Innovations

Transforming the Basic Science Pedagogy: The Experiential Learning Approach paradigm

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Abstract: *There are high expectations from science classrooms to meet with the technological demands of the modern society. This birth the need for a shift from the traditional chalk-board and paper processes to hands-on, practical and real-life teaching approaches in order to develop the students' competencies needed for their success in the recent world. Pedagogy evolves with innovation in science. Beginning with basic classes, learners requires learning experiences that are authentically set in real-life environments, built to intentionally imitate how the world operates outside the classroom boundaries. The experiential learning (EL) is believed to be among the methods that meets this criterion. The current review makes an effort to explain the need for a shift from conventional science teaching method to an Experiential learning (EL) method. It discusses Experiential learning (EL)with regards to; real-life learning environment, students' engagement, learning by doing, mental and skill development, retention and students' motivation while inspecting the backgrounds and values of EL. Subsequently, the efficacy of findings for transforming Basic science pedagogy is discussed.*

Keywords: *experiential learning, real-life learning environment, students' engagement, students' motivation, basic science pedagogy.*

Introduction

Education has never been as demanding as in the contemporary world where there are high expectations from science classrooms to meet with the technological demands of the society. Over the years, science education has been searching for new ways of teaching and learning to make a shift from the traditional chalk-board and paper processes approach which has been criticized for its limited engagement and lack of hands-on experiences and suspected to hinder students' understanding and application of scientific knowledge. In order to develop the students' competencies needed for their success in the recent world and in the bid to meet the high requirement of scientists in our society, there arises the need for innovative teachings that will develop learners' interest, enhance their attitude and improve performance in the learning of science. There

has been a growing interest in exploring alternative teaching methods, such as experiential learning, to transform basic science pedagogy and enhance students' learning outcomes.

Science learning has to begin with children, Children requires learning experiences that are authentically set in real-life environments that are built to intentionally imitate how the world currently operates outside the classroom boundaries. To encourage students' science learning from early years. it is necessary to introduce 'play/activity-based learning' 'experiential learning' in order to make learning exciting and engaging for children in view of the students' developmental and learning needs, which places more importance on student's creativity and innovation as well as personality development rather than requiring them to score high and memorise the content without acquiring a basic understanding of concepts. The traditional teaching approach is assumed to be teacher-centric (Che et al., 2021)

The need for pedagogical restructuring arises to step away from the traditional form of learning to 'experiential learning'. thus the necessity to expand students interest in a more unique, participative learning atmosphere by educational organizations who are now orienting toward learning approaches that cultivate students' involvement, interest, and dynamic participation. The introduction of experiential hands-on learning methods would ensure that students will have a more meaningful, holistic and coherent learning experience. This approach can certainly develop scientific spirit among students, create space for providing concrete experiences to children and make learning interesting and interactive. It will also make them enjoy the process of learning by building a proactive interest in them. Also, the narrowing of curricula to the respective core knowledge and practical applications across grades would create space for teachers to incorporate experiential learning, innovative thinking and critical thinking skills activities.

Pedagogy evolves with innovation in science, thus the need for a paradigm shift in the approach towards the teaching and learning of science concepts via practical, hands-on and experiential approach. It is wise for basic science students to be capable of much more than just being able to count, speak, read and write in the rapidly evolving and unpredictable modern world, influenced by technology and globalization. Real-world experiential learning can be truly transformative for the youth of the 21st century where children supposedly receive much of their education in the classroom.

Experience is generally said to be the best teacher. The experiential learning approach is thus believed to be among the methods that meets this criterion. The purpose of the study on the topic 'Transforming the Basic Science Pedagogy through Experiential Learning Approach' is to explore and encourage how the traditional teaching methods in basic science education can be transformed through the implementation of experiential learning approaches. The study aims to investigate the effectiveness of incorporating hands-on

experiences, experiments, simulations, or projects in the teaching basic science concepts. The significance of this study lies in its potential to enhance the teaching and learning of basic science subjects. By incorporating experiential learning, students can actively engage in the learning process, apply theoretical knowledge to real-life situations, and develop practical skills. This approach can lead to improved learning outcomes, increased motivation and interest in science, and the development of critical thinking and problem-solving skills. Furthermore, the study can contribute to the existing body of knowledge on pedagogy and education by providing insights into the benefits and challenges of implementing experiential learning in basic science education. It can inform educators, curriculum developers, and policymakers about effective strategies for transforming the teaching of basic science subjects and promoting student engagement and achievement. The overall significance of this study is its potential to improve the quality of science education, enhance student learning outcomes, and contribute to the advancement of teaching and learning practices in the field of basic science education.

Experiential learning Approach

Experiential learning can simply be referred to as learning by doing or learning through experience. Experiential Learning according to Bayineni (2023) derives its essence from Gurukul's ancient Indian tradition and the role of the Master Guru which is a significant feature. In essence, a place of learning a Gurukul was where students Shishya learned under the coordination of an expert Guru by performing different tasks. In such environment, students learn more because they conduct tasks which are relevant to learning their chosen skill. The students are also expected to learn by closely observing and analysing things around them with the Guru's help. They learn from their mistakes and are corrected at every juncture by the expert. This whole process become very significant in the overall personality development of the student. The Guruis prominent and occupies a vital position, serving as a facilitator or teacher (Bayineni, 2023).

It is an approach in teaching which offers students the opportunity to acquire skills and knowledge through first hand experiences and enable the students to reflect upon these experiences in developing other new skills, better attitudes, new ways of thinking and develop a better understanding of the concepts at hand (Bayineni, 2023).

One of the causative factor in learners' achievement is the learners' involvement in education process (Xerriet al., 2018 and Derakhshan, 2021). This type of education process enables learners to ask questions such as: "Why should I learn?" "How is this experience relevant to me and my fellow people?" and "How is this experience going to contribute to my growth and that of others? 'Where should I learn, How should I learn. Experiential learning is a powerful educational approach that goes beyond traditional classroom teaching. It

emphasizes hands-on experiences, active participation, and reflection to foster deep understanding, personal growth, and skill development. It is a successful teaching method facilitating active learning through providing real-world experiences in which learners interact and critically evaluate course material and become involved with a topic being taught (Boggu & Sundarsingh, 2019).

Experiential learning is considered to be an effective way of approaching education. Though in reality, learners are generally taught hands-on and skills development theoretically and in abstract, using conventional method (Green et al., 2017).EL is a learning style that has been extensively researched for decades, and has been discovered to be beneficial to students of all ages. As it is capable of influencing the development of cognitive and psychomotor skills of learners, helping them applying knowledge to relevant situations and providing self-learning opportunities to learners. The steps in experiential learning include; experiencing, observing, analyzing, and experimenting (Anusha & Prathik, 2022).

Experiential learning naturally starts at a young age and involves learning by doing. This is the experience in the sensorimotor stage of Jean Piaget theory of Cognitive development, which is the first stage denoted from birth to two years old. At this stage, the baby has no verbal actions, but begins to experience the consequences of actions. Learn how to sit, craw, walk, fall, walk to fall over and over again and try to do other new things until able to walk well without assistance (Surabhi, Athavan, Anand, Vinay & Hotha, 2020) Research has proven that students of all ages learn better during initiatives that involve applying concepts in practice, in order to solve real world problems, actively make decisions, and then reflect on the outcomes or consequences of their learning actions and decisions. During EL, people become remarkably liable for their learning which regulates a stronger connection between the learning involvement, practices, and reality (Salas et al., 2009)

Various examples of experiential learning activities include field research, class room activities, off-site school trips, project-based learning, field activities, experiments, simulations, field trips, learning projects, outdoor education, group work in and out of the classroom, open ended discussion activities and open-ended questioning guidance. Importance of experiential learning in education.

Experiential learning is an educational approach that emphasizes hands-on experiences and active engagement in the learning process. It involves students actively participating in real-world activities, experiments, simulations, or projects to acquire knowledge, develop skills, and gain practical experience. Experiential learning is considered important in education for many reasons:

- Enhanced learning outcomes. Experiential learning allows students to apply theoretical knowledge to real-life situations, which enhances their understanding and retention of concepts. It promotes deeper learning by encouraging critical thinking, problem-solving, and decision-making skills.

- Active engagement. Experiential learning actively involves students in the learning process, making it more engaging and interactive. This can increase motivation, interest, and participation, leading to improved learning outcomes.
- Practical skill development. Experiential learning provides opportunities for students to develop practical skills that are essential for their future careers. It allows them to practice and refine skills such as communication, teamwork, leadership, and problem-solving in real-world contexts.
- Personal and professional growth. Experiential learning experiences often involve reflection and self-assessment, leading to personal and professional growth. Students can gain a better understanding of their strengths, weaknesses, and areas for improvement, as well as develop a sense of self-confidence and self-efficacy.
- Real-world relevance. Experiential learning connects classroom learning to real-world applications, making the learning experience more relevant and meaningful. It helps students understand the practical implications and significance of the knowledge and skills they are acquiring. Overall, experiential learning is important in education as it promotes active engagement, enhances learning outcomes, develops practical skills, fosters personal and professional growth, and connects classroom learning to real-world contexts.

Basic Science curriculum and its implementation in Nigeria

The Basic Science curriculum and its implementation in Nigeria are crucial for understanding the challenges and opportunities in the country's educational system.

Basic Science education serves as the foundation for developing scientific literacy among young learners, providing them with the necessary knowledge and skills to understand the world around them. In Nigeria, the Basic Science curriculum is part of the Universal Basic Education (UBE) program, introduced to ensure that every child receives quality education, particularly in science, at the primary and junior secondary levels.

Structure of the Basic Science Curriculum

The Nigerian Basic Science curriculum is designed to cover key scientific disciplines, including biology, chemistry, physics, earth science, and environmental studies. It is taught from Primary 1 to Junior Secondary School 3, laying the basis for specialized scientific learning in senior secondary school. The curriculum aims to foster critical thinking, problem-solving skills, and a positive attitude towards science among students. It also emphasizes the relevance of science to everyday life, such as health education, environmental protection, and technological advancements.

The Nigerian government, through the Nigerian Educational Research and Development Council (NERDC) objectives of the Basic Science curriculum include:

- Promoting an understanding of scientific concepts and principles.
- Developing inquiry and investigative skills.
- Encouraging creativity and innovation in solving scientific problems.
- Instilling in students the ability to use scientific knowledge to improve their lives and communities.

By aligning these objectives with global trends in STEM education, the curriculum seeks to nurture future scientists, engineers, and innovators, critical for Nigeria's development.

Challenges in Implementing the Basic Science Curriculum

While the Basic Science curriculum in Nigeria is comprehensive and well-designed, its implementation faces significant challenges that hinder its effectiveness in many sch00ools. These issues, both systemic and logistical, prevent students from receiving the full benefits of science education and include:

i. Shortage of Qualified Science Teachers

A major challenge in implementing the Basic Science curriculum is the lack of qualified science teachers across many Nigerian schools, particularly in rural areas, there is a significant deficit of teachers with the necessary expertise to deliver the content of the curriculum effectively. Many teachers who teach science subjects are not adequately trained, leading to a heavy reliance on out-dated teaching methods such as rote learning, rather than encouraging hands-on, inquiry-based learning. The lack of on-going professional development programs further exacerbates this issue, as many teachers are not equipped with methods or practical laboratory skills, modern pedagogical techniques or knowledge of new scientific advancements.

ii. Insufficient Teaching and Learning Resources

A key component of effective science education is practical, hands-on experimentation. However, in many Nigerian schools, there is a severe lack of resources such as science laboratories, laboratory equipment, chemicals, and teaching aids. As a result, many students learn science in a theoretical manner, with little to no exposure to practical experiments that bring scientific concepts to life. In some schools, Basic Science lessons are taught using only textbooks, limiting students' ability to grasp the application of scientific principles in real-world contexts.

This lack of resources is more pronounced in public and rural schools, where inadequate funding results in poorly equipped classrooms. Without access to basic equipment such as microscopes, test tubes, or even basic science charts, students are deprived of the opportunity to develop a deeper understanding of scientific inquiry. In many public schools, science education is often limited to theoretical discussions, with few opportunities for hands-on experimentation. This

gap limits students' ability to engage with science practically, which is essential for a deep understanding of scientific principles.

iii. Overcrowded Classrooms

Overcrowded classrooms are another significant obstacle to effective implementation of the Basic Science curriculum. In many public schools, large student-to-teacher ratios make it difficult for teachers to give individual attention or manage practical sessions. This is particularly problematic in science education, where students need personalized guidance to conduct experiments, analyze data, and draw conclusions. Overcrowding limits students' engagement in class, with many unable to participate actively or ask questions, resulting in a passive learning environment.

iv. Inconsistent Policy Implementation

Although the Nigerian government has made efforts to improve science education through policies such as the Universal Basic Education (UBE) scheme, there remains a considerable gap between policy design and classroom implementation. Issues such as inadequate funding, bureaucratic delays, and regional disparities in resource allocation have led to inconsistent delivery of the Basic Science curriculum. Schools in urban areas tend to receive more attention and funding, while rural and underserved areas continue to lag behind. There is constant disparity in the implementation of the curriculum across different regions. While urban schools may have better access to resources and qualified teachers, many rural schools struggle with overcrowded classrooms, poor funding, inadequate teachers and inconsistent delivery of the curriculum.

v. Technological Gaps

In the modern world, integrating technology into education is critical, especially in the sciences. However, the implementation of the Basic Science curriculum in Nigeria is hindered by limited access to ICT tools and the internet in many schools.

In response to the above discussed challenges, the Nigerian government and various stakeholders have launched several initiatives aimed at improving science education. Programs like the Teacher Professional Development (TPD) initiative and investments through the Tertiary Education Trust Fund (TETFund) focus on enhancing teacher training and improving infrastructure in public schools. Additionally, international organizations such as UNESCO and UNICEF have partnered with the Nigerian government to support capacity-building programs for teachers and provide essential resources for science education.

There is a growing recognition of the need to integrate Information and Communication Technology (ICT) into science education. E-learning platforms, mobile apps, and digital laboratories can bridge the resource gap, making science education more accessible, particularly in under-served areas. Public-

private partnerships also offer a way forward, with companies contributing resources to support science education in schools through laboratory equipment donations and scholarship programs.

Moreover, some schools do not follow the curriculum guidelines strictly, either due to lack of resources or poor administrative oversight. This creates discrepancies in the quality of education students receive, with some exposed to a more rigorous science education than others.

Experiential Learning of science

Experiential learning is a dynamic process that encourages learners to engage in real-world experiences and actively reflect on their observations. It involves learning through direct experiences, whether it's conducting experiments, participating in simulations, or engaging in practical applications of knowledge. This approach enables learners to bridge the gap between theory and practice, promoting a deeper understanding of concepts and enhancing critical thinking skills. Experiential learning is not a new construct for science teachers, especially those who involve their students in research and problem-based learning. In science education, learners are encouraged to access available learning opportunities, as learners who has interest and actively participate in the learning progression are more likely to achieve higher levels of learning, whereas inactivity of learners results to lack of interest, boredom, negative attitude, poor performance and low achievement (Wang et al., 2021; Broido, 2014; Xie and Derakhshan, 2021; Derakhshan et al., 2021).

In teaching science, organizing experiential activity is to provide students with opportunities to observe and experiment; to apply knowledge; to solve theoretical and practical problems; to discover and explore science, through which they can continue to improve their skills.EL is a proven teaching method capable of facilitating active learning by providing real-world experiences where learners interact and get involved in the topic being taught (Boggu & Sundarsingh, 2019).

To ensure in learners the required knowledge and training, it is equally important to give them opportunities to develop their abilities in applying the knowledge and skills in real-world situations to resolve relevant problems (Huang and Jiang, 2020).

In experiential learning, the aim of teaching science is to link students to the realistic situations. As a result, students identify practical problems and have decision-making skills to solve the problems.

Theory of Experiential Learning

The concept of experiential learning was popularised by education theorist David A. Kolb, who, along with Roger Fry, developed the experiential learning theory (Sukanya, Anasuya & Sridevi, 2020) which posits that learning is a continuous process that involves four stages: concrete experience, reflective

observation, abstract conceptualization, and active experimentation. The concept of experiential learning by education theorist David A. Kolb, Roger Fry of 1984 is focused on learning through experiences (Sternberg and Zhang, 2014).Kolb suggests that learners should engage in hands-on experiences, reflect on their experiences, make connections to abstract concepts, and apply their knowledge in new situations. These theoretical foundations highlight the importance of active engagement, reflection, and the integration of theory and practice in the learning process. Experiential learning approaches draw upon these foundations to provide students with opportunities to actively engage in hands-on experiences, reflect on their learning, and apply their knowledge in real-life situations. The theory emphasized the relevance of learners' participation in learning processes and addressed the role of experience in learning (Zhai et .al., 2017).

concrete experience

observation and reflection

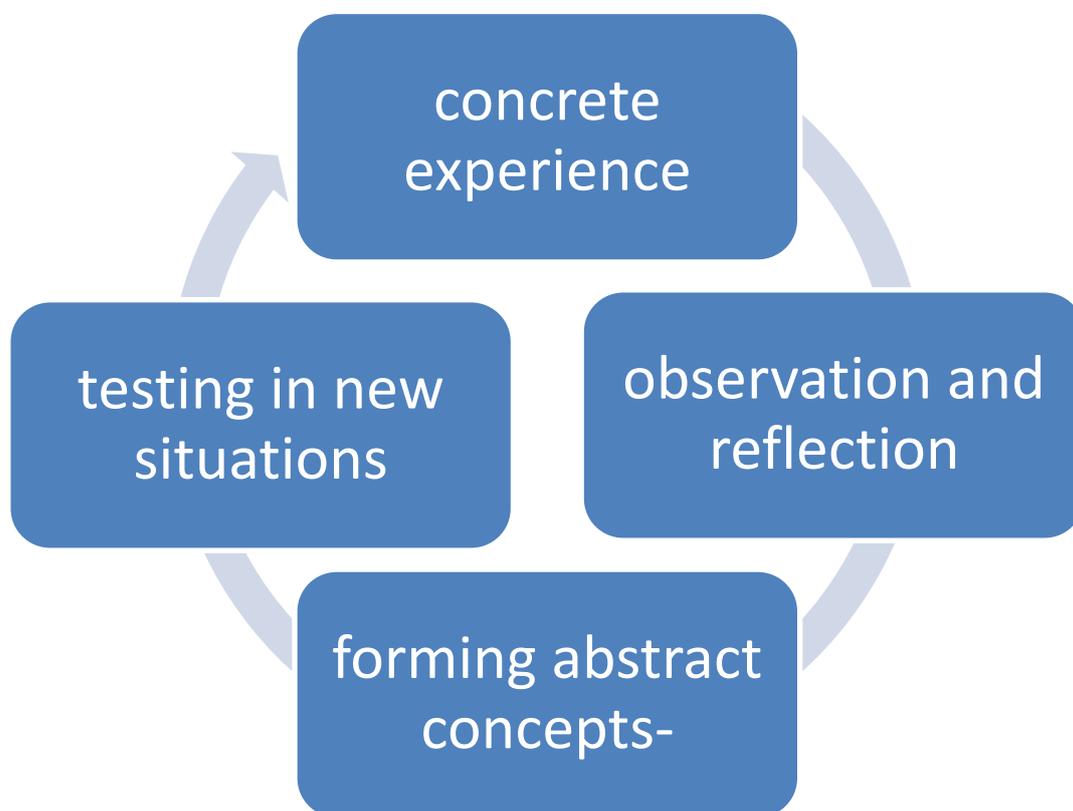forming abstract concepts-

testing in new situations

Fig: Representation of Kolbs Experiential Learning Cycle

It is a reliable instrument of modifying education which enable learners to appropriate what they have learned in school to real-world situations (Guo et al., 2016). Students participate to gain experience (Do),replicate that experience (Reflect), create ideas in line with the experiences (Think),and institute solution to problems (Apply).In this type of learning, learners possesses authority and develop a high sense of responsibility, as well as directly get involved in learning process within the learning environment. Furthermore, it encourages flexibility in learning as it put all available possibilities into full-cycle

learning, to bring about skills development and meta-learning abilities (Kolb and Kolb, 2017).

The theory of EL is based on four key elements; "Do, Reflect, Think and Apply" (Butler et al., 2019) involved during the learning process in a continuous cycle. Researchers debated that the learning cycle can begin at any one of these four points. These phases are strictly curricular and pedagogical in nature, and are intended to optimise learning Anusha & Prathik (2022) In summary, the theoretical foundations of experiential learning emphasize the importance of active engagement, reflection, and the construction of knowledge through hands-on experiences. This theory is based on four key elements which operates during the learning process in a continuous cycle which are: concrete experience, observation and reflection, forming abstract concepts and testing in new situations. It's a model that shows up again and again in literature.

Fore sighting the Bridging of gap between Theory and Practice in Education

Experiential learning gives learners the skills and experience they need for real-world success. Experiential learning may lead to higher domain specific creativity and practical use of knowledge in the current situation. Our traditional teaching system has been more of a theoretical than practical. In a traditional learning environment, textbooks and lectures are used in a classroom to teach students, the concepts that they don't know how to relate. They are expected to apply these concepts once out of the classroom. Whereas the experiential learning system bridges this gap between theory and practice. When planning experiential learning activities, the teacher becomes more of a facilitator. The facilitator introduces problems or challenges, and then allows the flexibility of the students (with guidance) to find ways to solve the problems. As it is actually taking place, the facilitator will then observe and direct learning. This suggests that as part of the learning process, questions and misunderstandings can be resolved immediately rather than corrected at a later point after the project/s has been completed, making it a much more successful problem-solving process. This is not same with the conventional learning method.

Some differences between conventional and experiential learning

Conventional	Experiential
Predefined learning	Customised learning
Transfer of knowledge	Knowledge being developed
Training focused	Learning focused
For organisational need	For personal growth
Theoretical	Hands-on
Fixed framework	Open-ended and flexible

Participation, interaction, and application are fundamental characteristics of EL. During the process, it is possible to be in touch with the environment and to be exposed to extremely flexible processes. In this way, education takes place on all dimensions which cover not only the cognitive but also the affective and behavioral dimensions to encompass the whole person. Learners enthusiastically participate in mental, emotional, and social interactions during the learning procedure within EL (Voukelatou, 2019).

In conclusion, transforming basic science education through experiential learning is not just a pedagogical shift, but it is a necessity in fostering deeper understanding and engagement among students. By integrating hands-on activities, real-world problem-solving, and collaborative projects into the curriculum, educators can create an enriching learning environment that stimulates curiosity and critical thinking. This approach not only enhances students' grasp of scientific concepts but also prepares them for future challenges in a rapidly evolving world. As we move forward, it is essential for educational institutions to embrace and invest in experiential learning strategies, ensuring that the next generation of scientists is not only knowledgeable but also equipped with the skills needed to innovate and lead in their fields. Through this transformative journey, we can inspire a passion for science that extends beyond the classroom, fostering lifelong learners who will contribute meaningfully to society.

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