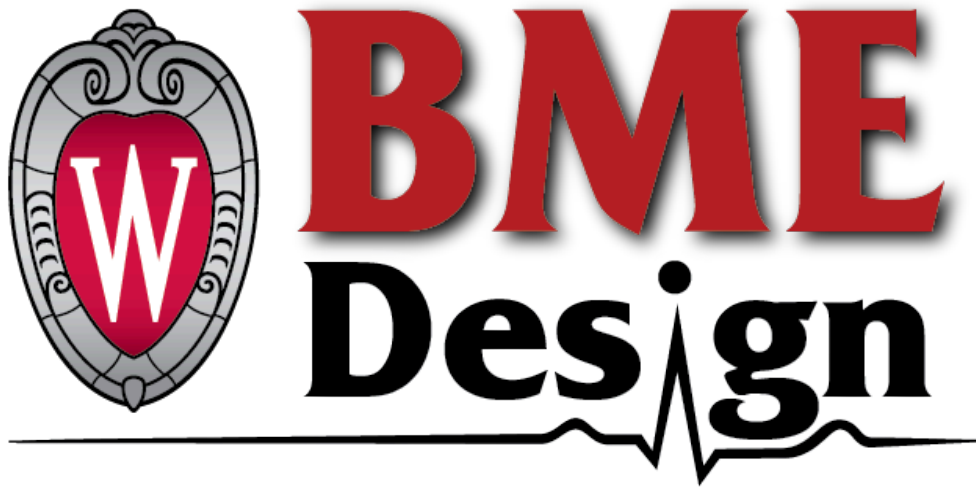




BME Design
The Design Matrix
of
3D Pelvic Floor Training Model
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Scoring Criteria

Play-doh adhesion (30%) - Measures how effectively play-doh adheres to the model's surface throughout the muscle layer construction process without slipping or sliding off, while still allowing for a clean and easy removal following classroom instruction. Adhesion of play-doh carries the highest weight (30%) because building the muscle is the primary requirement specified by the client. If the play-doh does not stick, the model loses its educational purpose. A high score (5) indicates that the play-doh grips securely during muscle construction and removes cleanly after. A low score (1) means the play-doh falls off during application or leaves permanent residue on the model.

Longevity (20%) - Refers to the structural durability of the model over a 3-5 year target lifespan, specifically the ability to resist student grip forces up to 623.9 N and accidental drops from table height (0.75 m) [1], [2]. Longevity is rated at 20% because models will undergo frequent repeated handling each year, and a fragile design would result in failure before the target lifespan is reached. A high score (5) indicates the structure survives frequent impact and handling without failure. A low score (1) means the model shatters or breaks easily from expected use or table drops.

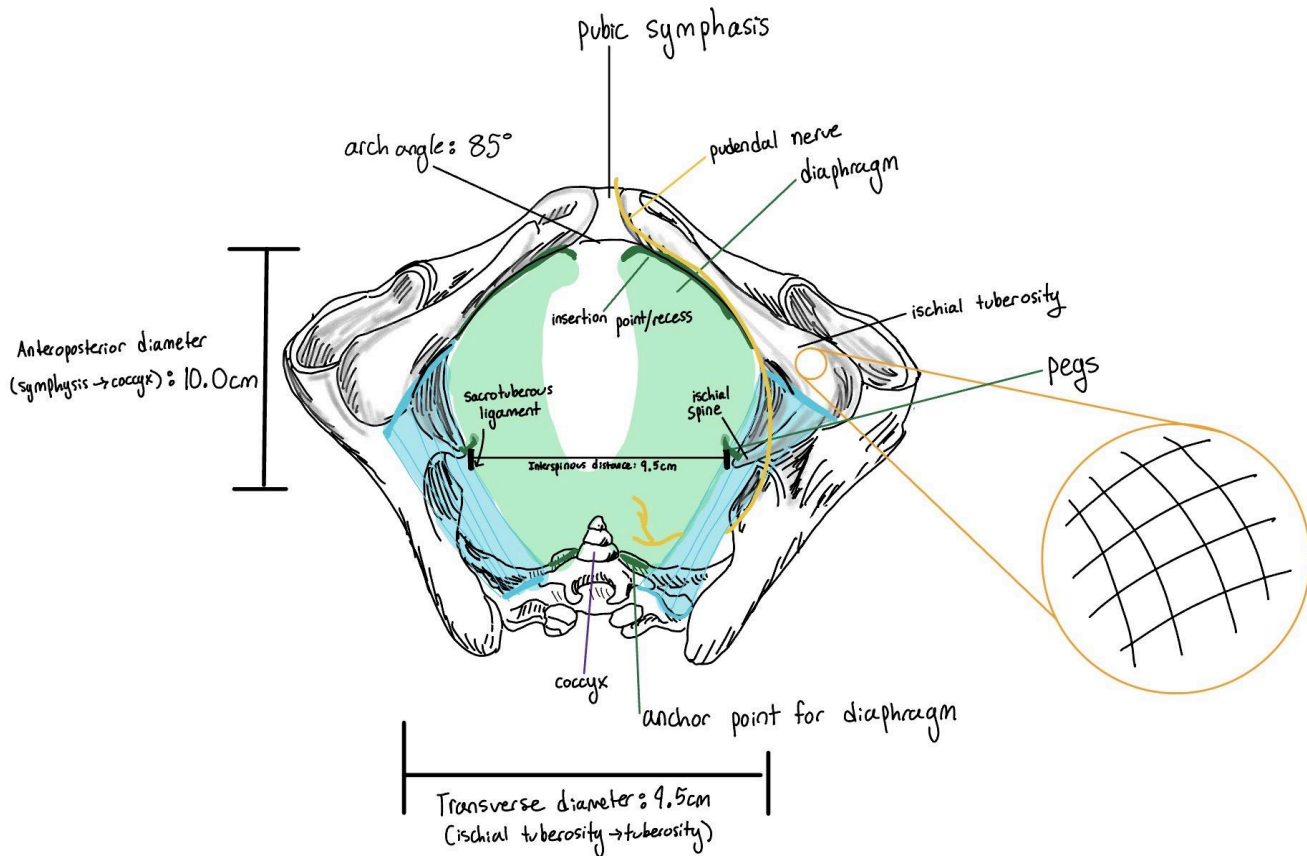
Ease of Fabrication (15%) - Evaluates overall ease of printing and any following work needed to create 30 models. Ease of fabrication is weighted at 15% because 30 models will need to be produced within one semester, making efficiency important. A high score (5) means the design prints quickly with minimal work required after. A low score (1) means long print times, complex assembly, or significant manual work following the printing process, making it difficult to produce the desired 30 models in the time required.

Anatomical Accuracy (15%) - Measures how accurately a design reflects key pelvic landmarks—including the ischial spines, ischial tuberosities, distal sacrum, and greater sciatic notches (within ± 2 mm tolerance)—as well as whether the overall dimensions and subpubic arch angle (85°) represent an average between male and female anatomy [3], [4]. Anatomical accuracy is weighted at 15% because PA students need a realistic 3D anatomy on which to construct both male and female pelvic floors. A high score (5) means landmarks are accurate and clear, with a subpubic angle appropriate for interchangeable perineal membranes of either gender. A low score (1) means landmarks are missing or inaccurate, making the model less helpful for teaching.

Cost Effectiveness (10%) - Evaluates material and printing cost per model in reference to our \$3-7 per model budget (\$100-200 total for 30 models). Cost is weighted at 10% because while staying on budget is important, common printing filaments (such as PLA) are fairly cheap. A high score (5) means the cost per model is easily within \$3-7, while a low score (1) means the cost per model significantly exceeds the budget.

Safety & Ease of Cleaning (10%) - Evaluates user safety, including toxicity of materials and dangerously sharp edges, as well as how easily play-doh can be wiped off between uses. A weighting of 10% was assigned because up to 2 students may handle a singular model during a class, so the model should be safe for skin contact and easy to clean with standard sanitizing wipes without leading to trapped bacteria or molding. A high score (5) means surfaces that can be easily cleaned without trapping residue. A low score (1) means sharp edges that could harm a user or pores that trap play-doh.

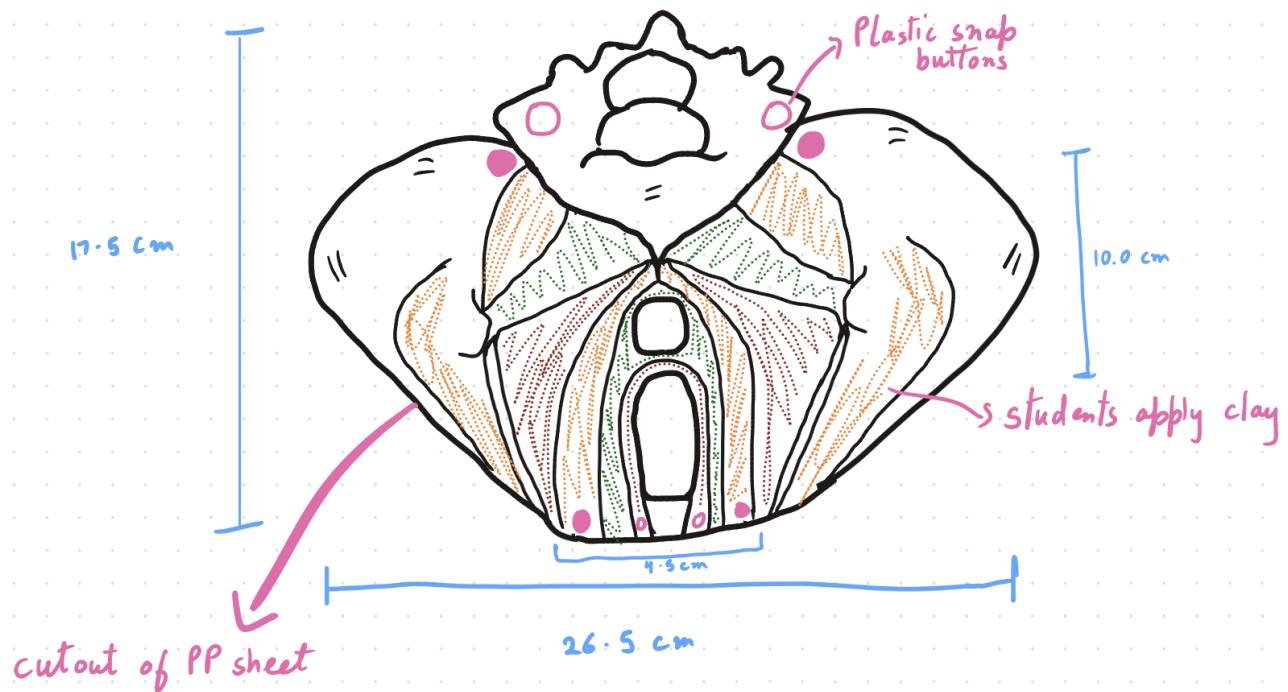
Design 1: Surface Texture and Diaphragm Shelf



The Surface Texture and Diaphragm Shelf design features a 3D-printed pelvic framework engineered to withstand and support students building tissues made out of PlayDoh. The pelvis itself is a simplified model, removing the broad iliac crests while preserving core landmark anchors including the sacrum, coccyx, ischial tuberosities, and ischial spines to optimize access to the pelvic floor. All structures will be designed using the average anatomical dimensions of male and female pelvises, resulting in a gender-neutral, multi-piece pelvis model. To enhance PlayDoh and modeling clay adhesion during student builds, the outer surface of the framework includes a scoring texture across the exterior.

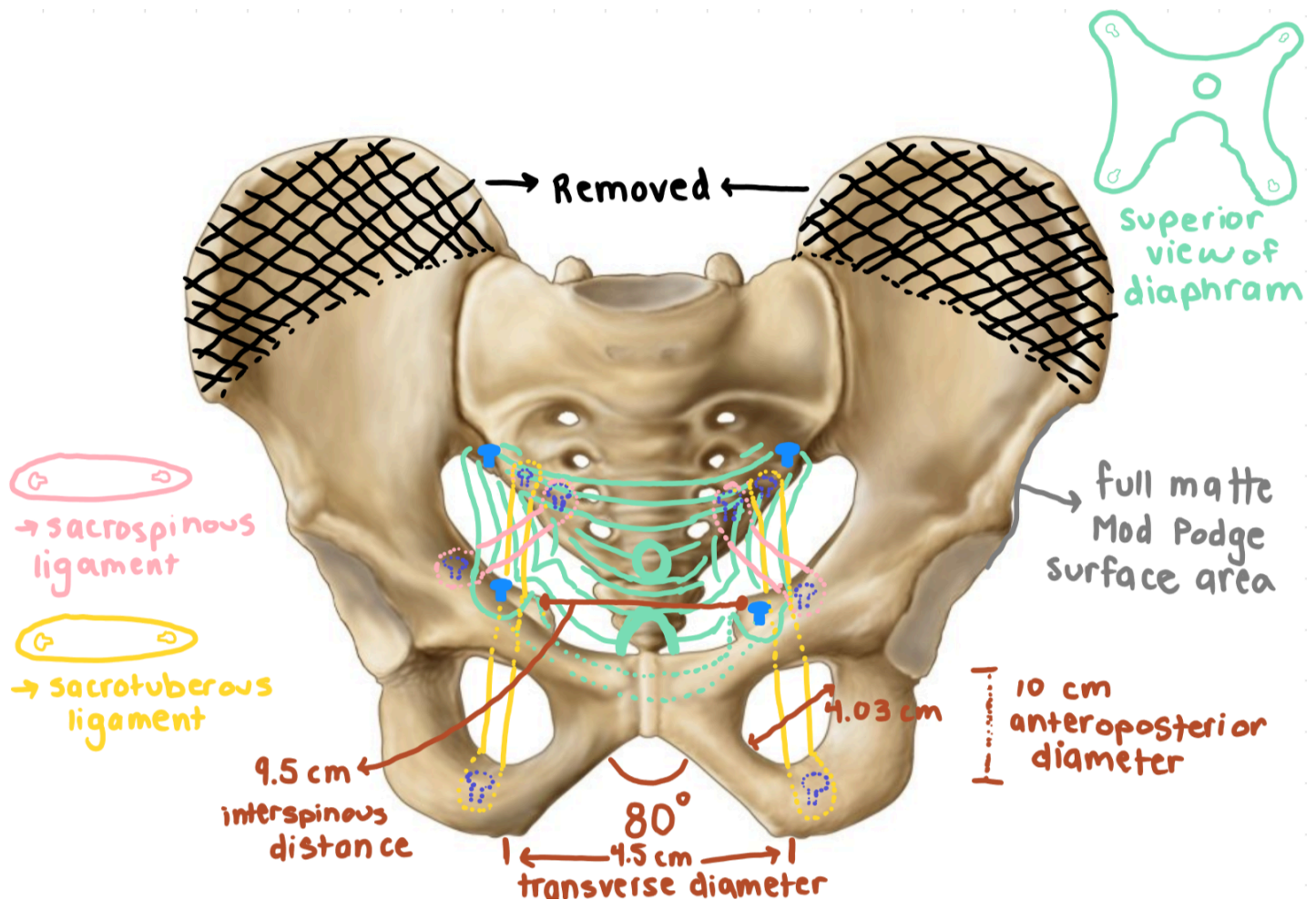
To facilitate layered tissue construction, the design incorporates a removable, flexible diaphragm shelf that locks into position using a slot-and-recess mechanism. The diaphragm features insertion points along the edge of the ischial tuberosities that allow it to click or slide directly into matching recesses on the model, anchored posteriorly near the coccyx. Additionally, sacrotuberous ligaments are integrated using a similar recess, enabling students to manually insert and snap them into place over the ischial spines. This removable diaphragm allows students to build individual pelvic floor muscles while providing a rigid structural shelf that prevents modeling materials from collapsing into the pelvic outlet during subsequent membrane builds.

Design 2: Foldable with Snap Buttons



The Foldable with Snap Buttons design features a 3-D polypropylene pelvic outlet model engineered to provide an anatomically accurate framework for anatomy students to construct each layer of the pelvic floor using PlayDoh. The pelvic outlet model consists of a set of polypropylene sheets that snap together with buttons to create a convex pelvic outlet. When separated, the individual polypropylene sheets lay flat and stack easily, aiding with storage and transportation between classrooms. When buttoned together, the polypropylene sheets create a 3-D pelvic outlet model that allows students to better understand pelvic floor anatomy through the workshop. The pelvic outlet is a simplified model, with no major 3-D forms other than the general pelvis shape. The polypropylene sheets are easily cleanable, waterproof, virtually tear-proof, handles clay and PlayDoh without staining or degradation, and folds without cracking. The snap buttons are durable, waterproof, user friendly, and need no special training to use.

Design 3: Pegs with Attachments



In the Pegs with Attachments design, there are 6 pieces total: a 3D printed pelvis, a flexible pelvic diaphragm, 2 flexible sacrospinous ligaments, and 2 sacrotuberous ligaments. The outer surface of the model will be coated with matte Mod Podge spray, allowing for better Play Doh adhesion onto the 3D printed surface. The pelvis is a simplified model, with the iliac crest sections superior to the proximal end of the sacrum removed. To allow the attachment of the diaphragm and ligaments, there are pegs on the pelvis surface. The pegs have a thick base and a wider head for durability, and are 3D printed as one structure with the pelvis. Each of the flexible ligaments and diaphragm will have attachment holes at the ends with a wide and a narrow section to allow application and removal of the structures from the pegs. The diaphragm will be shaped like an 'X', having 4 attachment sites on each corner, as well as an inlet and a hole to allow students to scaffold the male or female anatomy. Finally, all structures will adhere to an average of male and female anatomical dimensions, creating a gender-neutral multi-piece pelvis model.

Design Matrix Discussion

Category #1 - Design 3 was rated the highest, followed by design 1, then lastly design 2 with scores of 5/5, 4/5, and 3/5, respectively. Our main objective is ensuring the Play-Doh will adhere to the model, and the full matte mod podge surface in design 3 is the most promising when compared to design 1's texture inclusive only surface and design 2's polypropylene surface.

Category #2 - Design 1 was rated the highest, followed by design 3, then lastly design 2. Our client has expressed the importance of portability for these 30 models to and from different classrooms, so we designed models that can disassemble for ease of transportation, however, we need to ensure that continuously assembling these models will not affect the longevity of them. With that being said, the connection method of design 2 by poking holes in polypropylene could form a stress connection point, causing concern for enlargement of the hole at the connection point over time. Design 3 included attachment pegs that risk breaking if too fragile as well, but while still a concern for transportation, design 1 does not include connection joins of the main body of the model, making it the most likely to withstand continuous usage.

Category #3 - Designs 1 and 2 were rated the highest, followed by design 3. Since we are producing 30 identical models for our client, ideally we could establish the most productive way to achieve this quantity while maintaining the quality of each product. 3D printing each model would ensure precision and decrease room for human error like the fabrication method for design 2 would involve.

Category #4 - Design 1 was rated the highest, followed by design 3, then lastly design 2. Since this is an education tool for medical professionals, high anatomical accuracy is essential to ensure the 3D model is most effective. 3D printing, as used in design 1 and 3, would allow the incorporation of bony landmarks that are sacrificed in design 2 by accommodating the foldable component. Design 1 and 3 also both include built in sacrotuberous ligaments and diaphragm, increasing their anatomical accuracy.

Category #5 - Design 2 was rated the highest, followed by design 1 and 3. Different materials are used for each of the 3 designs with the most cost effective being polypropylene used in design 2. Standard 3D printing material is also relatively cost effective, but design 1 incorporates an additional material for the built in ligaments and diaphragm, while design 3 would need additional matte modge podge or sealer equivalent with additional material for the ligament and diaphragm structures to complete the design, ultimately raising the cost per unit. We are mindful of the cost in response to the quantity of models requested to produce.

Category #6 - Design 3 was rated the highest, followed by design 2, then lastly design 1. Our client mentioned a past struggle with modeling clay staining the paper 2D models and students' hands while they were completing the pelvis and perineum workshop. While we have decided on Play-Doh as our modeling medium, which is less likely to stain surfaces, we still want to ensure the staining is not a recurring issue with our models. Design 3 provides the best potential to avoid Play-doh residue on the model. The addition of a sealing coat also allows the surface to be disinfected and wiped down easily without damaging the model materials underneath. The texture of design 1 would make an easy place for Play-Doh residue to stick to, and the buttons in design 2 could also harbor Play-Doh residue, despite polypropylene being relatively easy to clean.

Winning Design

The winning design was Design 3: Pegs with Attachments, which received the highest overall score of 79/100. This design uses a 3D-printed pelvis with separate flexible pieces for the pelvic diaphragm and ligaments that attach to durable pegs on the pelvis. It scored highest because it provided strong Play-Doh adhesion (5/5), good anatomical accuracy (4/5), and excellent safety and ease of cleaning (5/5). The Mod Podge coating was expected to improve Play-Doh adhesion, while the separate diaphragm and ligament pieces allowed students to build the different layers of the pelvic floor. The design also had relatively good cost-effectiveness (3/5), although it would require 3D printing and additional materials.

One area that could still be improved is longevity, which scored only 3/5, because the attachment pegs could potentially break off with repeated use. Fabrication also scored 3/5, since the design requires adding pegs to the pelvis and creating the flexible diaphragm and ligament pieces. Overall, the design provides a good balance between functionality, anatomical detail, and classroom usability, but improving the durability of the attachment system and simplifying fabrication could make it even more effective for repeated classroom use.

Resources:

- [1] “International norms for adult handgrip strength: A systematic review of data on 2.4 million adults aged 20 to 100+ years from 69 countries and regions - PubMed.” Accessed: Sep. 24, 2026. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/39647778/>
- [2] “BIFMA G1-2013 Ergonomics Guidelines | PDF | Chair | Anthropometry.” Accessed: Sep. 24, 2026. [Online]. Available: <https://www.scribd.com/document/929848178/Bifma-g1-Ergonomics-Guideline-for-Furniture>
- [3] “Anatomy, Abdomen and Pelvis, Pelvic Outlet - StatPearls - NCBI Bookshelf.” Accessed: Sep. 24, 2026. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK557602/>
- [4] “7.7E: Comparison of Female and Male Pelves - Medicine LibreTexts.” Accessed: Sep. 24, 2026. [Online]. Available: [https://med.libretexts.org/Bookshelves/Anatomy_and_Physiology/Anatomy_and_Physiology_\(Boundless\)/7%3A_Skeletal_System_-_Parts_of_the_Skeleton/7.7%3A_The_Hip/7.7E%3A_Comparison_of_Female_and_Male_Pelves](https://med.libretexts.org/Bookshelves/Anatomy_and_Physiology/Anatomy_and_Physiology_(Boundless)/7%3A_Skeletal_System_-_Parts_of_the_Skeleton/7.7%3A_The_Hip/7.7E%3A_Comparison_of_Female_and_Male_Pelves)