Instructional Design for Augmented Reality (IDAR)

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Student: _5th – 8th Grade Science Students
Topic: Image-Based AR for Science Worksheet Enhancements

1. Analysis (10pts)

- Grades 5-6.

Needs assessment :

CPALMS is the State of Florida's official source for standards requirements for instructional resources in K-12 education (About CPALMS, n.d.). According to CPALMS standard SC.6.L.14.5, students performing science proficiency should be able to investigate, experiment, organize data and analyze information. Proficiency in scientific knowledge is evaluated in five achievement levels: Level 1 lowest – Level 5 highest (CPALMS Depth of Knowledge Rating).

During students' years in 5th grade through 8th grade, students in lower proficiency proficiency districts may be lacking quality access to Florida's standards-based science topics. Out of 201,809 8th graders, statewide science assessments in Florida, 45% of students performed at a level 3 (proficient) or above in 2024. Fifty percent of 5th graders scored at level 3 or above science proficiency.

Middle School Science Performance in Duval County School District, Florida

- A needs assessment in a 6th grade science class at Matthew W. Gilbert Middle School in Duval County Florida (2021-2022 Schoolwide Improvement Plan, n.d.) indicated students who were not proficient in the Nature of Science tested 17% lower. It was determined that many students at the middle school entered the 7th grade without receiving quality standards-aligned instruction in science.
- Planned actions towards improving pedagogy in 6th grade science included implementing practice to support differentiated learning for all students. Another plan for improvement in science includes effectively providing opportunities for students to bridge their scientific knowledge with hands-on demonstration of skills at appropriate levels of rigor.

Differentiating Instruction:

- When differentiating instruction in the classroom, teachers develop learning experiences that enhance instructional elements (Kilban & Milman, n.d.). A differentiated element that can be addressed is the learning content itself and the conditions of how learning takes place amongst a variety of students with different backgrounds and abilities (Kilban & Milman, n.d.). Technology can be used to address differentiation to make learning more accessible, engaging and to maximize how students learn about a certain topic (Kilbane & Milman, n.d.).

Worksheet use in K-12 Education

- Worksheets are a common tool used in K-12 instruction to construct knowledge by giving students the opportunity to fill-in blanks or gaps. (Lee, 2014)
- Guided worksheets provide representations of information that can be recalled and allow students to interact with the lecture content (Sujarittham et al., 2016). Worksheets provide structure for students to focus on the most relevant concepts.

Limitations of Worksheets

- During an activity, worksheets can help learners organize observations and knowledge, however there are some limitations to using worksheets in science learning (Lee, 2014). Limited time allotted to teach science in the school day (approximately 30 minutes) in the school day minimizes teachers' ability to support students in exploring topics in science (Kerawalla et al., 2006).
- In some cases, worksheet formatting (i.e. layout, text, language) may not promote conceptual understanding of concepts and support students to independently engage in active inquiry (Lee, 2014). Because paper worksheets cannot represent content in a multimedia format, it may be difficult for students to learn and apply concepts.

Augmented Reality (AR) and Image-based AR in Worksheets

- AR may be used to overcome the contextual limitations of paper worksheets (Zhang et al., 2020). Learning targets can be overlayed in worksheets to provide real-time information to enhance teacher-guided instruction (Zhang et al., 2020).
- In image-based AR, a 3D object can be detected with markers from a real-world image by using a web camera on a device (Cheng & Tsai, 2013). This technology allows users to manipulate objects and understand the structure of virtual objects, enhancing special and conceptual understanding (Cheng & Tsai, 2013).

Augmented Reality (AR) in Primary Grades (5^{th}-6^{th}) Science Learning

- Studies show that students who experienced changes in their understanding of science with the help of AR assisted inquiry, were able to manipulate 3D objects with the support of a structured learning cycle (Shelton & Hedley, 2003) .
- AR use is often teacher-guided for students to understand the inter-relationships between the science concepts and by controlling what students want to explore. Primary teachers found more student engagement in the 3D space when implementing role-play to encourage students to manipulate, explore and promote inquiry-based learning (Kerawalla et al., 2006).
- It is recommended that activity sessions with AR enhancement not be run unstructured where students explore concepts independently (Kerawalla et al., 2006). Independent science exploration with AR will not guarantee that the learning goals of a lesson will be met by primary grade students (Kerawalla et al., 2006).

Learning Cycle with Augmented Reality Worksheets (AR)

- In the context of science-based worksheets, there is a typical guided discovery learning strategy used as a cycle in three stages: exploration, concept introduction and concept application (Zhang et al.).

- The 3 stages are used in Guided Inquiry Worksheets by Palennari et al. (2019):
    - *Exploration*. Identify the learning target according to hints and guided questions by exploring features of the target and new concepts.
    - *Concept Introduction*. Refer to supplemental material about the target to clarify definitions of the learning targets.
    - *Concept Application*. Apply the definitions of the learning target to other learning scenarios.
- Augmented reality (AR) on mobile devices can potentially be used to enhance the three-stage learning cycle in worksheet applications.

2. Purpose and instructional goals (15pts)

- ***Significance and rationale for using AR***
    - *Florida State Standard SC.6.L.14.5* requires students in the 6th grade to be able to identify and investigate the general functions of the major systems of the human body (digestive, respiratory, circulatory, reproductive, excretory, immune, nervous, and musculoskeletal) and describe ways these systems interact at Level 3 performance (strategic thinking & complex reasoning).
    - Using Chromville Science AR app in this context may provide an environment for students to explore bodily functions through active object manipulation.
    - The use of AR to enhance science worksheets can be implemented to spatially explore and organize major systems of the human body with a 3D visualization tool for enhancing conceptual ideas of the body (e.g. molecule structures, skeletal system, circulatory systems) (Cheng & Tsai, 2012).
- **Measurable instructional objectives (Bloom's Taxonomy)**
    - It is essential to use AR to support meaningful investigation of the human body. Students can engage and participate in exploring the musculoskeletal system by *identifying* parts of the system, *analyzing* the functions of the system and thinking critically on how we *apply muscles* or bones for bodily motion (Akcayir & Akcayir, 2017).
        - Students will color the Chromville worksheets to openly explore parts of the body or muscular system. Scan the finished color sheet with a mobile device camera to produce a 3D image of the system.
        - Touch all the AR triggered muscle targets to define and clarify specific muscles in the body.
        - Manipulate the 3D image of the system to examine and interpret the location of each muscle in the body.

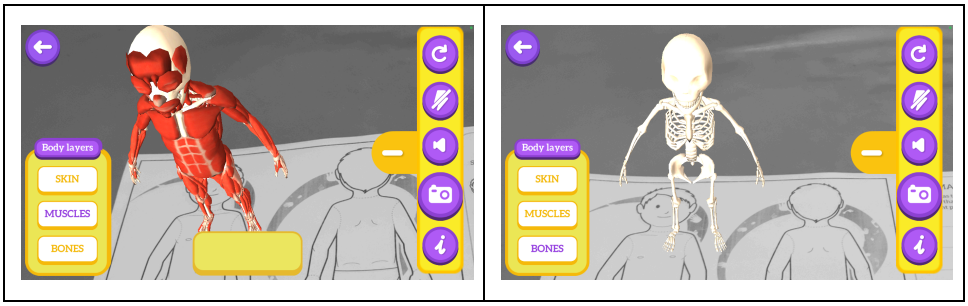
    Learning objectives:

    1. Students will be able to identify the major systems of the human body and describe their primary functions.
    2. Students will be able to explain how the body's systems interact with one another.

3. Students will be able to describe the location and function of specific muscles and bones in the body.
4. Students will be able to name and label key bones and muscles, clarifying their roles within the musculoskeletal system

3. Content (5pts)

- **Outline the unit content**
- Motion and Position of the Human Body
  - In this activity students will explore the interactions of the muscular and skeletal systems. Students will collect data based on their own body movements and identify how movement occurs through muscles, tendons, joints, or bones.
  - Musculoskeletal System Part 4 CPALMS
- Describe AR instructional materials / application that will be used in the unit.
  - The use of the Chromville Science AR app in this context will provide an environment for students to explore bodily functions through active manipulation of objects.
  - The use of AR to enhance science worksheets can be implemented to spatially explore and organize major systems of the human body with a 3D visualization tool for enhancing conceptual ideas of the body (e.g. molecule structures, skeletal system, circulatory systems) (Cheng & Tsai, 2012).
  - Chromville App Screenshots.



4. Instructional Strategies (10pts)

Before starting the mini-module, students will explore their body movements, focusing on muscles and bones. At home, they will perform simple movements like bending, stretching, or squatting and will observe which parts of the body are engaged. Following this, students will fill out an observation form detailing their insights.

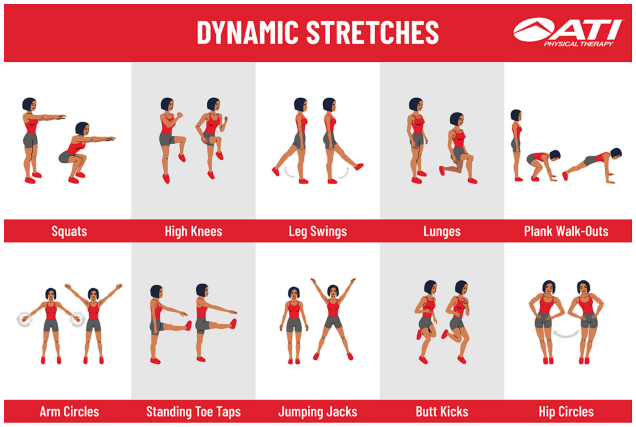
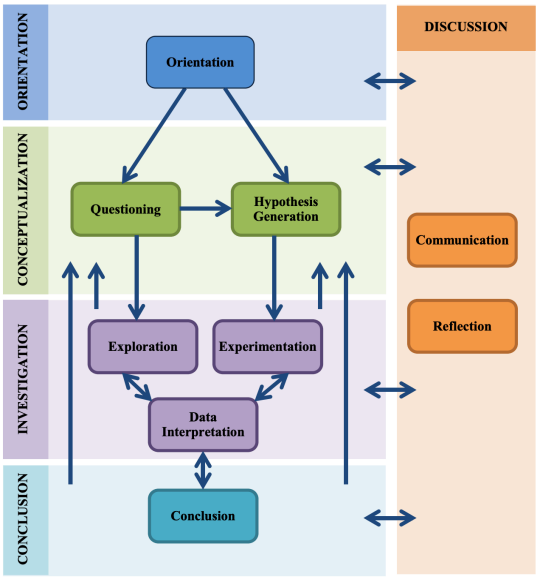


Figure 1: Example movements for observation

- **Teaching methods**

This mini-module used a revised version of the "Inquiry-based learning framework" by Pedaste et al (2015).



Orientation

- Students will explore the muscular and skeletal systems through physical body movements and interactions to get acquainted with the topic.

Conceptualization

- Students will use the AR application to visualize and clarify their understanding of how muscles, tendons, joints, and bones work together during movement.

Investigation

- Students will collect and interpret data based on their observed body movements, identifying key muscles and bones involved in various motions.

Conclusion

- Students will share their analysis and conclusions about how the muscular and skeletal systems interact, discussing their findings with peers in a small group discussion.

5. Assessment of learning outcomes (10pts)

- Formative Assessment: My Body Observation Sheet.pdf
  - Students will complete the "My Body Observation Sheet" by performing five body movements (squat, jumping jack, lunges, crunch, pushup). For each movement, they will note which body parts (joints and muscles) are engaged. This activity helps students understand the connection between muscles, joints, and bones in the musculoskeletal system.
- Summative Assessment: HumanAnatomyTestsPacket-1.pdf
  - Students will complete a multiple-choice and fill-in-the-blank assessment to evaluate their understanding of the concepts covered. This assessment will include questions related to human anatomy, focusing on identifying key terms, body parts, and their functions. Through this exercise, students will demonstrate their comprehension of the skeletal and muscular systems.

6. Follow-up Research (optional)

Analyze available follow-up research strategies/design/methods/techniques for evaluating the instructional impact of AR based learning.

Survey Study Design:

The survey study aims to evaluate students' attitudes and perceptions toward AR-based learning. Participants will be students who completed the AR-enhanced anatomy module. The survey will include Likert-scale questions assessing engagement, ease of understanding, and perceived effectiveness of the ChromeVille, with open-ended questions to capture personal experiences. Data will be collected at the module's conclusion and analyzed quantitatively for trends and qualitatively to extract insights on AR-based learning effectiveness and student satisfaction.

References:

About CPALMS. (n.d.). Cpalms.org. Retrieved September 22, 2024, from https://www.cpalms.org/CPALMS/about_us.aspx

Cheng, K.-H., & Tsai, C.-C. (2013). Affordances of augmented reality in science learning: Suggestions for future research. *Journal of Science Education and Technology*, *22*(4), 449–462.

Lee, C.D. (2014). Worksheet usage, reading achievement, classes' lack of readiness, and science achievement: A cross-country comparison. *International Journal of Education in Mathematics Science and Technology*, *2*(2). https://doi.org/10.18404/ijemst.38331

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., Manoli, C., Zacharia, Z., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational research review,* 14, 47-61.

2021-22 Schoolwide Improvement Plan. (n.d.). *Matthew W. gilbert middle school*. Duvalschools.org. Retrieved September 22, 2024, from https://dcps.duvalschools.org/cms/lib/FL01903657/Centricity/Domain/6029/2022-2023%20SIP.pdf

Kilbane, C., & Milman, N. (n.d.). *Differentiated learning and technology: A powerful combination*. ASCD. Retrieved September 22, 2024, from https://ascd.org/el/articles/differentiated-learning-and-technology-a-powerful-combination

Kerawalla, L., Luckin, R., Seljeflot, S., & Woolard, A. (2006). "Making it real": exploring the potential of augmented reality for teaching primary school science. *Virtual Reality*, *10*(3–4), 163–174. https://doi.org/10.1007/s10055-006-0036-4

Shelton, B. E., & Hedley, N. R. (2003). Using augmented reality for teaching Earth-Sun relationships to undergraduate geography students. *The First IEEE International Workshop Agumented Reality Toolkit*.

Sujarittham, T., Emarat, N., Arayathanitkul, K., Sharma, M. D., Johnston, I., & Tanamatayarat, J. (2016). Developing specialized guided worksheets for active learning in physics lectures. *European Journal of Physics*, *37*(2), 025701. https://doi.org/10.1088/0143-0807/37/2/025701

Sc.6.L.14.5. (n.d.). Cpalms.org. Retrieved September 22, 2024, from https://www.cpalms.org/PreviewStandard/Preview/1778

Zhang, J., Huang, Y.-T., Liu, T.-C., Sung, Y.-T., & Chang, K.-E. (2023). Augmented reality worksheets in field trip learning. *Interactive Learning Environments*, *31*(1), 4–21.