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Multimodal Learning Systems in Science Education: Personalisation and Effectiveness for Diverse Learner Profiles

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ABSTRACT This study investigated the impact of multimodal instruction on learning gains, engagement, and retention among 240 undergraduate STEM students at a Philippine state university. Using a mixed-method quasi-experimental design, researchers compared traditional lectures against a multimodal environment featuring videos, simulations, and interactive tasks. The results were decisive, wherein the multimodal group achieved significantly higher post-test scores ($p < 0.01$), demonstrated superior four-week knowledge retention, and increased material engagement by 35 percent. Qualitative data highlighted themes of enhanced motivation and accessibility, though some participants reported cognitive overload from excessive multimedia. Ultimately, the study confirms that multimodal instruction effectively boosts performance and inclusivity in STEM. These findings advocate for the strategic integration of digital pedagogies in higher education while emphasising the need for thoughtful multimedia design to balance cognitive load.