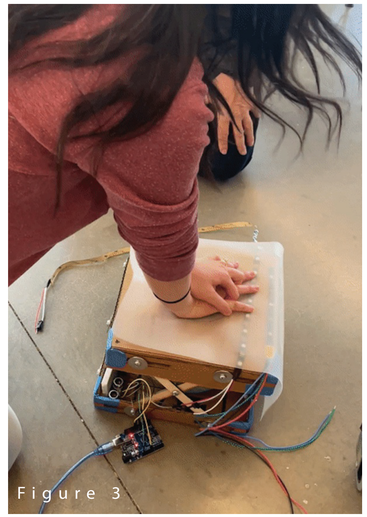
Figure 3

Rapid Prototyping & Usability Testing

To develop a prototype quickly and cheaply, we used a standard kickball as our design's cardiothoracic volume. We built a cardboard ball-holder that served to secure the kickball's movement and compress the ball. We attached stabilizing crossmembers to distribute compression force and minimize wobble. We laser-cut a wood panel to quickly make and test our initial ball-holder idea, using nuts, bolts and washers in our makerspace (Figure 2). We conducted iterative usability tests with one Weill Cornell emergency physician, one medical student, and two FDNY firefighters who served as CPR-certified trainers for the general public to ensure that its compressions and performance accurately simulated compressions on a human body (Figure 3). We received positive feedback and additional suggestions to consider portability, storage, and durability that we took into consideration in our final making process.

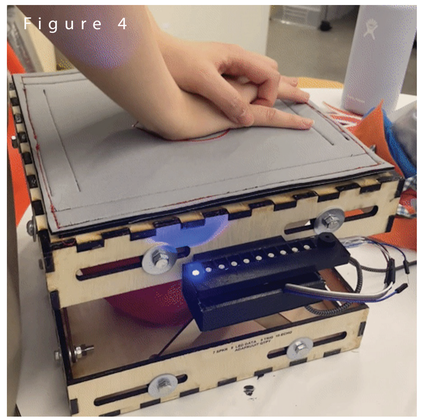
Figure 4

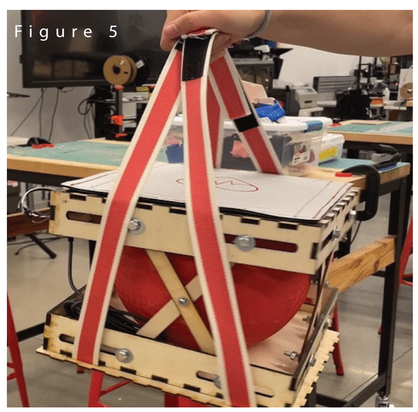
Figure 5

Digital Fabrication: Laser Cutting, 3D Printing, Electronics

Our final design is a compartmentalized, affordable, and adjustable CPR compression-only training model that provides immediate compression depth and rate feedback via a buzzer and LEDs (Figure 1 & 2). We used a kickball, laser-cut wood boxes to hold the kickball, laser-cut stabilizing crossmembers attached with nuts, bolts and washers, and a mountable 3D-printed electronics-holder to simplify and steady the ultrasonic depth sensor, microcontroller, buzzer, and LED strip that comprises the feedback system. Our final model includes a removable, laser-etched neoprene fabric cover to provide hand placement direction (rib cage) and to minimize injury to hands while practicing CPR compressions on our model. To make our model portable and scalable for CPR programs in schools, we created a laser-cut carrier platform that includes straps for easy transport (Figure 4).

When a user compresses our design, an LED strip informs them on the depth accuracy of their compressions: yellow means 'not deep enough', green means the depth is correct (2-2.5inches), red means 'too deep', and blue signifies that they have allowed the model to fully recoil post-compression, which is essential for administering high quality CPR (Figure 4). The buzzer will also trigger when they compress at the correct depth. Our use of a kickball, laser-cut box and neoprene fabric correctly simulate the pressure and recoil of a human chest when performing real CPR, as commented by emergency medicine physicians and CPR-certified trainers in the FDNY.

Results & Takeaways

We've created a portable, affordable, and adjustable CPR compression training device that provides quick feedback for students of any age and expertise (Figure 1). To address affordability, we used physical materials like wood, fabric, cardboard and a standard kickball that would be accessible in a variety of areas around the world, and materials accessible in a standard makerspace. Our CPR training model will cost ~$80 USD, but may be cheaper depending on adjustments and different markets in developing countries such as Pakistan. Our design can be easily customized and replicated to accommodate different ball sizes using our Instructables project [3]. We hope to improve our design by increasing the sensitivity of the depth sensor to provide more accurate compression feedback.

Conclusion

In conclusion, we partnered with Weill Cornell Medicine emergency physicians to develop a low cost version of a CPR training model that can be used by the PLSP, a low-resource CPR training program in Pakistan responsible for providing CPR training to school children nationwide. Using rapid prototyping techniques, usability testing, and digital fabrication methods, we created an affordable, reproducible CPR training model that provides immediate feedback on chest compression depth and rate.

References

[1] Hoskins, D. S. (2016). "CPR Training: Time for a Change". Journal of Emergency Medical Services, 41(8), 46-53.

[2] https://propakistani.pk/2022/06/21/cpr-traiing-will-now-be-mandatory-at-all-educational-levels/

[3] CPR for All Instructables →