Enhancing Science Education with Learning Management System for Effective Learning Outcomes

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Abstract

Students' learning outcomes in scientific education are still horrifyingly poor as of right now. Numerous scientific students, ranging from elementary school to university education, exhibit insufficient cognitive, attitudinal, and psychomotor skills in their science education. The didactic, traditional, conventional, and non-heuristic instructional pattern used in scientific teaching and learning is to blame for the horrifying learning outcomes in science education. Studies have shown that using technology to educate and understand science has favorable effects. Technology-assisted science instruction and reflective thinking are advised by the National Science Teachers Association (NSTA, 2012, 2015, 2020). The Learning Management System (LMS) is a reliable technological tool that controls learning effectiveness in all subject areas, including science education. With Immediate Knowledge of Results (IKOR), the Learning Management System (LMS) provides a thorough, heuristic, predictive, and stimulating instructional capability to direct and lead the students in a hands-on, mind-on manner. Instructional System Design (ISD) in science education improves, permits, enriches, and empowers science instruction and learning. Insufficient technological expertise, inadequate infrastructure, resistance to change, lack of real-world experience, poor content quality, low digital literacy, and numerous other constraining issues call for investing in the institution's IT infrastructure, address issues of access and equity; teach educators and students digital literacy; foster community and collaboration; and provide professional development to improve scientific education using learning management systems for enhanced learning outcomes.

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Introduction

Science education entails the teaching and learning of the science contents, concepts, constructs, facts, hypotheses, theories, scientific laws, processes (methods), attitudes, and scientific skills. Science education exposes learners to the physical, chemical, biological, and the numerical nature of the world at large. It sustains the right scientific attitudes in learners and builds learners' capability for further studies. The development of scientific knowledge, attitudes, and skills ought not to be by transmission of culture from one generation to another generation; rather, it ought to be the construction of ideas, knowledge, scientific attitudes, skills, and competencies in a hands-on, mind-on approach.

It is well reported in research findings that the performances of students in sciences right from primary to the tertiary institutional level are deplorably low (Adebiyi, 2019; Okebukola, 2021; Obanya, 2021). The students' low level of academic performance in sciences equally has negative and aversive effects on their attitudes to sciences, which invariably mar their skills acquisition in science (Adesina & Aquiguoro, 2023; Obanya, 2021; Okebukola, 2021). It was identified that the conventional instructional method adopted in science teaching and learning contributes significantly to science students' learning outcomes in the cognitive, affective, and the psychomotor domains of science education.

An empirical observation by the author of many lecture rooms reflects that numerous students are addicted to the use of technology while lectures were on. The students of this 5th Generation Revolution are engulfed and adept in technology utilization in schools. Really, it is high time technology is deregulated in science education right from primary schools to the tertiary institutions. It is also observed that because these students were not adequately cultured on the use of technology from the primary schools, their mindset is usually tilted towards the negative use of technology such as in pornography, gambling, internet fraud, and many other nefarious dispositions. What should be done at the present? There is an urgent need to integrate technology in science education to enhance students' learning outcomes and the development of 21st-century skills.

The National Science Teachers' Association in America has been persistently recommending science teaching and learning with technology and reflective thinking (NSTA, 2012; 2015; 2020). NSTA affirmed that teaching and learning science with technology boosts learners' attention span, stirs students' interest in science, and helps the learners develop 21st-century skills. Adebiyi (2019) reported the heightening effects of technology on students' attention span and learning outcomes compared to the conventional strategy. The author affirmed that while other conventional instructional strategies negate the optimum learners' achievement in sciences, technology raises the students' capability to learn and improve their learning outcomes as the students use, apply, and take the lead adopting a hands-on-mind-on instruction via technology.

The credit is usually given to the use of technology, but I guess it does introduce a change in teacher's practice, so it makes the lessons less boring.

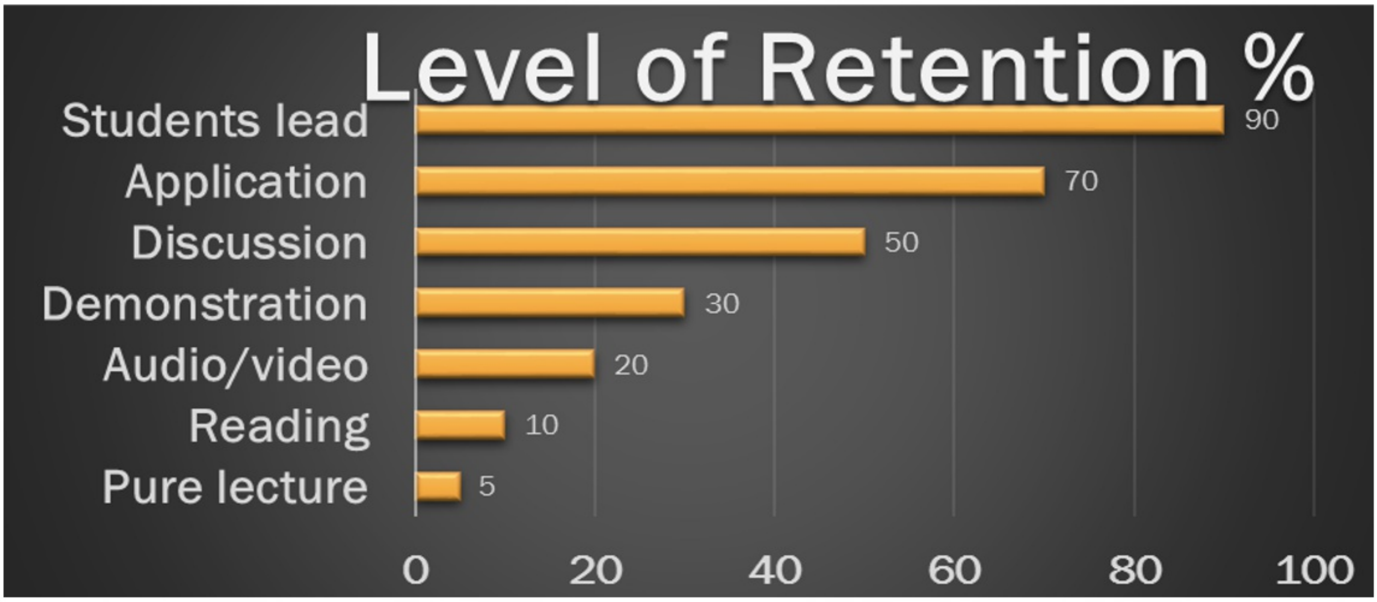

Figure 1. Students' Retention Levels based on Instructional Strategies Adopted from Adebiyi (2019)

From Figure 1, students retain the least through the conventional lecture method, the most when scientific contents, facts, hypotheses, theories, laws, and principles are applied, and students engage in self-regulated learning, which is easily enhanced using technology like a learning management system (LMS).

Gambari (2021) reported the impacts of technologies on students' theoretical and practical aspects of sciences. The author posited that the blending of virtual laboratories and simulated instructions improved learners' learning outcomes in sciences better than the conventional method. The simulated laboratory and virtual experimentation are repetitive, providing untiring access to instructions with assessment along with Immediate Knowledge of Results (IKOR). Students exposed to virtual laboratories and simulated instructions significantly performed better than those on conventional strategies in 21st-century skills development. Thus, a well-synchronized and well-packaged science instruction with specialized technology will eventually enhance students' learning outcomes in sciences. Such technologies are social learning tools, Google Docs, e-learning platforms, virtual classrooms, science simulations, science games, Learning Management System (LMS), etc. Among all, LMS stands out for its comprehensive and prognostic characteristics of lifting students' learning outcomes in science (Adesina & Ajadi, 2023; Gambari, 2021; Nguyen, 2021).

Learning Management System

The 1920s saw the introduction of learning management systems into use. Although a lot has changed since then, the objective has remained the same. Sidney Pressey created the Teaching Machine in 1924. There were mechanisms on this device that would pose a series of questions to the operator. Learning management systems have been utilized by organizations, academics, and military personnel over the years. These systems shared certain characteristics as they optimized. Robin McKinnon-Wood and Gordon Park created the Adaptive Teaching System in 1956 (Brückner, 2015). Using this LMS, questions were modified based on an individual's performance levels. Since the beginning, learning management systems have placed a strong emphasis on teaching and learning. The fundamental ideas of more recent models remain the same; however, there are various ways to display data, modify questions, and provide a platform for sharing information worldwide.

Learning Management System (LMS) is a construct that denotes technological software that enhances learning efficiency. The LMS construct emerged directly from e-learning. The reintroduction of LMS was in the 1990s and had its massive proliferation in usage during the COVID-19 pandemic. LMS is designed to fill the gaps in training and learning. It supports online learning in a synchronous and offline learning in an asynchronous mode of instruction. An LMS may offer classroom management for instructional interactivity and engagement in a flipped or blended classroom.

Improved online learning experiences for students are made possible by learning management systems (LMS). They make it possible to create, plan, and deliver training programs more quickly and efficiently. Offering a course library, content management system, user administration, and authoring tools is how most LMS achieve this. Additionally, they automate the majority of manual tasks that are often performed when organizing and carrying out training programs, like training trackers and user enrollment. Because of this, using learning management system examples can help you concentrate more on what matters most: giving your students the best possible instruction. In the context of remote instruction, the LMS acts as a comprehensive platform that promotes educational engagement between teachers and students (Adesina & Bamikole, 2022; Alenezi, 2018; Furqon et al., 2023; Ganeser & Robert, 2021). Teachers and students can share resources, learn, administer, and inform in an integrated environment by using the Learning Management System (LMS), which functions as an educational tool in a digital environment that uses web technology for the analysis, regulation, and distribution of knowledge, values, skills, and assessments.

Types of Learning Management Systems

Different types of Learning Management Systems (LMS) are available to meet different needs in training or education. Here are a few typical LMS types:

Corporate LMS: Designed for employee development and corporate training, these platforms assist firms in managing and delivering training materials, monitoring employee progress, and evaluating the skills and knowledge of their workforce.

Academic LMS: These are utilized by colleges, universities, and K–12 schools, among other educational establishments.

They assist teachers and students with communication, grading, content delivery, and course management.

Open Source LMS: Anyone can use, alter, and distribute open-source learning management systems (LMS) for free. Open edX, Sakai, and Moodle are well-known examples. They have a sizable user and development community and are quite customizable.

Cloud-Based LMS: These LMS systems do not require on-premises installs because they are hosted in the cloud. They are scalable, accessible from any location with an internet connection, and frequently have subscription-based cost structures.

Mobile learning management systems (LMSs): Specifically made for mobile devices, these facilitate students' access to course materials and interaction with information on tablets and smartphones. Their responsive designs make them ideal for viewing on a range of screen sizes.

Social Learning LMS: These systems include features that encourage peer learning and information sharing among learners, such as chat rooms, discussion boards, and collaboration tools.

Gamified LMS: Gamification is a technique used to increase the fun and engagement of learning. Gamified Learning Management Systems (LMS) include aspects akin to games, like leaderboards, badges, and points, to encourage and incentivize students.

Talent Management LMS: These systems concentrate on talent development, which includes skill evaluations, performance management, and succession planning. They go beyond traditional training. Departments dealing with talent development and human resources frequently use them.

Compliance and Certification LMS: Developed for sectors like manufacturing, banking, and healthcare that have stringent compliance regulations. These LMS platforms assist in monitoring and controlling staff compliance training and certification.

Blended Learning LMS: Blended learning is the integration of online learning with traditional classroom teaching. The combination of online and in-person learning components can be more easily managed with the help of these LMS platforms.

eCommerce LMS: These systems are employed in the distribution and sale of online training materials and courses. They have functions for managing customers, enrolling in courses, and processing payments.

Nonprofit LMS: Designed with nonprofit associations and organizations in mind, these systems frequently come with tools for volunteer recruitment, fundraising, and membership administration.

Extended Enterprise LMS: These LMS systems serve clients, partners, and other external audiences. They enable information exchange and training for personnel outside of an organization.

The type of LMS chosen will rely on the particular requirements and objectives of the institution or organization putting it into use. For these various needs, different LMS platforms provide different features and functionalities.

The Value of LMS

With its many features that improve teaching and learning, learning management systems (LMS) are important in science education (Adesina & Ajadi, 2023). The following are some main justifications for the significance of LMS in science education:

Digital Resource Access: Learning Management Systems (LMS) offer a central location for learning resources, such as research articles, videos, simulations, lecture notes, and textbooks. The variety and accessibility of learning resources in science education are improved by this access to digital resources.

Online Assessment and Grading: Learning Management Systems (LMS) make it easier to create and administer tests, assignments, and quizzes. They provide students with instant feedback by automating the grading process, which is essential for enhancing learning and comprehension in science courses.

Collaboration and Communication: Learning Management System (LMS) platforms facilitate communication between students and instructors as well as among students themselves by providing tools such as chat rooms, discussion boards, and messaging. Collaboration is crucial in science education for group projects, exchanging research results, and asking for assistance when needed.

Customized Learning: Learning management systems provide the ability to monitor the advancement of students and offer tailored suggestions for extra help or corrective assignments. This flexibility can serve students with different degrees of competency in science courses.

Integration of simulations and virtual laboratory experiments is supported by a large number of learning management system platforms. With the help of these interactive resources, students can investigate and test scientific ideas, improving their grasp of science in real-world contexts.

Flexibility and Accessibility: Students can participate in learning activities and access course materials from any location with an internet connection thanks to LMS platforms. Students with varying schedules and online education programs particularly benefit from this flexibility.

Real-time Updates: Science is a discipline that is always changing. With the help of LMS platforms, educators may instantly update materials to reflect the most recent findings and technological developments, guaranteeing that students are exposed to up-to-date knowledge.

Data Analytics: Learning Management Systems (LMS) provide tools for reporting and data analytics, enabling teachers to evaluate students' performance and pinpoint areas in which more assistance is required. With the use of this data-driven approach, educators can modify their pedagogical strategies to target certain problems in scientific education.

Learning can be done synchronously (in real-time) or asynchronously (at your own pace). This allows students with varying learning styles and preferences to be accommodated by LMS platforms. This adaptability is especially helpful in science education, where students may need more time to fully comprehend complicated subjects.

Sustainability: By reducing the need for paper-based materials and physical textbooks, LMS helps to save the environment by using less paper.

Tracking Progress: Throughout the course, LMS systems assist instructors and students in keeping tabs on each other's progress. While teachers can spot areas that need more guidance or assistance, students can keep an eye on their own progress and modify their learning tactics as appropriate.

To sum up, learning management systems (LMS) in science education provide an extensive range of features and tools that improve the quality of instruction. It encourages cooperation, facilitates examinations, allows for individualized learning, and provides access to a variety of materials, all of which help students become more proficient and scientifically literate.

Learning with More Than Human and Digital Media

An approach to education that is wider and more varied is required for learning that involves more than simply digital and human media. It recognizes the role that technology, the environment, and other media types have in education. The following are some components and ideas of learning with media other than humans and digital:

Multimodal Learning: This method acknowledges that people learn in different ways and tries to meet those needs by delivering content in a variety of ways. Text, graphics, music, video, and interactive simulations are some examples of these modes. Incorporating other senses into the educational process helps improve comprehension and memory.

Experiential Learning: Education is not just confined to computers and textbooks. Physical experiences, field trips, practical experiments, and real-world interactions can all be a part of it. Including students in a learning setting can be a very effective strategy to help them retain the information.

Environmental Learning: One can learn from their actual surroundings. An appreciation of the natural world and its systems is fostered by learning in nature, going outside, and participating in environmental education programs.

Social and Collaborative Learning: An integral part of a well-rounded education is gaining knowledge from social interactions with peers, mentors, and community members. Both digital and real-world environments may be used for this.

Cultural and Indigenous Knowledge: A more thorough grasp of the world and its history can be achieved by acknowledging and embracing indigenous and cultural knowledge systems.

Artificial Intelligence and Machine Learning: With the constant advancement of technology, these two fields can offer tailored educational experiences by adjusting to the unique requirements and preferences of each learner.

Virtual reality (VR) and augmented reality (AR) are two innovative and engaging instructional technologies that can submerge students in virtual worlds or augment the real world with digital content.

Gamification: Learning can be made more dynamic and interesting by including game aspects like competition, incentives, and challenges.

Adding more than just digital and human media to education acknowledges that learning is a multifaceted, multimodal, and dynamic process. It welcomes a wide variety of resources, settings, and experiences to meet the different needs and interests of students and promote a more comprehensive and in-depth understanding of the world.

How Does Education Take Place?

Learning is an intricate and diverse process that includes picking up new abilities, actions, or knowledge via a variety of channels. It takes place in the human brain and is impacted by a variety of elements, such as social, emotional, and cognitive elements. Although there are many theories and models of learning, the following basic ideas and processes aid in the explanation of how learning takes place:

Sensory Input: Environmental sensory input is frequently the first step in the learning process. Information is gathered by our senses—sight, hearing, touch, taste, and smell—and then processed by the brain. The process of choosing and concentrating on particular elements of the sensory information is known as attention. It chooses which information moves on through processing and becomes conscious.

Perception: After processing sensory data, the brain compiles it into coherent ideas and patterns. This is essential to identifying and comprehending the environment we live in.

Memory: The process of learning includes memory formation. Perceived and attended information gets encoded into memory. Sensory memory, short-term memory, and long-term memory are the three main categories of memory, each having a distinct duration and storing capacity.

Association: A key component of learning is creating links between newly acquired knowledge and preexisting information. The process of associative learning involves making connections between new information and prior knowledge.

Reinforcement: Associations can be made stronger or weaker by positive or negative reinforcement. Rewards and punishments are employed in operant training to promote or inhibit particular actions.

Practice and Repetition: These are crucial for skill-based learning, like learning to play an instrument or becoming an expert athlete. Building and strengthening neuronal networks is facilitated by repetitive engagement in a task.

Feedback: Feedback tells you how accurate and good your performance was. It aids students in modifying their behavior and enhancing their comprehension.

Cognitive Processes: More complicated kinds of learning heavily rely on higher-level cognitive processes like abstract reasoning, critical thinking, and problem solving. These procedures entail information manipulation in the mind.

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Learning is a process that is not consistent and might differ from person to person depending on personal traits, past experiences, and the particular material being learnt. Numerous internal and external influences might have an impact on this dynamic, lifelong process.

How Science Educators Can Use LMS

Incorporating a Learning Management System (LMS) into science education can improve instruction by giving teachers a digital platform to administer classes, distribute materials, and interact with students (Ajijola et al., 2021; Al-Sharhan et al., 2021; Gambari, 2021). The following procedures outline how to use an LMS in science education:

Choose the Correct Learning Management System (LMS): Make sure the system is user-friendly for both teachers and students and fits in with your educational objectives. Think about things like affordability, scalability, and the particular features you require for teaching science.

Course Design: Assemble texts, videos, assignments, quizzes, and lectures into a coherent whole. Organize the course in a sensible manner and make the LMS simple to use.

Upload and arrange your scientific resources, such as lecture slides, PDFs, videos, and other items. Make sure the content can be accessed and is LMS compatible.

Creating interactive content, such as discussion boards, polls, and quizzes, can be done using the LMS. Engaging pupils and reinforcing their learning can be achieved through interactive features.

Organize assignments, tests, and quizzes in the LMS with assignment and assessment management. Track student progress, collect and grade assignments, and give feedback using the LMS.

Communication: Make use of the LMS's communication features, like chat, discussion boards, and messaging, to let students and teachers connect with one another. Promote dialogue, inquiry, and cooperation.

Resource Sharing: Distribute supplementary materials and citations via the Learning Management System (LMS), encompassing scholarly articles, research reports, and external webpages.

Virtual laboratories: Incorporate virtual laboratories or simulations into the LMS, if appropriate, to offer practical experiences in a digital setting.

Announcements: Send out updates and announcements on a regular basis via the LMS to educate students about deadlines, changes in the courses, and other pertinent information.

Feedback and Assessment Analytics: Make use of the analytics and reporting tools provided by the Learning Management System (LMS) to track student progress, spot potential problem areas, and modify your instruction as necessary.

Online meetings and video conferencing: Incorporate video conferencing capabilities for online classes, office hours, or group discussions as needed.

Access & Accessibility: Ensure that all students, including those with impairments, have access to the LMS and course resources. When needed, offer content in alternate formats.

Training and Support: Ensure that teachers and students feel at ease using the LMS by providing them with training and support. Offer technical assistance, tutorials, and resources.

Security and Privacy: Take data security and privacy seriously. Verify that student data is secure and that the LMS conforms with all applicable laws.

Feedback and Adaptation: Obtain student input regarding their interactions with the LMS and the course structure. Utilize these comments to make any necessary modifications.

Constant Professional Development: Keep abreast of the most recent advancements in educational technology and the best practices when utilizing an LMS. To develop your abilities, participate in workshops or training.

An LMS can help provide a more adaptable and engaging learning environment in scientific classes. However, it's crucial to customize the technology to fit the unique requirements of your science classes and ensure it enhances, not hinders, your students' learning.

Difficulties with Using LMSs in Science Education

Learning Management Systems (LMSs) offer numerous advantages for science teaching, but they also present several difficulties. The following are some common challenges that arise when using LMSs in science education:

Technical Difficulties: Technical issues such as software bugs, server failures, and slow loading times can disrupt learning. Usability and compatibility problems with the system may pose challenges for educators and students.

Access and Equity: Disparities in learning opportunities may arise due to unequal access to technology and the internet among students. Students who lack easy access to devices or fast internet may struggle to engage with the LMS effectively.

Digital Literacy: Some teachers and students may feel uncomfortable using technology or lack the necessary skills to utilize the LMS effectively. This can hinder engagement and participation.

Content Quality: Developing high-quality digital content for scientific courses can be time-consuming and may require e-learning design expertise. Ineffective or outdated content can impede learning.

Assessment and Cheating: Ensuring the integrity of assessments in an online environment can be challenging. Monitoring students prone to cheating on online tests and quizzes can be difficult.

Engagement and Interaction: Keeping students engaged and fostering interaction may be more challenging in an online environment. Some students may experience feelings of isolation and miss in-person interactions with teachers and peers.

Lack of Practical Experiences: Many scientific courses require hands-on laboratory work, which can be challenging to replicate in an online setting. While virtual labs are available, in-person labs may still offer a more tactile learning experience.

Data Security and Privacy: Ensuring the security and privacy of student data is crucial, as LMSs handle sensitive information. Compliance with relevant laws and regulations, such as the Family Educational Rights and Privacy Act (FERPA), can be challenging.

Faculty Assistance and Training: Teachers may require assistance and training to effectively use the LMS. Lack of training can result in ineffective or inefficient utilization of the system’s functions.

Opposition to Change: Educators may exhibit resistance towards embracing new technology and transitioning from conventional classroom approaches to an online model.

Content Ownership and Licensing: Using digital content in an LMS may give rise to copyright, intellectual property, and licensing issues. It is crucial to ensure that content is used morally and lawfully.

Cost: Software licenses, ongoing support, and upkeep can all contribute to the total cost of implementing and maintaining an LMS.

Adaptation to Diverse Learning Styles: LMSs might not always be able to accommodate the needs and diverse learning styles of their users. There may not be much room for customization or flexibility in course design.

The abundance of digital resources, notifications, and virtual interactions found in learning management systems (LMS) can easily overwhelm students, leading to increased cognitive strain and reduced focus on the learning process.

It's critical that educational institutions provide adequate support, resources, and training to address these issues.

Furthermore, to ensure a smoother and more successful integration of technology in science education, ongoing assessment and adjustment of the LMS and course design are essential.

Way Forward on Enhancing Science Education with LMS

Using Learning Management Systems (LMS) to improve science education calls for a planned and forward-thinking strategy. The following actions can help you advance and get the most out of learning management systems (LMS) in scientific teaching.

Invest in the Institution's Technology Infrastructure: Ensure that your LMS can be used efficiently by having a strong and dependable technology infrastructure. This includes having stable gear, enough bandwidth, and fast internet connectivity.

Address concerns of equity and access by giving kids who might not have these resources access to gadgets and the internet. To close the digital divide, think about collaborating with government initiatives or nonprofit organizations.

Provide instruction on digital literacy to teachers and students to make sure they can utilize the LMS's capabilities and navigate it properly. Online safety, best practices, and fundamental technology skills should all be included in this course.

Invest in the creation of superior digital content for scientific courses through content development. Collaborate with subject matter experts and instructional designers to develop curriculum-aligned, interactive resources.

Building Community and Collaboration: Develop a feeling of community and cooperation between students and teachers. Promote group projects, peer support, and online conversations to mimic the collaborative elements of face-to-face instruction.

Professional Development: Educators can fully utilize the LMS if they are given an opportunity for continuous professional development. Effective online pedagogy, assessment techniques, and best practices for online science education should be the main topics of training.

Adaptive Learning: To tailor each student's learning experience, investigate the adaptive learning tools available in the LMS. By customizing exams and content to meet each student's needs, these tools increase student performance and engagement.

Maintaining the integrity of assessments in an online context requires the implementation of various measures. This could entail developing a culture of academic integrity, deploying proctoring software, and developing a variety of assessment formats.

Blended Learning: Take into account a technique that blends the advantages of online and in-person learning. This can assist in addressing the shortcomings of online labs and practical.

Information Analysis: Make use of the LMS's data analytics and reporting features to keep an eye on the engagement and performance of your students. Utilize this information to pinpoint potential problem areas for your kids and provide timely assistance.

Receive feedback from students on a regular basis regarding their interactions with the LMS and online courses. Make changes and improvements based on this feedback.

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