Multisensory Learning Method in Plant Science for Elementary School Students with Visual Impairments

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Abstract: *This paper presents a multisensory teaching approach for elementary-level plant science education designed for visually impaired students. Following Universal Design principles, we developed learning materials that combine tactile 3D models, varied textures, audio guidance, and visual elements to create an inclusive environment benefiting both visually impaired and sighted students. Our approach addresses practical challenges in teaching plant biology, including seasonal limitations and extended timeframes required for observation. By integrating VRAK (Visual, Reading/writing, Auditory, Kinesthetic) learning strategies, we make abstract concepts tangible and accessible. We discuss the theoretical framework, design process, implementation, and contributing to knowledge on inclusive educational design.*

Keywords: universal design, multisensory learning, visual impairment, inclusive education, plant science

1. Introduction

Educational technology has revolutionized learning by visualizing abstract scientific phenomena, with recent innovations like metaverse concepts providing students unprecedented access to "invisible" worlds. However, this emphasis on visual learning and accelerated digital content can marginalize "tactile awakening" and "slow learning" approaches. As a result, students with special needs, especially those with visual impairments or learning disabilities, often find themselves at a considerable disadvantage when trying to access and engage with educational materials. Metatla et al. (2018) noted that while "visuals" represent one of technology's greatest educational contributions, properly leveraging technology's characteristics can provide more appropriate teaching tools and equitable assessment methods to achieve educational equality. This paper describes a project that employs a multisensory approach to develop teaching aids for the "Plant Body" unit in science curricula for 8-9 year old students. Teaching plant biology in late autumn creates practical challenges, as most plants are entering dormancy during this season, and growing specimens from seeds to mature plants requires more than a month—often extending into winter when conditions are less favorable. Appropriate teaching aids can therefore significantly enhance students' understanding of plant biology concepts despite seasonal limitations.

2. Theoretical Framework

Our approach integrates Universal Design principles with Body Tactile Learning strategies as recommended by Professor Tseng, a special education expert on visual impairment. Burgstahler (2005) defined Universal Design for learning as "the design of instructional materials and activities that make learning goals achievable by individuals with wide differences in their abilities to see, hear, speak, move, read, write, understand English, attend, organize, engage, and remember."

The project employs VRAK (Visual, Reading/writing, Auditory, Kinesthetic) learning theory across populations to develop inclusive teaching aids that integrate knowledge, affective, and skill-based objectives. This approach overcomes limitations of season, weather, and insufficient campus facilities while providing teachers with educational materials that support both itinerant teachers for visually impaired students and frontline inclusive education teachers.

3. Design and Development

The project builds upon previous teaching strategies while adding "kinesthetic tactile" elements through multi-material models with positioning cognition for model assembly. Key technologies employed include:

1. **Enhanced Tactile Materials:** Rich surface textures with pronounced height differentiation and three-dimensional elevated printing using multiple materials.

Figure1
Example of tactile illustration

2. **Disassembly 3D Models:** Modular plant components that can be assembled and disassembled to understand structural relationships.

Figure2
3D Models

3. **Complete Audio Guidance:** Voice narration of all content to support independent learning.

Figure3
Interactive device

4. Preliminary Findings

Initial classroom testing indicates positive reception from both teachers and students. Visually impaired students demonstrate enhanced comprehension of plant structures through the tactile models, while sighted students benefit from the multisensory approach by developing deeper understanding than traditional visual-only methods.

The audio guidance component proves particularly valuable for independent exploration, allowing visually impaired students greater autonomy in their learning process. Teachers report increased engagement across the entire classroom and note that the physical manipulation of plant components improves retention of structural knowledge.

5. Conclusion

Our project demonstrates how Universal Design principles can be effectively applied to natural science education in inclusive settings. The multisensory approach not only accommodates the needs of visually impaired students but enhances learning for all students through engaging, hands-on experiences. Future development will include expanded subject coverage and longitudinal studies to assess long-term learning outcomes. This project contributes to the growing body of knowledge on accessible educational design and demonstrates the value of cross-disciplinary collaboration in developing inclusive teaching methodologies.

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