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IMPROVING THE METHODOLOGY FOR DEVELOPING STUDENTS' KINETIC INTELLIGENCE BASED ON SPECIALIZED SUBJECTS

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Abstract
Kinetic intelligence, also known as bodily-kinesthetic intelligence, plays a crucial role in students' cognitive and motor skills development. This study explores methods for enhancing kinetic intelligence through specialized subjects, incorporating practical, interactive, and movement-based learning activities. The research highlights the importance of integrating kinesthetic techniques into education, particularly in subjects requiring physical engagement, such as physical education, arts, and technical training. The findings suggest that applying structured movement-based methodologies improves students' engagement, comprehension, and skill acquisition in specialized disciplines.

Keywords: Kinetic intelligence, bodily-kinesthetic learning, specialized subjects, movement-based learning, active learning, skill acquisition, educational methodology, cognitive development.

INTRODUCTION
To fully comprehend the fundamentals of science and technology, learners must actively engage in knowledge-generating processes. This hands-on learning experience involves careful observation of natural phenomena, analyzing those observations through repeated experimentation, refining design concepts, and ultimately developing theories. Inquiry-based learning enables students to gain scientific experience and enhance their theoretical and conceptual understanding through practical activities in these disciplines. Practical work is not merely an essential component but serves as the foundation of science and technology education, fostering both knowledge creation and the development of process skills.

Rather than passively absorbing information from teachers, students actively participate in scientific inquiry and problem-solving activities in these subjects.

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Traditionally, such learning takes place in laboratories, where students experiment, troubleshoot, and apply their knowledge to better understand subject content. However, modern inquiry-based learning approaches also incorporate virtual experiments, such as interactive simulations, or a combination of real and virtual experiments. For students to effectively engage in these learning methods, science and technology educators must possess adequate pedagogical knowledge, practical skills, and subject expertise to successfully implement the curriculum.

In South Africa, many educators face significant challenges, including inadequate resources, limited infrastructure, and competing curriculum demands. To keep pace with global advancements, South Africa has restructured its science and technology curriculum to develop 21st-century skills such as critical thinking, problem-solving, and collaboration. Additionally, the revised curriculum aims to address skill shortages in STEM-related careers while tackling historical inequalities from the apartheid era. However, these conflicting educational priorities create complexities that hinder teachers from implementing the curriculum as intended. Although the curriculum has been updated, the environments and conditions for its execution remain unchanged.

Research has highlighted the persistent shortage of resources and the lack of practical work opportunities, particularly in rural schools. Furthermore, studies indicate that technology teachers often lack the necessary skills to effectively conduct hands-on activities. This shortage of both essential resources and adequate training puts educators in a challenging position. On one hand, they are unable to facilitate practical learning due to limited resources and, in some cases, insufficient technical skills. On the other hand, they face high cognitive demands, as they are expected to improvise and innovate to conduct practical work effectively. Common instructional strategies for practical activities include experiential learning, project-based learning, experimentation, hypothesis testing, fieldwork, inquiry-based learning, and virtual simulations.

LITERATURE REVIEW

Inquiry Learning in Science and Technology. Inquiry learning is an instructional approach in which students gain knowledge by assuming the role of scientists—formulating hypotheses, designing, and conducting experiments to validate or refute their assumptions. Traditionally, inquiry-based learning activities have been conducted using tangible (hands-on) materials in classrooms through physical experiments. Over the past two decades, advancements in digital technology have introduced virtual experiments as an alternative, and in some cases, a replacement for traditional hands-on experiments in implementing inquiry-based learning.

Virtual experiments, which involve computer-based interactive simulations of real-world experiments, have been shown to enhance students' conceptual understanding. Research suggests that both traditional analog experimentation and digital simulations provide distinct advantages, each contributing uniquely to students' comprehension of scientific concepts and methodologies. This variety of learning experiences enhances the educational process, offering students a more well-rounded understanding of scientific principles and investigative procedures.

Simulation-Based Learning. Simulations are interactive digital programs that replicate real or artificial systems and processes. These tools allow students to actively construct knowledge by engaging in authentic science and technology inquiry practices, such as making observations, conducting investigations, and virtually manipulating variables. Through simulations, learners develop analytical reasoning, critical thinking, and problem-solving skills. Additionally, simulations offer greater flexibility, as they enable students to modify variables in response to their inquiries—something that is not always feasible with physical equipment.

Before working with real laboratory equipment, students can use simulations to practice lab techniques, which enhances their preparedness. Furthermore, learners can access these simulations at home, enabling them to review or extend classroom experiments for deeper understanding. The ability to repeatedly engage with simulations helps students develop a clearer and more concrete grasp of scientific concepts.

Lindgren et al. emphasize that simulations enhance student engagement, encourage active knowledge construction, and improve comprehension of complex topics and concepts. Similarly, researchers argue that simulations improve academic performance in science by allowing students to apply scientific principles to real-life situations. Studies comparing students exposed to simulation-based learning (SBL) with those taught using conventional methods indicate that SBL leads to significant improvements in conceptual

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understanding and knowledge retention. Additionally, a meta-analysis of multiple studies found that SBL is associated with higher exam scores and better overall academic achievement across various science courses.

Theoretical Framework

This study is theoretically grounded in Experiential Learning Theory (ELT), which was chosen as the guiding framework due to its emphasis on learning through direct experience. ELT provides a structured approach to understanding participants' experiences with Simulation-Based Learning (SBL) and how they navigate the learning process.

The training participants underwent to engage in SBL allowed them to progress through the four phases of ELT, as illustrated in Figure 1. These stages facilitate a deeper understanding of learning by incorporating concrete experiences, reflective observation, abstract conceptualization, and active experimentation. By following this cyclical process, learners develop a more comprehensive grasp of scientific and technological concepts through immersive, hands-on engagement.

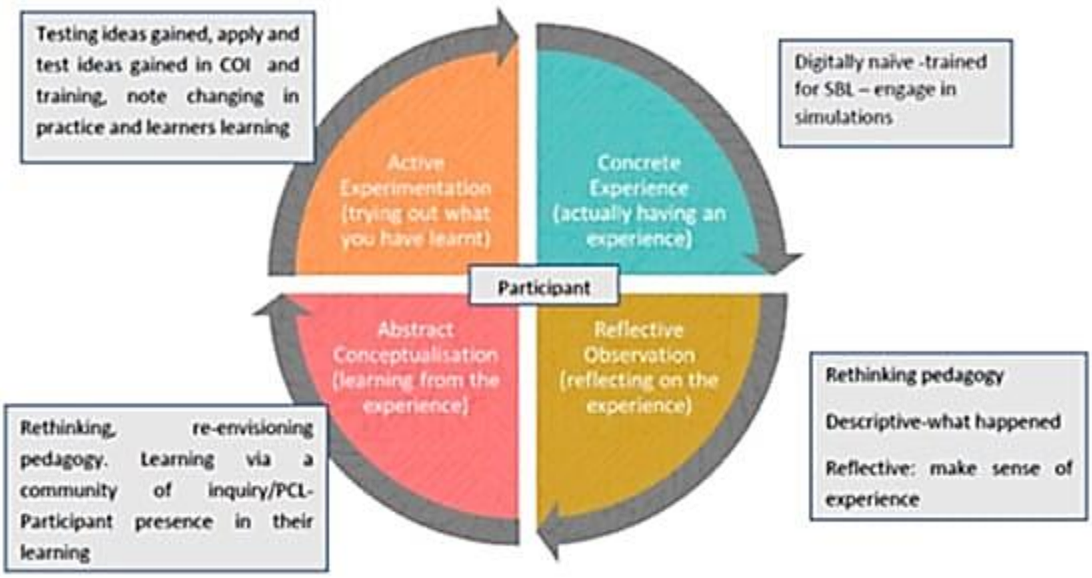

Figure 1. Kolb's Experiential Learning Cycle.

METHODOLOGY

Materials and Methods

This study was conducted within the interpretative research paradigm to explore participants' experiences of using Simulation-Based Learning (SBL) in their

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teaching from their personal perspectives. A qualitative research approach was employed as it provided the most suitable method for understanding the lived experiences of educators implementing SBL in their instructional practices.

The study took place at a teacher training institution in the KwaZulu-Natal province, where in-service teachers enrolled in an Honors degree program in Technology Education (2022) participated. Prior to the study, ethical approval was secured from the university's ethics office, and all sixteen enrolled in-service teachers voluntarily consented to take part.

Data Collection Methods

The research utilized multiple data collection techniques, including:

- Individual semi-structured interviews
- Interactive discussion forums
- Reflective journals

Before data collection, each participant was assigned a unique number (from 1 to 16), serving as their pseudonym to ensure confidentiality and facilitate consistent data management across different sources.

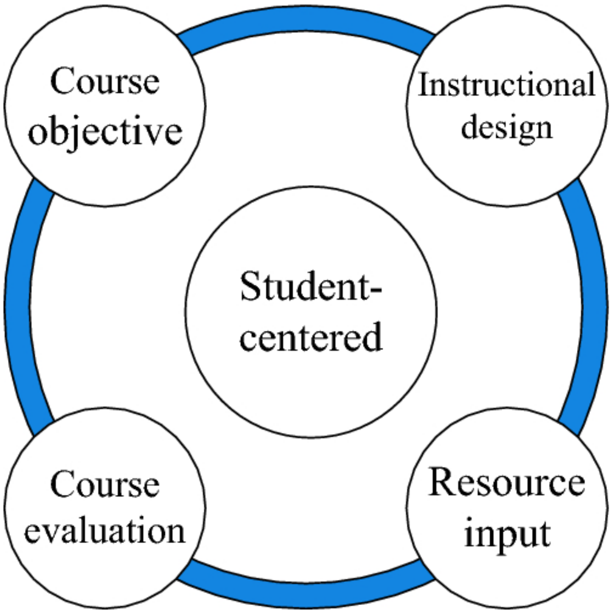

Figure 1. Student-centered instructional design.

Two discussion forums were organized:

1. During the SBL training phase
2. Midway through the semester

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These forums provided an interactive space for participants to discuss their pedagogical practices and share reflections on their experiences. Key questions included:

How has SBL influenced your teaching experience?
What new insights have you gained?
What additional knowledge do you require to implement SBL effectively?
Has your pedagogical content knowledge or instructional strategy evolved?
What changes have you observed in students' learning since adopting SBL?

To ensure consistency, workshops were held to guide participants on how to maintain a reflective journal. The semi-structured interviews lasted approximately 30 minutes, were audio-recorded, and centered on themes such as:

Benefits and challenges of SBL
Learners' engagement and learning experiences
Accessibility and equity concerns

The interviews were transcribed verbatim and sent to participants for member checking, allowing them to verify the accuracy of their responses and ensuring the credibility of the data. Additionally, data triangulation was achieved by cross-referencing findings from interviews, discussion forums, and reflective journals, further enhancing the reliability and validity of the study.

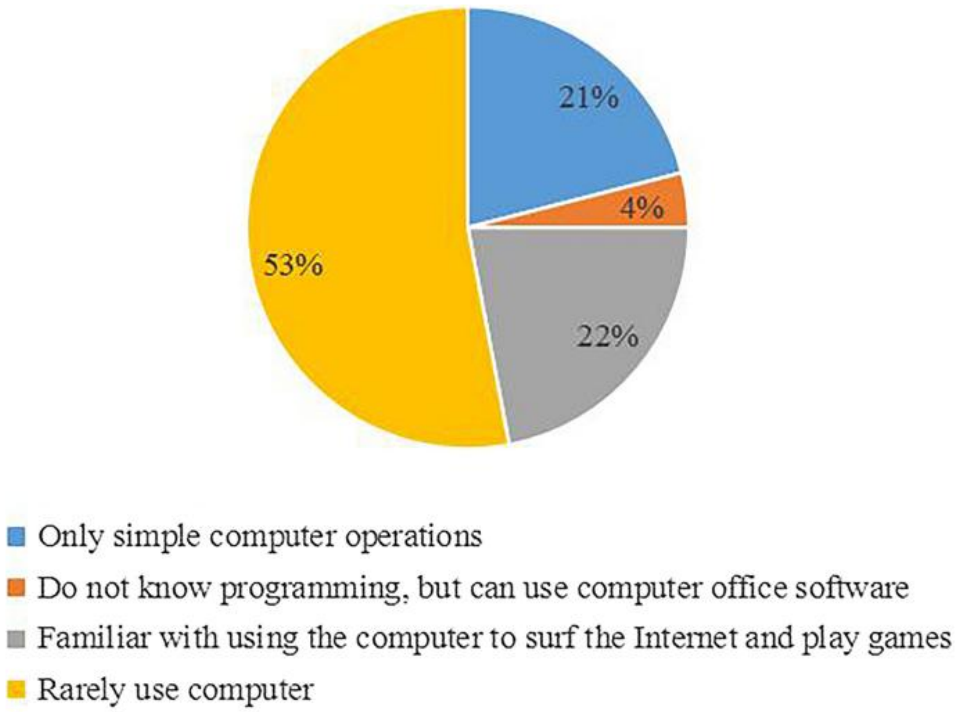

Figure 2. Analysis of the student surveys

The Role of Simulations in Learning

Simulations play a crucial role in enhancing conceptual understanding, as they allow learners to manipulate variables and observe cause-effect relationships in real-time. By increasing or decreasing variables, students can develop deeper insights into complex scientific and technological concepts, such as electrical resistance and trophic levels.

Simulations sharpen students' focus on specific scientific principles while bridging abstract ideas with visual representations of phenomena like velocity, force, and acceleration. Scholars such as argue that engaging with simulation-based activities enhances problem-solving skills and deepens conceptual understanding in science, particularly because many scientific concepts are abstract and not directly observable.

For instance:

Adjusting resistance in a circuit simulation allows learners to observe changes in current flow, fostering a practical understanding of Ohm's Law.

Modifying ecological simulation variables helps students grasp the interactions within food webs and energy transfers across trophic levels.

These findings underscore the effectiveness of SBL in enhancing both theoretical and applied knowledge, reinforcing the importance of experiential, inquiry-driven learning methodologies in science and technology education.

CONCLUSION

The integration of kinetic intelligence development into specialized subjects enhances students' learning experiences by promoting active participation and hands-on engagement. This study underscores the importance of incorporating movement-based methodologies to improve cognitive and motor skills. Future research should focus on refining these techniques and assessing their long-term impact on students' overall educational outcomes. A well-structured approach to kinetic intelligence development can lead to improved problem-solving abilities, better retention of knowledge, and increased motivation in learning.

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