Authors: Ben Bruick, Donovan Cece, Matt Prince

Lesson Plan Title: Posture Evaluation Lesson Plan

Grade Levels: 13-14

Student Prerequisites: There are no extraordinary prerequisites for this study. College students from grades 13-14 will participate using only the prior practices that they already possess, without any additional guidance. For the best results, students will ideally behave as they typically do when studying in various sitting orientations.

Estimated Activity Time: ~20-30 minutes.

Brief overview: Our study will consist of attaching two IMU sensors to our participants, one on their third lumbar vertebrae (lower back) and the other on their sternal angle (upper back). We will ask them to perform some calibration motion for us, first static for 10 seconds, then some rotation across 3 axes (right and left, forwards and back, twisting). Then we will instruct the participants to start work on their laptop or other studies as they typically would. As participants work through 3 different trials, we will be collecting the IMU data. The data is run through an analysis software, where after a few minutes we can give them a breakdown of their posture, allowing them to make conclusions about their posture over time.

Materials required:

- 2 IMU sensors
- Elastic velcro bands
- Laptop for data collection and analysis
- Desk chair
- Desk
- Couch or non-rigid lounge chair

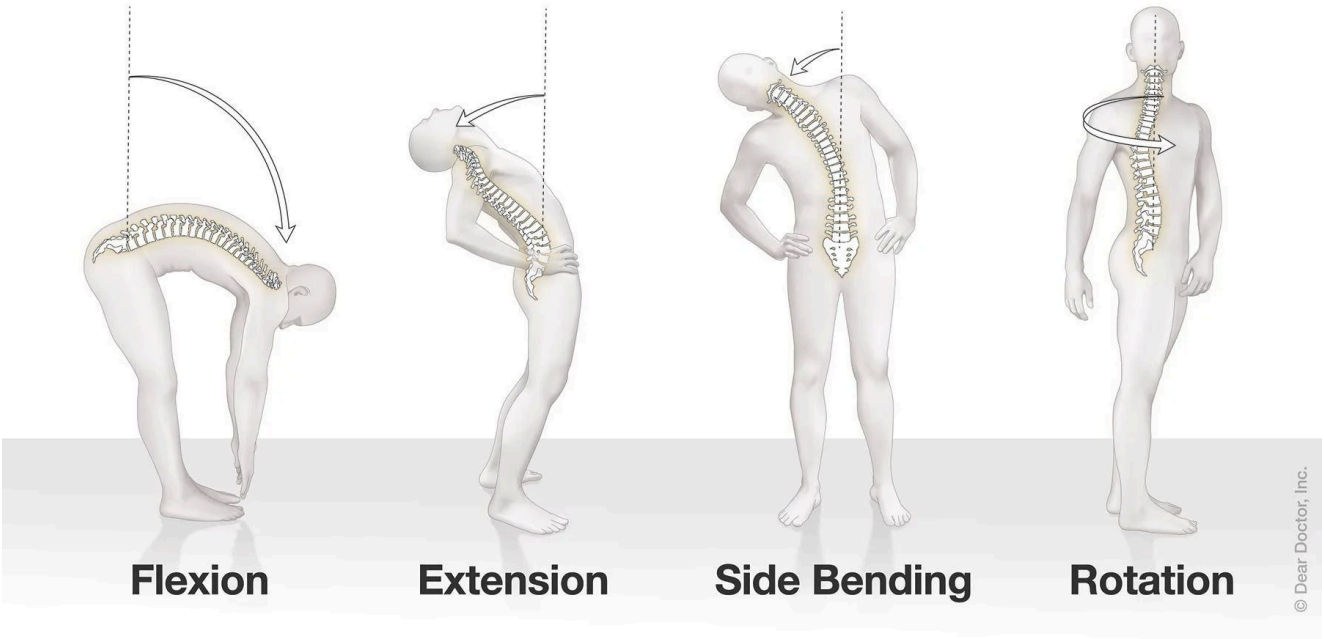
Understanding goals: Students will understand which postures promote musculoskeletal health and which are associated with risks of pain and long-term injury. The students will learn if their personal habits and common practices promote proper health.

Lesson plan objective: Students will be able to visualize their posture in a more interpretable way, and reflect on future application, to get rid of bad habits and learn new strategies for improving studying practices, as well improving their workspace ergonomics.

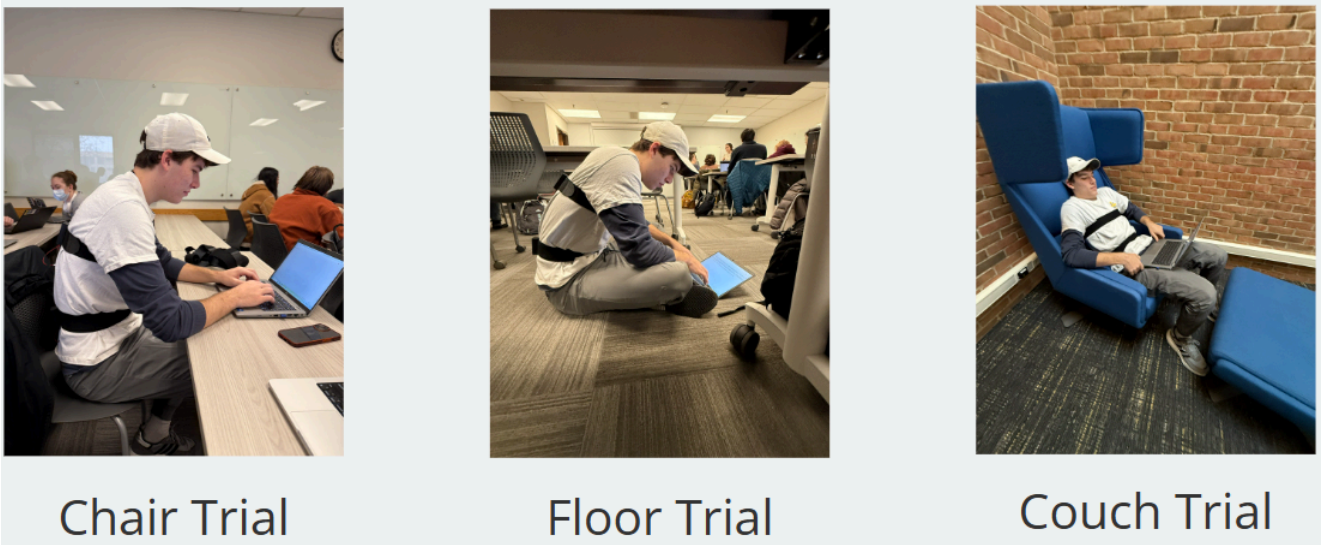
Lesson plan procedure:

1. Give a brief 5 minute presentation on the health impacts of posture, drawing from studies linking Forward Head Posture to headaches, neck pain, and mood disturbances [5][6].
2. Explain the study procedure and the importance of posture awareness
3. Attach 2 IMU sensors onto the upper and lower back of the participating student.

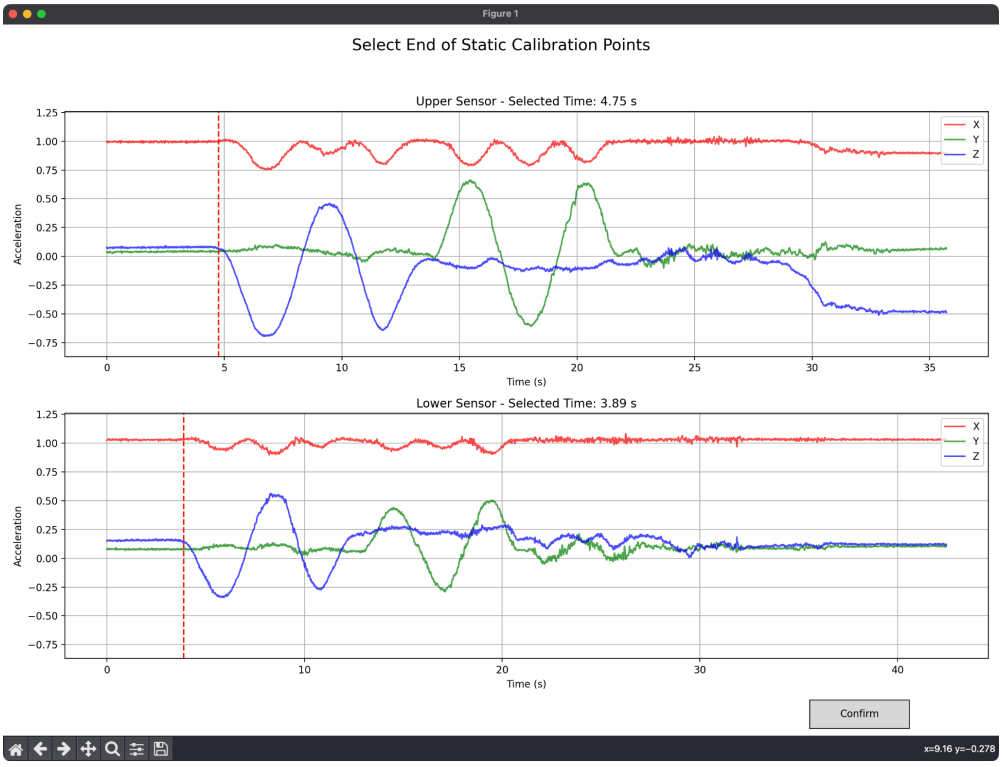
4. Record 10 seconds of static data in the upright position.



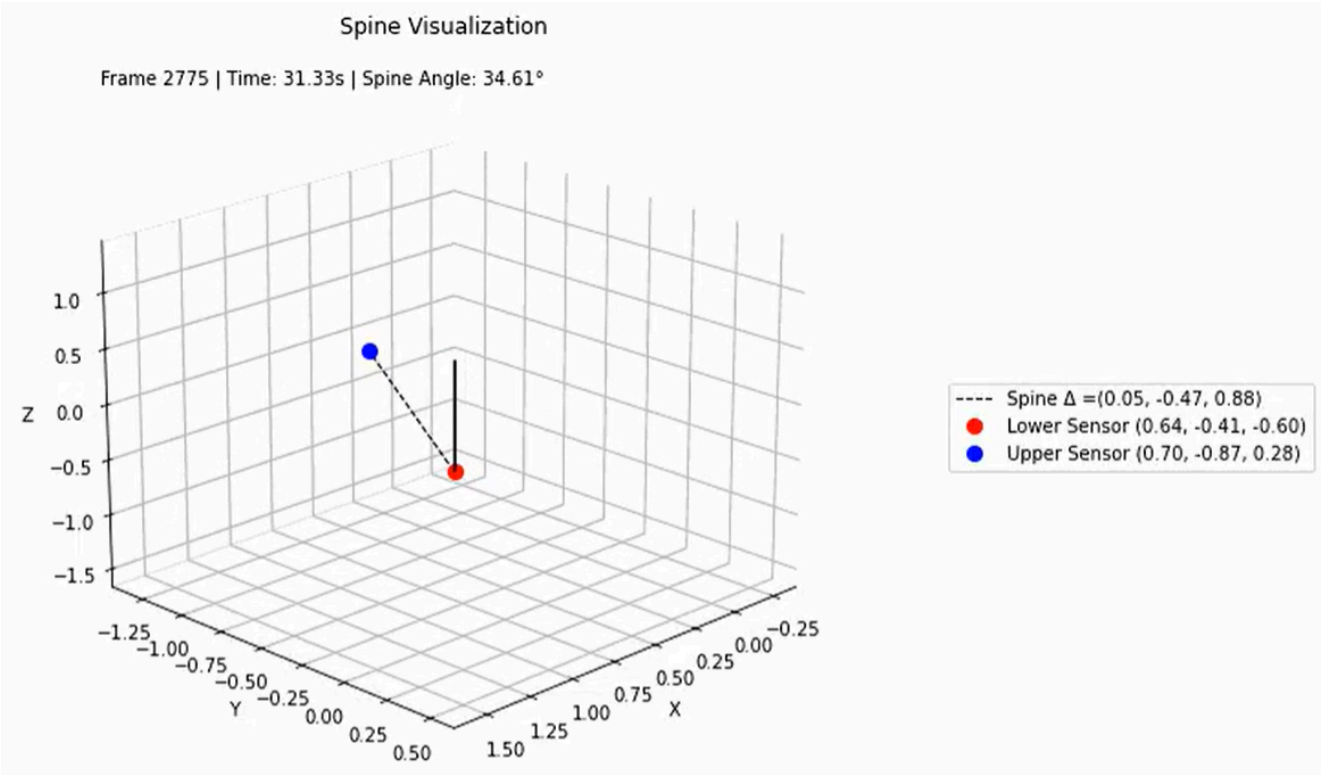
5. Record data from the 3 axes calibration motions (side bend, forward lean, twist).
6. Ask the student to begin studying for the next 5 minutes, while seated in one of the three environments (chair, floor, couch).
7. Repeat steps 4-6 for all three trials.



8. Upload data to analysis software (Python-based), perform filtering (Kalman filter), and align calibration data.
9. Analyze angles, posture profiles, and trends over time.



10. Share a visual report with the student, highlighting excessive spinal flexion or poor postural habits.



11. Advise on how the student could improve their posture with evidence-based ergonomic tips such as seat height adjustments and timed breaks, and reiterate the health effects of poor posture.
12. Perform a small survey asking questions on the student's understanding of the study, what steps they could seem themselves taking to improve, and their understanding of how that data is captured using IMUs.
    a. Example Survey Questions:
        i. How did your posture change over time during the study?
        ii. Did you expect your posture to be better or worse?
        iii. How can you adjust your study environment based on your results?
        iv. How did you understand the sensors used during the experiment?
13. Send them on their way with some take-home resources on good ergonomic practices and a hopefully increased awareness of their personal ergonomics.

Lesson plan assessment: The ultimate goal is to make sure that students are aware of the consequences of bad posture, and have the knowledge to correct themselves and inform others. We will ask a series of questions in the form of a survey after the study to both simultaneously assess their understanding of our experiment, and get a sense of how they might see this new information they learned play out in their regular life. In addition, while participants will already be enrolled college students, there is potential that this study will inspire interest into the field of sensing and health science, which we will have related questions in the post-study survey to measure that as well.

References:

[1] C. Wiesener *et al.*, “Supporting front crawl swimming in paraplegics using electrical stimulation: a feasibility study,” *Journal of NeuroEngineering and Rehabilitation*, vol. 17, no. 1, Apr. 2020, doi: https://doi.org/10.1186/s12984-020-00682-6

[2] Y. Elkaim, “Yuri Elkaim,” *Yuri Elkaim*, May 27, 2016. Available: https://yurielkaim.com/sitting-health/. [Accessed: Apr. 15, 2025]

[3] Alabama State Chiropractic Association, *Spine Movements*. 2024.

[4] Arpita Mallikarjuna Kappattanavar, H. Freitas, B. Arnrich, and E. Bottinger, “Position Matters: Sensor Placement for Sitting Posture Classification,” pp. 1–6, Nov. 2020, doi: https://doi.org/10.1109/ichi48887.2020.9374328

[5] L. Samuel T., T. Cynthia, D.-H. Meredith, R. Mark, A. David I., and I. Debi, “Impacts and Attitudes of Posture on Daily Function, Disability, and Psychological Measures in College Students,” *Journal of Musculoskeletal Disorders and Treatment*, vol. 9, no. 2, Jun. 2022, doi: https://doi.org/10.23937/2572-3243.1510124. Available: https://clinmedjournals.org/articles/jmdt/journal-of-musculoskeletal-disorders-and-treatment-jmdt-9-124.php?jid=jmdt#:~:text=Forward%20head%20posture%20(FHP)%20is. [Accessed: Oct. 06, 2023]

[6] Instituto Maxilofacial, “Bad posture and its effects on the maxillofacial area,” *Instituto Maxilofacial*, Apr. 07, 2022. Available: https://www.institutomaxilofacial.com/en/2022/04/07/bad-posture-and-its-effects-on-the-maxillofacial-area/

[7] W. Shirouchi, S. Ishii, and S. Yamamoto, “Effect of different seat heights on lumbar spine flexion during stand-to-sit motion,” *Journal of Physical Therapy Science*, vol. 34, no. 1, pp. 7–12, 2022, doi: https://doi.org/10.1589/jpts.34.7

[8] S. Tahernejad, M. Razeghi, M. Abdoli-Eramaki, H. Parsaei, M. Seif, and A. Choobineh, “Recommended maximum holding time of common static sitting postures of office workers,” *International Journal of Occupational Safety and Ergonomics*, pp. 1–15, Jun. 2022, doi: https://doi.org/10.1080/10803548.2022.2085418