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Pre- and Post-Assessments in Evidence-Based Science Education

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1. INTRODUCTION

The implementation of pre- and post-assessments as part of evidence-based practices in education provides a robust framework for evaluating teaching efficacy and student learning. By identifying baseline knowledge and measuring subsequent gains, educators can refine instructional methods to maximize impact. This literature review synthesizes findings from key studies, emphasizing how these insights can inform the design and functionality of the EduLab prototype (2024a; 2024b).

2. IMPORTANCE OF PRE- AND POST-ASSESSMENTS

Pre- and post-assessments serve as crucial tools in measuring the effectiveness of teaching interventions. Dimitrov & Rumrill (2003) highlight their utility in capturing changes over time, particularly through statistical methods such as ANOVA and ANCOVA. These approaches are invaluable for comparing cohort performance, offering a methodological foundation for EduLab to adopt as it evolves. While these advanced techniques may exceed the scope of the initial prototype, they underscore a pathway for future development to accommodate complex analyses.

Similarly, Bonate (2000) emphasizes growth-curve models and baseline control as key tools for analyzing pre/post data. A baseline established with pre-assessments allows for better interpretation of data and improvement. Developed models take into account the level of significance, sample size, and effective examples to draw correlations between pre- and post-assessment data. These methods offer nuanced insights into learning dynamics and could be integrated into EduLab's long-term functionality. Initially, EduLab will focus on simpler statistical approaches like t-tests, ensuring accessibility for educators while laying the groundwork for future integration of more sophisticated methodologies. Although baselines for different cohorts within a group might be different, Edulab focuses on measuring the changes in performances rather than absolute number comparisons. It is the change Edulab provides that allows instructors to evaluate the impact of their teaching.

3. EVIDENCE-BASED TEACHING STRATEGIES

Evidence-based teaching methods have demonstrated significant improvements in student outcomes, particularly in STEM education. Moon et al. (2021) showcase how active engagement techniques, guided by frameworks like PORTAAL (Practical Observation Rubric to Assess Active Learning), enhance exam performance and reduce equity gaps for underrepresented students. By aligning its design with these principles, EduLab can promote inclusive and effective teaching practices. For instance, the platform may in the future include pre-built modules or customizable templates for implementing active learning strategies.

Hake (1998)'s research reinforces the effectiveness of interactive engagement through pre/post-assessments, showing substantial learning gains in physics education. This finding aligns with EduLab's goal of empowering educators to experiment with diverse instructional methods. The inclusion of features that allow for comparative analysis of teaching strategies would enable educators to identify the most impactful approaches for their classrooms.

4. INNOVATIVE APPROACHES TO ASSESSMENT

Dellwo (2010) exploration of multi-stage assessments and normalized change highlights the potential for iterative feedback loops in refining instructional methods. EduLab could leverage these insights by enabling educators to implement sequential assessments, providing a dynamic and continuous evaluation of student progress. For example, a multi-stage pre/post-assessment cycle could be integrated to track incremental learning gains throughout a course.

Flanagan & Ogata (2018) call attention to the need for interoperable learning analytics systems that facilitate data sharing across institutions. By incorporating these principles, EduLab could address challenges such as data continuity and accessibility, by being open-source and allowing for easily exportable data, ensuring

that insights gained from assessments are easily transferable and actionable across different educational contexts.

5. VISUALIZATION AND USABILITY

Effective communication of assessment results is essential for driving instructional improvements. Fernandez Nieto et al. (2022) propose innovative visualization techniques that blend narrative and storytelling elements, making data more interpretable for educators. EduLab could integrate features such as interactive dashboards and tailored reports, enabling users to explore results through both visual and narrative formats. For example, plans for pre/post-assessment outcomes to be presented alongside actionable recommendations are in the works for this project going forward, streamlining the decision-making process for educators.

6. BARRIERS AND OPPORTUNITIES

Despite the demonstrated benefits of evidence-based practices, their adoption is hindered by various barriers. Sansom et al. (2023) identify challenges such as limited pedagogical training, time constraints, and institutional pressures. EduLab's streamlined, user-friendly interface addresses these barriers by minimizing the effort required to design and analyze assessments. Additionally, the platform could include training resources or guided tutorials to help educators unfamiliar with evidence-based methods effectively utilize the tool.

7. CONCLUSION

The integration of pre- and post-assessments into educational tools like EduLab represents a critical step in advancing evidence-based teaching. By drawing on the principles and findings outlined in this review, EduLab can empower educators to experiment with and refine their teaching methods, fostering a culture of continuous improvement. Future iterations should prioritize advanced statistical capabilities, iterative assessments, and actionable visualizations to enhance usability and impact. In doing so, EduLab has the potential to transform science education, supporting educators in delivering equitable and effective learning experiences.

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