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On the Potential Adoption of Digital Interactive Laboratory (DIL) in schools for Enhancing Students Integrated Science Process Skills (iSPS) in Chemistry

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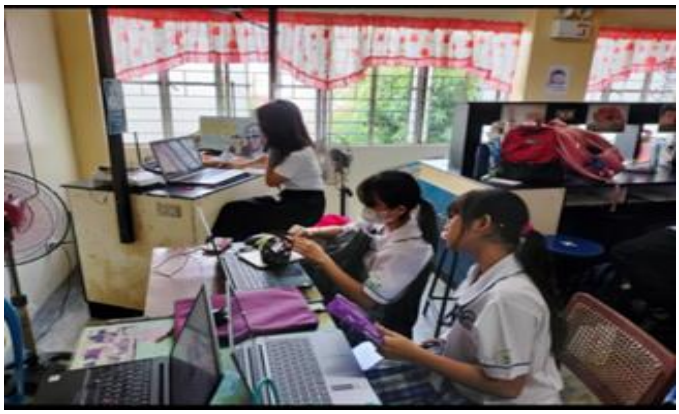

Online class discussing on how to navigate the Digital Interactive Laboratory (DIL) in a blended learning modality on enhancing the integrated SPS among grade 7 students in SDO of Pasig City

This policy brief explores the feasibility of adopting Digital Interactive Laboratories (DIL) for the enhancement of integrated science process skills (iSPS) among Grade 7 (G7) students in chemistry as its primary focus. It provides valuable insights for educators and policymakers seeking to enhance science education through the thoughtful incorporation of technology. The study delves into the potential adoption of policies concerning DIL in supporting students' understanding and application of iSPS within a chemistry laboratory setting in Santolan, Pasig City, Philippines.

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Integrated science process skills play a vital role in science education by facilitating a deeper comprehension and practical application of scientific principles. These skills, such as hypothesis formulation, variable control, data interpretation, and experimentation, empower students to actively participate in the scientific inquiry process (Yılmaz, 2023). Proficiency in these skills equips learners with the ability to grasp scientific methodologies and concepts, fostering critical thinking and problem-solving capabilities. (Darling-Hammond et al., 2020). As a stimulating factor for iSPS, information, communication, and technology (ICT) in the form of digital interactive learning resources capacitate students to become more engaged in the teaching and learning process. iSPS taught using a digital interactive learning platform in chemistry can significantly enhance science learning. This approach allows students to visualize abstract and complex chemical reactions and processes, promoting a deeper understanding of abstract concepts. Digital interactive learning environments, such as virtual labs and simulations, make learning more engaging and motivating, fostering curiosity and motivation. It involves critical thinking and problem-solving abilities, such as designing experiments, controlling variables, and interpreting data. Digital interactive learning platforms provide a safe and controlled environment for students to practice these skills without the risks associated with traditional laboratories. Digital interactive laboratories can be used by last-mile schools in remote regions with limited infrastructure and resources to deliver high-quality instruction.(DepEd, 2023) These virtual lab experiment simulations in subjects like physics, biology, and chemistry are a game-changer, offering more realistic hands-on learning and a deeper comprehension of intricate scientific ideas. It has been demonstrated that, in comparison to other teaching strategies, interactive simulations lead to a better comprehension of difficult scientific ideas. During emergencies like pandemics or disasters caused by nature (flood/extreme heat), digital laboratories also act as an anchor for education , enabling learning to continue at home. They are especially advantageous for last-mile schools with tight resources because they are affordable and don't require costly equipment or upkeep. Platforms like PhET simulations and Labster provide instructional assistance and guided self-training so they can give simple activities in the laboratories the help they need.

DILs feature three significant capabilities that include (1) accessibility, (2) low cost, and (3) ease of navigation.

Digital Interactive Laboratories (DILs) offer a practical and accessible solution for teaching chemistry laboratory skills, even in remote learning settings. Through DILs, students can engage in essential science processes such as observation, measurement, and data analysis within a virtual environment. These interactive simulations present a safe and cost-effective option, especially beneficial for schools facing resource constraints. While DILs cannot perfectly replicate the hands-on experience provided by a physical lab, they enrich student learning and participation. With technological advancements, integrating DILs into the chemistry curriculum emerges as a promising approach to enhance student education and adapt to evolving learning environments.

Incorporating DILs into chemistry education offers a transformative approach that enhances accessibility and cost efficiency compared to traditional physical labs. Through DILs, students can engage in virtual experiments with minimal requirement for expensive equipment, chemicals, and physical lab spaces. This inclusive approach is particularly advantageous for schools with limited resources and students with diverse needs, as DILs can be customized to accommodate individual learning styles. Moreover, DILs empower students to learn at their own pace, revisit experiments, and delve deeper into scientific concepts, nurturing a holistic development of science process skills. The affordability and inclusivity of DILs make them a valuable asset in enriching chemistry education and creating welcoming and diverse learning environments.

The effectiveness of utilizing DIL in chemistry to enhance iSPS hinges on various key factors, such as adaptability to technological advancements, necessitating systems that can easily incorporate upgrades and new technologies. The DIL is an essential and user-friendly application, with interfaces designed to be intuitive for both students and teachers. Its alignment with learning objectives is paramount, requiring simulations and experiments that directly support the chemistry curriculum's goals. It ensures that DIL systems are readily available to students in terms of cost, hardware, software, and implementation ease. Lastly, ongoing support, maintenance, and professional development are essential for the sustained functionality and effectiveness of the DIL system in educational settings.

In a nutshell, various countries have different levels of feasibility for DIL when applying integrated science process skills, which are impacted by technological, financial, and educational variables. Emerging and developing nations are looking to explore scalable and creative ways to include DIL in their educational systems, while developed countries may easily absorb and profit from these technologies. The increasing popularity of digital learning environments around the world emphasizes how crucial it is to keep funding teacher preparation programs, infrastructure development, and educational technology to fully utilize DIL's potential to improve science education.

Similarly, the adoption of DILs in chemistry emerges from the experiences of science teachers and learners in private and public schools of the Schools Division Office of Pasig City. Both schools identified gaps in learning chemistry based on a lack of

physical laboratory materials, leading to low performance in the subject. Likewise, low achievements on standard assessments are due to the poor engagement of students in abstract and complex lessons in chemistry. This suggests the need for policies prioritizing the development of iSPS through laboratory simulations. This can be achieved by endorsing the use of digital learning resources to support the learning of scientific concepts and skills. The integration of DILs into essential learning competencies is recommended for effective science lessons (Paje, 2021).

Clear guidelines and expectations should be established for an ideal virtual lab setup to ensure a smooth and productive learning experience for students. Additionally, policies should be developed to identify and understand the challenges faced by students in developing iSPS. This can be done by implementing strategies that support and promote coping mechanisms among students to overcome the identified challenges. Lastly, there is a need to establish policies that explore and promote the benefits of experimentation in science lessons, specifically in addressing challenges related to iSPS.

In conclusion, DILs hold promise in enhancing students' integrated SPS in chemistry. It guides the formulation of policies and practices for improving science education and fostering a deeper understanding of SPS among students. Learners can be taught to confidently handle scientific inquiries through iSPS, along with critical thinking and practical application. This will help students become prepared to deal with academic and real-world issues in the scientific area in the future.

Hence, it is necessary to implement policies that prioritize the development and improvement of iSPS among students through DILs. Additionally, the utilization of DILs to enhance the teaching of scientific theories and skills must be encouraged. Promote the integration of DIL as a tool to attain essential learning competencies and facilitate effective science curriculum, and establish clear guidelines and expectations for an ideal virtual lab setup to ensure a smooth and productive learning experience to augment and enrich the laboratory skills and experience of students.

POLICY RECOMMENDATION

Implications for the development of policies on enhancing the integrated science process skills of G7 students through laboratory simulations.

1. Implementing policies that prioritize the development and improvement of integrated science process skills among G7 students through laboratory simulations. (Derilo, 2019)

2. Encouraging the use of both digital and traditional learning resources to enhance the teaching of science lessons. (Paje et al., 2021)

3. Promoting the integration of digital laboratories (DILs) into essential learning competencies to facilitate effective science education. (Henne et al., 2022)

4. Establishing clear guidelines and expectations for an ideal virtual lab setup to ensure a smooth and productive learning experience.

Implications for the development of policies on identifying the challenges in integrated science process skills of the G7 students and their coping processes.

1. Implementing policies to identify and understand the challenges faced by G7 students in developing integrated science process skills. (Derilo, 2019)

2. Developing policies that support and promote coping mechanisms among G7 students to overcome challenges in integrated science process skills. (Agayon et al., 2022)

3. Establishing policies to explore and promote the benefits of experimentation in science education, specifically in addressing challenges related to integrated science process skills among G7 students.

Given the implications for empowering underserved students in school districts, officials in the Department of Education, as well as members of the House and Senate, can support Digital Interactive Laboratories (DIL) in scientific learning centers with the necessary DIL minimum matching grant to increase coverage. Each student, regardless of geography, will have significant opportunity to learn about science if DILs are incorporated into national STEM education programs. Additionally, policymakers might designate more funds to help schools purchase the equipment, internet access, and other necessary infrastructure needed to utilize digital laboratories. Additionally, funding teacher preparation programs would empower teachers to employ DILs to improve scientific education. In order to evaluate and scale successful DIL implementations, legislation might also enable pilot projects. This would ensure that the implementations are continually refined based on feedback and data. Furthermore, by utilizing the resources and experience of IT businesses, promoting public-private partnerships might lower costs and hasten the implementation of digital laboratories in schools. In addition to enhancing science instruction, these programs would increase the educational system's resilience, enabling it to continue even in the face of disruptions like pandemics or natural catastrophes. Policymakers may update scientific teaching and help bridge the resource gap between underprivileged and well-funded schools by giving DILs priority.

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